GLAUKO
Interactive System

UNIVERSITY of the AEGEAN | SCHOOL OF ENGINEERING
DEPARTMENT OF PRODUCT AND SYSTEMS DESIGN ENGINEERING

Design of an interactive kinaesthetic installation that conveys geological information about the island of Syros

Diploma thesis of

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Δηλώνω υπεύθυνα ότι η διπλωματική εργασία είναι εξ' ολοκλήρου δικό μου έργο και κανένα μέρος της δεν είναι αντιγραμμένο από έντυπες ή ηλεκτρονικές πηγές, μετάφραση από ξενόγλωσσες πηγές και αναπαραγωγή από εργασίες άλλων ερευνητών ή φοιτητών. Όπου έχω βασιστεί σε ιδέες ή κείμενα άλλων, έχω προσπαθήσει, όσο είναι δυνατόν, να το προσδιορίσω σαφώς μέσα από την χρήση αναφορών, ακολουθώντας την ακαδημαϊκή δεοντολογία.

To my sister Gina,
who always believed in me
and without whom I wouldn’t have come
to this beautiful, rocky island

Special Thanks

From the bottom of my heart I thank my parents, Demetra and Nickolas, who listened to my dreams no matter how strange they were, supported me throughout this journey and stood by my side from every corner of the world they were.

I thank Savvas, my brother who was the calm voice of reason in times of need.

I thank my friends Glykeria Makrygianni, Maria Ntourmetaki, Dimitris Katsakioris, Andreas Nikolarakis, Giorgos Detsikas, Christoforos Mertzanidis who inspired me to take leaps, motivated and supported me when I was lost, and helped me whenever and however they could from close or afar.

I sincerely thank Dr. Martin Engi, who taught me so much in such a short time, and opened my eyes to a wonderful new world.

I also thank Dr. Damianos Gavalas and Dr. Spyros Vosinakis for teaching me, evaluating my work, and accepting me.

Most importantly, I deeply thank my professor and supervisor Dr. Panayiotis Koutsampasis who was always patient with me, let me make my own mistakes, guided me and worked with me as an equal. You inspired me from the first minute of your lecture when I first tried your HCI class in my first year. You showed me a path which I fell in love with and now want to further pursuit. You are my mentor and academic father. Thank you for everything.

By being curious *we open ourselves up to the potential value of the things that would otherwise pass us by….*

… this is the realm of beauty

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0 Περίληψη Διπλωματικής Εργασίας στην ελληνική γλώσσα (Diploma Thesis Summary in Greek)

Το παρόν έγγραφο διπλωματικής εργασίας συνδυάζει τη σχεδίαση διαδραστικής εγκατάστασης στο πλαίσιο ενός γεωλογικού μουσείου, με τα θέματα της αλληλεπίδρασης ανθρώπου-υπολογιστή (HCI), της διαδραστικής σχεδίασης (IxD), της κιναισθητικής αλληλεπίδρασης, του γεωτουρισμού, και της ανάδειξης και διατήρησης της γεωλογικής κληρονομιάς της Σύρου. Ο σχεδιασμός και η ανάπτυξη μιας ενός πρωτότυπου διαδραστικής εγκατάστασης έχουν επίκεντρο τα γεωλογικά πετρώματα της Σύρου, σε πλαίσιο χρήσης διαδραστική έκθεση για ένα γεωμουσείο.

0.1 Γενική Προσέγγιση & Σκοπός

Οι στόχοι της παρούσας διπλωματικής εργασίας είναι η έρευνα (πεδίου), ο σχεδιασμός και η εμπειρική αξιολόγηση ενός κιναισθητικά λειτουργικού συστήματος το οποίο προσφέρει γεωλογικές πληροφορίες για το νησί της Σύρου. Η έρευνα πεδίου στοχεύει στην έρευνα του γεωλογικού περιβάλλοντος μέσω της βιωματικής μάθησης, της βαθιάς κατανόησης της γεωλογικής κληρονομιάς της Σύρου και της συγκέντρωσης κατάλληλου περιεχομένου για το προτεινόμενο σύστημα. Οι σχεδιαστικοί στόχοι του συστήματος είναι: α) η ανάδειξη της ποικιλίας των πετρωμάτων που υπάρχουν στο νησί , όπως αυτές προσδιορίζονται από την έρευνα πεδίου με τους γεωλόγους, β) η εισαγωγή του κοινού σε μια έκθεση των αντίστοιχων πετρωμάτων , γ) η πρόκληση της περιέργειας των χρηστών ώστε να αρχίσουν να αναρωτιούνται σχετικά με το γεωλογικό χαρακτήρα της Σύρου.

Ο σκοπός σχεδίασης ενός διαδραστικού συστήματος για τη γεωλογία της Σύρου έχει επίκεντρο την ενημέρωση του τοπικού πληθυσμού και των επισκεπτών για την γεωλογική, φυσική, και πολιτιστική κληρονομιά του νησιού. Η πλειοψηφία του ντόπιου πληθυσμού και των επισκεπτών, δεν γνωρίζει την ιδιαίτερα μεγάλη γεωλογική σημασία του νησιού. Παρουσιάζοντας αυτές τις πληροφορίες, ενημερώνοντας και εμπλέκοντας τους ανθρώπους μπορούμε να τους βοηθήσουμε να κατανοήσουν τη σημασία αυτή και να προστατεύσουν συλλογικά τον φυσικό βιότοπο, τους θησαυρούς του και τα μαθήματα που έχει ακόμη να μας διδάξει. Υπάρχει ανάγκη ευαισθητοποίησης για τη γεωλογική κληρονομιά της Σύρου στους ντόπιους και στους μελλοντικούς επισκέπτες, γιατί με αυτόν τον τρόπο όλοι μας μπορούμε να βοηθήσουμε καλύτερα στη διατήρηση των φυσικών θησαυρών και του χαρακτήρα του νησιού για το μέλλον.

0.2 Ανάλυση Μεθοδολογίας

Η μεθοδολογία που ακολουθήθηκε για το σχεδιασμό και την ανάπτυξη του διαδραστικού συστήματος GLAUKO αποτελούνταν από γεωλογική έρευνα, έρευνα διαδραστικών εγκαταστάσεων, και τις φάσεις σχεδιασμού και ανάπτυξης ως ένα στάδιο. Κατά τη διάρκεια της γεωλογικής ερευνητικής φάσης, πραγματοποιήσαμε έρευνα για να μάθουμε και να κατανοήσουμε βασικές γεωλογικές έννοιες. Με την καθοδήγηση του συμβούλου γεωλογίας Dr. Martin Engi, ομότιμο καθηγητή του Ινστιτούτου Γεωλογικών Επιστημών του Πανεπιστημίου της Βέρνης, τα θέματα που ερευνήθηκαν περιορίστηκαν σε περισσότερες λεπτομέρειες σχετικά με την περίπτωση της Σύρου. Με την κατανόηση της συγκεκριμένης γεωλογικής περίπτωσης για το νησί καταφέραμε να συλλέξουμε από πρώτο χέρι ψηφιακό περιεχόμενο, όπως φωτογραφίες, σημειώσεις, δείγματα πετρωμάτων, ηχογραφήσεις επιτόπιων διαλέξεων από τον σύμβουλο και σημεία ενδιαφέροντος με συντεταγμένες θέσης GPS, ως πρώτη ύλη. Η έρευνα σχετικά με τις εγκαταστάσεις συντελευθεί παράλληλα με τη γεωλογική έρευνα. Μέσω έρευνας γραφείου, ερευνήσαμε τη βιβλιογραφία για διαδραστικές εγκαταστάσεις και σχεδιασμό αλληλεπίδρασης όπως εφαρμόζεται σε εγκαταστάσεις, και εξετάσαμε άλλα συστήματα που σχετίζονται με το σχεδιασμό του πλαισίου μας στα μουσεία, τις γκαλερί τέχνης και τις εκθέσεις. Τέλος, ο σχεδιασμός και η ανάπτυξη μιας εφαρμογής συμβαδίζουν ως ένα στάδιο. Με βάση τα ευρήματά μας σχετικά με τις εμπειρίες των

επισκεπτών σχετικά με τη μάθηση σε μουσεία, αποφασίσαμε να διατηρήσουμε την οπτική σχεδίαση απλή. Στηρίξαμε το σχέδιό μας σε ένα διαδραστικό χάρτη, καθώς είχε αποδειχθεί χρήσιμο για τη δική μας κατανόηση της γεωλογίας της Σύρου, και δουλέψαμε για να γεφυρώσουμε το νοητικό μοντέλο των χρηστών μας και το πρωτότυπο μοντέλο των «επισκέψεων ιστότοπου». Ο προγραμματισμός της εφαρμογής υλοποιήθηκε σε πλατφόρμα WPF (Windows Presentation Foundation) αρχικά για χρήση σε σταθερό υπολογιστή.

Κατά τη διάρκεια της γεωλογικής ερευνητικής φάσης, ερευνήσαμε, κατανοήσαμε και μάθαμε βασικές γεωλογικές έννοιες. Μια γενική κατανόηση της επιστήμης της Γης αποκτήθηκε μέσω της έρευνας στην επιστημονική βιβλιογραφία. Στη συνέχεια, πήραμε συνέντευξη από τον καθηγητή Dr. Martin Engi. Ο καθηγητής Engi ειδικεύεται στην Πετρολογία και την Εξέλιξη των Ορογόνων. Ο καθηγητής συνεργάστηκε άμεσα μαζί μας, από τον Φεβρουάριο έως τον Ιούνιο του 2020, ως σύμβουλος γεωλογίας για να μας βοηθήσει να κατανοήσουμε τις ιδιαιτερότητες της γεωλογικής υπόθεσης της Σύρου. Με την καθοδήγηση του καθηγητή, η έρευνα περιορίστηκε σε συγκεκριμένα γεωλογικά θέματα σχετικά με τη Σύρο. Πραγματοποιήθηκε επιτόπια έρευνα με πεζοπορίες σε όλο το νησί και μελέτη των γεωλογικών εννοιών, της γεωλογικής εξέλιξης πετρολογικών δειγμάτων και του νησιού γενικότερα. Με την κατανόηση της συγκεκριμένης γεωλογικής περίπτωσης της Σύρου, καταφέραμε να συλλέξουμε από πρώτο χέρι ψηφιακό περιεχόμενο όπως φωτογραφίες, σημειώσεις, δείγματα ροκ, ηχογραφήσεις επιτόπιων διαλέξεων από τον σύμβουλο και σημεία ενδιαφέροντος με συντεταγμένες θέσης GPS, ως πρώτη ύλη. Μετά την επανάληψη της ίδιας διαδικασίας όπως απαιτείται, συγκεντρώθηκε το τελικό περιεχόμενο για το σύστημα.

Η διαδικασία σχεδιασμού του συστήματος GLAUKO ακολούθησε αλληλουχίες έρευνας και ανατροφοδότησης για γενικά γεωλογικά θέματα και σχεδιασμό της εγκατάστασης. Οι δύο αυτές φάσεις της έρευνας πραγματοποιήθηκαν σχεδόν ταυτόχρονα, μαζί με την τρίτη φάση Σχεδιασμού και Ανάπτυξης του συστήματος. Τα ευρήματα και το περιεχόμενο από τις δύο ερευνητικές φάσεις ενσωματώθηκαν στη φάση Deign & Development για την παραγωγή πρωτοτύπων από χαμηλή έως υψηλότερη πιστότητα. Τα σχόλια δόθηκαν καθώς προχωρούσε η ανάπτυξη. Τέλος, ένα λειτουργικό πρωτότυπο αναπτύχθηκε στην πλατφόρμα WPF και δημιουργήθηκε ως προβολή που ελέγχεται από έναν αισθητήρα Kinect για αξιολόγηση από τους χρήστες.

0.3 Γνωστικό Πλαίσιο

Ο γεωτουρισμός είναι μια μορφή φυσικού τουρισμού που εστιάζει ειδικά στη γεωλογία και το τοπίο. Προωθεί τον τουρισμό στους γεωσίτες , τη διατήρηση της γεωποικιλότητας και την κατανόηση των γήινων επιστημών μέσω της εκτίμησης και της μάθησης με τη βοήθεια ανεξάρτητων επισκέψεων σε χαρακτηριστικά γεωλογικά σημεία, της χρήσης γεωγραφικών μονοπατιών και σημείων προβολής, ξεναγήσεων, γεω-δραστηριοτήτων και προστασίας των κέντρων επισκεπτών (Newsome David, 2012). Περιοχές με παγκόσμια γεωλογική σημασία μπορούν να γίνουν προστατευόμενα Γεωπάρκα, δραστηριότητες διατήρησης ξενιστών, εκπαίδευση και τουρισμός και να γίνουν κέντρα διατήρησης της φυσικής κληρονομιάς. Τα γεωπάρκα δεν περιορίζονται στην προβολή μιας ακατοίκητης γεωγραφικής περιοχής (όπως τα Εθνικά Πάρκα). Τα γεωπάρκα προωθούν οποιαδήποτε άλλη πτυχή του πολιτισμού, συμπεριλαμβανομένης της γεωργίας, της τοπικής κουζίνας, της αρχαιολογίας, της χλωρίδας και της πανίδας. Ένα γεωπάρκο μπορεί να προσφέρει μια ποικιλία οργανωμένων δραστηριοτήτων, όπως εκπαιδευτικά και ψυχαγωγικά εργαστήρια, σεμινάρια, πεζοπορίες με ξεναγό και περιηγήσεις, φιλοξενία πολιτιστικών εκδηλώσεων, παράλληλα με σημεία επίσκεψης, όπως μουσείο ή έκθεση, και πώληση σημείο για παραδοσιακά προϊόντα. Τα Γεωμουσεία είναι απαραίτητα για την ανάδειξη της γεωλογικής κληρονομιάς ενός Γεωπάρκου, καθώς προσφέρουν μια πιο προσιτή επιλογή για έναν επισκέπτη να «βουτήξει» στη μοναδική κληρονομιά του Γεώτοπου. Τα γεωμουσεία περιλαμβάνουν εκθέσεις φυσικών αντικειμένων για εκπαιδευτικούς σκοπούς, στάσιμα εκθέματα και διαδραστικές εγκαταστάσεις. Τα γεωμουσεία είναι εξαιρετικά κέντρα ανάπτυξης διαδραστικών συστημάτων. Τα περισσότερα παραδοσιακά μουσεία φυσικών επιστημών καλύπτουν θέματα και θεάματα σχετικά με τα βιοτικά περιβάλλοντα, που απεικονίζουν τη γεωλογική κληρονομιά με πιο στατικό τρόπο.

Τα μουσεία παρέχουν στο κοινό τα εργαλεία για να εκπαιδεύσουν τον εαυτό τους και να διευκολύνουν την αυτο-μάθηση, γεγονός που οδηγεί σε ανθρώπους να γίνουν ενεργά χρήστες μουσείων και όχι παθητικοί επισκέπτες. Αυτό συμβαίνει επειδή η μάθηση είναι πιο αποτελεσματική όταν είναι ενεργή. όσοι μαθαίνουν καλύτερα το κάνουν όταν ασχολούνται με το υλικό (King & Lord, 2015) . Η κατανόηση ότι η έκθεση του μουσείου είναι ένας τόπος γνωστικής και συναισθηματικής μάθησης είναι απαραίτητος για την ανάπτυξη επιτυχημένων και ελκυστικών εκθέσεων. Η διαδραστική σχεδίασης και η σχεδίαση για την αλληλεπίδραση ανθρώπου-υπολογιστή (HCI) παρέχει μέσα για ενεργή εμπλοκή σε σχέση με την ανθρώπινη γνώση, παρέχοντας νέους τρόπους για ενεργό συμμετοχή σε ένα περιβάλλον έκθεσης, επιτρέποντας έτσι ισχυρότερες μαθησιακές εμπειρίες. Το HCI και ο σχεδιασμός αλληλεπίδρασης μπορούν να βοηθήσουν στη δημιουργία συναρπαστικών δραστηριοτήτων και να προκαλέσουν ισχυρές εμπειρίες, αξέχαστες για τους επισκέπτες του μουσείου. Μπορούν να βοηθήσουν στην αποδόμηση σύνθετων θεμάτων και να αντιπροσωπεύουν πληροφορίες με απλούστερους τρόπους, ώστε να είναι ευκολότερη η κατανόηση από τους μαθητές για πρώτη φορά. Οι διαδραστικοί χάρτες, οι οπτικοποιήσεις, οι κινούμενες εικόνες, η αφήγηση, οι εικονικές αναπαραστάσεις είναι μόνο μερικοί από τους τρόπους με τους οποίους το HCI μπορεί να μετατρέψει σύνθετα θέματα, όπως η γεωλογία, σε ορεκτικό περιεχόμενο. Η τεχνολογία μπορεί να ευαισθητοποιήσει τους ανθρώπους πέρα από τα φυσικά όρια του γεωπάρκου.

Η γεωλογία είναι ένας αχανής επιστημονικός τομέας και οι γεωλογικές πληροφορίες μπορούν να είναι αρκετά συντριπτικές για άτομα που δεν έχουν ξαναδεί ποτέ. Οι διαδραστικές εγκαταστάσεις μπορούν να παρουσιάσουν σύνθετα γεωλογικά φαινόμενα με απλούστερους τρόπους, ώστε να βοηθήσουν τους επισκέπτες του μουσείου να κατανοήσουν τις πληροφορίες. Ωστόσο, είναι εξίσου δύσκολο να σχεδιάσουμε με ακρίβεια μια τέτοια εγκατάσταση χωρίς υπερβολική απλοποίηση και απώλεια ζωτικών πληροφοριών, καθώς είναι συναρπαστικό να βιώσετε τέτοιο περιεχόμενο. Η Σύρος είναι ένα μοναδικό αρχείο γεωλογικής ιστορίας στον παγκόσμιο γεωλογικό χάρτη. Είναι ένα νησί άγνωστο για τη μη επιστημονική κοινότητα που έχει μεγάλη γεωλογική σημασία. Η Σύρος διατηρεί αξιοσημείωτα στοιχεία γεωλογικών διεργασιών, όπως ο μεταμορφισμός Υψηλής Πίεσης-Χαμηλής Θερμοκρασίας (HP-LT), που είναι εξαιρετικά δύσκολο να παρατηρηθούν και να μελετηθούν επειδή εμφανίζονται βαθιά υπόγεια. Το νησί είναι ένα λείψανο σπάνιων γεωλογικών κηλίδων (εκλογίτες και κυανοσχιστόλιθοι) που βρίσκονται σε λίγα μόνο μέρη στον κόσμο, όμως στη Σύρο τα βλέπουμε σε αφθονία, καλά εκτεθειμένα στην επιφάνεια και να διατηρούνται σε άριστη κατάσταση, σε αντίθεση με άλλες τοποθεσίες (Laurent VP, 2018). Αυτές οι συνθήκες έκθεσης επιτρέπουν στους γεωλόγους να διεξάγουν πιο ακριβείς μελέτες για τον καλύτερο προσδιορισμό της διαδικασίας δημιουργίας και σχηματισμού αυτών των σπάνιων τύπων πετρωμάτων και της Σύρου γενικά.

0.4 Εφαρμογές

Για τις ανάγκες της εργασίας, ερευνήθηκαν διαδραστικές εγκαταστάσεις πλήρως ενσωματωμένες σε ένα μουσείο , με ένα γεωλογικό πλαίσιο που αποτελεί ένα κύριο εργαλείο υποστήριξης για να κάνει το περιεχόμενο κατανοητό από τους καθημερινούς επισκέπτες . Το " Atomineralotouch " είναι ένας διαδραστικό τραπέζι με απτή αλληλεπίδραση για την ορυκτολογία, που εκτίθεται στο Μουσείο Φυσικής Ιστορίας της Λίλ στη Γαλλία. Το σύστημα δημιουργήθηκε με δημιουργικό τρόπο και εξηγεί πολύπλοκες διαδικασίες σχηματισμού ορυκτών. Η ανεπτυγμένη τεχνολογία δημιουργήθηκε κατά παραγγελία, με δαπανηρά κομμάτια τεχνολογίας που συνδυάζονται σε ένα διαδραστικό σχεδιασμό. Το GeoVR είναι μια διαδραστική εγκατάσταση εικονικής πραγματικότητας στο Magma UNESCO GLOBAL GEOPARK στη Νορβηγία και αναπτύχθηκε από την Doublethink . Το σύστημα χρησιμοποιεί την πλατφόρμα Unity για να δημιουργήσει την εικονική περιήγηση και το σετ Oculus VR για πλοήγηση και αλληλεπίδραση με το περιεχόμενο. Η εγκατάσταση είναι ανοιχτή σε θεατές που δεν χρησιμοποιούν στην πραγματικότητα το ακουστικό. Το σύστημα GeoVR είναι μια ενδιαφέρουσα εγκατάσταση που επιτρέπει στους επισκέπτες του Geopark να εξερευνήσουν μια τεράστια γεωγραφική περιοχή που είναι δύσκολο να καλυφθεί πλήρως με τα πόδια. Προσφέρει πληροφορίες σχετικά με το γεωλογικό και ιστορικό παρελθόν της περιοχής, βοηθώντας τους επισκέπτες να κατανοήσουν καλύτερα τη γεωλογική χρονική κλίμακα και τη συνολική επίδραση του χρόνου στη γη που ζουν. Η εγκατάσταση «Γεωλογικοί σχηματισμοί στην περιοχή της Στυμφαλίας » είναι μέρος μιας έκθεσης στο Μουσείο Περιβάλλοντος της λίμνης Στυμφαλία στην Ελλάδα. Το έκθεμα περιλαμβάνει μια ψηφιακή ταινία 3D που προβάλλεται σε επιτοίχιες οθόνες, με αφήγηση στα ελληνικά και αγγλικά. Η αφήγηση ελέγχει μια κεφαλή λέιζερ που ανάβει ένα μοντέλο γύψου (μακέτα) της γύρω περιοχής όταν αναφέρεται το αντίστοιχο θέμα.

0.5 Σχεδιαστική Προσέγγιση

Οι σχεδιαστικοί στόχοι για αυτήν τη διαδραστική εγκατάσταση με γεωλογικό θέμα είναι:

- Σχεδιασμός μιας ελκυστικής εμπειρίας για εισαγωγή στη γεωλογία της Σύρου
- Σχεδιασμός ενός μαθησιακού συστήματος για τα πετρώματα της Σύρου.
- Σχεδιασμός εμπειρίας με σκοπό να αποκτηθεί κίνητρο για περαιτέρω εξερεύνηση των γεωσημείων της Σύρου.

Σχεδιαστικό Brief: Ο σχεδιασμός μίας διαδραστικής εγκατάστασης η οποία έχει ως στόχο να αναδείξει την γεωλογική ποικιλία των πετρωμάτων της Σύρου, να ενημερώσει πιθανούς επισκέπτες γεωμουσείου σχετικά με τη γεωλογική σημασία αυτών των τύπων πετρωμάτων, και να προκαλέσει την περιέργειά τους σχετικά με τα γεωλογική θέματα και η γεωλογική κληρονομιά της Σύρου.

Το διαδραστικό σύστημα GLAUKO σχεδιάστηκε ως διαδραστική εγκατάσταση μεγάλης κλίμακας με γεωλογικό περιεχόμενο για τα πετρώματα της Σύρου, αναπτύχθηκε ως εφαρμογή WPF για προβολή σε τοίχο και έλεγχο από τους χρήστες μέσω αισθητήρα Kinect 2.0. Οι προκαταρκτικές και κύριες διαδικασίες σχεδιασμού εκτελέστηκαν παράλληλα με τη γεωλογική έρευνα και έρευνα διαδραστικού πλαισίου. Έτσι, τα mockups, τα πρωτότυπα και οι εκδόσεις εφαρμογών εξελίχθηκαν ως σχέδια καθώς καθορίσαμε περαιτέρω το τελικό περιεχόμενο, τα μέσα αλληλεπίδρασης και τους στόχους UX.

Το τελικό περιεχόμενο που επιλέχθηκε για την εγκατάσταση βασίζεται σε μια απλοποιημένη έκδοση του γεωλογικού χάρτη της Σύρου (Εικ. 105 (Δεξιά)), φωτογραφίες υψηλής ευκρίνειας πετρωμάτων (από διάφορες κλίμακες) από βασικές τοποθεσίες του νησιού, και περιγραφές των εικονιζόμενων φαινομένων. Ο χάρτης δείχνει τις τεκτονικές μονάδες και υπομονάδες της Σύρου, και σηματοδοτεί τον κυρίαρχο τύπο πετρωμάτων που βρίσκεται σε κάθε μία από αυτές. Τα πετρώματα και οι βράχοι που επιλέγονται, αντιπροσωπεύουν όλες τις ενότητες του χάρτη, έτσι ώστε ο επισκέπτης να μπορεί με μια ματιά να έχει πλήρη άποψη της πετρολογικής ποικιλίας. Οι πληροφορίες είναι ως επί το πλείστων περιγραφικές για το φωτοογραφημένο αντικείμενο, και μερικώς για το πώς δημιουργείται το εικονιζόμενο πέτρωμα, βράχος ή ορυκτό. Το κείμενο περιλαμβάνει τη βασική ορολογία για ό, τι βλέπουμε στις φωτογραφίες, διατυπωμένη όσο το δυνατόν πιο απλά χωρίς υπερβολική απλοποίηση στο σημείο της παραπληροφόρησης. Τα αναμενόμενα αποτελέσματα ήταν να προσελκύσουν το ενδιαφέρον των επισκεπτών, ώστε να αρχίσουν να κάνουν ερωτήσεις και να ενδιαφέρονται να μάθουν περισσότερα στον χώρο του μουσείου, καθώς και να επισκεφθούν τους πραγματικούς ιστότοπους που τους παρουσιάζονται.
Η προκαταρκτική σχεδίαση πραγματοποιήθηκε παράλληλα με τις γεωλογικές και αλληλεπιδραστικές έρευνες. Μέσα από την έρευνα ξεκινήσαμε μερικές ιδέες που δοκιμάσαμε σε χαρτί και σχεδιάστηκαν σε πρότυπα UI. Οι πληροφορίες και τα σχόλια από τη γεωλογική έρευνα μας έκαναν να συνειδητοποιήσουμε ότι το πλαίσιο ήταν πολύ μεγάλο για να καλύψουμε αυτήν την ενιαία εφαρμογή,

επομένως περιορίσαμε τις δυνατότητες και το περιεχόμενό της εφαρμογής μας, εξαλείφοντας δευτερεύουσες κατηγορίες περιεχομένου που απομακρύνουν τα σχέδιά μας μακριά από τους στόχους του σχεδιασμού. Προχωρήσαμε στον σχεδιασμό εφαρμογών σε πέντε πρωτότυπες εφαρμογές όπου δοκιμάσαμε διαφορετικές δυνατότητες και αναπτύξαμε περαιτέρω αυτές που θέλαμε να διατηρήσουμε. Το πέμπτο δοκιμαστικό πρωτότυπο ήταν το τελευταίο του είδους του, και καθώς είχε αναπτυχθεί ουσιαστικά με την προσθήκη συγκεντρωμένου περιεχομένου, επιλέξαμε να το αναπτύξουμε περαιτέρω στην τελική μας εφαρμογή.

Δείγματα του συνολικού υλικού φαίνονται στην ενότητα 4.3.3 . Το πλήρες υλικό διατίθεται στο προσάρτημα, ενότητα 8.1 . Τα μονοπάτια που επισκέφτηκαν οδηγούν σε συγκεκριμένες τοποθεσίες εκσκαφών, οι οποίες παρουσιάζουν τυπικές και παραλλαγές των πετρωμάτων της Σύρου. Τα σημεία ενδιαφέροντος επιλέχθηκαν από γεωλογική σημασία, ποικιλία τύπου βράχου, προσβασιμότητα σημείων και δυσκολία στο μονοπάτι πεζοπορίας, και επιπλέον αν μπορούσαμε να παρουσιάσουμε και να εξηγήσουμε μια γεωλογική διαδικασία σε ένα συγκεκριμένο POI παράλληλα με ένα outcrop. Μας ενδιέφερε να δείξουμε σημεία ενδιαφέροντος (points of interest-POI) με βράχους που χαρακτηρίζουν τη Σύρο, καθώς και με στοιχεία γεωλογικών διεργασιών, όπως διάβρωση, παραμόρφωση, σφάλματα τοπίου, rock subunit κ.λπ. Επιλέξαμε επίσης μερικά POI με σημαντική ιστορική ή πολιτιστική αξία. Αυτό έγινε καθώς στα γεωπάρκα η γεωλογική κληρονομιά παρουσιάζεται παράλληλα με την πολιτιστική κληρονομιά της τοπικής περιοχής, με θέματα, θέματα, τοποθεσίες και υλικό που διασυνδέεται και φέρνει ένα πιο ολιστικό πλαίσιο του τόπου που φιλοξενεί το Γεωπάρκο.

Τα POI που επιλέχθηκαν για μελέτη και προβολή στο διαδραστικό σύστημα ήταν δεκαέξι (16) (Εικ. 74):

Παραλία Αμπελάκι, Αερόλιθος, Άγιος Στέφανος, Άνω Σύρος, Άσπρο Πουντί, Φάμπρικα, Φοίνικας, Γριά Π ούντα, Κάμπος, Κομίτο, Λάκκοι,Παραλία της Λίας, Μαρμάρι , Μαύρο Πουντί , Μέγας Γιαλός και Βάρη.

Αυτά τα σημεία αντιπροσωπεύουν όλες τις υπομονάδες πετρωμάτων της Σύρου. Η βάση αυτής της μεθοδολογίας παρατήρησης και ηχογράφησης είναι να ζητήσει από τον ερευνητή να παρατηρήσει πρώτα τη συνολική σκηνή και το βράχο από μακριά και στη συνέχεια να αρχίσει να παρατηρεί λεπτομερέστερα. Με αυτόν τον τρόπο μπορούν να κατανοήσουν καλύτερα τα γεγονότα που έλαβαν χώρα για να σχηματίσουν το συγκεκριμένο τοπίο. Κατά τη διάρκεια των πεζοποριών, υλικό συγκεντρώθηκε με τη μορφή φωτογραφιών, ηχογραφήσεων και σημειώσεων. Για κάθε εξάρτημα, λήφθηκαν φωτογραφίες από διάφορες οπτικές γωνίες και σε πολλές κλίμακες για να επιτευχθεί μια διεξοδική μελέτη. Οι περιγραφές και εξηγήσεις των υπεύθυνων γεωλογικών διαδικασιών διευκόλυναν την κατανόηση των εκτάσεων και βοήθησαν να κατανοήσουμε τι παρατηρήθηκε. Οι πεζοπορίες κάλυψαν μια ποικιλία από μέρη που οδηγούν σε σημεία ενδιαφέροντος γύρω από το νησί, προκειμένου να καλύψουν επαρκώς όλες τις πετρολογικές μονάδες της Σύρου. Οι πληροφορίες που εμφανίζονται στην εφαρμογή είναι σε απλή γλώσσα, με μόνο την απαραίτητη ορολογία για την κατάλληλη ενημέρωση των επισκεπτών του μουσείου, αλλά όχι τόσο ώστε να οδηγήσουν σε επιστημονικές ανακρίβειες.

Για το πρωτότυπο και την ανάπτυξη του διαδραστικού συστήματος GLAUKO, αναπτύξαμε μια εφαρμογή επιτραπέζιου υπολογιστή WPF, η οποία θα συνδεόταν με έναν αισθητήρα Kinect για να επιτρέψει την αλληλεπίδραση με τον αέρα, και έναν τυπικό προβολέα για προβολή σε τοίχο για αλληλεπίδραση μεγάλης κλίμακας και καλύτερη αφοσίωση των χρηστών. Η ενδιάμεση αλληλεπίδραση περιλαμβάνει χειρισμούς ψηφιακού περιεχομένου ή απομακρυσμένων συσκευών χωρίς άγγιγμα, με βάση την παρακολούθηση του αισθητήρα των κινήσεων και των χειρονομιών του σώματος (Βογιατζτζιδάκης & Κουτσάμπασης, 2018). Η εφαρμογή και η προβολή WPF ήταν επιτυχής, ωστόσο λόγω τεχνικών δυσκολιών με το Kinect SDK και χωρίς πρόσβαση σε δωρεάν βιβλιοθήκες, δεν μπορέσαμε να αναπτύξουμε την εφαρμογή Kinect. Μετά την ολοκλήρωση, η εφαρμογή μεταφράστηκε στην ελληνική γλώσσα για να επιτρέψει σε όλους τους χρήστες να εμπλακούν καλύτερα και να βιώσουν τη μαθησιακή διαδικασία στην προτιμώμενη γλώσσα τους. Το πρωτότυπο δημιουργήθηκε για αξιολόγηση από δεκαέξι (16) χρήστες ως μαθητές της γεωλογίας για πρώτη φορά.

0.6 Αποτελέσματα Αξιολογήσεων

Το διαδραστικό σύστημα GLAUKO αξιολογήθηκε από δεκαέξι (16) χρήστες μέσω εμπειρικών αξιολογήσεων. Οι αξιολογήσεις πραγματοποιήθηκαν σε εργαστηριακό περιβάλλον που προσομοιώνει μια έκθεση γεωμουσείου , με τη διαδραστική εγκατάσταση κατά την είσοδο και ένα δείγμα τύπου ροκ ως συνέχεια. Το σύστημα GLAUKO δημιουργήθηκε ως προέκταση τοίχου ελέγχεται από έναν αισθητήρα Kinect, ωστόσο , λόγω τεχνικών δυσκολιών με το SDK, στις αξιολογήσεις ακολουθήθηκε το πρωτόκολλο «Μάγος του Οζ», για την αξιολόγηση εμπειρίας των χρηστών, την κατανόηση περιεχομένου και έναυσμα περιέργειας από το σύστημα. Η εφαρμογή ελεγχόταν από τον αξιολογητή από μια εφαρμογή υπολογιστή .

Οι χρήστες υποβλήθηκαν σε τέσσερις φάσεις στη διαδικασία αξιολόγησης. Η πρώτη φάση δοκίμασε τη δέσμευσή τους στην αλληλεπίδραση με το σύστημα GLAUKO, θέτοντας στους χρήστες 4 εργασίες εξερεύνησης του διαδραστικού χάρτη, πλοήγηση σε τέσσερα σημεία ενδιαφέροντος και μετά σε συγκεκριμένες εικόνες και περιεχόμενο στη συλλογή εικόνων κάθε σημείου. Στη δεύτερη φάση, οι χρήστες χρησιμοποίησαν τη νέα γνώση για να προσδιορίσουν τους τύπους πετρωμάτων από το δείγμα έκθεσης και να απαντήσουν στις ερωτήσεις αναγνώρισης με τον καλύτερο δυνατό τρόπο. Στην τρίτη φάση, οι χρήστες ερωτήθηκαν σύντομα από τον αξιολογητή για να παράσχουν σχόλια σχετικά με την εμπειρία τους στη χρήση του συστήματος GLAUKO. Στην τέταρτη και τελευταία φάση, οι χρήστες συμπλήρωσαν ένα ερωτηματολόγιο UX κατατάσσοντας την εμπειρία τους στο σύστημα σε αριθμητική κλίμακα.

Οι στόχοι της αξιολόγησης του συστήματος GLAUKO ήταν οι εξής:

1. Δοκιμή της νοητικής εμπλοκής των χρηστών στο σύστημα.
2. Έλεγχο για το εάν το σύστημα προκάλεσε ενδιαφέρον προς τη γεωλογία
3. Δοκιμή της ευκολίας κατανόησης του περιεχομένου από το χρήστη, και της εκμάθησης των πληροφοριών που παρέχονται από το σύστημα GLAUKO.
4. Έλεγχος εάν το σύστημα παρακίνησε τους χρήστες να πάνε και να επισκεφθούν σημεία γεωλογικού ενδιαφέροντος στη Σύρο.

Το σύστημα GLAUKO δημιούργησε μια συνολική θετική εμπειρία στους χρήστες. Λήφθηκε ως ένα ελκυστικό προϊόν, παρέχοντας ένα αξιόπιστο πλαίσιο για τους χρήστες, τους αρχάριους μαθητές και τους προ-εκτεθειμένους, να μάθουν για τον γεωλογικό χαρακτήρα της Σύρου και που διεγείρει την περιέργειά τους κάνοντάς τους να ενδιαφέρονται για γεωλογικά θέματα που σχετίζονται με την υπόθεση του νησιού ή γενικά. Τέλος, το σύστημα GLAUKO δεν εμφανίστηκε ως ένα ιδιαίτερα καινοτόμο σύστημα, καθώς δεν εξέπληξε τους χρήστες με τα τεχνολογικά χαρακτηριστικά και τις δυνατότητές του. Ωστόσο, έγινε αντιληπτό ως οικείο ή εύκολο να κατανοηθεί πώς να συνεργαστείς και δεν αποσπά την προσοχή από τη μαθησιακή διαδικασία. Οι στόχοι αξιολόγησης επιτεύχθηκαν ως εξής. Οι χρήστες είχαν ισχυρή εμπλοκή με το σύστημα GLAUKO. Οι χρήστες εξέφρασαν ενδιαφέρον για γεωλογικά δεδομένα σχετικά με τη Σύρο και γενικά τις γεωλογικές γνώσεις καθ’ όλη τη διάρκεια της διαδικασίας. Είχαν μια προκλητική εμπειρία στην πλήρη κατανόηση του περιεχομένου, επομένως είναι ένας τομέας για περαιτέρω βελτίωση. Η πλειοψηφία των χρηστών παρακινήθηκε να επισκεφτεί τα γεωσημεία αφότου είχαν χρησιμοποιήσει το σύστημα GLAUKO.

1 Introduction

1.1 Background

Interactive installations allow for many possibilities in creative learning and design. They offer lively experiences as they engage users into learning through unique ways of interaction, and content presentation. As they follow relatively fluid rules for design, developers and designers are often quite free to create almost any type of experience with any types of means available to them. From largescale to small-object oriented installations, they can be found nowadays in museums, art galleries, and exhibitions of almost any kind. Interactive installations manage to trigger the imagination and contribute to an active learning experience in a museum setting.

Museums have started to change dramatically from the quiet static exhibitions they once were, to more active and participatory settings for learning for all age groups. Museums tend to renovate their exhibitions as to create compelling experiences, yet by keeping technology not at the center of attention, but by basing what they offer onto well-crafted, meaningful content that does not bore the visitor with its seriousness. Museums are providing audiences with the tools to educate themselves and facilitate self-learning, which leads to people becoming active museum users rather than passive visitors (King & Lord, 2015). This new approach to active education in museums is due to the fact that such spaces usually contain artifacts, information, and general content on serious topics, such as natural and earth sciences, technology fields, historical and archeological sciences, and art studies. Such topics are challenging to understand by first-time learners, especially at a limited amount of time usually spent in a museum. Thus, exhibition and installation design require a combination of factors to bring forth a pleasant, engaging and informing experience. A learning experience is primarily affective when its focused on our feelings, and affects our interests, appreciation, beliefs and values (King & Lord, 2015). Understanding that the museum exhibition is a site of both cognitive and affective learning is essential to developing successful and engaging exhibitions. Human-computer interaction and interaction design provide means for active engagement with respect to human cognition, providing new ways for active involvement in an exhibition setting, thus allowing for stronger, more engaging learning experiences for museum visitors and exhibit users.

The present diploma thesis document combines interactive installation design for a museum setting with the topics of Human-Computer Interaction (HCI), Interaction Design (IxD), Kinaesthetic interaction, Geotourism and preservation of Geologic Heritage of Syros island in Greece. These topics interconnect for the design and development of a prototype installation conceptualized as an interactive exhibit for a geomuseum in the island of Syros. The interactive installation will be introducing the users to the special geologic rock types of Syros, by explaining their uniqueness and informing them about their geologic stance. With this project we hope to bring awareness to the local population of Syros and future visitors, about the geologic importance of the island and its importance in the natural environment. Such awareness can help better preserve the geological heritage of the island for the future. The methodology followed for the development of the GLAUKO system combined extensive research on general and regional geological topics, examination and research on designing interactive installations and visitor/user experience, and application prototyping and evaluation.

1.2 Goals

The goal of the present diploma thesis is the (field) research, design and empirical evaluation of a kinaesthetically- operated system that displays geological information about the island of Syros. The field research aims at researching the geologic context through experiential learning, gaining a deep understanding of Syros's geological heritage, and gathering appropriate content. The designed system aims at: a) highlighting the variety of rocks present on the island, as these were identified from field research with geologists, b) introducing the public to an exhibition of the respective rocks, c) sparking the users' curiosity to start asking questions about the geological case of Syros. In simpler terms, if a person interacts with the system and during one hike stands to observe one outcrop and recognizes at least one rock type or geological process, then GLAUKO system would be considered a success.

1.3 Methodology

The methodology that was followed for the design and development of the GLAUKO interactive system consisted of Geologic research, Research on Installations, and Design/Development phases. The three phases were executed almost simultaneously, each one included repeated cycles of feedback and redirection, and as the findings progressed, they were incorporated as needed to the next steps of the same or other phase (Fig. 1).

During the Geologic research phase, we conducted research in order to learn and understand basic geologic concepts. A general understanding of Earth science was first acquired through desktop research on scientific literature. Afterwards, we interviewed Dr. Martin Engi, emeritus professor of petrology at the university of Bern, who continued as a geology consultant throughout the project to understand the specifics of the geologic case of Syros. With the guidance of the geology consultant, the topics researched were narrowed down to more specifics concerning the case of the island of Syros. Again, with Professor Engi, we conducted field research by going on hikes around the island and studying the geologic concepts though outcrops and rock samples. By understanding the island-specific geologic case we were able to gather first-hand digital content such as photographs, notes, rock samples, recordings of on-site lectures by the consultant, and points of interest with GPS location coordinates, as raw material. After repeating the same process as needed, the final content for the system was gathered.

The research on installations took part alongside the geologic research. Through desktop research we researched bibliography on interactive installations and interaction design as applied to installations, and examined other systems related to our design context in the context of museums, art galleries, and exhibitions. In addition, we researched the topics of geoparks and geotourism as to understand them as means for the preservation of geologic and natural heritage. The museum context, as a learning and engagement setting, was examined via desktop research and museum visits to the Natural History Museum of Crete, as it is was an accessible museum also as part of a geopark (the Psiloritis Geopark in Crete). Through this research we were able to define visitor engagement techniques, means of interaction, exhibit setting and an insatiable niche on geologic learning in museums. At this point, we started combining our understanding of the geologic case of Syros plus the gathered raw material, to clarify our final content and design a suitable visitor/user experience for our context.

Lastly, the design and development of an application went hand-in-hand. Based on our findings regarding visitor experiences on learning in museums, we decided to keep the visual design simple. Thus, after defining a general use case scenario, and creating UI mock-ups, we dived into development as to see how a simple UI could be functional. We based our design onto an interactive map, as it had proven helpful for our own understanding of Syros' geology and worked well to bridge our users' mental model and our concept model of "site visits". The parallel evolution of the front and backend coding in a WPF application (Windows Presentation Foundation) helped us develop functional prototypes to receive feedback on multiple points. As we reached a prototype version with all the basic functionalities, we started to more actively mold the created content around the desired user experience, and implement it into the functioning prototype. Onward from there, we received feedback for content and UI adjustment, eventually leading up to a working desktop prototype. The Microsoft Kinect SDK was added to make the application functioning form a distance and add to the visitor's experience of interacting with an installation. The prototype was set up for evaluations by sixteen (16) users as first-time learners of geology. Due to technical difficulties with the SDK, the evaluations followed the "Wizard of Oz" protocol as to evaluate the users' experience, engagement, and learning from the system. The GLAUKO interactive system proposed here is the product of this procedure.

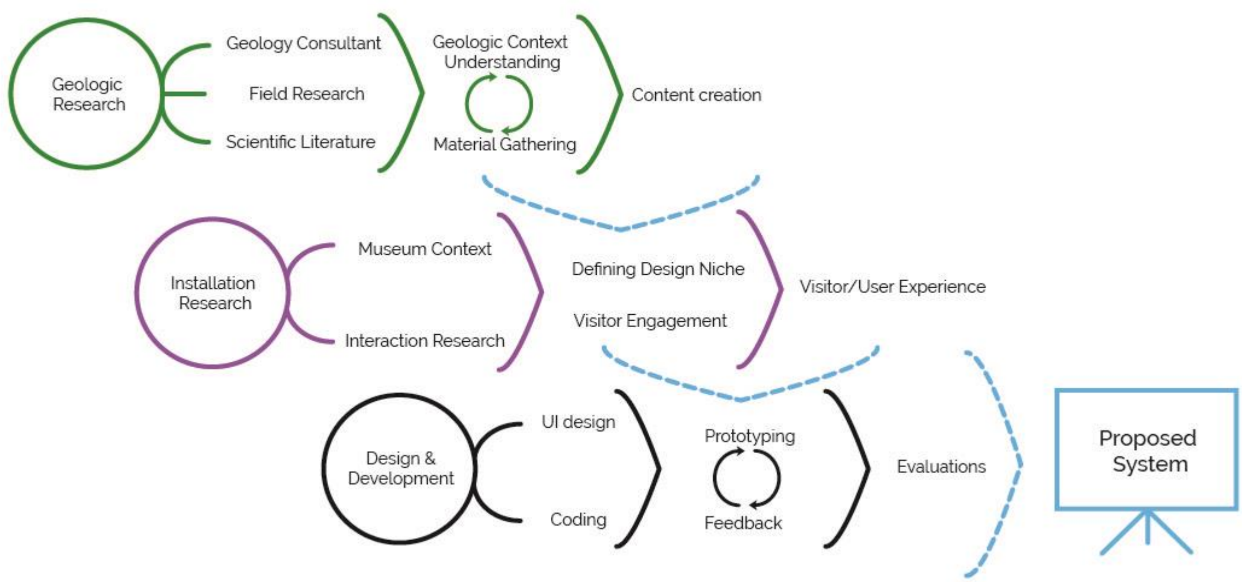

Fig. 1 Methodology for designing and developing the GLAUKO System.

1.4 Document Structure

This document presents the research, design and development of an interactive system. The first chapter defines the background, goals and methodology of the project. The second chapter presents a general overview of the basic principles of Human-Computer Interaction and Interaction Design, with a focus on Kinaesthetic interactions applied to large scale interactive installations in museums. The third chapter provides a general introduction to Geotourism, where it falls in the spectrum of the tourist industry, it's contribution to the quality of tourism for local and visiting parties, and the important part it plays in the preservation and protection of areas rich with natural heritage. Specific examples of interactive systems in geological or other museum contexts are analyzed so as to clarify the niche for which the project is designed, as well as define possible gaps and needs to justify the proposed system. The fourth chapter showcases the desktop and field research on general geological background, Syros geology and its importance, expert's inquiry, and content gathering and inventory. The fifth, sixth and seventh chapters analyze the design process followed for the interactive system, the evaluation results and the overall conclusions of the thesis respectively. More specifically, chapter 5 is divided into two parts, with the first part introducing the theoretical aspects: theme, context, purpose of the system, definition of the design goals, target group, design brief, specifications of the system, and overall design process and methodology followed. The second part presents the more hands-on steps of the process, such as conceptualization, including preliminary design, choice of technology, use case scenarios, and prototyping & development comprising analysis of the technological platforms, interaction means, final application and exhibit concept placement. Chapter 6 presents the evaluation setting, criteria, and methodology followed to conduct the user tests, showcases the two types of tests performed (processes of indoor system evaluation and experience tests in the field), and finally analyses the results. Chapter 7 discusses the overall conclusions, important use case findings, and suggestions for further development. Chapters 8, 9, and 10 are the appendices which provide a table of figures, bibliography, and a full collection of the photographic and geological information content presented in the GLAUKO interactive installation, as well as the WPF application code.

2 Interactive Installations in museums and exhibitions

Interactive installations are dynamic designs of digital systems combined with a physical artifact. They are designed according to specific settings aiming to raise awareness, educate, aestheticize, or inform an audience of a particular site. They are commonly found designed as exhibits for museums, galleries, libraries, exhibition halls and other such places. Depending on their goal, interactive installations are designed with the help of Human-computer Interaction and interaction design. The methodologies and theories of these fields of study provide good basis for creating a user-friendly product, thus can better serve a human goal. Engaging means of interaction are examined here in the context of interactive installations in museum settings for educating, informing and entertaining museum visitors on topics of history, engineering, craftsmanship, natural and cultural heritage.

2.1 Background on main concepts and definitions

An installation is an artistic genre of three-dimensional works that are often site-specific and designed to transform the perception of a particular space. At first installations, were focused within spaces of art such as galleries and public spaces, which could transform through the applied installation and convert into more active spaces. The act of installing takes place when setting up any sort of exhibition, whether it is for artistic, informing, educating, or awareness raising in an indoor or outdoor environment. An exhibition, in the most general sense, is an organized presentation and display of a selection of items. In practice, exhibitions usually occur within a cultural or educational setting such as a museum, art gallery, park, library, exhibition hall, or World's fairs. Exhibitions can include many things such as art in both major museums and smaller galleries, interpretive exhibitions, natural history museums and history museums. Modern exhibitions are concerned with preservation, education and demonstration, while sparking the interest and curiosity of the audience.

An educational installation is usually an artifact of concentrated learning material, designed in a way to ease the user into a learning process without them realizing the severity of the topic. Learning is primarily affective when its focused on our feelings, and affects our interests, appreciation, beliefs and values (King & Lord, 2015). As static exhibits or active artifacts, installations have the power to engage the audience and make a point come across by depicting their content in an inspiring, touching way that triggers an emotional response. Installations that require the audience to act upon the artifact, or part of it, have a designed interaction. The audience is called upon to interact with the installation via given means and functionalities. This way, they may have an active “dialogue” with the installation’s content and better engage in the learning process offered to them.

The installation genre incorporates a broad range of everyday and natural materials, which are often chosen for their "evocative" qualities, as well as new media such as video, sound, performance, immersive virtual reality. Such media can be examined from the point of interaction design and human-computer-interaction. Through these viewpoints, an installation creator is able to design with a focus on the user’s experience (UX), creating an interactive installation tailored to the audience. User experience (UX) is the experience the product creates for the people who use it, and it can often make the difference between a successful product and a failure (Garrett J. J., 2011). UX is not about the inner workings of a product or service, but how it works on the outside where a person comes into contact with it, or else at the interface level.

Interactive systems can be object or products with which a person (user) interacts with to achieve a certain goal. In the context of HCI the systems that are discussed are those which include a software and therefore have a form of interface with the user (a User Interface-UI), and depend on a number of interactions with the user (Koutsabasis, 2011). Interactive systems emphasize on interaction with the user and a vital part of its development is evaluation and feedback from the users. Interaction design (IxD) or design for interaction is the design of interactive systems, which support the way in which humans communicate and interact in everyday life (Preece J., 2015). The aggregate means by which people (the users) interact with a particular interactive system is an interface (machine, device, computer program, or other complex tool) (Griffin & Baston, 2014). In computing, an interface is a shared boundary across which two or more separate components of a computer system exchange information. The exchange can be between software, computer hardware, peripheral devices, humans, and combinations of these (Hookway, 2014). The variety of technologies has encouraged the development of innovative ways of control and interaction with digital information, which include gesture based interaction, touch and even brain interaction with the computer (Preece J., 2015). Preece et al. list the different kinds of interfaces in such:

Table 1 Types of interaction according to (Preece J., 2015).

Types of Interaction	
Command-based	Touch
Windows, icons, menus, pointing device (WIMP) and Graphical user interface (GUI)	Gesture, voice and face recognition
Multimedia (WIMP & Web)	Haptic
Virtual Reality (VR)	Multimodal
Information visualization	Shareable
Web (mobile and multimedia)	Tangible
Consumer electronics and appliances	Augmented and mixed reality
Mobile	Wearable
Speech	Robotic
Pen	Brain-computer

Interactive installations of educational, awareness rising, artistic, or other character, may include more than one of these types of interaction in order to engage their audience and transmit their message. According to context of use, user needs, and design specifications, the designer of the interactive installation will choose a type and means of interaction accordingly. The present thesis will examine Gesture recognition and Mid-air interaction in a projected window application.

2.1.1 The value of designing for Human-Computer Interaction - Interaction Design

Human-Computer interaction (HCI) is a field of studies that sprouted in the 1970s, and studies the design and use of computer technology, focusing on the interfaces between people and digital systems. The value of designing for HCI lays in providing efficient ways for people to use a computational device without struggle in their every-day lives. HCI combines human behavior science, computer science, design, media studies and other disciplines according to context, in order to better understand the problem at hand and the best applicable solution to it.

Peoples' values and initial ideas of the world are their inherent or constructed mental models of reality. The behavioral and cognitive sciences incorporated in HCI study these models to better define human cognition and understanding on general aspects of every-day life or specific topics. By unlocking and deconstructing the users' mental models, designers and developers are able to recreate similar patterns and representations in their attempted designs. They strive to bridge and correlate the user's mental model to the designer's conceptual model (or concept models of the designed system); sort of like putting themselves in the user's shoes to understand their perspective, instinct, and initial reactions. The study of human behavior in relation to computer science and design, has established interaction principles to outline helpful guidance for the design process. Interaction design principles are generally applicable guidelines that address issues of behavior, form, and content. They encourage the design of product behaviors that support the needs and goals of users and create positive experiences. These principles are, in effect, a set of rules based upon our values as designers and our experiences in trying to live up to those values. At the core of these values is the notion that technology should serve human intelligence and imagination (rather than the opposite), and that people's experiences with technology should be structured in accordance with their abilities of perception, cognition, and movement (Cooper, 2007). By understanding the mental models, matching them to (new) conceptual models, and following interaction design guidelines, designers are able to create engaging user experiences.

The practice of creating engaging, efficient user experiences is called user-centered design. User-centered design has been around for several decades, originating in the field of physical product design. What does it do in the digital world? Design follows fundamental processes which can be applied to any sort of product development, whether that is a physical object, a service, or a digital product. The principal approach is that if users cannot use the system in front of them, they will simply walk away from it, feel disappointed in themselves, and will not return to the system or service which gave them a negative experience. The concept is that the designer considers the user at every step of the product development (Garrett J. J., 2011). People engage better in activities which trigger positive experiences, they better emerge into the context they examine through the system, and thus learn more efficiently the information presented to them. Engaging experiences have a positive impact not only at the time they are triggered, but also at future times when people recall the activity and the emotions they felt. It is not only a matter of designing a functional and interesting system for the present moment, but to create an experience worth remembering.

In summary, HCI is based on fundamentals of technological possibilities and the ways in which these can better serve a human goal. By examining human behavior and cognition HCI experts are able to define and design efficient, creative interactions between users and technological systems. When users are able to effortlessly understand and use an interactive system, they better engage with its content and have satisfying, enjoyable, and memorable experiences. Such experiences root into our consciousness, enhance our understanding of the world, broaden our mental horizons, and help us change our perspectives when it matters most.

2.1.2 Interactive learning & User engagement in museums

Learning is a cognitive process that we all experience when we stumble upon an unfamiliar context. When trying to understand a new concept or acquire a new skill, we go through a new process that shifts and evolves our perception and knowledge; a learning process. A museum visitor's objective is to learn something new, but most likely, the knowledge visitors gain from their visit is selective. For instance, one chooses what to see and what to ignore in an exhibition, drawn by motivations, interests, and emotions (Falk, 2009). In his book "Identity and museum visitor experience", Falk re-introduces the problem: museums fail because many of them run with 20th century practices adopting a "one size fits all" position when dealing with visitors. Falk's model attempts to change this, as it suggests ways to customize and personalize visitor experiences, and provides ideas for attracting and engaging visitors in museums. Falk proposes combinations of guided tours, new technologies and customized study of each museum case to address the visitor engagement issue.

Professor Dr. Sarah Kenderdine, a creator of interactive experiences for museums gave a talk in 2013 on visitor engagement using emerging technologies. In her talk "How will museums of the future look?", she remarks that we must find strategies not only to preserve our heritage, but to let its stories be rediscovered and reinvented. This is both an artistic and technical challenge. New means of technology allow us to capture the world in unprecedented resolutions, digitize the natural content, and preserve it in an intangible, unfading way. However, technological means alone are not enough to bring heritage to life in profound and unforgettable ways. It is about creating new narratives of engagement around those artifacts (Kenderdine, 2013). Dr. Kenderdine was talking about preserving cultural heritage sights via mapping technologies and recreating the visiting experience through interactive installations hosted in museums and exhibitions. Her perspective of visitor engagement and active learning about artifacts aligns with new learning objectives called for in the education sector.

Research in the education sector calls for skill development at schools such as problem solving, media literacy, collaboration and communication skills, in order for children to be able to challenge the status quo, innovate, and learn responsibility skills and ethics. This is about wanting to give students the tools for life-long learning rather than require them to know static information, still offered today in formal education. According to Michael Wolf, a Formula D developer, interaction design in conjunction with the available technologies can challenge the educational setting and come up with creative ways of learning relative to the real world and not limited in the school classroom (Wolf, 2013). Learning should be linked to curiosity, inherent to human nature, to real world experiences and challenges, and to be open to activities outside the classroom. Museums can be an extension of a school classroom, despite the visitors' age group and level of education. Museums offer unique circumstances for a variety of learning topics, interconnecting artifacts, and safe spaces to apply the aforementioned ideas, methods, and designs. When it comes to designing new interactive experiences for museums, this doesn't mean that the visitor's focus will be on the piece of technology. On the contrary, creating compelling experiences where technology is not center-stage calls for well-crafted, meaningful content that does not bore the visitor with its seriousness (Kuang, 2013).

Museums are providing audiences with the tools to educate themselves and facilitate self-learning, which leads to people becoming active museum users rather than passive visitors. This is because learning is most effective when it is active; those who learn best do so when engaged with the material (King & Lord, 2015). Understanding that the museum exhibition is a site of both cognitive and affective learning is essential to developing successful and engaging exhibitions. Human-computer interaction and interaction design provide means for active engagement with respect to human cognition, providing new ways for active involvement in an exhibition setting, thus allowing for stronger learning experiences.

Across time, space and disciplines, developers, educators, scientists, and artists call for museums to be redefined as spaces for active learning for all ages. By providing engaging experiences and interactions with valuable content regarding humankind's heritage museums and exhibitions can educate visitors, stimulate imagination and creativity, and establish deeper understandings about the value of preservation and conservation of human-made and natural artifacts. Afterall, such artifacts hold pieces of our history and can help us understand where we come from, how we are shaped, and how we can move forward.

2.2 Types of interactive Installations in museums and exhibitions with examples

All types of interaction come with their allowances and limitations. It is up to the designers and developers to choose according to the problem space, context and user needs, the appropriate type or types of interaction they ought to implement in an interactive system.

2.2.1 Non-interactive wall-mounted displays

Non-interactive wall mounted displays can be quite compelling and manage to capture the attention of exhibition or museum visitors instantly. Such exhibits create a strong sense of awe by depicting moving imagery and sound in various scales, allowing for set narrations and visual storytelling. They can be highly educational and informative, while stimulating the visitors' imagination. However, they can be quite expensive for full development. It can border in the lines of filmmaking, which although exciting on its own, is quite familiar to the visitors. Visitors can grow tired of them after a certain amount of content repetitions, as it does not leave margins for content choice and deeper topic discovery. Non-interactive wall-mounted displays can offer strong senses of awe and instantly stimulate the viewers' imagination; however, the set flow of content can eventually tire exhibition visitors.

The Van Gogh Alive exhibition is a multisensory experience showcasing the works of the impressionist painter Vincent Van Gogh (Fig. 2) (Grande Exhibitions, 2019). It has been created by Grande Exhibitions and is a traveling exhibition being displayed in cities around the world. It consists of large-scale screens, about 5 meters tall, which display Van Gogh's paintings dynamically (Fig. 3). The exhibition was developed using the SENSORY4 technology, which is a system that combines multichannel motion graphics, surround sound and multiple HD projectors for a multi-screen experience (Van Gogh Alive: Redefines a Traditional Museum Experience). The creators designed a coordinated sense of space, movement, and sight, via large scale and close placement of the displays along with vibrant sounds which complement the artwork to create an immersive experience. The virtual paintings are not static, but parts of the imagery have been converted to animations. Visitors engage in entertainment and education about cultural appreciation and examination of Van Gogh's unique style.

Fig. 2 Van Gogh Alive exhibition - Athens

Fig. 3 Van Gogh's *Starry Night* painting projection in the Van Gogh Alive exhibition

Another exhibiton of this sort is the Dynamic Earth visitor attraction situated at Edinburgh's World Heritage Site in the UK (Dynamic, 1999). Dynamic Earth tells the story of planet Earth and how our Earth works, how life has evolved on its differing environments and the future challenges faced by planet Earth. The exhibition features a number of display systems, including a time travel walk-through with non-interactive wall-mounted displays which narate via animation and voical storytelling the history of the Earth from the big bang, to the planet's geologic formation and shaping phenomena (Fig. 4, Fig. 5) and human kind's appearance (Look inside - Dynamic Earth, Edinburgh 2017). The displays are either set along a walking path which leads from one room to the next, or they are set as small theatre displays. It the first type of set up the information presented is animated and voice naration explains the topic, and in the second set up the visitors are exposed to longer documentaries with real video captions of Earth scenery, again acompanied with a voice naration.

Fig. 4 Dynamic Earth wall-mounted display of Earth's tectonic plates formation.

Fig. 5 Visitors watching content on glacier formation.

2.2.2 Interactive touch screens

Interactive touch screens are a significant step up in content presentation from non-interactive wall-mounted displays. They allow for much content to be presented in multiple ways and for direct object manipulation, thus offering the opportunity for a unique story flow per person. Depending on the information and interaction design, touch screens can support complex and engaging applications to museum visitors, making their visits more memorable and distinct form passive exhibitions. On the downside, touch displays can be a costly piece of technology, and need serious investment for small museums and exhibitions. They can certainly be used more than once, but they set a very specific frame for any experience that is to be designed and displayed there.

Fig. 6 Visitors at the Cleveland Museum of Art using the ARTLENS Gallery interactive display.

The Cleveland Museum of Art in the US hosts the virtual ARTLENS Gallery (Collections Wall, Gallery One/Cleveland Museum of Art, 2012). ARTLENS is an application developed for a 40-foot long touch display, offering virtual iterations of the original gallery art pieces, such as works of Pablo Picasso, Auguste Rodin, Viktor Schreckengost, Giovanni Panini, and Chuck Close (ARTLENS Gallery First Iteration: Gallery One, 2012). The ARTLENS interactive wall displays arrays of art works which the visitor can select via touch on the display and learn facts about it (Fig. 6). Visitors get to create their own tours of the museum and discover the full breadth of the collections on view throughout the museum's galleries (Fig. 7). ARTLENS can be paired with the ArtLens App for iOS and Android devices, offering access to additional multimedia content form home.

Fig. 7 ARTLENS user choosing a virtual painting from the installation.

Another interactive touch screen exhibit worth mentioning is Polyapton: A Symposium from the Macedonian Tomb of Agios Athanasios. Polyapton is a custom multitouch interactive display in the Archaeological Museum of Thessaloniki, Greece. The tomb is not open to visitors, thus the Polyapton system offers museum visitors the opportunity to enjoy the painting without compromising its survival. The system comprises of a large interactive screen that can be used by several visitors who wish to explore multifaceted information on a subject at the same time (Fig. 8). The multi-touch screen recognizes multiple touch inputs by fingers or hands via computer vision techniques, as well as input from specific objects, at the same time. Users are able to navigate across the image and focus on points of interest that offer multimedia information by touching them. They can also interact with the touch screen via physical objects and perform tasks such as zooming in on details with the use of a cardboard magnifying lens, while an infrared torch displays a modern rendition of the painting (Fig. 9) (Grammenos D. et al., 2012).

Fig. 8 Two users simultaneously using the Polyapton system.

Fig. 9 Users interacting with Polyapton via physical objects The

2.2.3 Touch Projections

Touch projections are similar in interaction to touch screens, however they come with far less hardware limitations. The large-scale viewing spectrum offers an awe experience to museum or exhibition visitors, capturing their interest and stimulating their imagination. This also allows for better examination of details without much focusing effort. Touch projections come in many variations, from affordable off-the-shelf to custom technology, offering visual and capacitive touch recognition, while allowing flexibility in choice of optional additional hardware. Projectors can be connected to a variety of control hardware, providing a larger pool of choice from interactive technologies for designers, developers and clients. This way, medium and small institutions can afford a good investment in an interactive technology which can be applied in multiple ways with few modifications, and only significant software changes depending on the desired application. Some downside of projected installations can be the quality of the displayed colors, depending on the exhibition lighting, which can prove challenging to the visitors' vision. Also, such systems require high definition imagery in order to project accurate details of the content. Thus, the developers may need to acquire pieces of content multiple times, or even digitize the content for the first time, in order to achieve the appropriate quality for projection.

Interactive touch projections can be developed around quite affordable pieces of hardware. The i-Wall project (Fig. 10) is such an example as it is an affordable interactive wall system built from off-the-shelf components and technologies, and was designed for the Syros Industrial Museum (Greece) and presents a narrative about a particular exhibit, the Enfield E8000, which is the first electric car that reached small-scale production in 1973 (Gkiti, 2018). The system consists of an interactive wall (plywood surface) with components painted with conductive paint (Fig. 11) which trigger, via a Bare Conductive Arduino board, optical feedback projected with projection mapping onto the wall. Users get to interact with the physical components by touch, and trigger animation effects and cyclical storytelling of the history of the Enfield car.

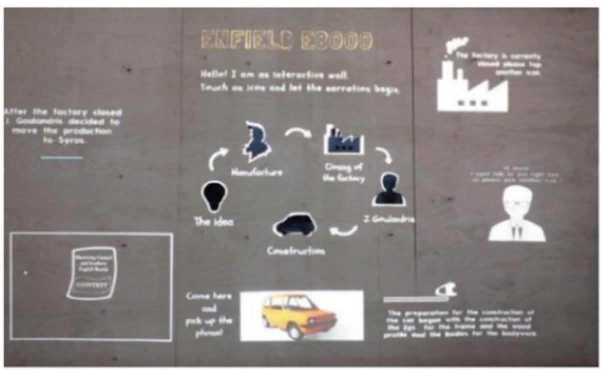

Fig. 10 i-Wall with animated content activated (Gkiti, 2018).

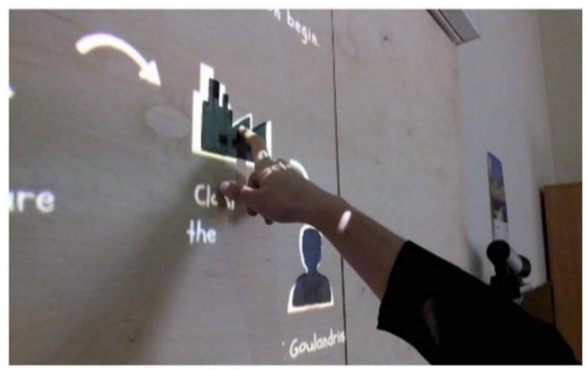

Fig. 11 Tangible interaction with the wall via icons with conductive paint (Gkiti, 2018).

Projection technologies can of course be customized and be developed into highly accurate interactive systems. Wall Touch interactive system is such an example, developed by the Ambient Intelligence Programme (AmI) at FORTH (Foundation for Research and Technology-Hellas). Wall Touch has been developed to detect fingertip contact upon planar surfaces to provide interactivity to upon projected displays (Ntelidakis, 2017). The system comprises of a large projection area allowing for simultaneous use by several visitors who wish to explore information. Visitors can explore multimedia information, which can be freely moved and tossed around, as well as magnified or shrunk. This system has been applied thrice, once as a permanent installation, and twice as a temporary one. The permanent exhibit was designed for the Cyprus Centre for Environmental Research and Education, in Limassol, Cyprus (AmI-ICS-FORTH, 2017). The exhibit focuses on the threatened by extinction fauna and flora species of Cyprus (Fig. 12). It aims to educate visitors about the ecological value of the natural ecosystems of Cyprus, highlighting the ecosystems of Cape peninsula in Akrotiri (Limassol), the dangers that threaten them and the need to preserve them for future generations. Visitors and students are given the opportunity for a more experiential educational approach. The temporary installations of Wall Touch were developed for the Techn-e-ology exhibition on the merging of art and technology or the "Art en Route" Pancretan Street Festival which took place in Heraklion, Crete (Greece) in 2017 and 2018 (AmI-ICS, AmI-Arts & Culture-Wall Touch, 2017). Both times the Wall Touch installation was designed to serve cultural heritage and offered alternative experience of the visual arts, by approaching art works of Cretan and other painters of the past two centuries (Fig. 13).

Fig. 12 Wall touch for the threatened fauna and flora of Cyprus.

Fig. 13 Wall Touch at Techn-e-ology 2018.

Fig. 14 Young child interacting with the virtual night environment of the River of Grass system.

Another projected touch installation, this time for educational entertainment (edutainment), is the River of Grass exhibit (Formula D-interactive, 2017), which was commissioned for the Frost Museum of Science in Miami, Florida along with two Shark Sense 4D virtual reality exhibits and the Immersive Gulf Stream Experience. The immersive experience teaches children about the Everglades' unique ecosystem (Formula D, 2017). The interactive River of Grass exhibit is a large room with a virtual reality projection on the walls and floor targeted at preschool children to provide an experience of an animated interactive day in the Everglades (Fig. 14). The interactive wall and floor projection system provides a host of playful interactions within the virtual environment to stimulate understanding of Florida's precious wetland ecosystem. The users can interact with the projected natural elements without using any special equipment. Children learn about weather dynamics and witness the pertinent changes that happen over the seasons as they progress through the exhibit (Fig. 15).

Fig. 15 Multiple young users engaging in the VR projected experience.

2.2.4 Midair and Kinaesthetic interactions with projected content

Mid-air interaction involves touch-less manipulations of digital content or remote devices, based on sensor tracking of body movements and gestures (Vogiatzidakis & Koutsabasis, 2018). In mid-air interaction, users make use of their whole body—with a strong focus on hands—and apply gestures, postures, and movements to interact with digital content on distant displays or remote devices (Koutsabasis & Vogiatzidakis, 2019). This kind of interaction is made possible by recognition of the human body via camera and depth sensor, which can recognize the body, limbs and gestures of a person in a room (Preece J., 2015). Popular mid-air interaction application systems are Microsoft's Kinect sensor and Ultraleap's Leap Motion sensor.

Kinaesthetic interactions are ways of interacting with a system from a distance, not needing any tangible equipment to operate the application. Such interactions are based on tracking hand and body movement in order to allow natural interaction of a system by the user in mid-air. They can be paired with projection technologies or large wall-mounted displays to provide a sufficient view of the content to the users. Such projections and displays, as mentioned before, can magnify optical feedback and interaction radius, and create sensations of amazement to exhibition and museum visitors. Motion tracking sensors require some time spent in front of an installation in order to sufficiently interact with the content, however they provide a flexible platform for development of various applications at a relatively low cost. Affordable technology requires sensors of human movement such as Microsoft's Kinect sensor. By the end of 2010, Microsoft released a new gaming system for Xbox, which was based on gestures, the Kinect. Kinect uses camera technology and a depth sensor, as well as multidirectional microphone for voice interaction, to recognize the user. An RGB camera mounted tracks the space to locate the user's body. Once found, the camera analyzes the tree-dimensional position of the user's main joints (Preece J., 2015). Thus, it is ready to recognize any gesture performed by the user which is coded into the program in use. There are no established, universal gesture vocabularies for mid-air interactions with digital content or remote devices based on sensor tracking of body movements and gestures. The original Kinect relied on a structured lighting approach, which involved plastering a distinct pattern of infrared dots from its laser, somewhat like a QR code, on everything within its field of view. Knowing that objects farther away would have more distorted infrared dot patterns, the Kinect v1's infrared camera captured this distortion through triangulation and determined the depth of any scenery within its field of view (Rahman, 2017). Kinect's technological features were not unique. However, what made this device stand out in the market was that the technology was neatly packaged in a small piece of hardware for a relatively low price. Microsoft was able to retail it as such for consumer use due to the company's high development budgets, high-level scientific research groups, and strong market position in the gaming industry (Rahman, 2017).

Etruscanning 3D is a virtual exploration of the Regolini Galassi Tomb in Cerveteri, Italy, in which the users can interact with the system via body movement. The installation uses a Kinect sensor to track the users' gestures and allow for them to interact with the content of the application. The tomb has been virtually reconstructed in order to re-contextualize its precious funerary goods, today preserved in the Vatican Museums, in their ancient space (Etruscanning3D, 2012). The application is built in Unity 3D and uses the Kinect sensor for motion capture, and the virtual environment is projected onto the wall. The user uses simple static gestures (poses) to navigate inside the tomb and approach the marked "hotspots" (Fig. 16, Fig. 17). The hotspots are objects in the tomb, and once approached they trigger storytelling features, such as narration. The hotspots can be activated in any order. The projection of 12 m², the first-person storytelling, the gradual lighting of objects as approached, and the motion interaction help immerse the user in the exploration experience (Hupperetz, 2013).

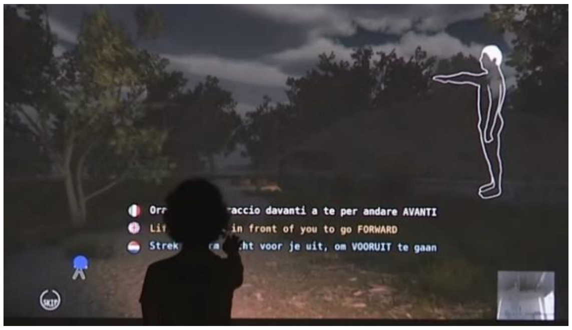

Fig. 16 User testing a control gesture.

Fig. 17 User navigating through the virtual environment.

Fig. 18 Media Gallery installation at the Heraklion International Airport (HER).

Kinaesthetic operation can be implemented for distant interaction in public places such as museums, exhibitions, outdoor or indoor environments. In the following example, the Kinect sensor has been implemented in the Media Gallery interactive system. Media Gallery is a system that allows browsing and exploring large collections of multimedia information (images and videos) using touchless remote interaction, by employing computer vision technologies. The system has been developed by the Ambient Intelligence Programme (AmI) at FORTH to introduce points of interest around Crete to visitors of the island. It is designed for use in public spaces relative to tourism and transportation, and as such it has been placed for long term use in the Heraklion International airport “Nikos Kazantzakis” (HER) (Fig. 18) and Chania International Airport “Ioannis Daskalogiannis” (CHQ), tourism information centers and offices of the Municipality of Heraklion, Crete, Greece. The Media Gallery system aims for touchless remote motion-based interaction through hand detection using Microsoft’s Kinect, in order to allow natural interaction in mid-air (Drossis G., 2013). The system allows browsing and exploring large collections of multimedia information (images and videos). Media Gallery presents a grid of multimedia components from which the user may select an item of interest and find out information about a place or attraction of Crete (Fig. 19). The system includes a quick overview of the entire collection, allows for focus on a single item to obtain additional information (e.g., a short description) and easy browsing of items in the vicinity of the selected one, as well as zooming functionality in the details of the selected item (Fig. 20) (AmI-ICS, Media Gallery, 2013). The Media Gallery allows users to interact with systems at a distance without coming to physical contact with any tangible object.

Fig. 19 User Interacting with Media Gallery via a Kinect sensor.

Fig. 20 Zoom functionality on selected image from gallery (island of Crete).

Natural interaction can be any sort of movement that can be performed easily by a human without much effort. Walking is such a movement, rarely used as a means of interaction with interactive systems. Another system worth mentioning, which actually implements walking interaction is the Macrographia interactive installation, part of the “Macedonia: From Fragments to Pixels” exhibition at the archeological Museum of Thessaloniki, Greece. The application was developed in 2010 by AmI Programme. Macrographia can present large scale images of artifacts, with which one or more visitors can concurrently interact by walking around. Macrographia presents the "Wall-painting of the Royal Hunt" from the tomb of Philip II at Vergina (Grammenos D. et al., 2012). This artifact is the largest ancient Greek painting that has been found to date, its length exceeding 5.5 meters, and its creation dating back to 336 BC, the year of King Philip’s death. The large work of art is presented almost in real size in the Macrographia installation. The system is installed in a room comprising of a computer vision subsystem of 3 depth sensors and a large-scale projection of the artifact. The room is conceptually split in 5 vertical zones of interest, delimited by different themes presented on the wall painting, and 4 horizontal zones that run parallel to the wall painting. The system assigns each user an id number, tracks their position, and responds with the chosen language (Greek when entering the room from the left, and English when entering from the right) (Fig. 21) (AmI-ICS, 2010). As the visitors approach the projection, the system changes the projected image of the corresponding zone, thus revealing additional details of the artifact, including a 3D reconstruction of the original wall painting (Fig. 22). There are four levels of information: the present state of the painting, an artist’s sketch, an artist’s modern rendition, and notable details (Grammenos D. et al., 2012).

Fig. 21 Users choose their preferred language via walking interaction with the Macrographia.

Fig. 22 Projection changes from ancient wall painting to 3D reconstruction of the scene based on user location.

Fig. 23 Leap Motion sensor tracking user's hands.

An additional means of touchless interaction is offered by the Leap Motion sensor (Fig. 23). This piece of technology is an optical hand tracking module that captures the movements of the user’s hands with high accuracy, and it is meant for close-distance interaction on a desktop-like environment (Ultraleap, 2019). The Leap Motion controller uses optical sensors and infrared light to track the hand and finger gestures and movement of the user, allowing for natural interaction with the digital content. The sensors are directed along the y-axis – upward when the controller is in its standard operating position – and have a field of view of about 150 degrees. The effective range of the Leap Motion Controller extends from approximately 25 to 600 millimeters above the device (1 inch to 2 feet) (Developer archive). It is an affordable piece of technology, with many applications on various software and creative designs, and can be paired with VR or AR equipment as an extension of interaction means, or it can be used alone on desktop applications. Detection and tracking of the sensor work best when the controller has a clear, high-contrast view of an object’s silhouette, therefore Leap motion best works at well light environments.

Close-range natural interaction via Leap motion has been implemented eloquently for cultural heritage purposes in the Cycladic Sculpture Application. The interactive system is targeted from young users to adults. It places the user in the role of the ancient craftsman or sculptor (Koutsabasis & Vosinakis, 2016). The Cycladic Sculpture application uses the Leap Motion sensor to allow the user to interact with a virtual environment displayed in a desktop monitor. The user performs the carving, smoothing and engraving stages of constructing the figurine by selecting the appropriate tool and imitating it’s use with a series of gestures performed over the Leap Motion sensor (Fig. 24). The user gets optical and sound feedback as the 3D sculpture changes from a piece of marble to that of the figurine. The Cycladic Sculpture Application is a simple, low-cost, small scale interactive system and intends to immerse the users into the world of sculpting craftsmanship alongside physical sculptures and exhibits.

Fig. 24 Young user virtually sculpting a Cycladic rhythm sculpture. (Left) carving, (Center) smoothing, (Right) engraving.

Mid-air interaction can provide users the ability to interact with a system in a natural way using familiar movements and motion patterns or easily learn new ones. It is affordable, packaged in single devices which can connect to many different development platforms for basic to expert developers to work with. They can also be connected to multiple types of application output, such as desktop computers, wall-mounted displays, and wall projections, allowing for a variety of possible designs and experiences to be created. Kinaesthetic interactions can meet small to large scale application designs, easily tailoring to each system's specifications and requirements. They can be used on simple applications displayed in a conventional medium, or be combined with Virtual or Augmented Reality environments for enhanced experiences, adding a more realistic interaction with virtual worlds.

2.2.4.1 Interactive installations with virtual/augmented reality

Virtual reality (VR) uses graphical simulations generated from a computer to create the sense of existing and participating in an artificial environment, as opposed to a physical one (Gigante, 1993). VR imagery is presented in 3D to the users, usually through the use of virtual reality headsets (Fig. 25) and the user usually uses an input device such as a joystick or hand controller (Fig. 26) to interact with the environment and its elements (Preece J., 2015). The headset is a head-mounted display with separate lenses for each eye, and comes with head motion tracking sensors to track the orientation and movement of the user and transfer the same behavior in the virtual environment.

Fig. 25 Oculus Rift headset 2016

Fig. 26 User using an Oculus Quest headset and hand touch controlers-2019.

Fig. 27 HoloLens AR headset controller.

VR extends the possibilities for new user experiences allowing users to interact with objects they couldn't have through two-dimensional means of interaction or in the physical world (Preece J., 2015). This type of interaction can be highly immersive, having the user believe that they really exist within the displayed environment. Due to this effect, VR interaction is being used in entertainment for better gaming experience, in education for higher exposure to themes and understanding, in professional simulations for aviation training, and in exhibitions for more captivating experiences and even protecting and preserving heritage artifacts. VR environments can be displayed in computer or television monitors, large scale screens, or even projected onto walls. While the graphical representations of a physical environment are always up to debate depending on the design intent of the system, VR environments can provide a higher quality of imagery, and the ability of better examination of artefacts. VR sets are balancing between comfort and performance in pursuit of creating an immersive user experience (Martindale, 2020). As immersive as the experience can be, there are always issues with headset comfort, as well as nauseating effects on the users, after some time of use (Preece J., 2015). VR applications also have a higher development cost due to demanding special equipment, and detail in the environment representation and behavior.

Fig. 28 User wearing the Microsoft HoloLens.

In addition to Virtual Reality, there has been the development of Augmented Reality (AR) as a way to bridge the physical with the virtual world. AR is the optical representation of virtual elements on a physical object or environment, combining the real and virtual perspectives (Drascic & Milgram, 1996). Static graphic representations (e.g. maps and paintings) can be covered with additional dynamic, virtual elements and information, allowing the users to interact with the content more innovatively (Preece J., 2015). To achieve this overlapping effect, the use of mobile and tablet devices, or special set of glasses (e.g. Microsoft HoloLens) (Fig. 27, Fig. 28) is required. Users use mobile applications in their devices, point them at the corresponding physical element or space, and see in their screen the virtual elements. AR provides more flexibility, comfort, and lower cost, due to requiring simpler equipment that the majority of the users already possess. It can also create rich experiences, however not completely immersive as in the scale of VR applications.

Some examples of VR and AR interactive installations implemented in museums are the “Pure Land: Inside the Mogao Grottoes” VR and AR system, the “Mona Lisa: Behind the Glass” VR application, and the “Petersen Automotive Museum: a HoloLens experience” AR system. These three systems cover a spectrum of museums, from heritage and art preservation to automobile history.

Fig. 30 Pure land Inside the Mogao Grottoes 360o VR installation.

The first VR system is *Pure Land* Inside the Mogao Grottoes at Dunhuang. It is a heritage application developed by the Applied Laboratory of Interactive Visualization and Embodiment (ALiVE) (Kenderdine, Pure Land : Inside the Mogao Grottoes at Dunhuang, 2012). Pure Land is a two-version interactive system, originally developed as a VR installation, and later modified into an AR application. The system aims to showcase an UNESCO World Heritage site known as the Caves of the Thousand Buddhas, located at Dunhuang, a small town in northwestern China that is an oasis in the Gobi Desert (ALiVE, 2012). The Caves, 492 in their number, host centuries old mural (wall art) and statues crafted by Buddhist monks over a period of a thousand years. These caves are endangered by tourism and climate change, making most of the caves restricted from on-

Fig. 29 Caves selection menu in the VR application.

site visitors. Pure Land VR installation (Promo video, ALiVE's project: Pure Land: Inside the Mogao Grottoes at Dunhuang) was developed for the "Run Run Shaw Creative Media Centre" at the City University if Hong Kong in 2012, to replicate the wall art of each of the caves, allowing museum visitors to virtually enter the caves and observe the art. Visitors enter an enclosed room of 10 meters in diameter and 4 meter-high walls with a 360º screen (Fig. 30) and browse through the most significant caves using special glasses and a hand controller to navigate the application (Fig. 29), choose the cave, observe and examine the wall art (Fig. 31). The room allows about 30 visitors a one-to-one experience of being inside the caves.

Fig. 31 (Left) User observing the wall art of a sealed cave. (Center) Detail examination of a figure on the wall art. (Right) Multiple users in the VR installation using special glasses to view their chosen information.

The AR version (Promo video) was implemented the same year for the Hong Kong International Art Fair. This implementation allowed for the mobility of the installation. Users used a tablet (Fig. 32) as a "lens" to reveal the virtual artwork of a particular cave that has been sealed, in a 360º translation of the physical space around them.

Fig. 32 (Left) AR version of the Pure Land installation. (Right) Virtual area of the cave wall art shown on user's tablet.

The second system is a VR experience in the Louvre Museum called Mona Lisa: Beyond the Glass. The installation dives into the techniques of Leonardo Da Vinci used to create the famous renaissance painting of Mona Lisa, and allows the visitors to examine details of the painting (Fig. 33) that they couldn't take in before due to the protective casing of the original artwork and crowd around it (Mona Lisa: Beyond the Glass, 2019). The VR experience combines moving imagery, sound and interactive design to showcase how the painting was originally created (Fig. 34) (video, 2019). This application is not only offered at the Louvre, but it can also be downloaded in any remote VR system, making the experience accessible to a larger group of users.

Fig. 33 Users experiencing the Mona Lisa-Beyond the Glass VR application.

Fig. 34 Illustrated representation of the VR experience (Top), 3D model of Mona Lisa as an element of the VR app (Bottom).

Petersen Automotive Museum is giving visitors the opportunity to experience the Ford GT cars they love, through interactive HoloLens technology. The Petersen Automotive Museum: a HoloLens experience is an AR system which takes place in the museum (Fig. 35), augmenting and explaining features of the Ford GT model with HoloLens technology (glasses), such as interior engine (Fig. 36), aerodynamic engineering and comparison with other car designs of the company. With this application the museums aimed to elevate the storytelling of their car racing history and highlight the importance of a significant car model which made history in the arena.

Fig. 35 Visitor at the Peterson Automotive museum using the HoloLence glasses.

Fig. 36 AR element presented on physical exhibit.

Virtual and augmented reality interactive systems are excellent for presenting cultural heritage sights, historical artifacts, and other subjects that must be physically preserved. They allow people to experience a realistic representation of the real artifact without further endangering its existence. This is especially critical when it comes to endangered or protected sights, whether those are artificial or natural. Kinaesthetic interaction, whether it is used in addition to VR and AR, or standing alone in applications, offers great advantage of non-harmful visitor-artifact interaction. In addition, distant use of a system can draw attention of other visitors to the system and its content, as the application is freely exposed in plain sight, and not enclosed in a head-mounted device. Thus, more visitors are likely to interact with a kinaesthetic application as the display or projection easily captures their attention, and the natural interaction seems friendly enough even to first-time users.

2.2.4.2 Tangible interactions and interactive installations

Tangible interfaces use interactivities based on sensors, where physical objects are connected with digital representations (Ishii & Ullmer, 1997). When a person is using the physical object, that is being detected by a computer system, via the sensor mechanism embodied in the physical object, causing the response of a digital effect, such as sound, animation, or vibration (Fishkin, 2004). Digital effects may be implemented in external media or be assembled into the physical object. Such designs are popular for simpler tasks, or younger target groups since they can be better understood in cross-referencing the digital and the physical object.

Tangible interfaces have many advantages over the other types of interactions. Physical objects allow the freedom of placement. They can be stacked, placed together or apart, and rearranged creatively in any order and form, allowing for broader exploration of the problem space (Preece J., 2015). Also, they can be used by both hands and/or by multiple users at a time, thus expanding in the possible ways of interaction, in contrast to other types of interaction which require singular inputs. They can provide a clearer correlation between the physical and digital representations, thus triggering greater awareness, more memorable experiences for learning and problem solving (Marshall, 2003). However, tangible interfaces and interactions also come with limitations. They require detailed hardware design in order to be durable and ergonomic, thus their conceptualization and development automatically become more diverse and complex. In addition to their physical complexity, the digital feedback source is directly related to the context of use and design purpose of the interface (Preece J., 2015). Furthermore, when we consider the demands of a fast-paced information world, we must consider the appropriate flexibility for content updates into the system. For a relatively static context with little need for updates, tangible interaction is a good option. Yet, when it comes to systems which will need to present additional information in the future (e.g. new exhibits in a museum), tangible interaction brings with it the limitations of hardware production cost and slower overall system update. Also, as backed up by Miller's Law of Short-Term Memory Load, there is a limited number of components and relations that a user can keep track of in one time in order to be able to use the system successfully (7+-2 pieces of information at a time).

Fig. 37 The hybrid (digital and physical) prototype of the loom (Dimitropoulos, 2018).

Tangible interaction can be combined with digital media to enhance and augment user experiences and understanding. The Loom project designed and prototyped by students of the University of the Aegean and was intended as an exhibit at the Industrial Museum of Hermoupolis in Syros, Greece. Loom is a hybrid interactive system involving both tangible and digital aspects (Fig. 37). Such a media combination adds physicality to the interaction and a livelier user experience. Loom comprises of a small-scale (shoebox-sized), simplified loom replica made of wood that is connected through appropriate (Arduino) sensors to an interactive application (Unity) that digitally recreates and enhances the outcomes of user interaction onto a multitouch screen. (Dimitropoulos, 2018). Museum visitors witness the exhibit next to a real loom artefact, and are able to experiment, play and gain awareness about the weaving process through interacting safely with the loom prototype. They get to view the results of their virtual weaving on a screen with the loom model. Additionally, a multimedia interface on the same screen presents information about the rest of the loom exhibits in the museum and textile industry.

In standard museum and exhibition settings, often people with disabilities are overlooked. Tangible interaction can provide alternative means of navigation, learning and overall experience. Orasis is a conceptualized interactive system targeted to visually impaired museum visitors. The system implements tactile interaction and has been prototyped to a limited degree as a student project at the University of the Aegean, Greece. It has been designed as an affordable approach and prototype system that can enhance the accessibility of museum exhibits to visually impaired users. The approach supports the navigation in exhibition halls and the tactual exploration of exhibit replicas using touch-sensitive audio descriptions and touch gestures on a mobile device (Fig. 38). The required technology includes 3D printed exhibits with attached touch sensors (Fig. 39), Arduino boards, and a respective mobile app (Anagnostakis, 2016). Tactile exploration makes the museum exploration more purposeful to visually impaired visitors as it allows them to realize the form of exhibits, and combined with mobile touch gestures available in museum mobile devices offered to them, they are able to control the audio description of the exhibit they are examining each time.

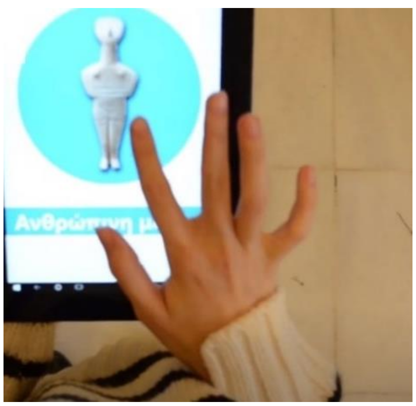

Fig. 38 User selecting to listen to audio information.

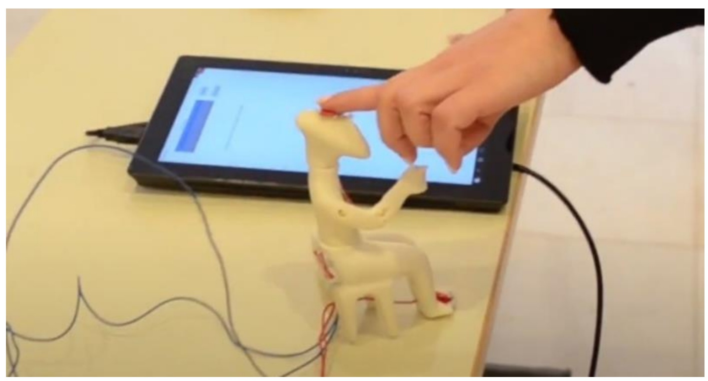

Fig. 39 User examining the interactive exhibit, triggering the corresponding audio description in the app.

2.3 Chapter Overview

Interactive installations can be extremely creative designs providing new ways to perceive and experience the world around us. From massive, aweing scales to miniature sized, interactive installations can be implemented with affordable, off-the-shelf technologies to custom made designs. Designers and developers choose, mix and match different aspects, technologies and means of interaction in order to tailor their creations to the users' needs and create unique and memorable experiences. Different settings and needs call for different combinations of interactive media and result in distinct experiences. It is up to the creators to research their given context, examine various scenarios and combine technologies as to design the proper interfaces, interactions and experiences for each given case and interactive system.

3 Interactive installations with geological content

Geotourism is a form of natural area tourism that specifically focuses on geology and landscape. It promotes tourism to geosites, conservation of geo-diversity, and understanding of earth sciences through appreciation and learning through independent visits to geological features, use of geo-trails and view-points, guided tours, geo-activities and patronage of geosite visitor centers (Newsome David, 2012). Areas with global geological significance can become protected Geoparks, host conservation, education and tourism related activities, and be centers of preservation of natural heritage. Geomuseums are essential in highlighting the geological heritage of a Geopark, as they offer a more accessible option for a visitor to dive into the unique heritage of the geopark. Geomuseums include natural artifact exhibitions for educational purposes, stationary exhibits, and interactive installations. Geomuseums are great centers for development of interactive systems. Most traditional museums of natural sciences cover topics and spectacles regarding biotic environments, depicting geological heritage in a more static way. In this chapter we also present three state of the art examples of interactive installations with geological content.

3.1 Geotourism and geoparks

Geotourism is sustainable tourism with a primary focus on experiencing the earth's geological features in a way that fosters environmental and cultural understanding, appreciation and conservation, and is locally beneficial (Dowling R. K., 2011). In the broad spectrum of tourism, it falls closely to ecotourism, and has links to cultural tourism and adventure tourism (Fig. 40). Ecotourism brings biotic nature into focus through educational activities, passive visitor interaction with the natural environment, and general appreciation of wildlife, while geological features serve as a context provider. Cultural tourism enlightens humankind's relation to geological riches as means for art and cultural archives. Adventure tourism has the weakest link to geotourism and focuses on sporting activities for people to experience in the given geological setting. The strongest relation is between geotourism and ecotourism, with the difference that the second deals with abiotic nature, yet both aim to create experiences via education and appreciation of the natural environment. It is strongly believed that geotourism can help people better understand the Earth and its geological attributes, thus promoting preservation and conservation of the natural environment. (Dowling R. K., 2010) (Dowling R. K., 2006) (Tourtellot, 2011) (UNESCO Global Geoparks, 2020) (What is a UNESCO Global Geopark, n.d.).

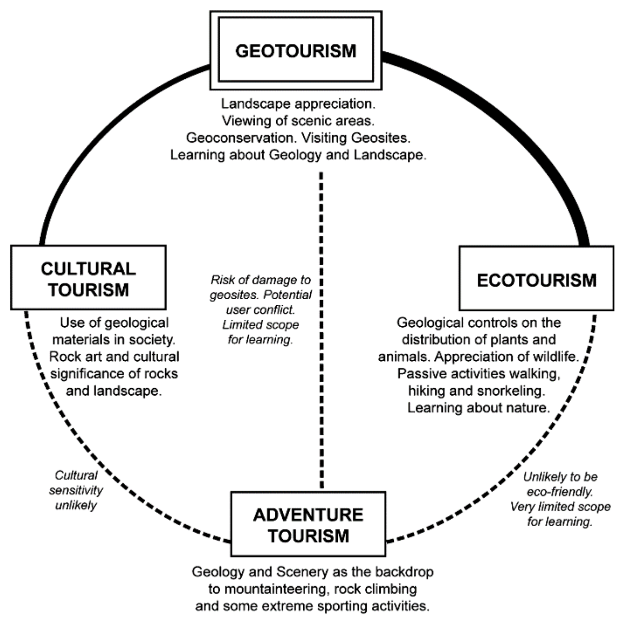

Fig. 40 The relationship of geotourism with other forms of tourism. *Solid* and *dashed* lines represent interconnecting pathways. The connection between ecotourism and geotourism is represented as a particularly strong relationship (Dowling R. K., 2010)

Growing on this idea, geotourism continually expands and develops in geoparks throughout the world. A Geopark is a nationally protected area containing a number of geological heritage sites of particular importance, rarity or aesthetic appeal. These Earth heritage sites are part of an integrated concept of protection, education and sustainable development (UNESCO, 2006). A geopark achieves its goals through

Fig. 41 Shilin stone Forest UNESCO Global Geopark, China.

conservation, education and tourism. It seeks to conserve significant geological features and explore and demonstrate methods for excellence in conservation and geoscientific knowledge (Dowling R. K., 2011). In 2015 the Member States of UNESCO ratified the UNESCO Global Geoparks label, which draw on professional, multidisciplinary teams that combine scientific knowledge, science communication and outreach events to achieve heritage transmission through actions that target schools, the local population and the general public (Justice, 2018). An UNESCO Global Geopark is defined by the organization as single, unified geographical areas where sites and landscapes of international geological significance (Fig. 41, Fig. 42) are managed with a holistic concept of protection, education and sustainable development (UNESCO Global Geoparks, 2020). A UNESCO Global Geopark must demonstrate geological heritage of international significance, and its purpose is to explore, develop and celebrate the links between that geological heritage and all other aspects of the area's natural, cultural and intangible heritages (Is a UNESCO Global Geopark only about geology?, 2020).

Fig. 42 Haute-Provence UNESCO Global Geopark, France.

This meaning that, Geoparks are not limited to showcasing an uninhabited geographical area (like National Parks). Geoparks promote any other aspect of culture including agriculture, local food, archaeology, flora and fauna (Fig. 43, Fig. 44). A geopark can offer a variety of organized activities, such as educational and recreational workshops, seminars (Fig. 45, Fig. 46), guided hikes and tours, hosting of cultural events, alongside visitation points, like a museum or exhibition, and sale point for traditional products. By showcasing aspects and knowledge about the geopark’s geological characteristics and importance with the local communities and their traditions, a Geopark can be a self-sustained entity. The interconnectedness of humans and nature can create a sustainable cycle of actions, where the population conserves the natural environment because they have come to understand its inherent value in their own existence.

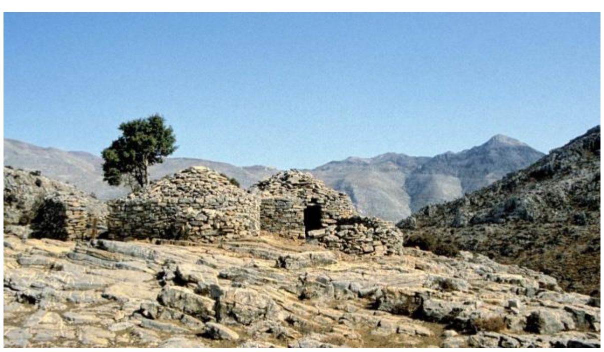

Fig. 43 Traditional Shepperd house "Mitato" at Psiloritis Geopark, Greece.

Fig. 44 Cultiral heritage site at Copper Coast UGG, Ireland.

Fig. 45 Lesvos UNESCO Global Geopark, Greece.

Fig. 46 International course at Lesvos UGG, Greece 2017.

While the natural geographical area of the geopark is essential, a second center of interest is usually paired with it, known as a geomuseum. Geomuseums are essential in highlighting the geological heritage of a Geopark. They are usually off-site science centers and exhibitions with sample artifacts, educational content, stationary exhibits, and interactive installations. Everything included in a geomuseum contributes in showcasing the uniqueness of the geopark by explaining its geologic and human history in order to highlight its significance and heritage value to visitors. The contents of the geomuseum can offer general knowledge about topics relevant to the geopark, such as geological processes, natural phenomena of the area, local traditions, cultural heritage relics, folklore and others (Fig. 47, Fig. 48). The exhibitions mainly correspond to the geographical area where the geopark is physically set, and do not usually include artifacts from other places of the world, as do museums of Natural History.

Fig. 47 Geomuseum at the Qeshm Island UGG, Iran.

Fig. 48 Digital Geomuseum at the Lesvos UGG, Greece.

The geology of a place can reveal clues about every aspect of natural and cultural heritage, and life throughout the ages. Every place is unique, and offers a completely different story and content to its observer and inhabitant, yet we are still unaware of most of them. By getting to know about them we can have a greater understanding and respect for the world around us, and protect it instead of disrupting it.

3.2 The value of interactive technology in understanding and engaging with geology

As discussed in the previews chapter, HCI and interaction design can help create engaging activities and trigger powerful experiences, memorable to museum visitors. They can assist in deconstructing complex topics and represent information in simpler ways as to make it easier to understand by first-time learners. Interactive maps, visualizations, animations, narration, virtual representations are only few of the ways in which HCI can convert complex themes, such as geology, into appetizing content. Technology can bring

Fig. 49 Guggenheim Hall of Minerals (Top), Mineral and rock samples in the Hall (Bottom).

awareness to people well beyond the physical borders of the geopark. From a website to a virtual game, or an interactive map of the area, can inform people around the world about the existence and significance of the geopark. Remote technology can only take our understanding so far, yet it is key to interesting people into visiting the geopark and experiencing all that it offers, on and off-site.

Geology is a vast scientific field, filled with unfamiliar terminology, complex processes, intertwining scientific facts and can be overwhelming to non-experts. Geoparks are excellent places to observe geological sites, learn about the processes that created them, and appreciate the natural ecosystem. In geoparks, visitors can choose their level of involvement in activities. Those able to go on hiking tours can observe first-hand the geosites, while others who do not have the time or means can experience the geological treasures in the geomuseum.

In traditional natural history museums, national parks and science centers, the geologic exhibitions are designed as static displays of rock types and minerals enclosed in protective glass cases (Fig. 49, Fig. 50). Geological processes and natural phenomena are explained through passive media, and rarely connect natural to cultural heritage. A rather unexplored niche has been rising for new design opportunities; that of interactivity in geological learning. Traditional, non-interactive exhibits in aforementioned institutions, showcase illustrated representations of geological processes (Fig. 51), without depicting realistic virtual worlds. Realistic representations of sites and artifacts are necessary to showcase geologic activity, tectonic movement, landscape deformation, outcrop erosion, minerals and rock types in a way that can be easily understood by museum visitors. Few geological artifacts can actually be exhibited in museums due to size or location constrains. Those which can be displayed are almost always encased, thus preventing people from closely examining them and understanding what it is they are looking at. A fundamental process in understanding geology is to observe from up close, examine with ones' hands, ask questions and compare artifacts. None of this can take place effectively in such a museum setting or by just looking at the rocks. Additionally, in traditional museums the focus is on displaying general geological information, and little effort is put on explaining local heritage geosites, unless they are of extreme magnitude (e.g. glacier remains, meteor craters, active volcanoes, mile-long canyons etc.). These topics are noble and fascinating, but they can take away the holistic approach to geology, local history and related heritages. In an attempt to teach visitors about both general geology and rare natural sites, too much information is cramped in an exhibition with a set narration flow, overwhelming the learners.

Fig. 50 Rock types and focils at the Natural History Museum in Crete.

Fig. 51 Geologic exhibition at the Estonian Museum of Natural History.

Geoparks and geomuseums cocreate a freer and more interconnected frame for learning and understanding geology, exactly because they keep the focus on local topics and relevant geological processes. HCI and interaction design come to deconstruct and recompose the complex information in more digestible forms. Interactive maps, virtual representations of geological events, and content controlled by the visitors can establish a co-learning relationship between visitors and institution. Interactive systems allow for visitors to explore the content in a dynamic way, discovering the information for themselves and engage in connecting the dots. To include interactive exhibits and technology in geoparks and geomuseums, can enhance the visiting experience and have a strong impact on visitor sensitization, and build awareness about safeguarding the environment. Thus, geopark visitors are better able to understand and embrace the value of natural heritage sites, than visitors of traditional museums.

3.3 Interactive installations with geological content

Geology is a vast scientific field and geological information can be quite overwhelming to people who have never before being exposed to it. Interactive installations can showcase complex geological phenomena in simpler ways as to assist museum visitors in understanding the information. However, it is equally challenging to accurately design such an installation without oversimplifying and loosing vital information, as it is exciting to experience such content.

3.3.1 “Atomineralotouch”- Mineral composition

Fig. 52 User interacting via tangible objects representing atoms.

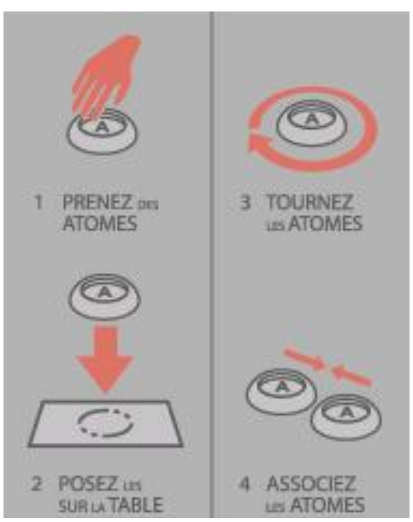

Fig. 53 Gestures for tangible object interaction. (1) Take atom (2) turn the atom (3) Put them on the table (4)

The “Atomineralotouch” is an interactive table with tangible interaction for mineralogy, exhibited in the Natural History Museum of Lille in France. The system was conceptualized and developed by Devocité in 2011. The interactive table aims to educate visitors about minerals and how they result from various combinations of chemical elements (Devocité, 2011). The design idea of the system is for users to simply “Compose your mineral by grouping the atoms on the table”. The table works with a combination of tangible interaction and gestures on the physical pieces for interaction. The physical objects represent atoms of chemical elements, and the user can place together many them on the table surface to form atomic structures (Fig. 52). The table reads the atom represented in each object and animates their chemical reaction to the other atoms, finally informing the user of the type of mineral he created (ATOMINERALOTOUCH / TABLE TANGIBLE DE COMPOSITION DE MINERAUX, 2012). Each physical object placed on the table is augmented by a virtual part forming a hybrid whole. The object becomes intelligent, it has a function, and reacts according to its position and its rotation, as well as its proximity to other objects (Fig. 53). In 2013 Devocité, in collaboration with Tangible Display, developed a solution for object detection without a camera on a “standard” multitouch table, with a capacitive screen or PQLabs type. This technology was presented at SimeSitem in January 2014. This type of interface is very suitable for valuing objects or explaining complex scientific concepts, such as the “Atomineralotouch” interactive system.

The system was created in a creative way and explains complex processes of mineral formation. The developed technology was custom made, involving costly pieces of technology to be combined into one interactive design. The exhibit allows for only one user to participate at a time, with little viewing freedom to others in order to capture their interest from afar. The "tangible" interface improves the feeling of immersion and ease of use, and the overall tangible interaction allows for a more engaging experience, however the gestures needed to be performed may confuse the user at the beginning. The system has an overall high learning value; however, it is debatable whether the content is easily understood due to the scientific terminology.

3.3.2 "geoVR"

GeoVR is a Virtual Reality interactive installation at the Magma UNESCO GLOBAL GEOPARK in Norway, and was developed by Doublethink. The virtual exhibition is placed in the Magma Geopark new info center. It allows people to virtually travel in space and time over the Geopark region. GeoVR showcases scenery, historical information and scientific phenomena (geoVR (promo English), 2016). The pilot project launched in 2017, and it planned to grow as a global platform for any Geopark or World Heritage site to be captured as immersive 360° scenery, adding 3D visuals, knowledge hotspots and interactive features (Magma UNESCO, 2017). From December 2017 each Geopark could be part of geoVR content management system which allow users to self-develop and upload in the platform contents and videos (geoVR, 2017).

The system uses the Unity platform to create the virtual tour and the Oculus VR set to navigate and interact with the content. The installation is open to viewers who are not actually using the headset. The virtual tour is displayed on a screen on the wall so that other visitors can see what the Oculus user is looking at (Fig. 54). The user takes a virtual tour of the Magma geopark area, meeting virtual points of interest that contain historical or geologic information about the sight. The information is presented in the form of a text over the scenery (Fig. 55). Overall the geoVR system is an interesting installation that allows Geopark visitors to explore a vast geographical area that is hard to cover completely on foot. It offers information regarding the geological and historical past of the region, helping visitors better understand the geologic time scale and overall impact of time on the land they live. Doublethink's initiative of creating geoVR as a global platform to showcase any Geopark or World Heritage site in the world is a noble, unifying idea that could enhance the global geopark network.

Fig. 54 User immersed in a virtual in the geoVR.

Fig. 55 Text information in the geoVR virtual tour.

3.3.3 “Geological Formations in the Stymphalia Region”

Fig. 56 Set up of the "Geologic Formations in the Stymphalia Region" installation.

The “Geological Formations in the Stymphalia Region” installation is part of an exhibition in the Environment Museum of Stymphalia, in Greece. The museum presents interactive digital exhibits to raise the public's ecological awareness and preserve the knowledge relating to the region's traditional technology (makebelieve, 2009). The exhibition was designed and developed by makebelieve design & consulting group, and consists of the four interactive systems: “Geological Formations in the Stymphalia Region”, “Reconstruction of Hadrian's Aqueduct”, “Myths and Birdlife of lake Stymphalia”, and “Stymphalia – a virtual journey through the site from Antiquity to the Middle Ages”.

Fig. 57 Blocked sink-hole in Stymphalia.

The installation on focus, “Geological Formations in the Stymphalia Region”, highlights the unique geological history of the area of Stymphalia mountain lake (600m altitude), in the northern Peloponnese. It is designed as a 3D experience about the geographic formations, erosions, waterways and valleys of the greater region around lake Stymphalia. The exhibit includes a digital film (Geological Formations in the Stymphalia Region, 2014) played on a wall-mounted displays, narrated in Greek and English, that controls a laser-head which lights a plaster model (maquette) of the surrounding area, placed right underneath the wall-mounted display (Fig. 56). The user stands in front of the installation, selects their preferred language, and throughout the video they can spot the mentioned geological features (Fig. 57) on the plaster model in front of them.

The “Geologic Formations in the Stymphalia Region” installation, along with the rest of the project’s installations, is fully integrated in the museum, forming a main support tool to make the content understandable by every-day visitors. The system holds an important role in supporting the interpretative, educational and experiential strategy of the Environment Museum of Stymphalia. It is also valuable to the local area as it helps people understand the uniqueness of the Stymphalia lake and the great geological and heritage value it holds. As the largest mountain lake in Peloponnese and southernmost mountain wetland in the Balkans, Symphalia holds its own geologic history worth telling. At the same time, it is remarked in Greek mythology as the place where Hercules completed one of his Labours (V-Must, 2009).

3.4 Chapter Overview

Geotourism is a sustainable kind of tourism that rises awareness for areas of geological significance through onsite activities within the geopark or offsite educational centers such as geomuseums. Interactive installations can offer much in highlighting geological, natural, and cultural heritage in geomuseums, as they bring forth engaging experiences to visitors. Existing interactive installations present complex scientific and geologic concepts in an easy, learning friendly manner through meaningful content and inspiring interactions.

4 Research

The first encounters with prof. Dr. Martin Engi clarified that much needed to be learned and understood in order to obtain a sufficient background and vocabulary of geology. Thus, much research was done on the necessary general concepts of geology, that could lead to better understand the case of Syros. Bibliography from the Greek and global scientific literature was studied to understand basic earth science concepts, such as earth anatomy and formation, geologic time scale, tectonometamorphic evolution, the rock cycle, and rock and mineral formation processes. The newly acquired knowledge was further clarified during field research, as Dr. Engi led several hikes around Syros to showcase specific outcrops, explain geological processes, and help us understand the overall geologic uniqueness of Syros. During the hikes we gathered raw material in digital form (photographs, notes, recordings, GPS locations etc.). All research pieces were combined to create the final content used in the GLAUKO system.

4.1 Desktop research and scientific paper reviews

The history of the Earth's formation from birth to present time is a billion year-long history, which cannot be properly analyzed and presented in a single source or research of this kind. Instead, this work will only scratch the surface of the geological events leading up to the formation of the landmass now called Syros. Basic terminology will be explained as to provide the reader with enough vocabulary to follow the geological timeline and events that shaped this region of the world.

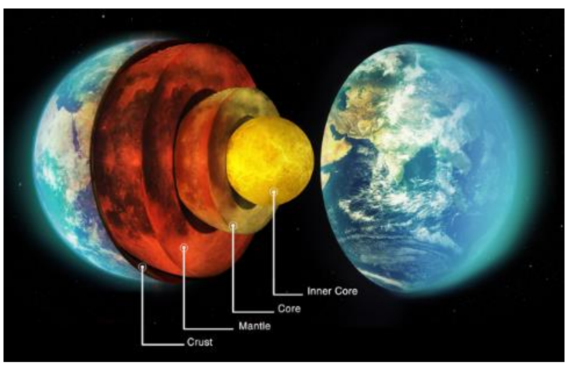

Fig. 58 Anatomy of the Earth: Structural layers (Arcurs).

4.1.1 General Geology

Geology is an earth science which studies and describes the solid Earth, the rocks which compose the planet, and the processes that shaped this structure over time. It combines scientific tools from other disciplines, such as physics, chemistry and biology to determine the relative and absolute ages of rocks found in a given location, ultimately describing their histories, and the history and age of Earth as a whole (Montagner, 2011).

The interior structure of the Earth is divided into layers of different physical and chemical properties, and from inner to outermost these layers (Fig. 58) are the Core, Outer Core, Mantle, and Crust (Montagner, 2011). The Crust and the uppermost mantle make up the Lithosphere, immediately bellow follows the Asthenosphere which includes the viscus part of the upper mantle, and lastly the Mesosphere refers to the mantle's region under the lithosphere and the asthenosphere, yet above the outer core (Fig. 59).

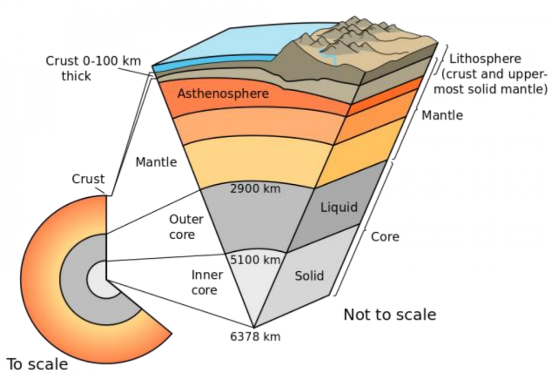

Fig. 59 A cut-away of Earth's layers reveals how thin the crust is when compared to the lower layers.

4.1.1.1 Geologic time Scale and Earth tectonic evolution

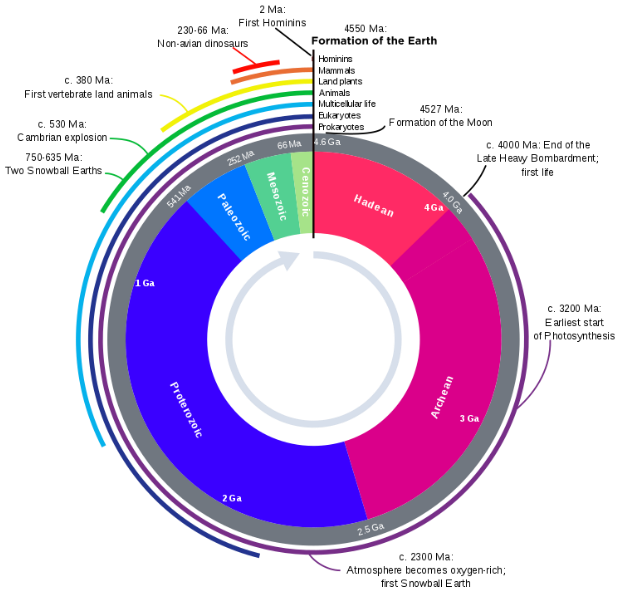

Fig. 60 Geologic time represented in a diagram called a geological clock, showing the relative lengths of the eons of Earth's history and noting major events (Public Domain).

Earth has been dated to be approximately 4.5 to 4.6 billion years old (Dalrymple, 2001). Compared to the Earth's age, humankind's existence corresponds to only 200,000 years of the planet's lifetime. During humankind's lifetime it is nearly impossible to observe and understand the processes that shape the Earth. In Geology, and other sciences, units of time are defined according to the rate of change from one state of the observed "object" to the forthcoming. Geological time is a scale used to set order in the gradual transition between states of the earth's formation (Fig. 60). This particular time scale can be understood from the largest and most general intervals, or units, to the smallest, most specific intervals; Eons, Eras, Periods, Epochs, and Ages.

There are four Geologic Eons, the Hadean, Archean, and Proterozoic Eons, otherwise grouped together and referred to as the Precambrian supereon, and the Phanerozoic eon, the one we are living through to this day (Cohen, 2013). The Hadean eon lasts from the Earth's formation about 4.5 billion years ago (Ga for gigaannum) to 4.0 Ga (Dalrymple, 2001). During this period the Earth was initially molten due to extreme volcanism, until the cool off of the outer layer into a crust when water began accumulating in the atmosphere (Carlson, et al., 2014). The Archean eon lasted from 4.0 Ga to 2.5 Ga (Cohen, 2013) during which the first single-celled organisms formed (Schopf, Kudryavtsev, Czaja, & Tripathi, 2007) and from which our earliest rock samples have been dated. The Proterozoic eon extends from 2.5 Ga to 542 million years ago (Ma for mega annum) (Brian, 1997), and evidence from the period show a more defined continental formation and high tectonic plate activity with evidence of subduction zones (Bird, 2003), as well as the appearance of eukaryotes and multicellular life forms (Stanley, 1999). After 541 Ma the Earth enters the Phanerozoic eon, which is subdivided into the Paleozoic, Mesozoic and Cenozoic Eras. The eras are named after the stages of geological or biological events on Earth each subdivided into different periods, epochs and ages. Geological events happened simultaneously as biological ones, affecting the life conditions and spreading of organisms. Early Paleozoic era, named Cambrian period (541-489 Ma), sees an explosion of life

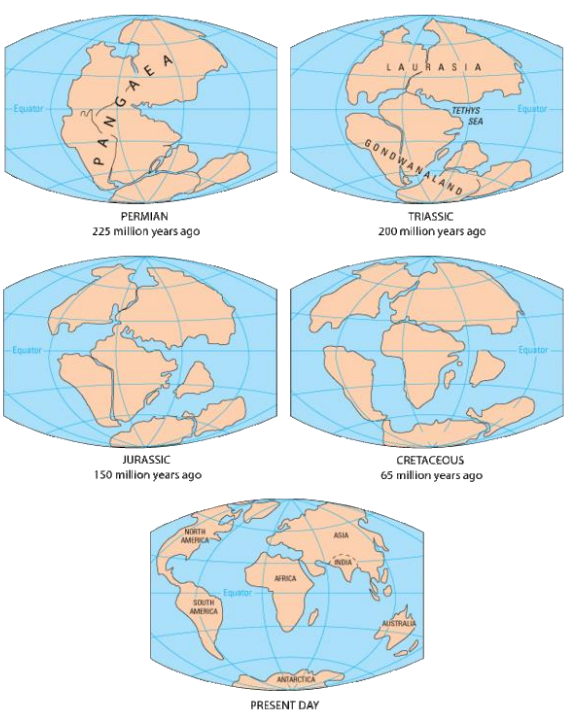

Fig. 61 Pangaea breakage into present day continent formation (Kious, Tilling, & Kiger, 1996).

(Zhuravlev & Riding, 2000). By mid-Paleozoic era (358-330 Ma), Earth hosts primitive trees, amphibious species, fresh-water predators, and sharks (Beerling, 2017). Geologic activity at the Earth's crust resulted into the formation of supercontinents since the mid-Archean eon (3.6-2.7 Ga) (Zegers, 1998).

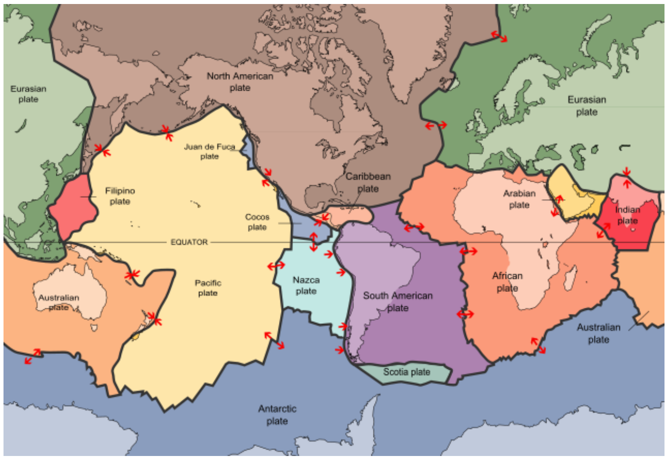

Fig. 62 The key principle of plate tectonics is that the lithosphere exists as separate and distinct tectonic plates, which float on the fluid-like (visco-elastic solid) asthenosphere. The relative fluidity of the asthenosphere allows the tectonic plates to undergo motion in different directions. This map shows 15 of the largest plates.

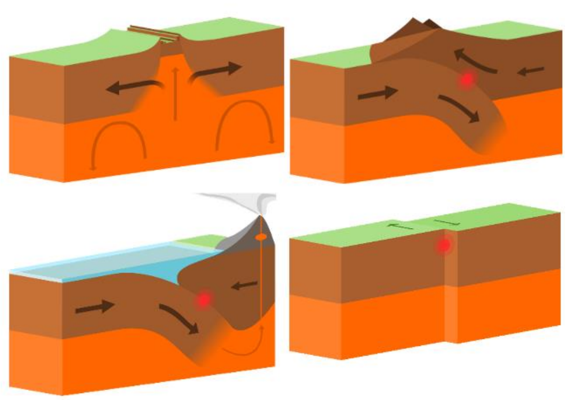
Fig. 63 (Top Left) constructive/divergent, (Top Right) convergent boundary, (Bottom Left) Convergent boundary between oceanic and continental plates, (Bottom Right) transform boundary. (Domdomegg, 2016), (Alexnikifix, 2016), (Madfedora, 2017), (Domdomegg, 2016).

A supercontinent is a single continental landmass assembled from most or all of Earth's continental lithosphere at the time (Rogers, 2004) (Fig. 61). A cycle of supercontinents forming and splitting up every few million years, is driven by plate tectonics. Plate tectonics are pieces of lithosphere which contain continental or oceanic crust or both (Fig. 62). These plates float on the fluid-like asthenosphere which mainly consists of magma. The relative fluidity of the asthenosphere allows the tectonic plates to undergo motion in different directions. Gradual shift of the plates results in separation of the continents and alteration of the geomorphology of the Earth's surface, volcanic activity, changes in climatic conditions, thus impacting life adaptation or extinction of life on Earth (Oregon State University). Tectonic activity is responsible for orogeny (mountain ridge formation), creation of subduction zones, volcanoes, mid-ocean ridges, and oceanic trenches (National Oceanic and Atmospheric Administration). Such events occur mostly at the plates' boundaries. As the plates interact, they may slide away from each other allowing for land creation from magma overflow, (divergent boundary), collide against each other causing land deformation (destructive boundary), or grind along their boundary (transform boundary) (Fig. 63) (USGS, Understanding plate motions, 2014). Plates include both oceanic crust and continental crust. Subduction zones exist at convergent plate boundaries between continental plates, oceanic plates or one of each kind. Subduction is a geological process that takes place at convergent boundaries of tectonic plates (Fig. 63), where one plate moves under another and is forced to sink due to high gravitational potential energy into the mantle (Stern, 2002).

By the mid-Paleozoic era in the Earth's crust, supercontinents had formed and broken apart repeatedly allowing or restricting the spread of life at sea and land. The most recent supercontinent, Pangaea (Fig. 61), started forming about 335 million years ago and began to break apart at 175 million years ago (Rogers, 2004). This time window is divided into the Carboniferous (~335-303 Ma), Permian

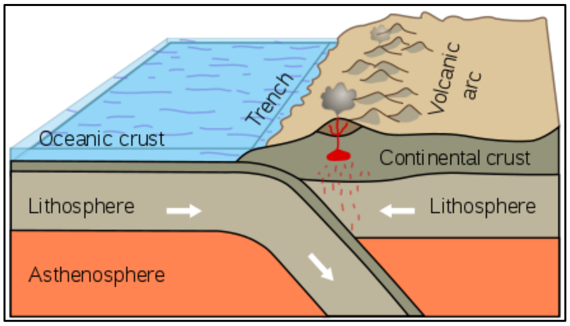

Fig. 64 Subduction of an oceanic plate beneath a continental plate to form an accretionary orogen (USGS, Understanding plate motions, 2014).

(~298-254 Ma), Triassic (~251-208 Ma), and Jurassic (~201-152 Ma) geological periods (Cohen, 2013). By the time Pangaea was fully formed and started to break apart, the dominant species on the planet were dinosaurs (Haines, 1999.), with small mammals subtly existing alongside the great reptiles (Luo & Wible, 2005). The Cretaceous period (~145-72 Ma) dawned with Pangaea having split into almost present time continents, however at different positions from today (Vennari, et al., 2014).

Jumping forward to the Eocene epoch (~56-37 Ma) of the Cenozoic era (~66-Present day), the African-Arabian tectonic plate subducts underneath the Eurasian plate (Fig. 64). This process formed the Hellenic belt, or Hellenic orogeny, which covers today's terrestrial region of Greece and marine area of the Aegean Sea (Mountrakis, 2006) (Paleogene period ~66-28 Ma, or late Eocene epoch ~47-37 Ma). As the oceanic part of the African plate subducted under the continental Eurasian plate, the lithosphere was deformed, squeezing and uplifting the surface rocks together into mountains towards the continental plate, and pushing or dragging the rocks right at the fault deep within the earth. This tectonometamorphic evolution was responsible for shaping the Cyclades archipelago at the southern part of the Aegean Sea.

Fig. 65 Artistic interpretation of the Mediterranean geography during its evaporative drawdown, after complete disconnection from the Atlantic. The rivers carved deep gorges in the exposed continental margins (Paubahi, 2013).

However, the aforementioned events created the landmasses of the Hellenides, which are in reality simply mountain tops. To define an islandic complex, such as the Cyclades, we must answer both when the terrestrial bodies were formed, and most importantly when the sea rose up to substantial levels to cover the basin of the archipelago, and separate the mountaintops, thus defining them as islands. During the late Miocene epoch which follows (~11-7 Ma), the collision of Africa-Arabia to the stable Eurasian continent shaped the Mediterranean Basin (Krijgsman, 2001). This collision caused the Strait of Gibraltar to close about 5.96 million years ago, sealing the Mediterranean off from the Atlantic, causing most of the water to evaporate and dry out the Basin (Gargani, 2007) (Fig. 65). This event, known as the Zanclean flood or Zanclean deluge, is a flood theorized to have refilled the Mediterranean Sea 5.33 million years ago (Blanc, 2002). This flooding ended the Messinian salinity crisis reconnecting the Mediterranean to the Atlantic Ocean (Fig. 66) (Gautier, 1994). The Cycladic plateau is generally less than 200 meters deep, thus it lies mostly underwater because of the thinner crust (Gaki-Papanastassiou, 2010). Consequently, the Cyclades formed as mountaintops about 50 million years before we can define them as islands, and more or less still lay in a shallow puddle of water.

Fig. 66 Artistic interpretation of the flooding of the Mediterranean through the Gibraltar Strait (A) and the Strait of Sicily (F) about 5.3 million years ago (Paubahi, 2013).

4.1.1.2 The Rock Cycle

Earth is a closed system of matter and an open one to energy. This means that all matter on the planet is constantly being recycled, reformed, and emitted back into space, but not created anew or completely destroyed, and new energy enters the ecosystem from the sun. The rock components of the crust are slowly but constantly being changed from one form to another and the processes involved are summarized in the rock cycle. The Rock Cycle (Fig. 67) describes transitions through geologic time among the three main rock types: sedimentary, metamorphic, and igneous. Each rock type is altered when it is forced out of its equilibrium conditions (Blatt, 2006). Igneous rocks are formed from the cooling and crystallization of magma (molten rock). Sedimentary rocks are formed when weathered fragments of other rocks are buried, compressed, and cemented together, or when minerals precipitate directly from solution. Finally, metamorphic rocks are formed by alteration (due to heat, pressure, and/or chemical action) of a pre-existing igneous or sedimentary rock (Earle, 2018).

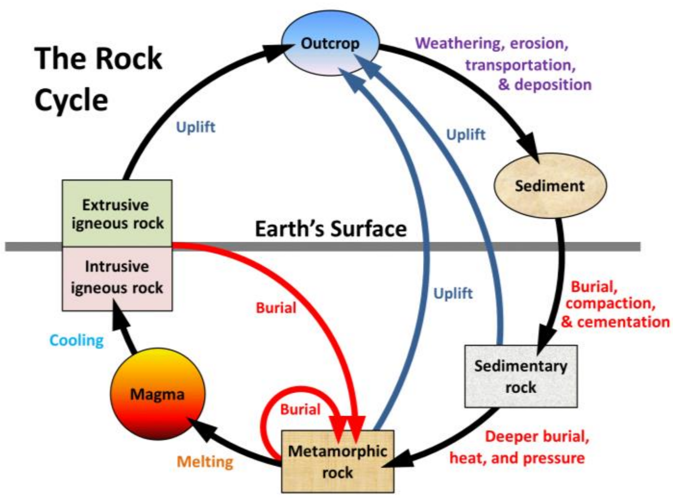

Fig. 67 Schematic view of the rock cycle (Earle, 2018).

The rock cycle takes place both above and below the Earth's surface. The rock deepest beneath the earth's surface, and under extreme heat and pressure, is metamorphic rock. This metamorphic rock can melt and become magma. When magma cools below the earth's surface, it becomes "intrusive igneous rock." If magma cools above the earth's surface, it is "extrusive igneous rock" and becomes part of the outcrop. The outcrop is subject to weathering and erosion, and can be moved and redeposited around the earth by forces such as water and wind. As the outcrop is eroded, it becomes sediment which can be buried, compacted, and cemented beneath the Earth's surface to become sedimentary rock. As sedimentary rock gets buried deeper and comes under increased heat and pressure, it returns to its original state as metamorphic rock. Rocks in the rock cycle do not always make a complete loop. It is possible for sedimentary rock to be uplifted back above the Earth's surface and for intrusive and extrusive igneous rock to be reburied and become metamorphic rock (Earle, 2018). Metamorphism is the transformation of a parent rock into a new rock as a result of heat and pressure that leads to the formation of new minerals, or recrystallization of existing minerals, without melting (Earle, 2018). Most metamorphism results from the burial of igneous, sedimentary, or pre-existing metamorphic rocks to the point where they experience different pressures and temperatures than those at which they formed.

4.1.2 Syros Geology

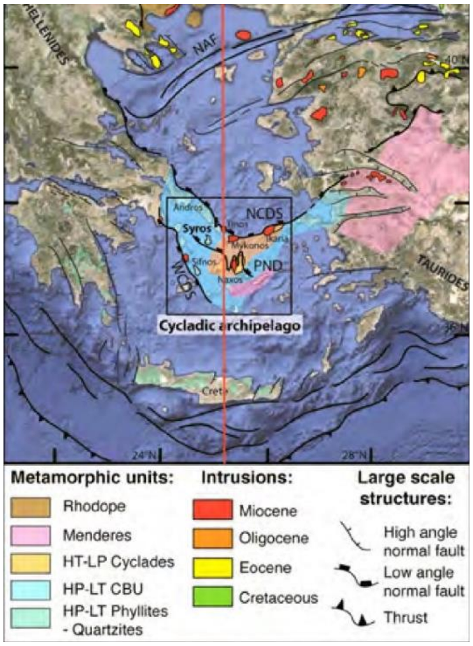

Fig. 68 Metamorphic units, intrusions, and subduction zones in the Cycladic archipelago of the Hellenic subduction zone (Jolivet & Brun, 2010).

The Hellenic orogeny hosts the Aegean domain, which is a collapsed segment of the belt, and was evolved in two main stages (Ring, Glodny, Will, & Thomson, 2010). The first stage took place during the Cretaceous-Eocene period (~145-33 Ma), as the African plate converged with the Eurasian plate forming the Hellenides-Taurides belt. The Hellenides were forming during this first stage, between 58 to 35 million years ago. During these events, large masses of oceanic and continental rocks entered the subduction zone between the Eurasian and African plates, and thrusted along the horizontal fault (nappes), getting mixed one on top of the other in a High-pressure – Low-temperature (HP-LT) metamorphic context (Bonneau, 1982). The second stage was relatively short for geologic scales, and took place between 35 and 30 Ma (Eocene-Oligocene), as the African slabs retreated in an accelerating rhythm, thus migrating the whole subduction front southward, and reworking the nappe stack (Jolivet et al., 2004).

The Cyclades archipelago is part of the Hellenides orogeny and went under extreme conditions of change, during the second stage of events (Fig. 68). The archipelago got subducted and re-surfaced between the two tectonic plates, Eurasian and African. This exhumation process (Fig. 69) birthed the proper conditions for HP-LT metamorphism to occur in some of the islands. In these few islands of the Cyclades, these conditions formed rare rock units, most famous of all the Cycladic Blueschist Unit (CBU) (Laurent V. P., 2018). Syros island, located in the central part of the Cyclades, is mainly composed of the CBU and is famous for its excellent preservation of HP-LT metamorphic rock types, such as eclogites and blueschists (Laurent V. P., 2018). Outcrops of these rare rock types and evidence of their parent geological processes (HP-LT metamorphism, unit subduction etc.), are extremely hard to observe and study because they occur deep underground and the outcrops rarely surface completely in good conditions. Such rock types are found in few other places in the world that have undergone similar subduction and exhumation process as Syros, yet in Syros we see them abundant and clearly exposed on the ground surface (Laurent V. P., 2018). As a result, Syros holds great geological importance, and has been the focus of countless petrological, structural and geochronological studies that aim to better define the formation process of the CBU subduction complex.

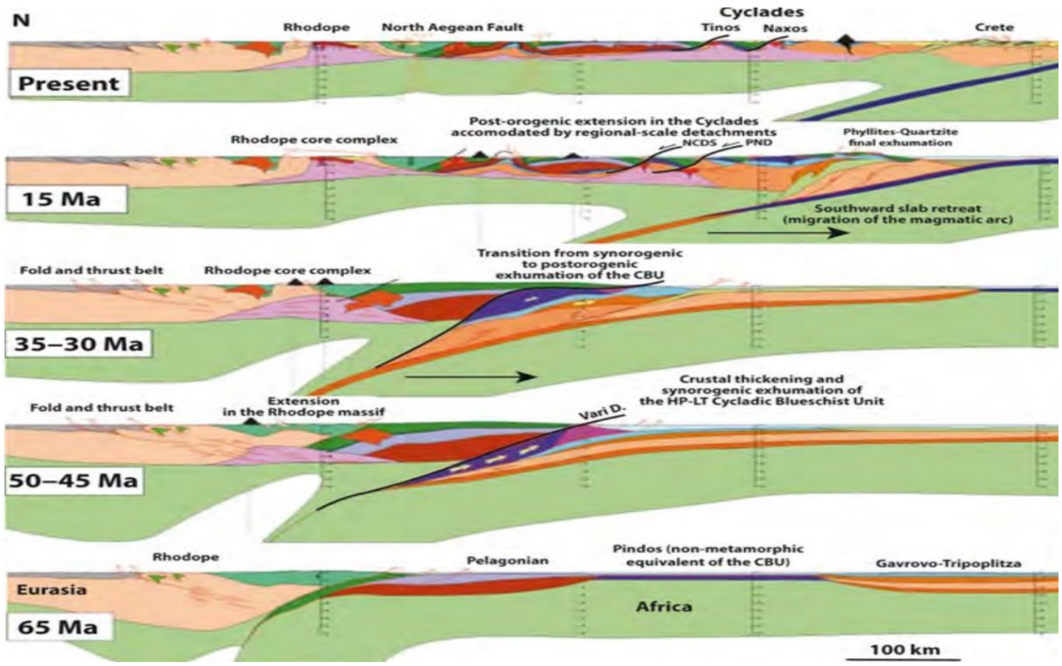

Fig. 69 Tectonic reconstructions of a N–S section of the Aegean domain highlighting the structure of the Hellenic subduction zone, the southward retreat of the slab with time and the evolution of the Cycladic Blueschist Unit (CBU) from burial to final exhumation (after Jolivet & Brun, 2010). NCDS, North Cycladic Detachment System; PND, Paros-Naxos Detachment; WCDS, West Cycladic Detachment System, NAF, North Anatolian Fault.

Syros consists mainly of metamorphic rocks such as mica schists, marbles, gneisses, amphibolites, blueschists (or glaucophane schists), and eclogites (Papanikolaou et al., 1981, Papanikolaou, 1987). The last two groups of rocks are HP-LT metamorphic rocks, and the rest formed under different metamorphic conditions during exhumation and retrogression. The compressional period changed to tensional during Oligocene or Miocene times in the form of shallow normal faults. During the Miocene the Central Aegean was a very shallow domain with extensive emerged regions and small elongated basins, as a consequence of prolonged intense compression (Angelier, 1976, 1979, Mercier et al., 1976, 1979) which resulted in the formation of steep graben faults that rapidly uplifted the blueschists. In this period lower pressures metamorphosed a new group of rocks which formed the greenschists.

The main subunits of Syros, which are defined also as the island's rock units, contain the following dominant rock types (Fig. 70). Proceeding north to south, metasedimentary micaschists exist in the northern region, the (meta)conglomerates are found only at the north tip of Syros, metabasite rocks are found in the Kampos subunit (North and along the coastline), marble extends almost to the whole island except the Poseidonia subunit, in the Chrousa unit we find marbles and micaschist interchanging constantly in the landscape, greenschists dominate the Poseidonia subunit, the SW Komito region has a distinct type of gneiss, and finally the SE is the Vari Unit which consist of low-pressure metamorphic rocks mainly mylonitic greenschist and gneiss, and is a completely distinct unit from the rest of Syros.

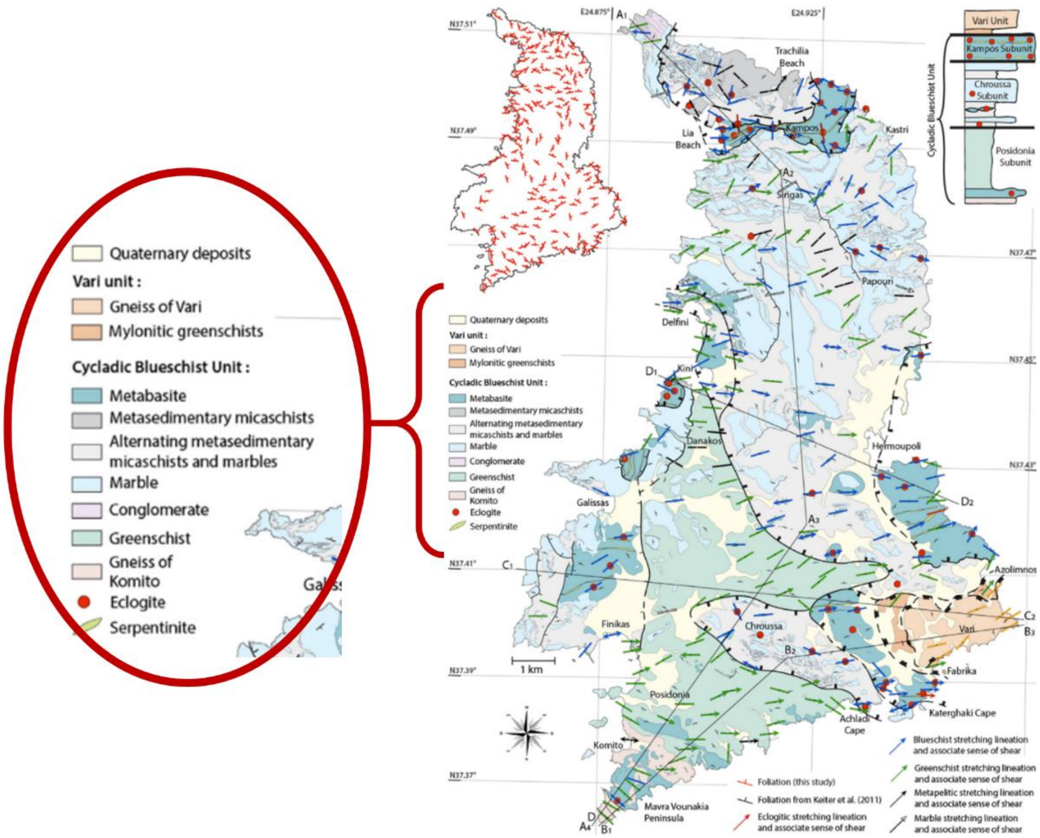

Fig. 70 New geological map of Syros showing the main tectonic structures and lithologic distributions (geometry of the Vari Unit after Soukis and Stöckli, 2013). Cross-sections are traced with black lines and highlight the architecture of Syros. Planar (foliation planes) and linear (stretching lineations) fabrics are represented with their associated metamorphic facies. Also shown are the localities cited in the text (Laurent, 2016).

4.1.3 Related work and systems

Presentation and analysis of interactive systems with related content was covered on chapter 2, section 2.2 Types of interactive Installations in museums and exhibitions with examples, and chapter 3, section 3.3 Interactive installations with geological content. Interactive installations with geological content on Syros have not been designed or developed yet.

4.2 Interviews with Prof. Dr. Martin Engi

Interviews with professor Martin Engi were recorded over a period of time, on sit down appointments and during field research hikes. We gathered an overall of 12 record files, adding up to 13.5 hours of relevant recorded material. The topics discussed varied from general geological concepts to particular processes responsible for the formation of Syros and the Cyclades island complex, and to specifics on high-pressure metamorphism which characterizes the majority of the rock types of Syros. At first the interviews followed a more or less structured flow of set questions in order to get an initial understanding of the geological case of Syros. As the topics progressed into more details and observations on the field, the questions were improvised and focused on increasingly more detailed-specific topics. Professor Engi provided information on general geological topics, such as geologic time scale, earth's formation mechanics, and mineral chemistry in order to set a basic level of geological knowledge and concept understanding. The full extent of the on-site lectures was recorded during the geological field research, and is available in section 10.2.

4.3 Geologic Field Research & Content Creation

In order to gather all the required information and photographic material, field research was conducted by visiting a handful of important geological sites around the island. Direct observation and documentation of the outcrops made the study of geological concepts, processes and overall importance well understood. In this section, we explain the process that we followed to learn about the outcrops, spot them, understand them and photograph them along with matching the information. The field research method followed during the hikes is similar to the one used by geologists when conducting field research. We used the same observation and recording process, similar scaling and recording tools and techniques, but the depth of information was suited to own level of understanding. Samples of the overall material are shown in section 4.3.3. The full material is available at the appendix, section 10.1.

4.3.1 Field visits

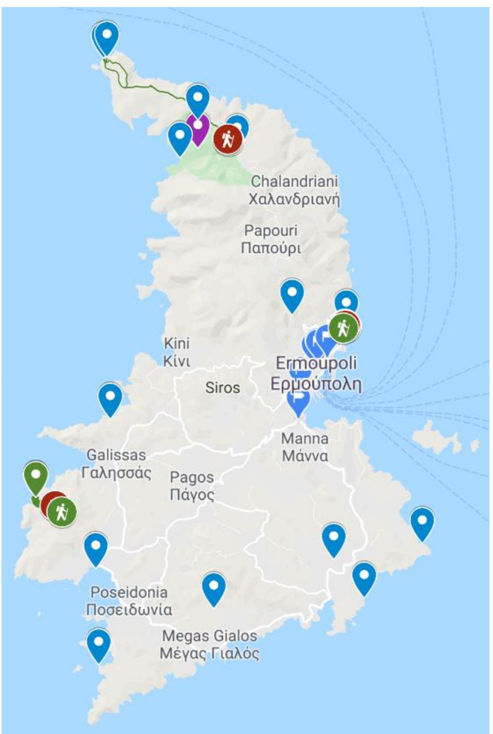

Fig. 71 Visited locations and hiking routes.

All the sites chosen and displayed were visited on foot by hiking to the destination or by car when accessible. The trails that were visited lead to the specific outcrop locations, which showcase typical and variations of the rock types of Syros (Fig. 71). The points of interest were chosen by geological importance, rock type variety, point accessibility and hiking trail difficulty, and additionally if we could showcase and explain a geologic process at a particular POI alongside an outcrop. We were interested in showing POIs with outcrops characteristic to Syros, as well as with evidence of geological processes, such as erosion, deformation, landscape faults, rock subunit or unit contact etc. We also chose a few POIs with significant historical or cultural value. This was done as in geoparks the geological heritage is presented alongside cultural heritage of the local area, with topics, themes, locations and material interconnecting and bringing forth a more holistic frame of the place hosting the Geopark.

Selected POIs

The POIs chosen for study and display in the interactive system were these sixteen (16) (Fig. 72**Error! Reference source not found.**): Abelaki beach, Aerolithos, Agios Stefanos, Ano Syros, Aspro Pounti, Fabrika, Foinikas, Gria Pounta, Kampos, Komito, Lakkoi, Lia beach, Marmari, Mavro Pounti, Megas Gialos, and Vari.

These spots were chosen because they are scattered all over Syros, and represent all rock type subunits. The POIs Abelaki beach, Aerolithos, Foinikas, Kampos. Lakkoi, and Lia beach are all found in the Metabasite rock subunit. This is the rock family that Syros is most famous for in the geologic community, thus we needed to represent the classic outcrops, as well as variations, to showcase the geologic variety.

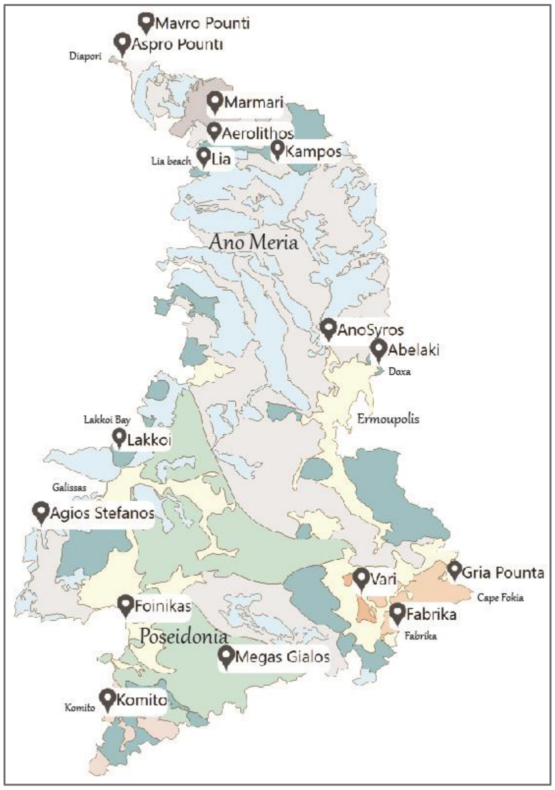

Fig. 72 Simplified geological map of Syros, with POIs and relative regions marked.

The POIs Fabrika and Gria Pounta do not belong in the same rock unit, however they appear together as Fabrika is on the outside verge of the Vari unit, and depicts beautifully various geological processes. Gria Pounta is the only POI in the Vari unit (mentioned as Vari Gneiss subunit in the Lauret et. al. map (Fig. 70)), a region of Syros without any high-pressure rocks and geologically intriguing to the scientific community.

The POIs Marmari and Mavro Pounti, on the northern part of Syros, represent the Metasedimentary Micaschist rock subunit. Only Mavro Pounti showcases unique outcrops, however, Marmari is a historical site due to a Marble quarry.

The rest of the POIs corelate to rock subunits as follows: Aspro Pounti located in the (Meta)Conglomerate subunit, Ano Syros located in the Alternating Metasedimentary Micaschists & Marble subunit, Agios Stefanos belongs in the Marble subunit, Megas Gialos is in the Greenschist subunit, Vari is located in the Mylonitic Greenschist subunit, and Komito is found at the Komito Gneiss subunit.

Walks on Geopaths

Fourteen of the sixteen POIs were visited and covered during four hikes to the geosites. The material for the other two POIs was gathered remotely with the help of prof. Engi. On the course of one hike outing we visited between two (2) to five (5) POIs. During the first hike we covered the POIs Ano Syros, Kampos, Aerolithos, and Lia. The full hiking trip took about 7 hours to complete (9 am ~ 4 pm), as it was our first field study hike, and there were many topics to learn in the beginning, thus many stops were made to make sense of the new information. The Ano Syros POI was revisited without professor Engi, to gather more photographic material. The outing took about 1 hour to complete. On the second hiking trip we covered the POIs Abelaki, Fabrika, Komito, Foinika, and Lakkoi. This field study took seven (7) hours also to complete, from 10 am to 5pm. Most of these spots where accessible by car, besides Lakkoi and Abelaki. The third outing covered the POIs Vari, Mega Gialo, Foinikas (for additional content) and Agios Stefano. We visited these sites without prof. Engi, however, we knew what outcrops we were looking for to document, as the professor had already provided us with sample images to recognize them. Agios Stefanos is a known location in Syros, thus we had no problem locating and reaching the POI, other than the trail difficulty. This outing took also 7 hours, from 4 pm to 10 pm. The visits were conducted with the assistance of a fellow undergraduate collogue. The final hike outing was done once again with the company of professor Engi and a group of university professors and local residence. The outing served different groups for different research goals. We covered the POIs Aspro Pounti and Mavro Pounti, located right next to each other at the northern tip of Syros. The hiking trip took about 8 hours to complete, from 9am to 5pm, with only half of the group completing the whole trail.

Complete raw material gathered

Overall, we completed 30 hours of hike outings, 22 with professor Engi and 8 without him, to gather raw material. From the hikes, professor Engi, Mrs. Hara Pelekanou, a fellow hiker, and us, gathered 721 photographs as raw material (515 taken by us, 40 contributed by prof. Engi, and 166 by Mrs. Hara Pelekanou). Of those photographs 105 where used in the final application, of which 78 were taken by us, 24 of those were contributed by prof. Engi, and 3 were contributed by Mrs. Pelekanou. In addition to photographs, during the hikes we recorded professor Engi's field lectures and conversations with us. During the hikes the recording device was rarely stopped, and for brief moments. We gathered an overall of 12 record files, adding up to 13.5 hours of relevant recorded material. The recordings were listened to carefully afterwards, and the information was recorded in written form for better examination. These recordings were a great source of content for the information included in the interactive system.

4.3.2 Content gathering Methodology

Geologists follow a specific approach when they work in the field and document outcrops. Prof. Engi showed us the same procedure and we followed it during every hike when we recorded information and gathered content for the application. The base of this observation and recording methodology is to have the researcher first observe the overall scene and the outcrop from afar, and then start observing more in detail. This way they can better understand the events that took place to form the particular landscape. The larger event usually translates to smaller scale effects, and vice versa. If we observe closely an outcrop, most likely, the surrounding area will be similarly affected by whatever geological event. However, this is not always the case, and as non-expert researchers we were advised to follow the large-to-small scale approach. The reverse is usually correct observation when the observer is well trained in the field, not without experience.

Tools

During the hikes we used a digital, mirrorless, single-lens reflex camera (SLR) to take high definition photographs of the landscapes, outcrops, rock samples and rock surfaces. A notebook was used to take notes on key points and to sketch outcrops as a means of study. A magnifier (eye-lens) was used to examine in detail the surface of the rocks and outcrops. Finally, a cellphone was used to record Prof. Engi as he explained the geological processes and features, we were observing, and also to track the GPS coordinates of the outcrop location, and in the harder hikes the trail route followed (Fig. 71). Additionally, we used a coin (1 euro or 50 cent), a knife, and a hammer as scales to include in the outcrop photos we took in order to make clear to the viewer of the image the actual size of the depicted outcrops (Fig. 73). For larger scales we used the landscape to show the outcrop in relation to the surrounding environment.

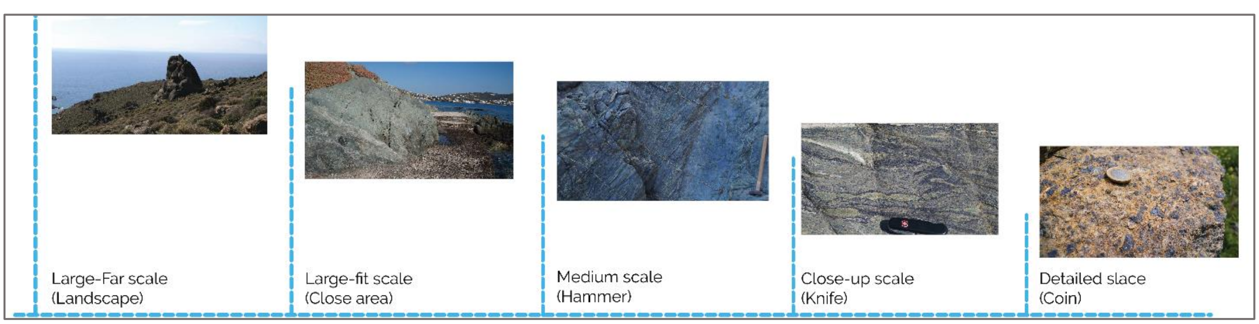

Fig. 73 Sizing scales used when photographing outcrops.

Field Research Method

The method can be split in two phases (Fig. 74). In the first phase, of observation, we first stood and observed the overall landscape and the subject outcrop from a distance to get a first idea of what was going on. Then we studied the topic to get an initial understanding of the case. Afterwards we moved in closer to the outcrop to observe its form and characteristics in more detail, and finally we used a magnifier to examine the rock's surface and take a close look at the minerals. During the whole observation phase prof. Engi gave small, comprehensive lectures about what we were observing and how it had come to be. These lectures were recorded fully with the cellphone device, and later studied thoroughly for content creation. Once most of the questions were answered and we had a good idea of what material we wanted to gather, started the second phase of the method, the recording. As prof. Engi taught us, we took a step back, re-observed the outcrop, and take notes. At this point, it was time to record the GPS location of the outcrop. It was necessary to understand what exactly we wanted and needed to show in order to transmit the proper information. We needed to decide on what we wanted to show and make a sketch of the area that we were studying, large or small. The sketching helped with breaking down the "picture" and understanding what we had to show. For both sketching and photographing, we needed to use the appropriate scale-tool, depending on how close of far was our viewpoint. After the sketch study, we set up the various scales as needed and took the photos we wanted to show the outcrop in multiple scales (Fig. 73). We had to have a clear, unshaded view of the outcrop to get a comprehensible picture. We were advised to go from large to smaller scale, both for sketching and photography, as it would help to better keep track of the focal points.

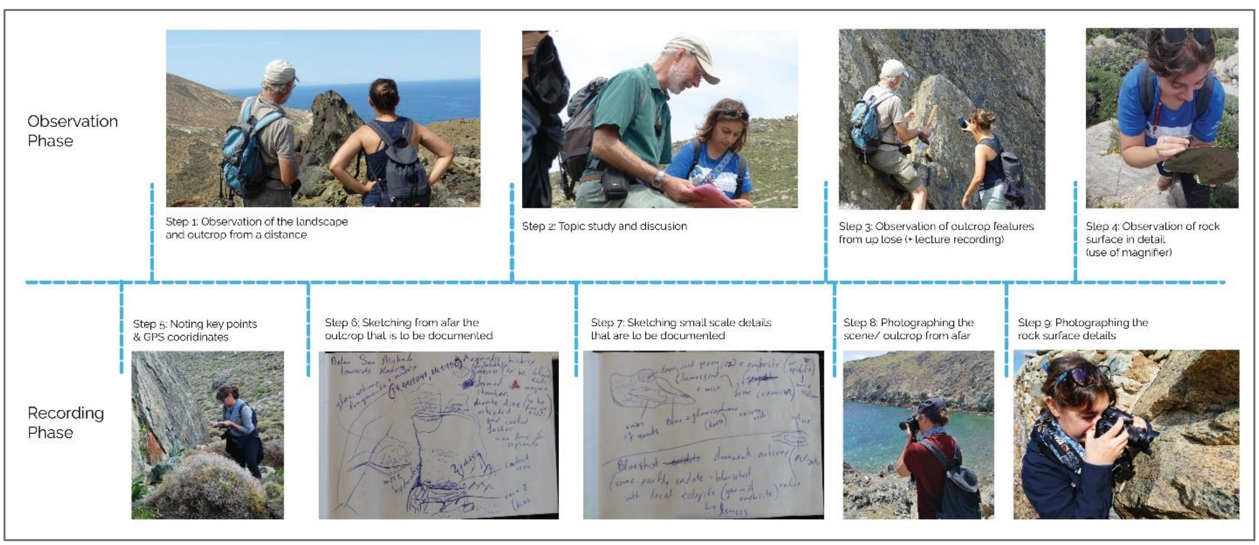

Fig. 74 "Field geology" method used for content gathering during the hikes.

4.3.3 Briefing of Hikes' Material (More at Appendix)

During the hikes, material was gathered in the form of photographs, sound recordings and notes. For each outcrop, photos were taken from various angles and at many scales to achieve a thorough study. Descriptions and explanations of the responsible geological processes made the outcrops easier to understand and helped make sense of what was observed. The hikes covered a variety of places leading to points of interest around the island in order to cover all rock units of Syros sufficiently. The visited points of interest (POIs) which are also displayed in the final system are the following. The information displayed in the application is in simple tongue, with only the necessary terminology in order to inform the museum visitors properly, yet not oversimplified to result in sciolism.

Hike 1: Ano Syros-Kampos-Aerolithos-Lia POIs (Hiking with Prof. Engi)

Fig. 75 Path to Pigi from west gate of Ano Syros (at the foot of the settlement).

Ano Syros is a POI chosen to represent the Alternating Micaschist and marble Unit of Syros. It falls right on the cross section of three units, Alt. Micaschist-Marble, Marble, and Quaternary Depostis, making it ideal to showcase and explain a characteristic landscape of central-to-northern Syros (Fig. 75). The path displayed is the path form Ano Syros to Pigi. It is easily accessible by foot, well known to the local population, and very close to both the towns of Hermoupoli and Ano Syros. The photo samples were taken from this location: 37.4547003, 24.9335157.

Kampos is a point of interest located at the north area of Syros, known as Apano Meria or Ano Meria. It is inside the Kampos sheer zone which extends from west to east of this particular point of interest. It is one of the points of interest representing the Metabasite rock type subunit. The POI is accessible by car, and eclogitic outcrops are exposed along the main road. We see partly deformed metagabbro (coarse-grained glaucophane-eclogite (Fig. 77) that has originated inside a magma chamber, and a chlorite -serpentinite schist (Fig. 76). The photo samples were taken from this location: 37.41731, 24.917003

Fig. 76 Chlorite-serpentinite schist in Kampos.

Fig. 77 Glaucophane crystals (pseudomorphs) in Metagabbro.

Aerolithos is an eclogite outcrop in the Metabasite Unit of Syros. It can be found right on the path from Kampos to the beach of Lia, in the northern region of Syros, better known as Apano Meria. This sight was chosen due to it already being known to locals, geology experts and introduced in tourist guides. It is a good point of interest to showcase the characteristics and uniqueness of the eclogite rock type, for which Syros is well known for in the scientific field of geology. The visitors get a glimpse of the outcrop from the path view (Fig. 78) down to surface level (Fig. 79), and are exposed to the corresponding geological facts step by step. The photo samples were taken from this location: 37.49224, 24.90679.

Fig. 78 Aerolithos outcrop view from the Kampos-Lia path.

Fig. 79 Close-up of Aerolithos surface to showcase the glaukophane "skin" layers.

The Lia beach point of interest is a thematic continuation of the Aerolithos and Kampos POIs. It is another POI in the Metabasite unit, and the third in the Kampos shear zone. The beach is easily accessible from Kampos via a marked hiking trail. It features rock types which form under special high-pressure conditions, usually close to eclogites such as Aerolithos. The application emphasizes on two main rock types found at the beach; serpentinite schists and lawsonite blueschists (Fig. 80, Fig. 81). The photo samples were taken from this location: 37.49001, 24.90174.

Fig. 80 Serpentinite schist at the north side of Lia beach.

Fig. 81 Lawsonite blueschist at the South side of Lia beach.

Hike 2: Abelaki-Fabrika-Komito-Foinikas-Lakkoi (Hiking with Prof. Engi)

Abelaki is an extremely interesting spot featuring the second most famous geologic relic of Syros, the blueschist. It is located just north of Hermoupolis, along the east coastline, at the region of Doxa. The path is easily accessed on foot and leads to a beach sight filled with epidote blueschists (Fig. 82). Visitors can come to this spot if they do not have time to visit the Kampos zone in the north, since they can witness quite nicely the same rock types (Fig. 83). The photo samples were taken from this location: 37.45219, 24.94886.

Fig. 82 Abelaki beach as reached from the short path from Doxa.

Fig. 83 Massive Blueschist outcrops on Abelaki beach. The same type as north in the Kampos region.

Fabrika is a point of interest located in the south of Syros, in a narrow contact area between the Quaternary Depostis Unit and the south-west edge of the Vari unit. It is also an easily accessed spot by car with a small distance from the road to the outcrops. This point of interest has well exposed structures and deformation marks which are ideal for visitors to understand some effects of seismic events (Fig. 84). In addition, Fabrica exhibits a rare coexistence of two completely opposite rock families, high-pressure and low-pressure rocks (Fig. 85). The photo samples were taken from this location: 37.39089, 24.95399.

Fig. 84 Landscape deformation due to seismic activity.

Fig. 85 Heterogeneous mixture of eclogite and marble.

Komito is the point of interest featured on the South-West tip of Syros. It belongs to the rock subunit of the Komito gneiss. The POI lays close to the Komito beach, which is accessible by car. The POI showcases outcrops of Komito gneiss. This rock type is a mixture of mica, quartz and feldspar. Komito gneiss was strongly fractured and locally contains black tourmaline (Fig. 86), a hydrothermal mineral that crystallized as fracture fillings, or else a hydrothermal breccia. Erosion has stripped away the gneiss, leaving massive fracture fillings of quartz and tourmaline weathering relics sticking out sharply (Fig. 87). Tourmaline and quartz were deposited here by hot aqueous solutions. These may point to a granitic intrusion at depth (but not visible at the surface). The photo samples were taken from this location: 37.37577, 24.87856

Fig. 86 Large outcrop of Komito gneiss with tourmaline vein (large Breccia formation).

Fig. 87 Small scale Breccia in Komito.

Foinikas is the last point of interest in the Metabasite unit. It is included as it is a well know town to both locals and tourists, and provides an easily accessed outcrop spot right at the Foinikas port. Metabasite unit extends to areas around the island, however not all such regions provide both accessible and bare outcrops easily recognized by an untrained eye, as Foinikas is. The outcrops displayed depict a rare geological prosses of retrogression from one stage of metamorphism into the previous whilst maintaining certain characteristics of the pre-retrogressed rock (Fig. 88). Museum and sight visitors can easily observe and examine the outcrop, following the different stages and levels of metamorphism it had undergone (Fig. 89). The photo samples were taken from this location: 37.39752, 24.87785.

Fig. 88 Lawsonite blueschist retrograded into greenschist. Outcrop sits on a manmade path on the south side of the port.

Fig. 89 Outcrop that has undergone different levels of retrogression.

Lakkoi is another point of interest in the Metabasite unit, located on the south side of the Lakkoi Bay, north of Galissas. It is another eclogite concentration spot, just like in Apano Meria. The dominant overlay of the eclogites in this sight is layers of chlorite schist (Fig. 90). An additional reason to call attention to this particular location, other than geologic value, is the myriad petroglyphs carved on the surface of the outcrops, which still have not been properly researched by Archeologists (Fig. 91). With the dual focus of this spot on geologic and archeologic value, the Lakkoi exposure is a small effort in putting out the word and attracting the attention of experts, as well as educating every-day visitors. The photo samples were taken from this location: 37.43121, 24.88186.

Fig. 90 Eclogite lens with a skin of chlorite schist, at Lakkoi.

Fig. 91 Undated petroglyphs on the chlorite schist.

Hike 3: Vari-Megas Gialos-Agios Stefanos POIs (Hiking without Prof. Engi)

Fig. 92 Mylonitic greenschist in the Vari detachment base: A cataclastic zone (left, reddish) cut through banded greenschist.

Vari is the last point of interest chosen. Although its name suggests otherwise, it is not part of the Vari Unit, but it rather belongs to the neighboring Mylonitic greenschist unit (Fig. 92). This spot is located just outside of Vari town and is easily accessible by car. Photo samples were derived from this location: 37.399531, 24.945383.

Megas Gialos POI is located in the Greenschist Unit, south of Agia Marina in the region of Megas Gialos (Fig. 93). It represents a vast unit which covers most of the south part of Syros. The point of interest showcases an outcrop of greenschist, displaying information on low-pressure metamorphic outcrops and deformation effects on it. The spot is easily accessible by foot and car as it sits right on the main road towards Agia Marina. The photo samples were taken from this location: 37.388442, 24.911342.

Fig. 93 Greenschist outcrop for the Megas Gialos POI. The church of Agia Marina is visible in the background.

Agios Stefanos (Saint Stefanos) is another point of interest representing the Marble Unit of Syros. It has been chosen due to its already established visitation from locals and tourists. Also, it provides a clear example of results of strong geological processes, such as deformation effects on land formation. Agios Stefanos is a small chapel built inside a large cave of marble (Fig. 94) overlooking the sea at the West coast of Syros. Museum and sight visitors can clearly see multiple varieties of marble making up the cave structure and exhibited around and inside it. It is a great spot for the application users to compare and contrast different types of marble in one collection of photos, thus better understanding the differences between the real outcrops. The photo samples were taken from this location: 37.41353, 24.860700.

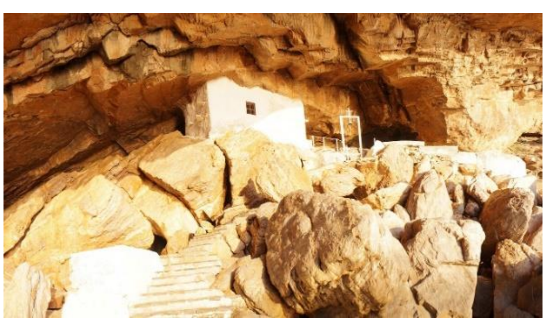

Fig. 94 Agios Stefanos chapel inside the marble cave. Different marble variations construct the cave than those at the opening at sea level.

Hike 4: Aspro Pounti-Mavro Pounti POIs (Hiking with Prof. Engi)

Aspro Pounti is the only point of interest representing the Metaconglomerate Unit of Syros. The unit spreads to only a small region of the northern most tip of the island and it can be reached only by the marked path from Kampos to Diapori. Nevertheless, parts of the hiking path require some skill and good condition of the hiker, making this POI not as accessible as other paths in the Kampos area. Aspro Pounti literally means “White Mountaintop” and it is named as such due to the white, calcite-rich, conglomerate outcrops that cover the area (Fig. 95). Visitors get to see a hard “soup” of marble containing rounded calcite pieces of material “floating” inside the marble (Fig. 96). The exact geological process which forms metaconglomerate outcrops remains unknown to geologists. However, its uniqueness should be displayed in the Geomuseum to inform the visitors about this mysterious relic. The photo samples were taken from this location: 37.51244, 24.87993.

Fig. 95 Conglomerate hillside in Aspro Pounti (West mountaitop of the northern tip of Syros).

Fig. 96 Metaconglomerate mixture of coarse-grained calcite lences mixed in the fine-grained marble.

Mavro Pounti is an unprecedented sight, limited to the east mountaintop at the northern tip of Syros. The steep, dark colored, metavolcanic outcrops (Fig. 97) give the name Mavro Pounti to the hillside, literally meaning Black mountaintop. The Mavro Pounti POI is one of the two sights representing the Metasedimentary Micaschist Unit of Syros, and is in direct contact to the metaconglomerate unit (Fig. 98). It is located right next to the Aspro Pounti POI, yet it represents a completely opposite geological process and rock types. It has been chosen for this application because it is not easily accessible to hikers with little or none experience. The application displays the uncommon outcrops of the POI, explaining their formation conditions and connecting the information to the neighboring conglomerate unit. The photo samples were taken from this location: 37.51266, 24.88093.

Fig. 97 Metavolcanic outcrops at Mavro Pounti.

Fig. 98 Direct contact of the Mavro and Aspro Pounti and their respective rock units.

Remote Content Gathering: Marmari-Gria Pounta POIs

Fig. 99 Marmari quarry on the path from Kampos to Marmaras beach.

Marmari is the second point of interest located within the Metasedimentary Micaschist Unit. In contrast to Mavro Pounti, this sight has been chosen for its historical importance rather than its geological treasure, since information on marble properties is already provided in the Agios Stefanos POI in the Marble Unit. Marmari is an old marble quarry, abandoned in the 1930s, on the path from Kampos to the beach of Marmaras (Fig. 99). The quarry is a historical sight left as is since the time it was abandoned. Visitors get to witness the leftover blocks of marble and understand the extraction and transportation process of the material. The photo samples were taken from this location: 37.295490,24.542443.

Gria Pounta represents the Vari Unit in the South-West of the island, and is geologically completely different from the rest of Syros. This unit is comprised of only low-pressure rocks and sits higher than the rest of the units (Fig. 100, Fig. 101). The unit is characterized by a rock type named after the unit, the Vari gneiss. Gria Pounta is located on the upper-east coast of the Vari unit, and connects due south to Cape Fokia via road. The displayed rock types are from both of these locations. Photo samples were derived from these locations: Gria Pounta - 37.404950, 24.968692 and Cape Fokia - 37.400772, 24.972708.

Fig. 100 Leucogneiss outcrop at Gria Pounta.

Fig. 101 Amphibolite cliff at Cape Fokia, south of Gria Pounta.

4.4 Chapter Overview

To understand the scientific context provided, geologic research was conducted via literature examination, field research, and guidance by a geology consultant. Complex geologic concepts were understood, as well as the case of Syros and its global geologic importance. The digital material gathered from this research phase was inventoried into appropriate content and incorporated in the stages of designing the user experience and application development. The outcrops and landscapes were documented, photographed with a high definition camera, and the hiking trails were tracked via a mobile tracking app to capture the exact location of the outcrop and access path leading to it. During the field research we learned much about the geology of Syros, documented the relevant information corresponding to the chosen outcrops, as to later cross reference the photographs with the depicted geologic phenomena.

5 Designing the GLAUKO interactive system

In this section, we present the basic concepts and goals that were retrieved from geologic, interaction and state of the art researches that defined the design direction for the GLAUKO interactive system. We define the context, design goals, design purpose, design brief, specifications, and methodology for the design and development of the GLAUKO system. We present the conceptualized UI mockups, rough prototypes, and received feedback as the design and development progressed simultaneously. The system was developed as a WPF application (Windows Presentation Foundation) and was designed as an interactive projection with midair interaction via Kinaesthetic control.

5.1 Basic Concepts and goals of the GLAUKO system

The design process of the GLAUKO system followed paths of intense research and feedback on general geologic topics and installation design. These two phases of research were executed almost simultaneously, along with the third phase of Design and Development of the system. Findings and content from the two research phases were incorporated into the Deign & Development phase to produce prototypes from low to higher fidelity. Feedback was given as the development progressed. Finally, a functional prototype was developed in WPF platform and was set up as a projection controlled by a Kinect sensor for evaluation by users.

Our goal for this project is to design and prototype an interactive installation about the rock types of Syros. This installation is intended for the geomuseum that is planned to be established alongside a geopark of the island. The geopark will allow people to get to know the geological, natural and cultural heritage of the island as a holistic prism. The geomuseum will offer more accessible, detailed information on those topics. This particular installation will serve as an entry piece, introducing the geomuseum visitors to Syros' rock types and briefly introduce their geologic origins. It is meant to trigger their curiosity and entice their appetence for learning.

5.1.1 Defining the Need

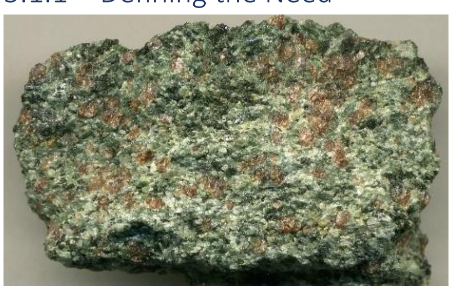

Fig. 102 Eclogite rock sample.

To define the need for awareness and learning about the geological history of Syros, for locals and visitors, we must first establish the geological case of Syros, and set it on a global scale of importance. Geographically Syros is part of the Cyclades island complex at the southern region of the Aegean Sea, in Greece. Geologically, these islands belong to an arc of mountaintops that was been created from 58 to 35 million years ago, called the Hellenides orogeny (Mountrakis, 2006). Syros is a landmass of great geological importance, even amongst the rest of the Cyclades. It remarkably preserves evidence of geological processes, such as High-Pressure-Low-Temperature (HP-LT) metamorphism, that are extremely hard to observe and study because they occur deep underground. The island is a relic of rare outcrops, such as eclogites (Fig. 102) and blueschists (Fig. 103), which are found in few other places in the world, yet in Syros we see them abundant and clearly exposed on the ground surface (Laurent V. P., 2018). These conditions allow geologists to conduct more accurate petrological, structural and geochronological studies to better define the creation and formation process of these rock types. In other words, Syros is a unique archive of geologic history on the global geologic map.

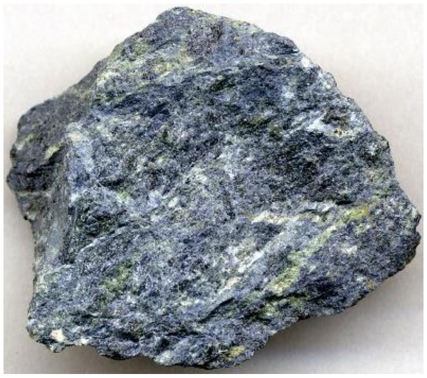

Fig. 103 Blueschist/glaucophane schist rock sample.

In contrast to the scientific community, the local population remains ignorant of the natural uniqueness and significance of the island. Syros has never been a center for mass extracting or exporting physical wealth, as for example Tinos and Paros are with marble and sculpture. So far, the island has been known for its cultural and industrial heritage and influence, rather than its natural, environmental character. Awareness about the geological value of Syros is necessary in order for people to better understand the natural and geological heritage of their home. Such awareness can help protect, preserve and conserve the natural environment and geologic treasures of the island, better than any enforcement methods.

5.1.2 Defining the Experience & Technology

We wanted to create a memorable experience for the visitors upon entry to the geomuseum. To remember, a person needs to have a strong reaction and response to an experience. The goal of the interactive installation for the rock types of Syros is to entice the museum visitors, and interest them in taking a first look at the geological features and treasures of the island. It is not possible for everyone to visit the geopark sites and observe firsthand the outcrops. Thus, we needed to recreate the scale and awe of the real outcrops in an indoor environment, yet without overwhelming the visitors with excessive information. It was also necessary to leave room for further experiences to be triggered by the rest of the museum systems and rock exhibition.

Research revealed a design niche for interactive technology on rock types that has not been filled yet. Since the rock samples that are to be exhibited will be protected, we wanted to offer another way of examining the rocks and outcrops from up close. Also, we needed to offer limited information, with only necessary references to other geologic topics, other than those on display, to avoid overwhelming and confusing the users. Thus, the interactive installation is designed as a wall projection with kinaesthetic control. Projection technologies provide a sufficient view of the content to the users. They can magnify optical feedback and interaction space, thus creating sensations of amazement to exhibition and museum visitors. To control a wall projection, we needed a flexible sensory technology to track the user's input, without depending on permanent physical markers that would restrict the physical installation and future update of the prototype. In addition, we wanted to keep the complexity of the technology limited, so that any future developer would be able to learn it fast, maintain and update the system as needed. In addition, the cost of making the installation, and repairing it in the future if necessary, needed to remain as low as possible. Thus, we settled on Microsoft's Kinect 2.0 sensor (Fig. 104), as it is an off-the shelf, low-cost product, and the company will continue its support for a few more years. It is easy to learn by developers as it comes with clear instructions and ready-functioning libraries. It tracks successfully the user with minimum sensory technology (no special equipment), and allows for natural interaction of a system by the user.

Fig. 104 Microsoft Kinect 2.0

For designing the experience, we were inspired by some elements of all three aforementioned interactive systems that deal with geologic content. We needed to showcase the rock types realistically, as we saw in the mineral interactive table, so that the users would be able to recognize them afterwards in the physical exhibits. We also wanted our users to relate the rock types with their location, so that they could visit the real outcrop in a point of interest, as we also saw in the geoVR system at the Magma Geopark, and better understand the bigger picture of Syros's geological profile. Finally, we wanted to connect the geological heritage to the local history and folklore, because it would add a more relatable dimension to geology for the visitors, as we examined in the Stymphalia exhibit.

5.1.3 Defining the Content

The content for the application needed to be simple, precise, inclusive, and understandable. First and foremost, we needed to understand what was available to us, what was its geological meaning and value, how relevant it was to our target topic (rock types), and finally how it fit with our overall goal of geological heritage awareness. We consulted an expert on the geology of Syros who was also involved in the establishment of the geopark and geomuseum. Thusly, they could approach the subject with a holistic view and help us avoid expanding our content beyond necessary.

In order to define precisely what our content should be, we needed to grasp the geologic context we faced. In other words, to "teach" geology to our visitors, we needed to dive into it ourselves and learn firsthand about the geologic profile and rock types of Syros. The consultant offered us a brief introduction to the general geologic history and importance of Syros, and introduced us to relevant scientific literature. The learning process unraveled over a period of time, mainly during hiking tours leading to key points of interest around Syros, with the geology consultant on our side.

As it helps with most expeditions, we also based our research on a detailed geological map of Syros. The map shows the tectonic units and subunits of Syros (Fig. 105 (Left)), and marks the dominant rock type on found on each of them. It also, marks subduction zones, contact areas between units, fault directions and other geologic information. We discussed with the consultant about the possible points of interest within each subunit, where clear cases of the rock types in our interest were easy to visit, spot and document. The dominant factors in choosing a rock type were, in order of importance, representation in the scientific literature, rareness on the island, outcrop scale, and point of interest accessibility. Additional criteria were, if alongside the rock type we could showcase and explain a relevant geological process to the outcrop or the overall landscape, such as deformation, erosion, unit contact and others. The outcrops and landscapes were documented, photographed with a high definition camera, and the hiking trails were tracked via a mobile tracking app to capture the exact location of the outcrop and access path leading to it. During the field research we learned much about the geology of Syros, documented the relevant information corresponding to the chosen outcrops, as to later cross reference the photographs with the depicted geologic phenomena. The consultant approached our learning the same way he would conduct it with geology students. We followed the same process of scale-down observation, examining the landscape as a whole to carefully inspecting the surface of the outcrop. With this method we were able to better understand the characteristics of the rock type and grasp its overall role in the geological scene.

The final content chosen for the installation consisted of a simplified version of the geologic map of Syros (Fig. 105 (Right)), high definition photographs of outcrops (from various scales) from key locations on the island, and descriptions of the depicted phenomena. We decided to base our design off of the suggested geologic map of Syros, as it had proven helpful to our own understanding. The map shows the tectonic units and subunits of Syros, and marks the dominant rock type on found on each of them. The original map by Laurent V. et. al. marks subduction zones contact areas between units, fault directions and other geologic information that we decided not to include, as it was quite advanced for first time learners, and it would take away from our main goal to introduce the rock types themselves. The simplified version of the map keeps the focus on the rock units representing the main rock types of Syros.

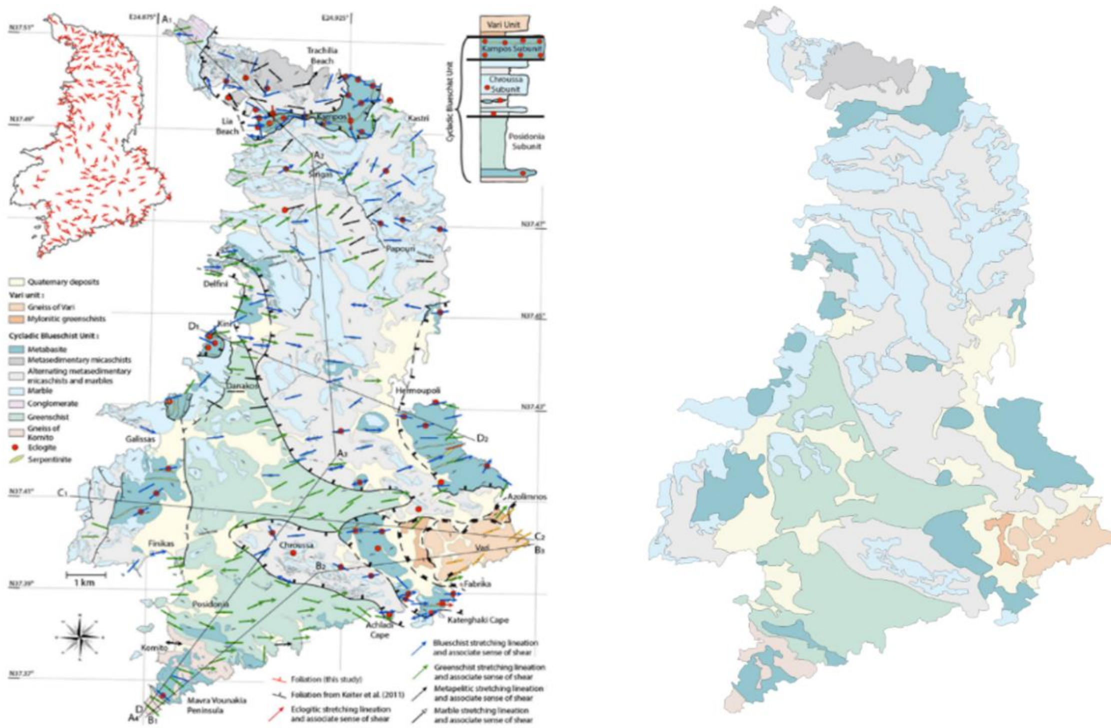

Fig. 105 Detailed Geologic Map of Syros (Left) by Laurent V., 2016, Simplified Geologic Map designed for the installation (Right).

The rocks and outcrops chosen, represent all units in the map, so that the visitor can glance at a complete petrologic variety. The information is mostly descriptive of the photographed artifact, and a little on how the depicted outcrop, rock, or mineral is created. The language includes basic terminology for what we see in the photographs, phrased as simply as possible without oversimplification to the point of misinformation. The expected results were to capture the interest of the visitors so that they may start asking questions and get interested to learn more in the museum space, as well as go and visiting the actual sites presented to them.

5.2 Context

The context of study is the geological rock types of Syros and their importance. Within this context, we defined a context of use for an interactive installation as a means to introduce users to the aforementioned topic in a setting of a Geomuseum visit. Geomuseums are centers of learning within established natural areas were natural and cultural heritage co-exist; Geoparks. Such aspects form settings for Geotourism, a sustainable way of tourism which brings awareness to the natural environment without excluding the human community living in peaceful coexistence with the natural environment. Such settings provide excellent contexts for lively and experiential learning.

Engaging interactive systems have the power to trigger strong, positive experiences to the users, helping them expand their knowledge, understanding and perspective. When set in an equally interesting natural environment, they can have a greater learning impact, raising awareness for topics of value, such as preservation and conservation of geologic heritage.

5.3 Design Purpose – Why Its needed

Syros is a unique archive of geologic history on the global geologic map. It is an island unknown to the non-scientific community as having great geological importance. Syros remarkably preserves evidence of geological processes, such as High-Pressure-Low-Temperature (HP-LT) metamorphism, that are extremely hard to observe and study because they occur deep underground. The island is a relic of rare geologic outcrops (eclogites and blueschists) which are found in only few other places in the world, yet in Syros we see them abundant, well-exposed on the surface, and preserved in excellent condition, as opposed to other locations (Laurent V. P., 2018). These exposure conditions allow geologists to conduct more accurate studies to better define the creation and formation process of these rare rock types and of Syros' in general.

The design purpose for an interactive system on the geology of Syros is necessary to inform local and visiting population of the inherit, natural heritage of the island. The majority of the local and visiting population, are unaware of such importance of the island. By presenting this information, teaching and involving the people we can help them understand the significance and collectively protect the natural habitat, its treasures, and the lessons it has still to teach us. There is a need to bring awareness to the geological heritage of Syros to locals and future visitors, because this way all of us can help better preserve the natural treasures and character of the island for the future.

5.4 Design Goals

The design goals for this interactive installation with a geologic topic are to:

- Design an engaging experience for introduction to Syros' geology
- Design a learning system for the rock types of Syros.
- Design a motivation trigger for further exploration of the geosites of Syros.

5.5 Target Group

The large-scale interactive installation is visually rich and has a simple interaction. It simulates a visual journey from large-scale observation to up close detailed examination. The visual aspects are accompanied by relevant information, explaining the imagery shown. The system uses some terminology to provide accurate information on a scientific topic. It works with simple navigation, and the experience is trigged by the content. It requires the user to have a basic level of understanding for complex topics.

Our target group includes any adult visitor of a Geomuseum with no or some prior knowledge of geology. This is why it is important for the application to provide proper content as to engage, inform, and not overwhelm the user and first-time learner of geology. The main target group consists of local residents of Syros island and potential Geotourists. Both groups may come with a limited or no knowledge of the geological heritage of Syros. The system's role is to raise awareness in an engaging way, to help both groups understand the geological value of the island and motivate them to further explore the geosites.

5.6 Design Brief

This thesis project deals with the design of an interactive installation which aims to highlight the geologic variety of the rock types of Syros island, to inform potential Geomuseum visitors about the geological significance of these rock types, and to spark their curiosity on geological topics and the geological heritage of Syros.

5.7 Design Specifications

Through thorough literature, desktop and field research analyzed in preview chapters, and based on the design goals set for the project, we set Design Specifications as a result of the aforementioned research on geologic topics, installation and interaction requirements, context characteristics, and user needs. The specifications are separated into functional and non-functional ones.

Functional Requirements:

Environment

- Installation in an indoor environment
- Public space with many visitors
- Easily set up and transportable body
- Hardware non-distracting to the eye
- Need for power source

Technology

- Low cost
- Easily changeable
- Easily upgraded software
- Know development platform with external support
- Connecting to a Projection
- Use of WPF for application development

Image

- Presented through projection
- Clear UI elements for selection
- High definition

Non-Functional Requirements:

Way of interaction

- From a distance
- Natural to the users
- Intangible

General characteristics

- Large-scale interaction
- Engaging to the users
- Motivating for further exploration of geologic themes
- Introductory application to a complex theme
- Content understood by first-time learners

- Content scientifically interesting to users with prior knowledge on the topic
- Simplified content
- Scientifically accurate content
- Simple in use
- Safe to use

Environment

- Simple aesthetics
- Designed for indoor use
- Designed to correlate to with future exhibits

Image

- Visually Appetizing
- Realistic imagery
- High definition
- 2D images

Software Technology

- Usability friendly
- Functional

5.8 Design Process and Methodology

The process comprised of three different pillars, geologic research, installation research, and a common design & development stage. The methodology followed to complete these processes was to work on them almost simultaneously, co-researching the main topics of the thesis (**Error! Reference source not found.**). This co-research of the topic allowed us to better relate our findings, and corelate the respective contexts. Our progress was more gradual at first, however it was a helpful approach when we needed to clarify our context to include both the geologic and the interactive themes. First began the geologic research stage, during which thorough examination and learning of geologic processes took place. After having established a first frame of understanding the scientific context, we also started working on researching about interactive installation systems. Through this research we examined various means of interaction incorporated in interactive systems. Having established an interaction context, we started to combine research findings from the geologic and installation researches. Thusly, we specified our research on interactive installations with geologic themes and content. After having established a new frame of understanding, we started working on rough application designs and prototypes. Once again, the common-research frame was now further examined in correlation to the application development. This allowed us to establish early on design goals that aligned both with the established geologic installation context and with the realistic development possibilities of creating such an application.

More specifically, during the Geologic research phase, we researched, understood and learned basic geologic concepts. A general understanding of Earth science was acquired through desktop research on scientific literature. Afterwards, we interviewed Dr. Martin Engi, an Emeritus Professor at the Institute of Geological Sciences, Universität Bern. Professor Engi specializes in Petrology and the Evolution of Orogens. The professor worked with us directly throughout the project, from February to June 2020, as a geology consultant to help us understand the specifics of the geologic case of Syros. With the guidance of prof. Engi, the research was narrowed down to specific geological topics concerning Syros island. With professor Engi, we conducted field research by going on hikes around the island and studying the geologic concepts though outcrops and rock samples. By understanding the island-specific geologic case we were able to gather first-hand digital content such as photographs, notes, rock samples, recordings of on-site lectures by the consultant, and points of interest with GPS location coordinates, as raw material. After repeating the same process as needed, the final content for the system was gathered.

The research on installations started after we had first set a general geologic understanding, and continued simultaneously with the geologic research. Through desktop research we researched bibliography on interactive installations and interaction design as applied to installations, and examined other systems related to our design context in the context of museums, art galleries, and exhibitions. In addition, we researched the topics of geoparks and geotourism as to understand them as means for the preservation of geologic and natural heritage. The museum context, as a learning and engagement setting, was examined via desktop research and museum visits to the Natural History Museum of Crete, as it is was an accessible museum also as part of a geopark (the Psiloritis Geopark in Crete). Through this research we were able to define visitor engagement techniques, means of interaction, exhibit setting and an insatiable niche on geologic learning in museums. At this point, we started combining our understanding of the geologic case of Syros plus the gathered raw material, to clarify our final content and design a suitable visitor/user experience for our context.

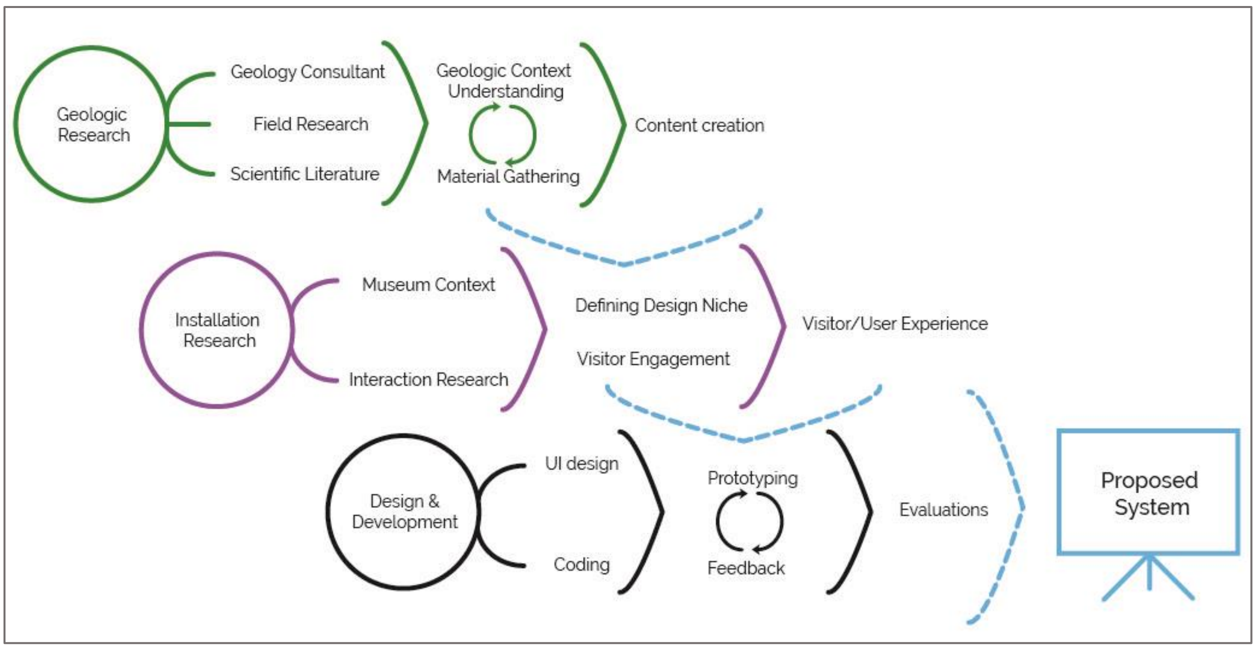

Fig. 106 Design process and methodology followed to produce GLAUKO system.

The design and development of the application were executed as one. Based on our findings regarding visitor experiences on learning in museums, we decided to keep the visual design simple. Thus, after defining a general use case scenario, and creating UI mock-ups, we dived into development as to see how a simple UI could be functional. We based our design onto an interactive map, as it had proven helpful for our own understanding of Syros' geology and worked well to bridge our users' mental model and our concept model of “site visits”. The parallel evolution of the front and backend coding in a WPF application (Windows Presentation Foundation) helped us develop functional prototypes to receive feedback on multiple points. As we reached a prototype version with all the basic functionalities, we started to more actively mold the created content around the desired user experience, and implement it into the functioning prototype. Onward from there, we received feedback for content and UI adjustment, eventually leading up to a working desktop prototype. The Microsoft Kinect SDK was added to make the application functioning form a distance and add to the visitor’s experience of interacting with an installation. The prototype was set up for evaluations by sixteen (16) users as first-time learners of geology. Due to technical difficulties with the SDK, the evaluations followed the “Wizard of Oz” protocol as to evaluate the users’ experience, engagement, and learning from the system. The GLAUKO interactive system proposed here is the product of this procedure.

5.9 Conceptualization

The conceptualizing process took place parallel to the geological and interaction researches. Through the research we initiated some ideas that we tested on paper and designed into UI mockups. The information and feedback from the geological research made us realize that the context was too vast to cover in this single application, thus we narrowed down our application features and content by eliminating secondary content categories that moved our designs away from the design goals. We progressed the application design over five prototype applications where we tested different features and further developed the ones we wanted to keep. The fifth trial prototype was the final one of its kind, and as it had been developed substantially with the addition of gathered content, we chose to further develop it into our final application. Along with the application conceptualization, a brand identity was also designed to better introduce the system to the users.

5.9.1 UI Concepts

The idea of building our application around an interactive map was settled during the geologic research, as our own approach to Syros’ geology had been initiated through the original geologic map by Lauret et.al. The concept helped us a lot in understanding the basic geologic profile of the island and we wanted to present the same mental mode to our users. There were two mockup UI designs created in adobe illustrator and tested for basic navigation flow in the online platform inVision. The first UI (Fig. 107) was designed very early on during the design process. We were at our first mass research gatherings and we wanted to include specific exhibit showcases (Fig. 108), geology of Syros’ rock types (Fig. 109, Fig. 110), historical facts about Syros’s rock types in the life of humans (History) (Fig. 111), and information on general geologic processes such as the rock cycle (Fig. 112). We quickly realized that this was an overwhelming amount of information to present to the users, as well as for the design purpose of the system.

UI Mockup 1

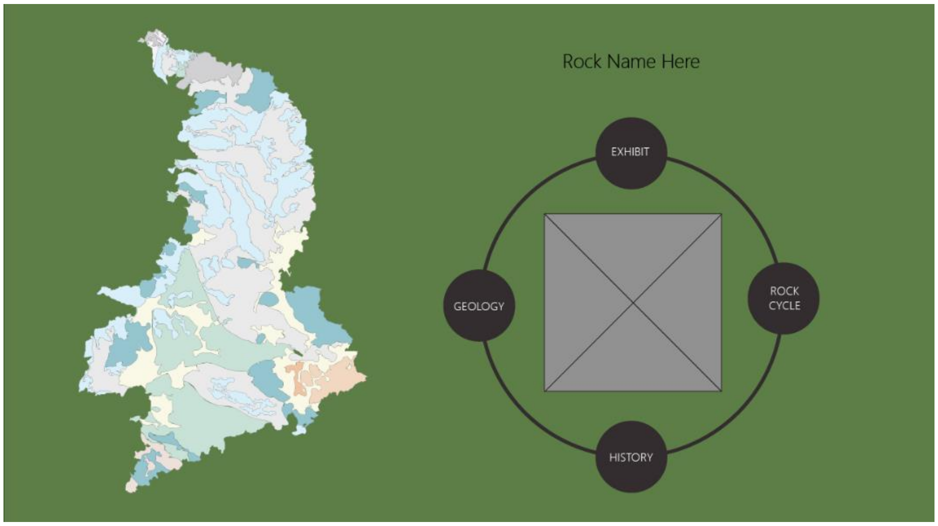

Fig. 107 Initial Mockup of interactive application main menu UI.

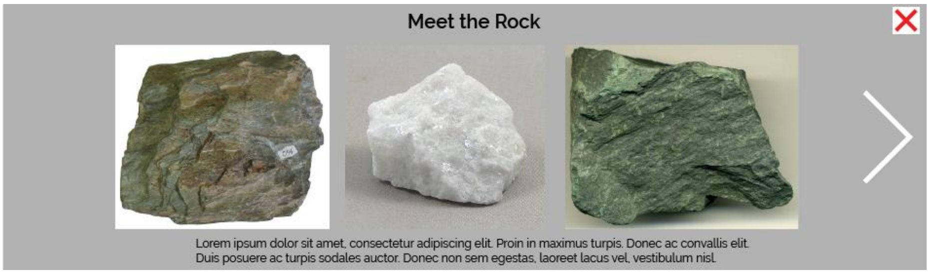

Fig. 108 Image gallery mockup 1 on selection of Exhibit button from main menu.

Fig. 109 Image gallery mockup 1 on selection of Geology button from main menu.

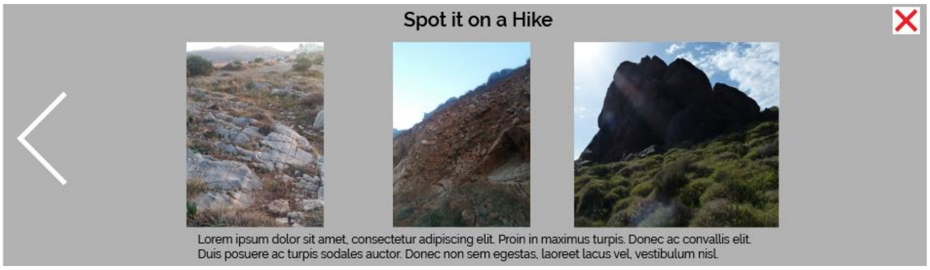

Fig. 110 Continuation of image gallery mockup 1 on selection of Geology button from main menu.

Fig. 111 Image gallery mockup 1 on selection of History button from main menu.

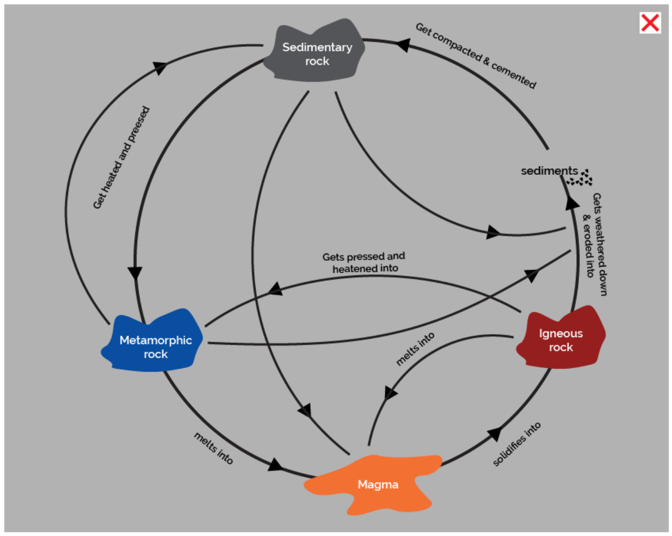

Fig. 112 Popup schematic mockup 1 on selection of Rock Cycle button from main menu.

Mockup 2

For the second mockup UI we used the same design tools as for the first. As research on the geological profile of Syros progressed, we eliminated information that was unnecessary to the system, such as separate sections for historical rock use and general geology (rock cycle). Thus, for the second mockup we only focused on designing an image gallery that would allow users a sufficient view of all UI features (map, selected photo, thumbnails, image caption) (Fig. 113, Fig. 114).

Fig. 113 Mockup 2-Main Menu

Fig. 114 Mockup 2- Image gallery

Prototype 1

As we evolved our initial ideas on the content through the research, we started prototyping a simple application to see basic navigation flow and interactivity with the system. We prototyped a modification of mockup 1 with less menu categories (Fig. 115). We also tried to create a random POI selection feature for the user to select any place on Syros to view (Fig. 116). For further development, this idea would need coordinates and access to satellite maps. This model would be harder to develop in an interactive application, plus it was moving away from our design goals of an introductory system to Syros' rock types, and would become more of a navigation application with no purpose in being a static exhibit.

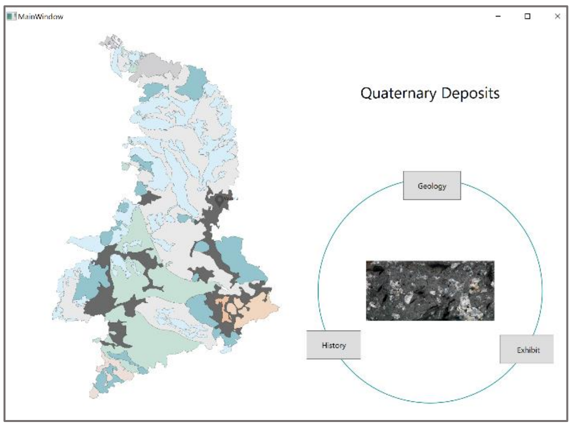

Fig. 115 Prototype 1- Interactive map on hover showing the representative rock type of the affected rock unit.

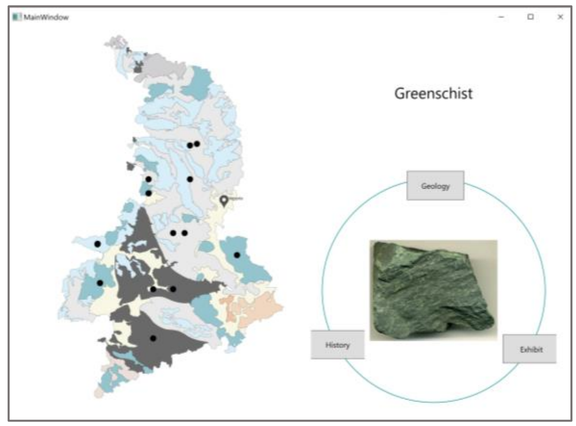

Fig. 116 Prototype 1- POIs generated on click point.

The feature that was kept from this prototype onto the next was the geologic map with interactive regions. The map was created by tracing the original Lauret et.al. geologic map (Fig. 105 Left) from the publication image in Adobe Illustrator. The traced map was exported to XAML markup via an open source pug-in to Illustrator, thus is could be included directly into the WPF application.

Prototype 2

The second prototype carried the interactive map and was a first attempt to experiment with code to create an image gallery. The application window was too narrow, and the points of interest were still randomly selected without some confirmation for their geological value (Fig. 117, Fig. 118, Fig. 119, Fig. 120). Basic event handlers, such as MouseEnter, MouseLeave, and MouseDown worked properly.

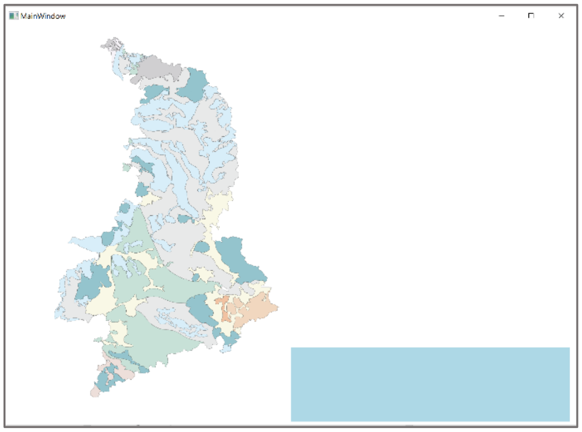

Fig. 117 Prototype 2- Application main menu

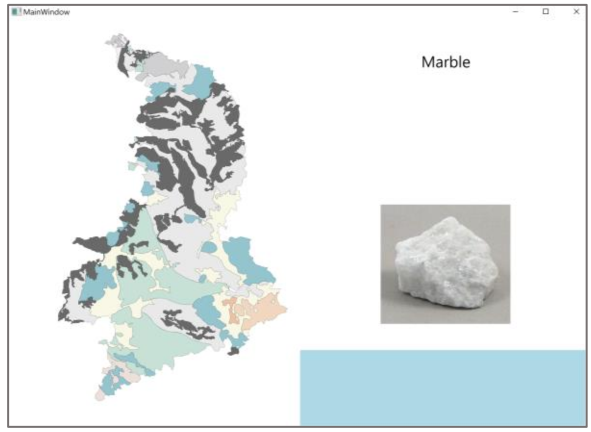

Fig. 118 Prototype 2- Hover over interactive map and reveal of rock type on affected area.

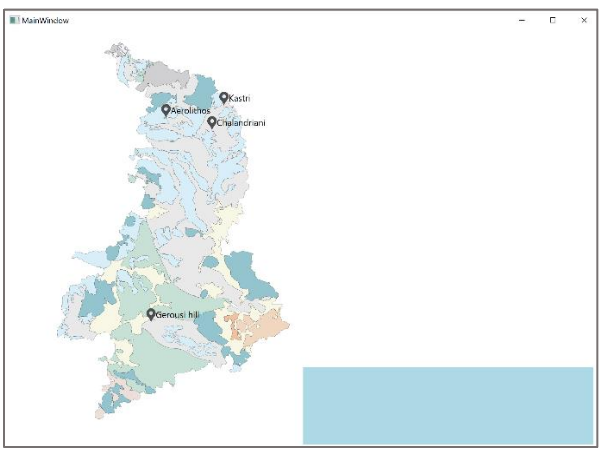

Fig. 119 Prototype 2- Rock unit selection and apearance of POIs on Alternating Marble-Micaschist unit.

Fig. 120 Prototype 2-Outcrop image popup upon selection of Ermoupolis POI.

Prototype 3

Prototype 3 was a further development of the image gallery, the window size and spacing of the UI elements. The image thumbnails were placed underneath the enlarged (selected image), and the image caption was sandwiched between the selected image and the thumbnail ribbon (Fig. 121).

Fig. 121 Prototype 3- Image gallery with horizontal thumbnails.

Prototype 4

In prototype 4 we further developed the image gallery interface, placing the thumbnails vertically on the right, as it would be more user friendly for midair interaction (Fig. 122). By this point, the first correct POIs were decided and hikes to those geosites were taking place to gather content.

Fig. 122 Prototype 4- Image gallery with square vertical thumbnails.

Prototype 5

Prototype was a well-defined application, with most of the image and caption content included. The hover feature was changed to include a background appearance of a texture of the represented rock types in the reacting unit (Fig. 123). The content features were changed to include an image Title and Subtitle, along with the initial image caption (Fig. 124). This was the final testing prototype which we chose to build upon our final application.

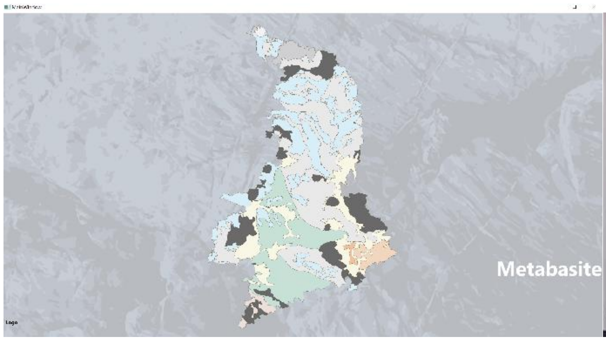

Fig. 123 Prototype 5- Hover over Metabasite unit on interactive map. Showing illustrated background and unit name.

Fig. 124 Prototype 5- Image gallery with Title, Subtitle and vertical thumbnails.

GLAUKO visual Identity

The proposed system was designed as an interactive installation with kinaesthetic interaction. We decided to create a visual identity for the system to complete it as a designed system (Fig. 127). Borrowing from geologic terminology learned during the research, the system is named GLAUKO after the mineral glaucophane. With a play on words to match its goal and means of interaction, GLAUKO is an acronym for Geologic Learning Assistance Unit via Kinaesthetic Operation.

Glaucophane is a high-pressure-low-temperature mineral that has formed on rock types and full outcrops all around Syros. We believe it best represents the island, as it holds very important evidence in how Syros formed and reformed through geologic history over millions of years. The best relic to represent this million-year history of Syros, we believe is a glaucophane pseudomorph (Fig. 125). Pseudomorphs are remaining formations of old mineral crystals that once formed under unique conditions, were highly metamorphosed to the point where they changed in composition; but they retained the structure of that first crystal born millions of years ago deep within the Earth (Fig. 126).

These fake forms are “lying” about what they are. They are not the old mineral once formed. They have transformed into something extraordinary and new, but they still “remember” something of what they used to be. This concept can be parallelized with human nature. Humans strive to keep changing and moving forward; but if they don’t hold something dear form their past, they may be lost. Thus, it is important to know and understand our heritage of any kind; it can help us know who we are over time.

Fig. 125 Glaucophane pseudomorph as inspiration source.

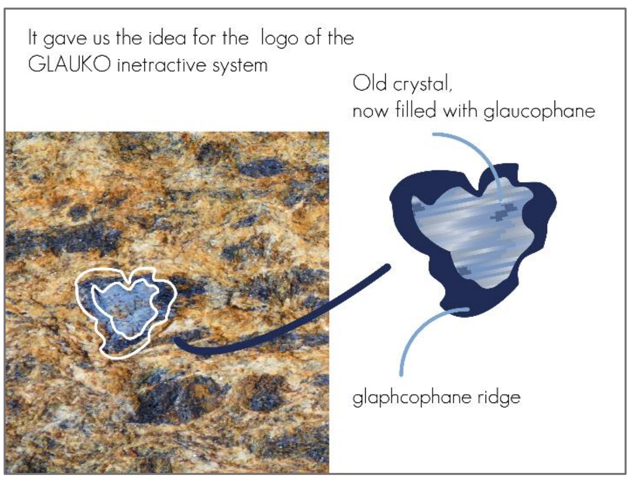

Fig. 126 Logo design explanation.

Fig. 127 GLAUKO system logo.

5.9.2 Installation Description (physical)

Fig. 128 Projection display of the GLAUKO application. Kinect sensor placed underneath the projection.

The physical design of the interaction had initially started as an interactive wall with projection and tangible interactions. However, the tangible aspects would be harder to update in the future, thus we decided to use as much digital means as possible. The projection setup was backed up by research, as it provided a low-cost, adjustable display of the system and could be easily connected to any other piece of technology (Fig. 128).

Thus, we concluded on using the Kinect 2.0 sensor for tracking the user's control with the system. The Kinect is placed directly underneath the projection (Fig. 128), facing the user from the front. This way the sensor's tracking technology is not disturbed by the projection and has a clear view of the user in order to track their gestures.

5.9.3 Choice of Technology

The technologies we combined to create the GLAUKO interactive system include programming in C# programming language and XAML markup language to develop a WPF application (Windows Presentation Foundation). The programming software used was Microsoft's Visual Studio 2017 & 2019. The wall projection was achieved with a standard projector mounted from the ceiling. The Kinect 2.0 sensor was chosen for tracking the gestures midair interaction and for the programming of the sensor we worked with MS Kinect SDK 2 to develop the Kinect application on the WPF application.

5.9.4 Use Case Scenarios

We determined two main use case scenarios to help us achieve our design goals. We set the first use-case scenario as a case where a user interacts with the system in only one POI. In the second scenario a user uses the system to visit two POIs in different rock units.

1st Use case scenario

- The GLAUKO system is set up and running on an exhibition space.
- The visitor enters the exhibition and approaches the system.
- The Kinect sensor tracks the user.
- The user receives optical feedback of the avatar on the projection.
- The application is already loaded on an intro page with language choice. The screen also shows a schematic of the selection gesture that the user must perform to select an element in the interface (hand-close gesture)
- The user performs the gesture to select their preferred language
- The system loads the main application screen with the interactive map of Syros. The system indicates with text that the map regions can be selected or paned-over to reveal more information.
- The user pans their cursor over the interactive map by moving their hand around, palm facing the Kinect sensor.
- The system changes the color of the unit to indicate interactivity, reveals the name of the rock unit affected, and shows a texture image of the dominant rock type of the unit.
- The user pans over more rock units until they decide to select a rock unit.
- The user sets the cursor over the map region they choose to select, and performs the hand-closed gesture as indicated by the system.
- The system reveals some POIs at specific spots within the selected region (rock unit). The POIs have the name of the real geosite they represent.
- The user selects a POI
- The system opens an image gallery next to the interactive map, with an enlarged image, thumbnails of other images, and informative text underneath the large image.
- The user reads the information and examines the image provided.
- When satisfied, they select one of the thumbnails.
- The system changes the enlarged image to that shown on the selected thumbnail.
- The user examines the information on this image as well.

- The user is satisfied and moves away from the system
- After a set amount of time (3 minutes) the system returns automatically to the language selection screen.

2nd use case scenario

- The system has been left recently by a user and depicts the main application window with the interactive map and the gesture and interaction written indications
- A user steps forth before the system returns to the language window. They lift their hand, with their palm facing the system in front of the system
- The system reveals the cursor and follows the movement of the user's hand
- The user performs the select gesture on a rock unit and a number of POIs pop up on the map, within the borders of the selected unit.
- The user selects one POI
- The system opens up the geosite's image gallery.
- The user wants to choose another location (POI), so they pan the cursor over the map
- The rock units affected by the pan/hover event change color and their corresponding names and rock texture images
- The user places the cursor over a new unit and performs the select gesture
- The system reveals a new set of POIs within the borders of the new selected unit.
- The user pans over a POI button and selects it.
- The system opens the corresponding image gallery with the accompanying information.
- The user goes through all the thumbnails
- The system responds accordingly
- At the last thumbnail, the user pans over the map and performs the double-selection gesture (lasso gesture)
- The system returns to the main menu of the interactive map.

5.10 Prototyping & Development

For prototyping and developing the GLAUKO interactive system, we developed a WPF desktop application, which would connect to a Kinect sensor to allow for midair interaction, and a standard projector as to be projected on a wall for large-scale interaction and better user engagement. The WPF application and projection were successful, however due to technical difficulties with the Kinect SDK and not having access to free libraries, we were unable to develop the Kinect application. Upon finalization, the application was translated to the Greek language to allow all users to better engage and experience the learning process in their preferred language. The translated content was checked by the geology expert Andreas Gialoglou.

5.10.1 WPF platform

Windows Presentation Foundation (WPF) is a free and open-source graphical subsystem originally developed by Microsoft for rendering user interfaces in Windows-based applications (Nathan, 2006). This framework can be worked in Microsoft's Visual Studio developing platform, making it easier for non-experts to develop an application. The WPF platform comprises of two main code files, a XAML file (.xaml) for the frontend markup language, and a C# (.cs) file for programming the interface with classes, methods and event handlers. WPF is used mainly to develop desktop applications, however it is usually easy to combine with external software, like the Microsoft Kinect.

5.10.2 Midair interaction

Midair interaction provides a natural way for users to operate large scale applications. It allows them to maintain a distance from the display, thus gaining a macroscopic view of the presented content, giving them physical and mental space to better absorb the information. It uses familiar movements as set gestures to allow the user to interact with the system. It can be packaged in off-the shelf sensory products with tracking functionalities, thus being easily available for low-cost systems, and is such cases the tracking system offers a number of ready-made libraries. This way, the developers have access to working code to develop applications easier and faster. They can also be connected to multiple types of application output, such as desktop computers, wall-mounted displays, and wall projections, allowing for a variety of possible designs and experiences to be created. Kinaesthetic interactions can meet small to large scale application designs, easily tailoring to each system's specifications and requirements. They can be used on simple applications displayed in a conventional medium, such as a tv screen, a computer monitor, or a projection.

The chosen gestures for the GLAUKO system needed to be natural with low work effort as to not tire the user during their navigation in the system. We chose to have our users interact via the Pan (hover) gesture, the hand-closed gesture instead of Push for selection, and the Lasso gesture for going back to the main map (instead of right-click on the desktop application).

For the application interaction, the Kinect 2.0 sensor was chosen as it has higher accuracy than previous versions and offers simpler coding libraries for gesture recognition. However, there were problems with finding any free library to see how the code works, and if it suited us for our application design. The problems are explained in the following section.

5.11 MS Kinect SDK 2 Support from newer versions of the Windows SDK

Completing the GLAUKO application software with the MS Kinect SDK 2 requires the use of the application's pointer operators, especially PointerEnter, PointerLeave, PointerPressed, so that the user can handle it manually (hand pointer). The completion of the GLAUKO application with MS Kinect SDK 2 was attempted in successive, multi-day tests with different application development software frameworks in Windows. They all failed for different reasons. More specifically:

- Test 1. MS Kinect SDK 2 and Windows Presentation Framework (WPF)

WPF does not support pointer events but individual events for each input device, such as Mouse (MouseEntered, etc.), Stylus, Touch, etc. It is not possible to override these operators by hand cursor. That is, to programmatically change the position of, for example, the mouse from the current position of the user's hand, nor is it possible to take advantage of individual events, e.g. of the mouse. To implement events similar to mouse events for Kinect hand cursor is possible, but requires further work on understanding the API of the library Microsoft.Kinect.Controls. Unfortunately, this API is briefly documented since that it was not supported for long by Microsoft. Furthermore, the code samples examined were not informational, since they encapsulated similar interactions to our app, into DLL libraries.

- Test 2. MS Kinect SDK 2 and Universal Windows Platform (UWP)

UWP supports pointer events, but unfortunately the Kinect SDK is not fully supported, i.e. the rest of the required functionality for reading the data from the sensor (and especially the KinectRegion class, which is the most important). The reason is that UPW has evolved independently of the latest version of Kinect SDK 2 without being compatible with it.

- Test 3. MS Kinect SDK 2 and Windows 8.1

Windows 8.1 were tested because it was the current version of Windows when the MS Kinect SDK 2. Unfortunately, the application was not completed there either because there were incompatibilities with the rest of the Windows 10 functionality. Windows 8.1 were tested because they were the current version of Windows when the MS Kinect SDK 2. was released. Incompatibilities occurred with the rest of the Windows 10 functionality.

It is emphasized that MS Kinect SDK 2 is supported by Windows (WPF or UWP) in terms of gesture detection, especially if they are modeled with gesture recording software tools such as Visual Gesture Builder and Visual Studio. Of course, once the application is used in the future, the integration with MS Kinect or another user motion detection sensor will need to be reconsidered.

For the aforementioned reasons, user testing was performed using the "Wizard of Oz" method, that is, by simulating the interaction process in the place of the user's performed gestures.

5.12 Projection/ Application Screens

We transferred our gained understanding of the complex scientific context learned during the field research, to a visual narration, accompanied by descriptive text. The final content was split among all 16 chosen POIs, with all sites having from 5 to 8 photographs and respective captions to showcase the important rock types of the point. We based the information flow of the system to the way we were taught the geological concepts. We rooted the visual narration to a scale-down observation, just like the one we learned during our hikes with prof. Dr. Engi. Thus, the image galleries started with a relatively large-scale depiction of the landscape of the geosite, and frame by frame the images focused on different outcrops and different details on the rocks (Fig. 129). This scaling of the viewpoint was designed to give the impression of getting closer to the rock and "diving in" to its secrets.

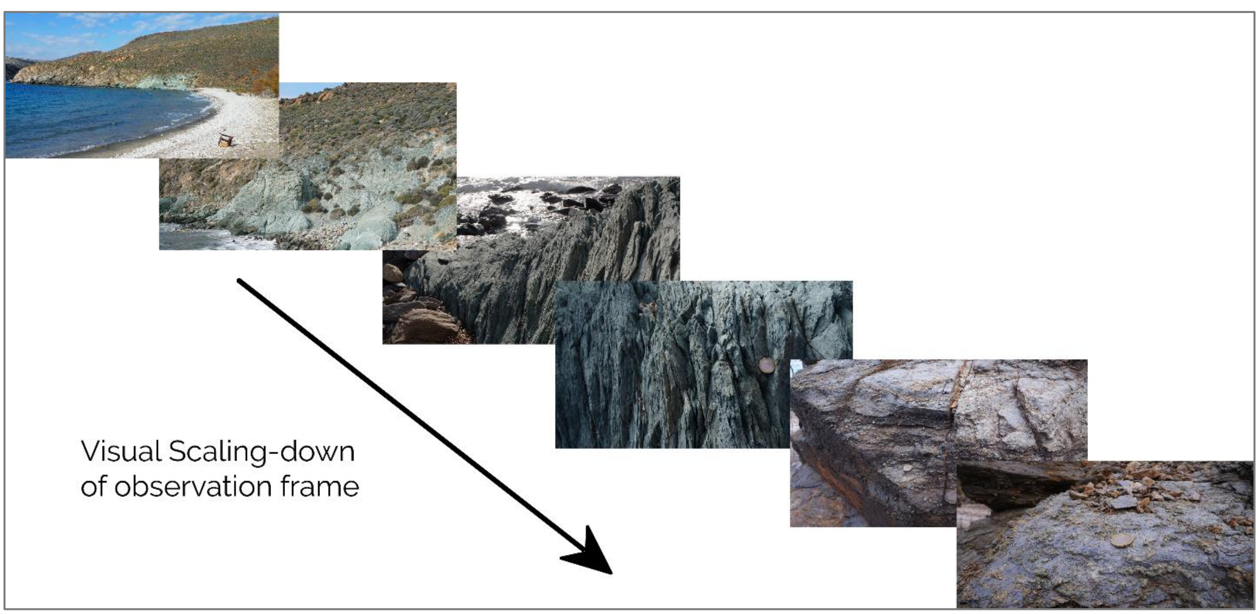

Fig. 129 Lia beach POI image gallery frames - Visual narration example.

The GLAUKO application screens presented here represent all the points of interest included in the application. The application opens directly at an interactive map menu (Fig. 130). The rock units change color as the user hovers over each one (Fig. 131) revealing the dominant rock type. Upon selection of any unit, the POIs included in said unit appear on screen (Fig. 132). By selecting any POI on the map from any unit, the user sees an image gallery with thumbnails and different written context regarding every photo (Fig. 133, Fig. 134, Fig. 135, Fig. 136, Fig. 137, Fig. 138, Fig. 139, Fig. 140, Fig. 141, Fig. 142, Fig. 143, Fig. 144, Fig. 145, Fig. 146, Fig. 147, Fig. 148).

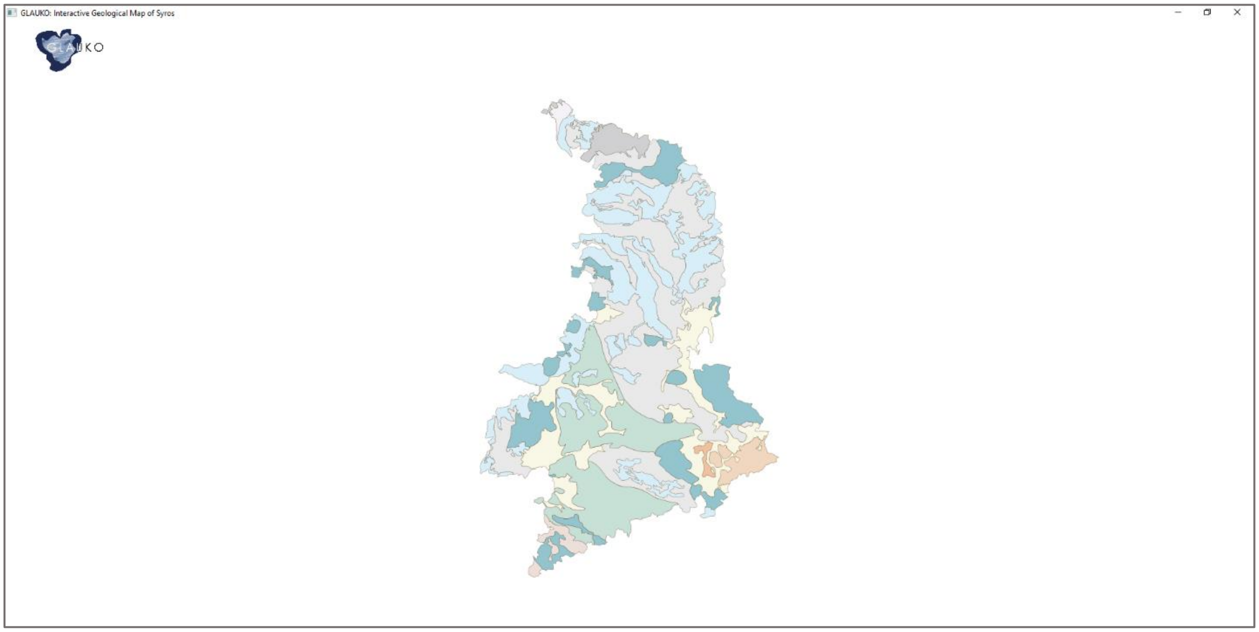

Fig. 130 GLAUKO application main menu screen.

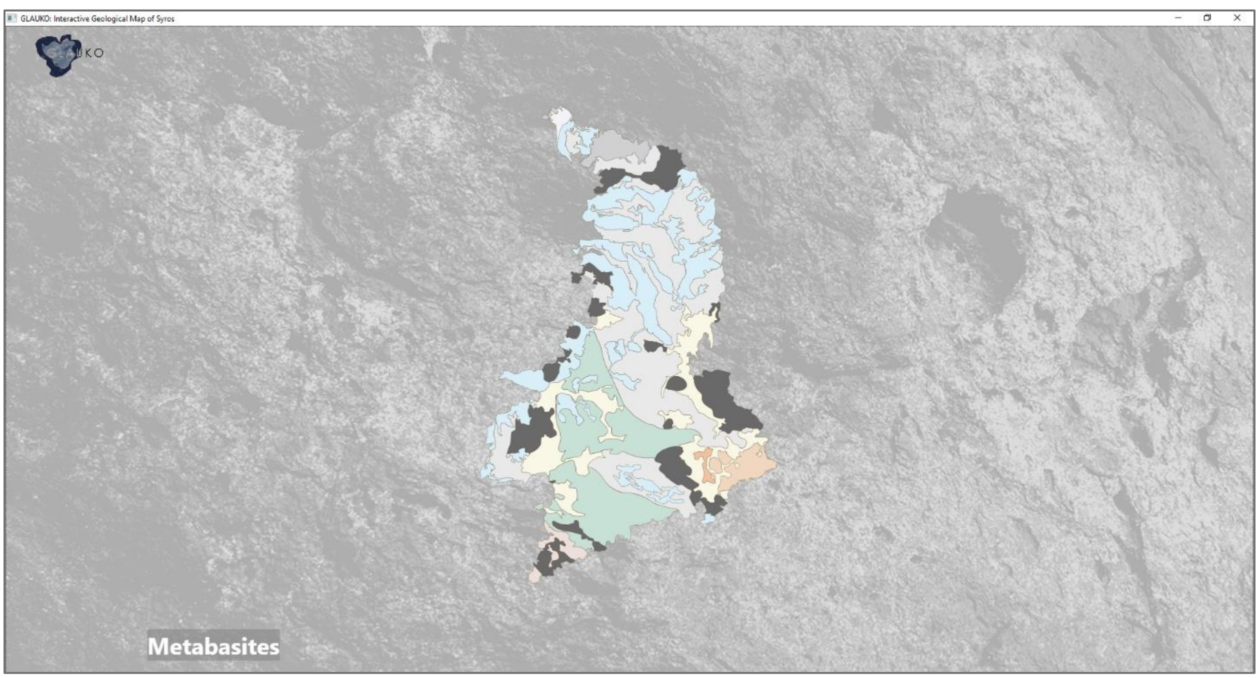

Fig. 131 GLAUKO interactive map on hover event, highlighting the Metabasite rock unit of Syros.

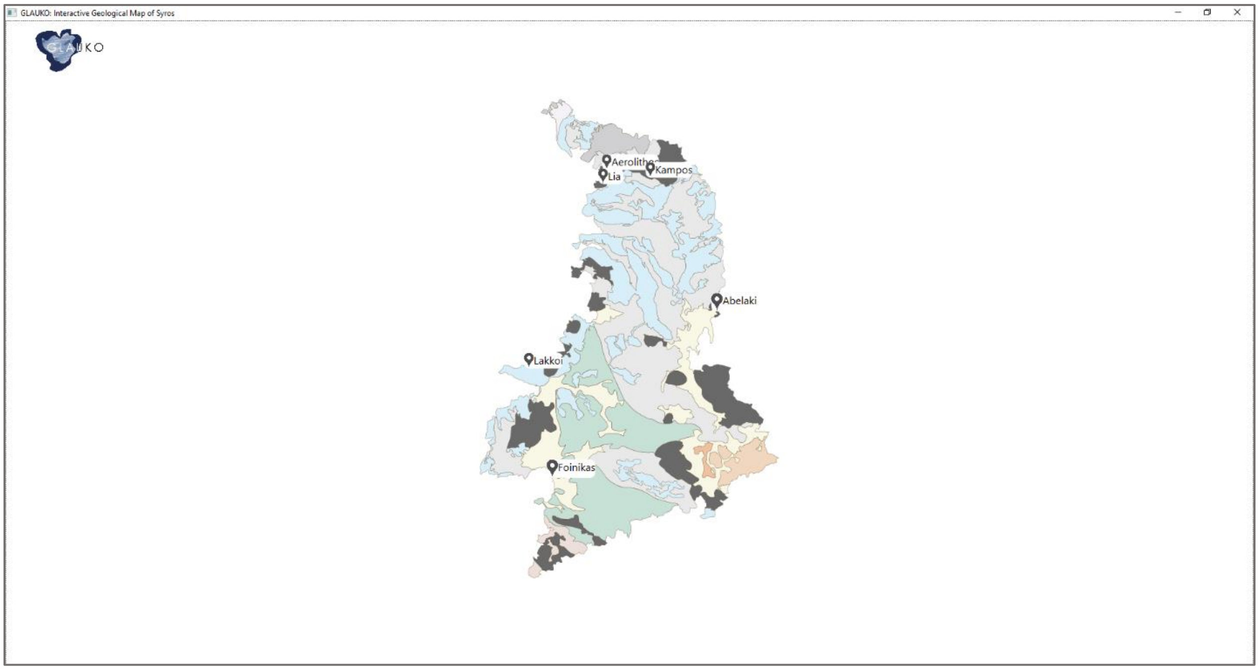

Fig. 132 GLAUKO interactive map with selected unit showing the available POIs for selection.

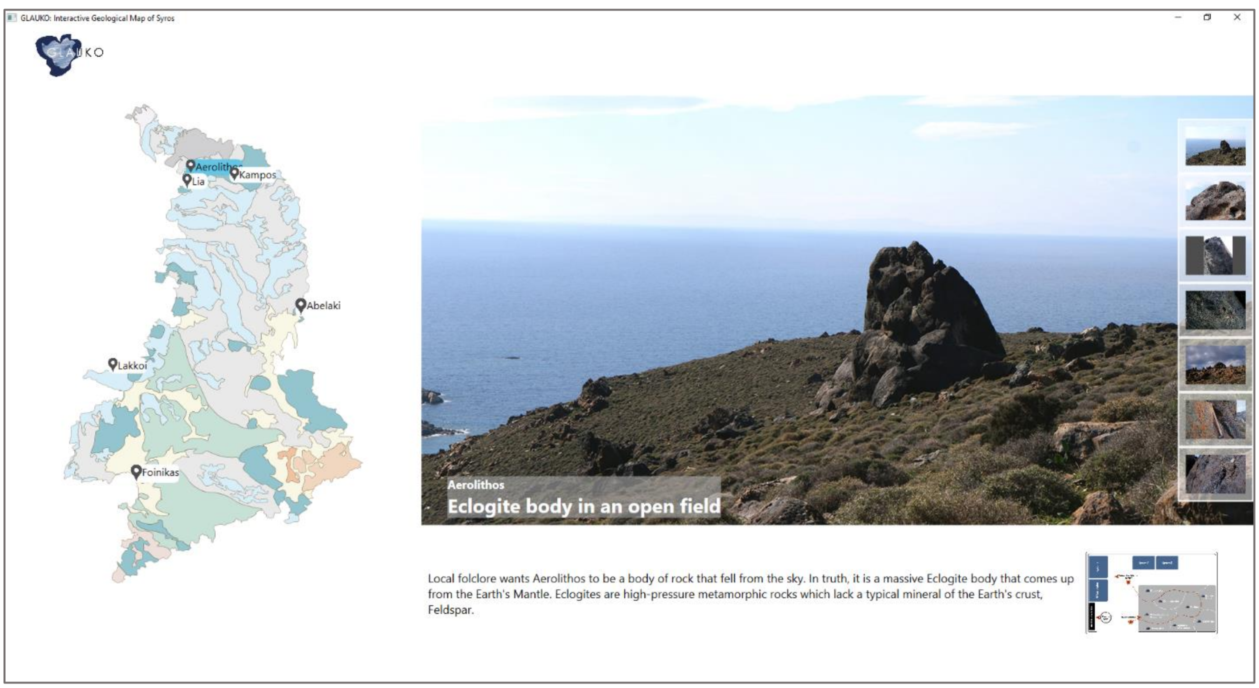

Fig. 133 Metabasite Unit selected - Aerolithos POI selected showing outcrop image gallery with 1st thumbnail selected.

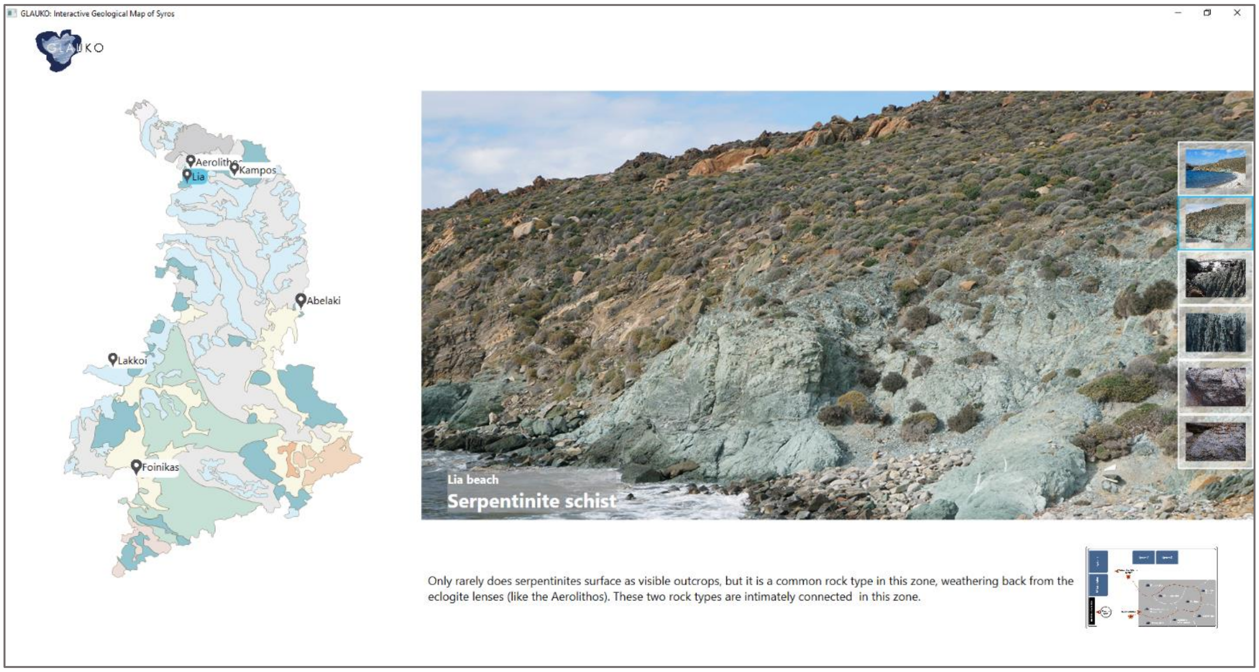

Fig. 134 Lia POI selected showing outcrop image gallery with 2nd thumbnail selected.

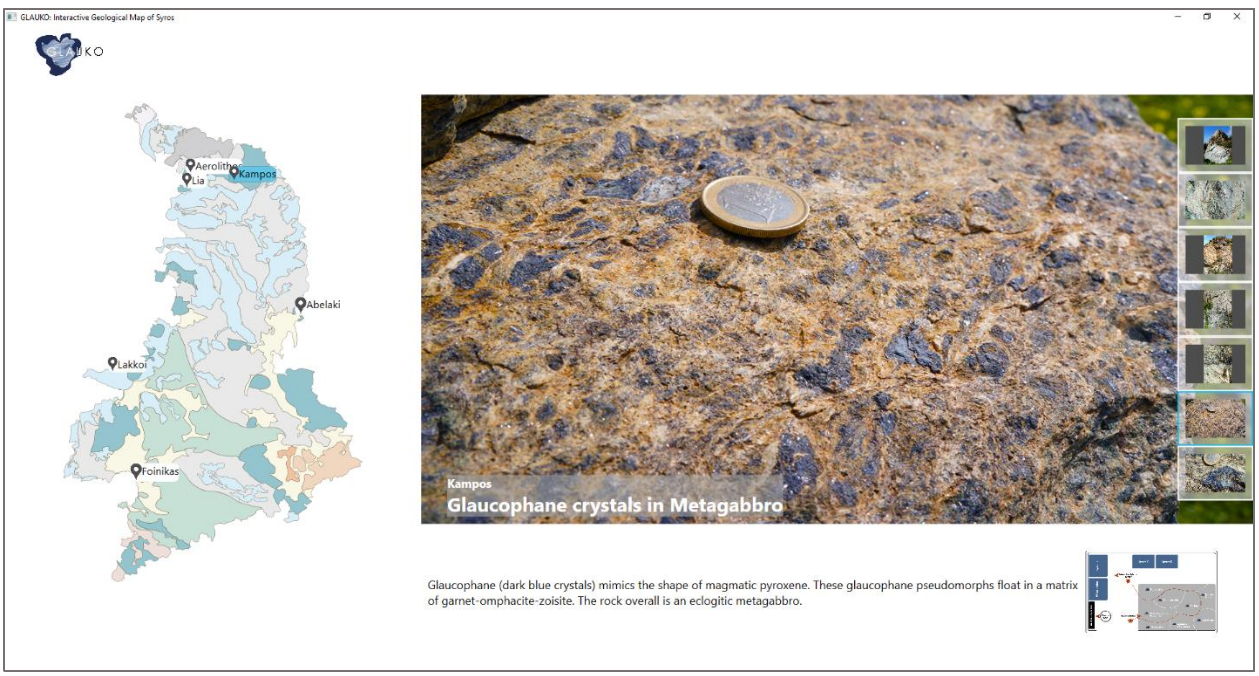

Fig. 135 Kampos POI selected showing outcrop image gallery with 6th thumbnail selected.

Fig. 136 Abelaki POI selected showing outcrop image gallery with 3rd thumbnail selected.

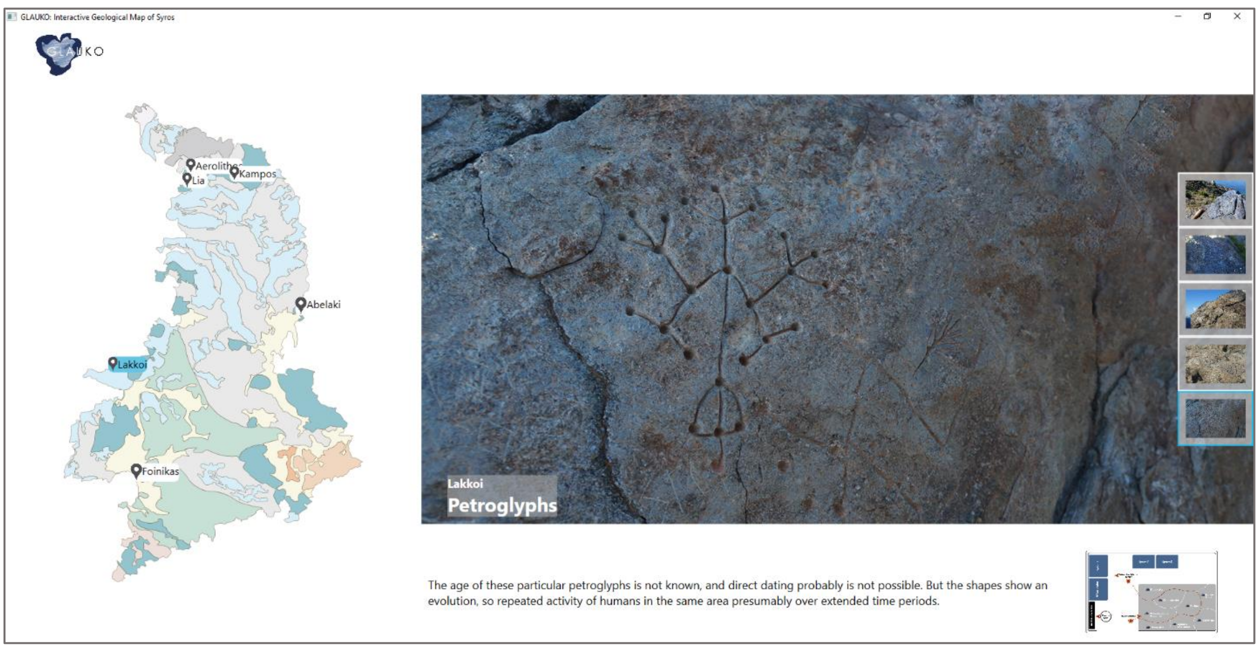

Fig. 137 Lakkoi POI selected showing outcrop image gallery with 5th thumbnail selected.

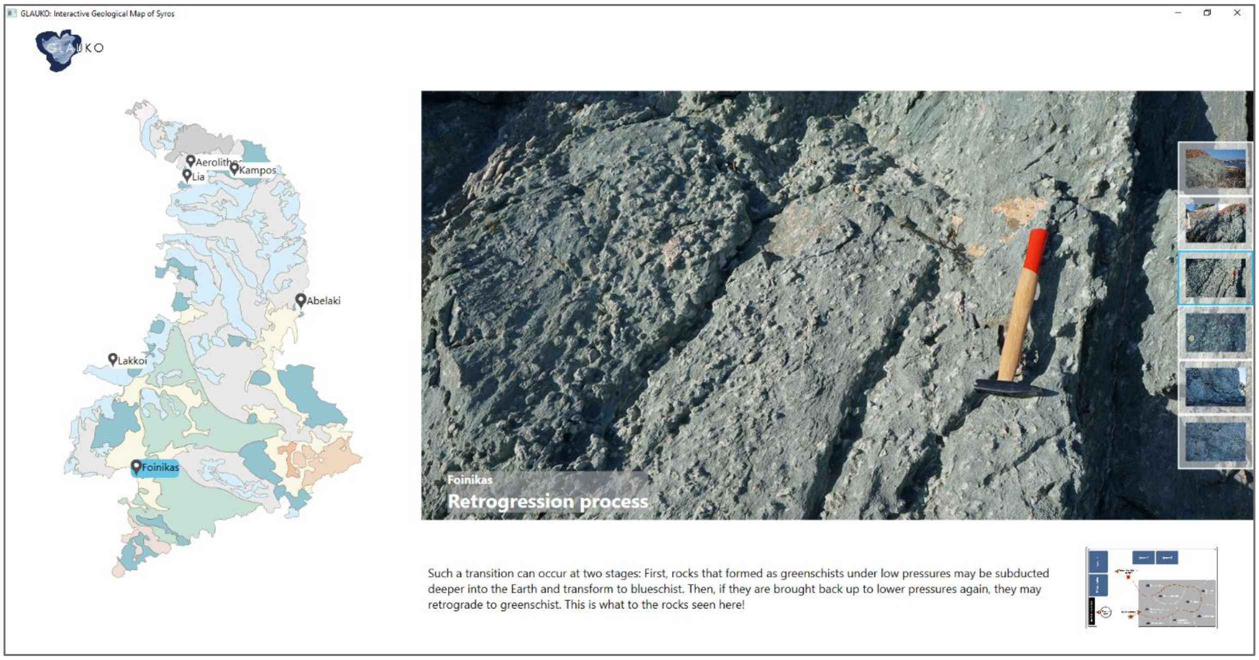

Fig. 138 Foinikas POI selected showing outcrop image gallery with 3rd thumbnail selected.

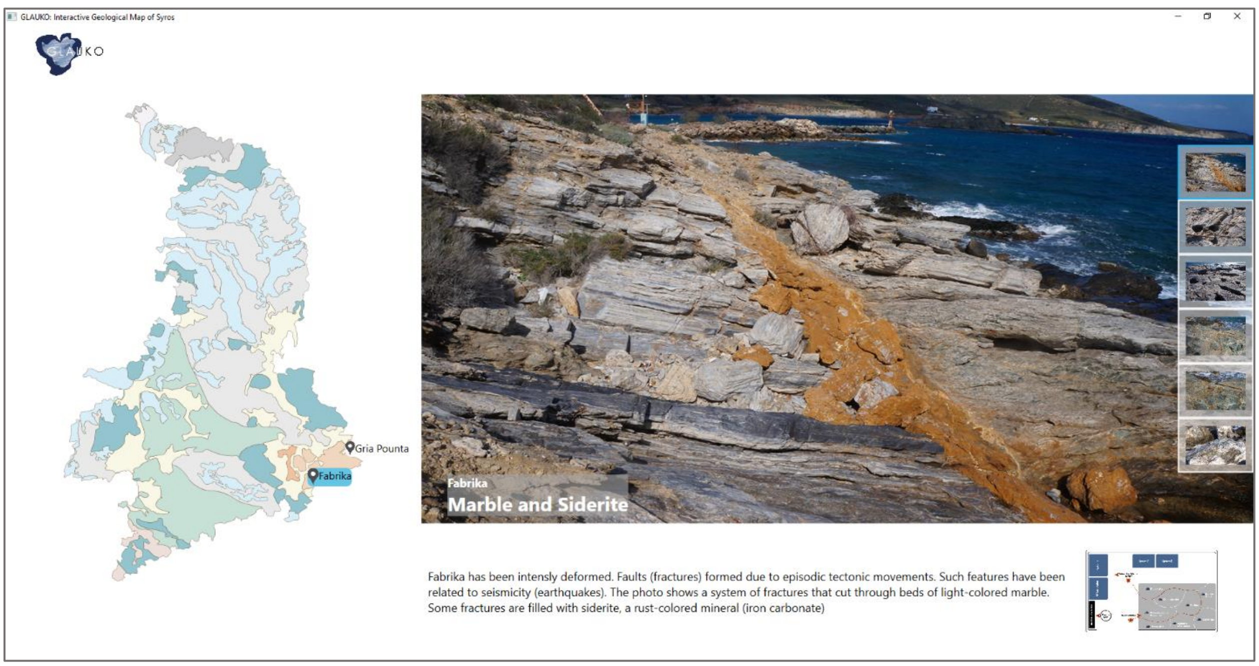

Fig. 139 Vari Gneiss Unit selected-Fabrika POI selected showing outcrop image gallery with 1st thumbnail selected.

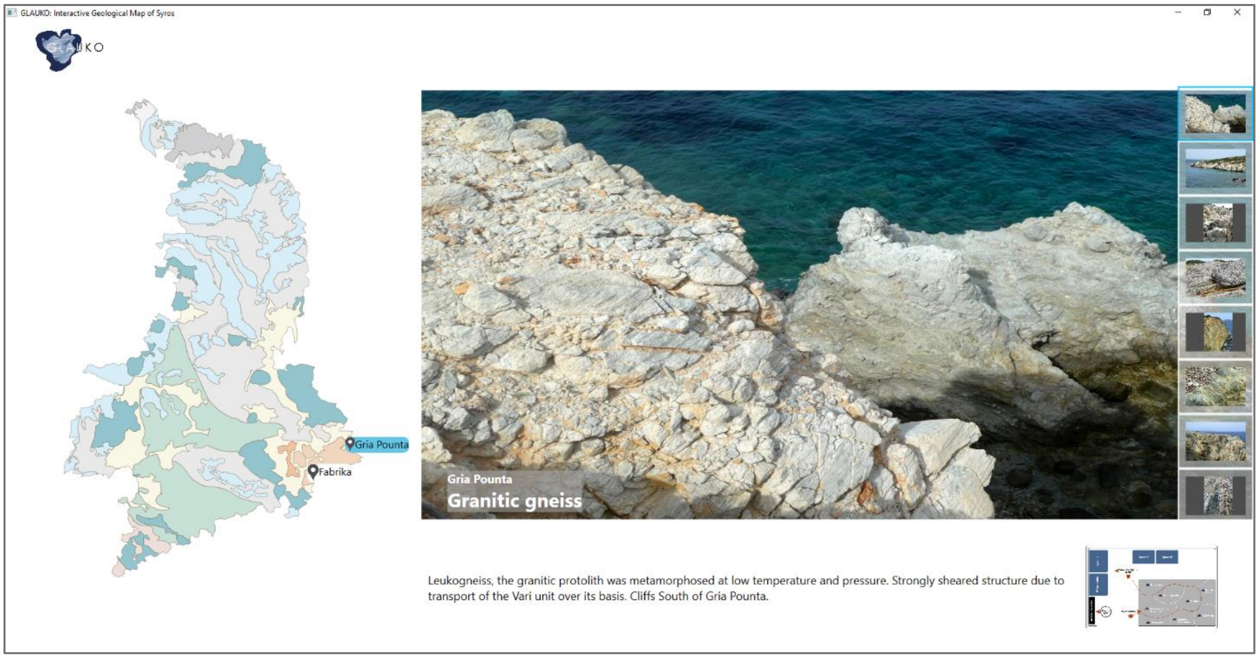

Fig. 140 Vari Gneiss Unit selected - Gria Pounta POI selected showing outcrop image gallery with 1st thumbnail selected.

Fig. 141 Greenschist Unit selected - POI selected showing outcrop image gallery with 3rd thumbnail selected.

Fig. 142 Komito Gneiss Unit selected - Komito POI selected showing outcrop image gallery with 3rd thumbnail selected.

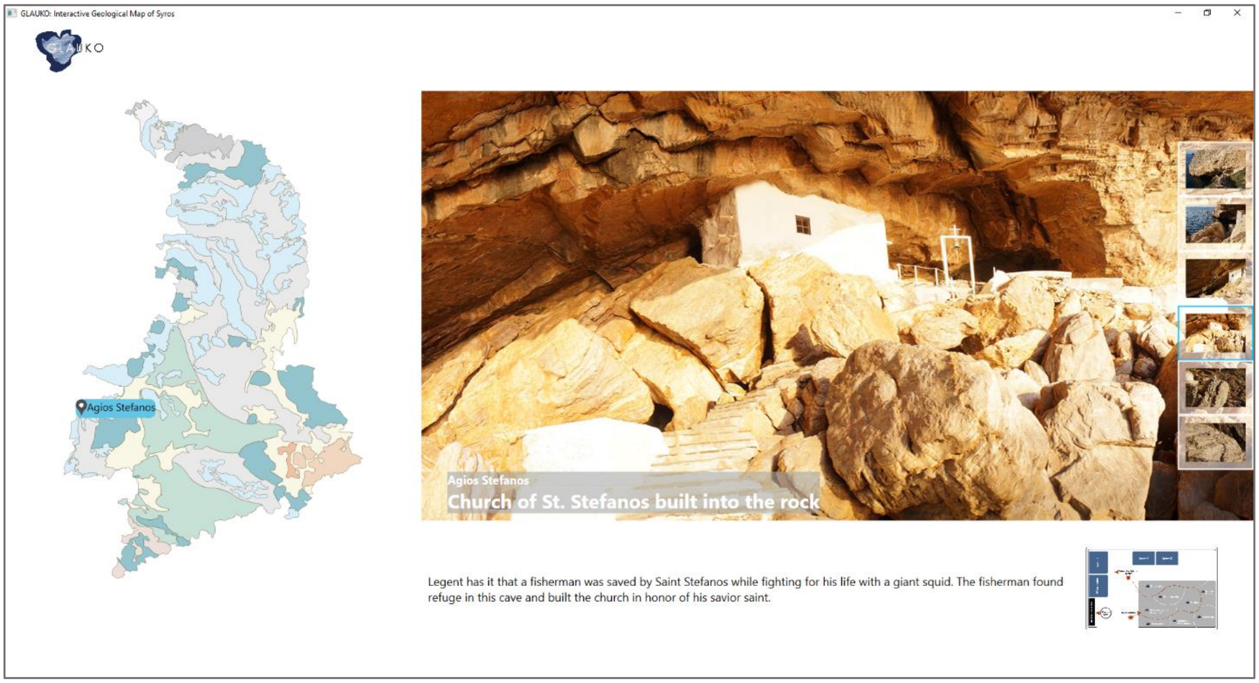

Fig. 143 Marble Unit selected - Agios Stefanos POI selected showing outcrop image gallery with 4th thumbnail selected.

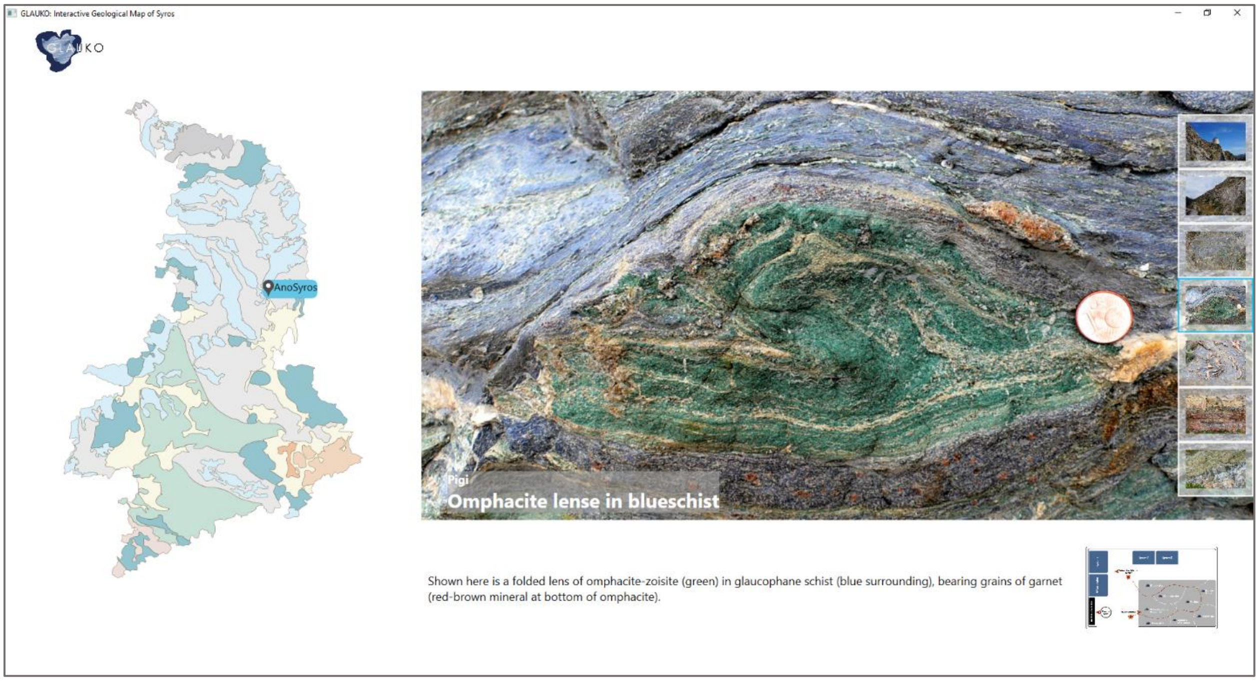

Fig. 144 Alternating Marble & Micaschist Unit selected - Ano Syros POI selected showing outcrop image gallery with 4th thumbnail selected.

Fig. 145 Metasedimentary Micaschists Unit selected - Marmari POI selected showing outcrop image gallery with 2nd thumbnail selected.

Fig. 146 metasedimentary Micaschists unit selected - Mavro Pounti POI selected showing outcrop image gallery with 4th thumbnail selected.

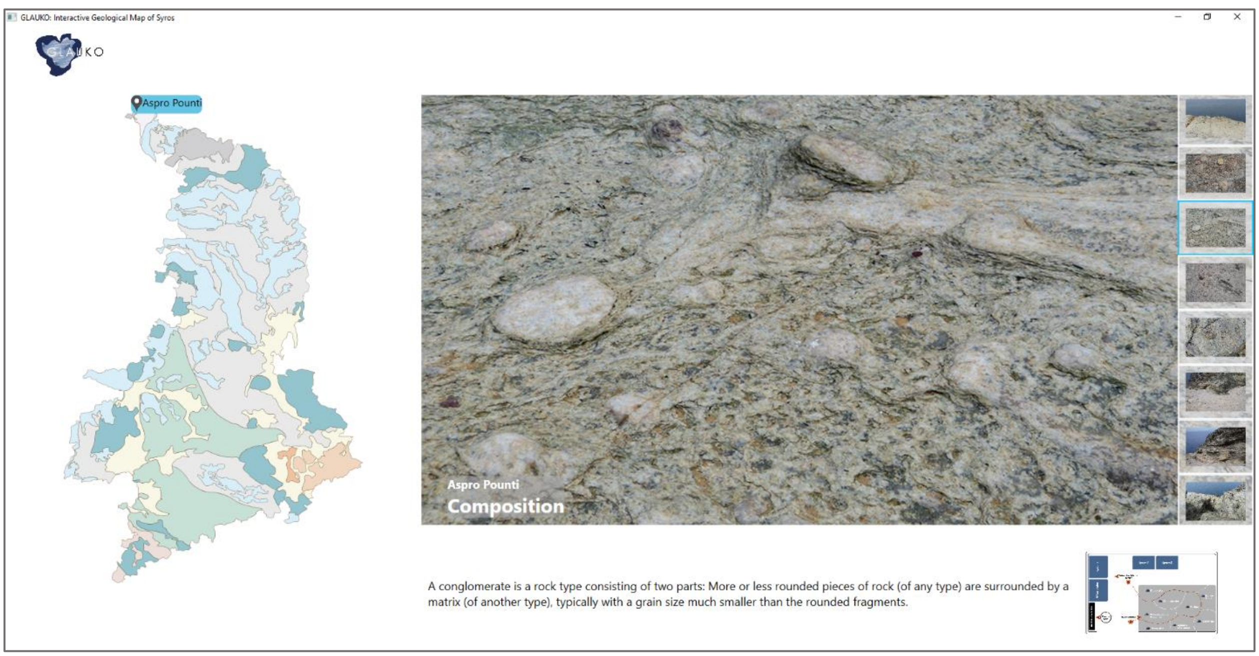

Fig. 147 (Meta)conglomerate Unit selected - Aspro Pounti POI selected showing outcrop image gallery with 3rd thumbnail selected.

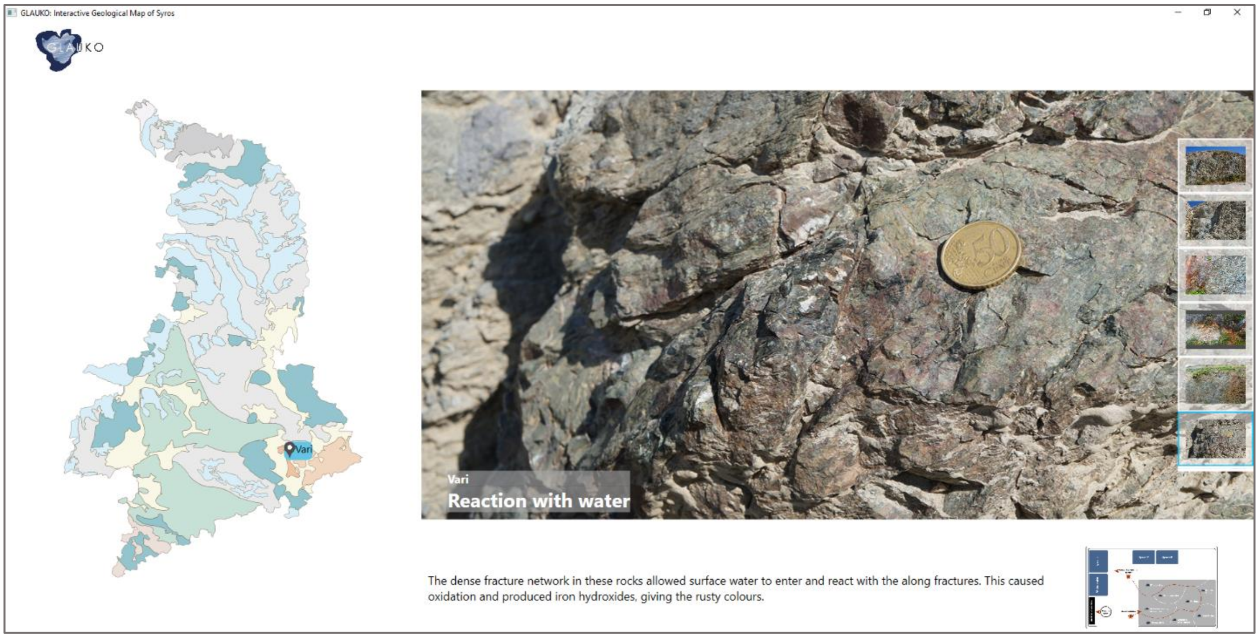

Fig. 148 Mylonitic Greenschists Unit selected - Vari POI selected showing outcrop image gallery with 6th thumbnail selected.

5.13 Chapter overview

The GLAUKO interactive system was designed as a large-scale interactive installation with geologic content for the rock types of Syros island. It was developed as a WPF application to be projected on a wall and controlled by the users via a Kinect 2.0 sensor. The preliminary and main design processes run parallel to geologic and interaction research. Thus, the mockups, prototypes, and application versions evolved as designs as we further determined the final content, means of interaction and UX goals.

6 Evaluation

The GLAUKO system was evaluated through empirical evaluation with sixteen (16) users. The evaluations took place in a laboratory environment, at the department of Product and Systems Design Engineering, of the University of the Aegean in Syros, Greece. The laboratory setting simulated a museum exhibition flow, where the users first encountered the GLAUKO interactive system upon entry to the room and later were directed to an exhibit with rock samples from the points of interest included in the system. The users followed a set procedure of four (4) phases, interacting with GLAUKO, testing what they learned at the rock samples exhibit, giving overall feedback in the form of a short interview, and taking a UX survey. Through the evaluations we wanted to test the engagement the system triggers for the users, geology interest triggers, the ease of understanding and learning information from GLAUKO, and motivation on further exploration of Syros' geological features. The procedure was recorded through video, a rock type learning quiz, and a UX questionnaire. The data was combined to provide overall results.

6.1 Aims and procedures

Our test goals for the evaluations of the GLAUKO systems were the following:

1. Test the engagement the system triggers for the users.
2. Test if the system triggered interests in geology
3. Test how easy it is for the user to understand and learn the content information provided by the GLAUKO system.
4. Test if the system motivated the users to go and visit points of geological interest in Syros.

The evaluation process was set to a one-hour session per user, and it was separated into four (4) phases. The first phase was using the GLAUKO system. All users used the application in their own language, as the content was translated into both the English and Greek languages. Each user would position themselves in front of the projection and completed the tasks set by the evaluator. Throughout this phase we recorded videos of the users' interaction with the system to capture initial responses and document further interest in geology. The second phase was to test out their memory in how much they learned from using the GLAUKO system. Each user would take a brief test to identify some of the rock samples at the rock exhibit set up. This phase was recorded to document the user's level of difficulty in remembering the information and completing the test. The third phase was giving feedback on their experience, negative and positive. Each user would be given the option to use the system freely in Desktop mode and navigate through the rest of the POIs. This phase was recorded to capture the brief interviews with the users and allow them to better express their feedback verbally, instead of in writing. The final phase was for the users to answer the UEQ questionnaire (User Experience Questionnaire) and rank their experience of using the GLAUKO system as truthfully as possible. This questionnaire rated the UX of the GLAUKO system through six (6) scales/ attributes, attractiveness, perspicuity, novelty, stimulation, dependability, and efficiency. These scales are set by the UEQ for the purpose of testing the user experience in various products. This phase was not recorded.

6.1.1 User profiles

For the evaluation procedures, we followed the "wizard of Oz" protocol as to examine the user's experience on an as realistic as possible setting and use case. We separated the evaluation process into four (4) phases in order to test our hypothesis in a collective perspective. We tested the system on 16 users; a combination of university undergraduate and PhD. students, professors and university staff, locals, and geology experts. The user pool consisted of two (2) geology experts (GE) (one being a local resident), (3) university professors (two of which had medium geological knowledge (MGK) and the third being one of the geology experts), two (2) staff members with MGK, three (3) PhD. and six (6) undergraduate students and one (1) more local resident of no prior geological knowledge. Thusly, 10/16 users were first-time learners, 4/16 were pre-exposed to Syros' geology, 2/16 were experts in the field. All users went through the same procedures and tasks.

6.1.2 User tasks

The Tasks given to the users to complete during the first phase were "visits" (selections) of four POIs on the interactive map. On each POI the user needed to select specific photographs from the thumbnail menu that the evaluator requested. This was necessary as to keep the evaluation within time limits, have each user explore a minimum variety of information, have them informed about the main rock types that make Syros special, and have as much of the information as possible repeated more than once to help them remember it later on.

Task 1: Aerolithos

The first task shows the user about eclogites and glaucophane, the two most characteristic geological treasures of Syros. It focuses famous body of eclogite called Aerolithos which is well known around the island. For the Aerolithos POI the users were asked to select the 1st,2nd,3rd, and 4th thumbnails and read aloud their captions (Fig. 149). This distinction of photos was done to help keep the information more concentrated.

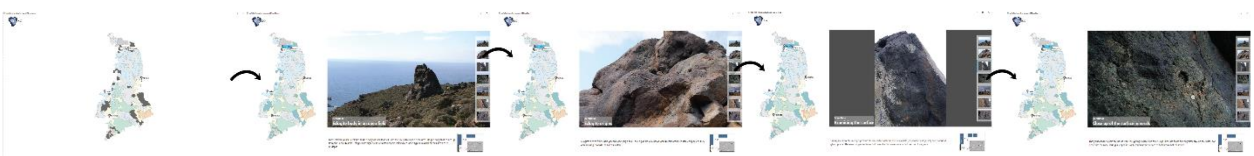

Fig. 149 Aerolithos POI task storyboard.

Task 2: Lia

The second task takes the user to Lia beach. The user selects the pictures 1,2,3,4, and 6 to learn about two main rock types in the beach. The navigation starts from large frames and narrows down to close up details on the rocks. The relevant caption on each photo informs the user about serpentinite schists, gradually going into more detail as the photos progress, and about lawsonite blueschists (Fig. 150).

Fig. 150 Lia POI task storyboard.

Task 3: Kampos

The third task informs the user about variations of eclogitic rocks and informs them about the formation process of the particular rocks. The user chooses pictures 3,4,5, and 6 to read about the formation and characteristics of a metagabbro with coarse-grain glaucophane crystals (Fig. 151). Through this, the user gets closer and closer to the outcrop and meets a new variety of the two special rock types.

Fig. 151 Kampos POI task storyboard.

Task 4: Abelaki

The fourth task showcases the Abelaki beach. In this POI the user learns of a geologic site very close to the main town, thus more accessible for visiting, and gets to go through some of the previews information. The photos chosen in this point of interest are numbers 2,3,5,6, and 8, and they showcase blueschists and relics of eclogites (Fig. 152).

Fig. 152 Abelaki POI task storyboard.

6.1.3 Rock Type Learning Quiz Setup

The purpose of the rock type learning quiz was to test if (first-time) learners would be able to remember information from the system and identify correctly the rock samples. After having completed the first phase of interacting with the GLAUKO system, the users moved to the rock sample exhibit and were given a set of seven (7) questions. The questions asked them to identify certain rock types from a selection of 22 rock samples placed in front of them (Fig. 153). The users were not required to answer all the questions, only those they felt confident.

Rock type learning quiz - questions

1. Find at least three rocks with garnet crystals.
2. Identify the two purest eclogites (Hint: look for garnet and omfacite)
3. Identify the three (partially or fully) metagabbro rocks.
4. Choose three rocks with coarse-grained glaucophane crystals.
5. Put the following rocks in order from magnesium-rich to iron rich (4,6,9,15)
6. What will you look for to find a lawsonite? Find the one or more lawsonites.
7. Examine the rocks 17,2,5. Which one is the serpentinite?

Fig. 153 Rock samples used in Phase 2-Rock Type quiz, for users to identify.

6.1.4 Short Feedback interviews

The purpose of the short interview was to give the users the opportunity to provide feedback in an open verbal way, as oppose to asking them to write down comments on a survey. This way, they spoke freely and expressed their ideas better. The interview was partially planned. We prepared two main interview questions to test if the system motivated the users to go and visit points of geological interest in Syros. We asked the users the following questions:

1. Have you ever been hiking to any of the places you saw here?
   A. If yes, where/which ones? Had you noticed some of the rock types shown here? Did the system help you understand questions that you had during that hike? Would you like to have seen additional things from those trails here?
   B. If no, are you interested to go see the POIs from the system for real? Would you look for anything in particular that you learned from the system?
2. Do you feel interested and motivated to visit some of the POIs after seeing them in the GLAUKO system?
3. How does the large-scale interaction via Kinect control compare to a small-scale desktop application via mouse control?

In addition to those questions, we asked them to use the GLAUKO system once again as a desktop application, to allow them to navigate throughout the program. This free choice navigation is considered a fifth task (5). Task 5/ Open choice is about allowing the users to explore the whole system, play around and discover the other POIs and navigate through their photographs and information as they pleased. This was also a good way for them to examine the system and provide clearer feedback on their experience. The fifth task takes place after the rock type quiz as to not confuse the first-time learners with more information. The task is completed during a brief interview with each user. The users are given the opportunity to navigate freely through the application by choosing to see other POIs they would like to explore and learn about. The purpose for this option is to allow the users further exploration of the system. We run this task during the interview to help the users open up and express their feedback without overthinking it in a more natural, verbal way, instead of taking a written survey.

6.1.5 User Experience Questionnaire tool (UEQ)

	1	2	3	4	5	6	7		
annoying	○	○	○	○	○	○	○	enjoyable	1
not understandable	○	○	○	○	○	○	○	understandable	2
creative	○	○	○	○	○	○	○	dull	3
easy to learn	○	○	○	○	○	○	○	difficult to learn	4
valuable	○	○	○	○	○	○	○	inferior	5
boring	○	○	○	○	○	○	○	exciting	6
not interesting	○	○	○	○	○	○	○	interesting	7
unpredictable	○	○	○	○	○	○	○	predictable	8
fast	○	○	○	○	○	○	○	slow	9
inventive	○	○	○	○	○	○	○	conventional	10
obstructive	○	○	○	○	○	○	○	supportive	11
good	○	○	○	○	○	○	○	bad	12
complicated	○	○	○	○	○	○	○	easy	13
unlikable	○	○	○	○	○	○	○	pleasing	14
usual	○	○	○	○	○	○	○	leading edge	15
unpleasant	○	○	○	○	○	○	○	pleasant	16
secure	○	○	○	○	○	○	○	not secure	17
motivating	○	○	○	○	○	○	○	demotivating	18
meets expectations	○	○	○	○	○	○	○	does not meet expectations	19
inefficient	○	○	○	○	○	○	○	efficient	20
clear	○	○	○	○	○	○	○	confusing	21
impractical	○	○	○	○	○	○	○	practical	22
organized	○	○	○	○	○	○	○	cluttered	23
attractive	○	○	○	○	○	○	○	unattractive	24
friendly	○	○	○	○	○	○	○	unfriendly	25
conservative	○	○	○	○	○	○	○	innovative	26

Fig. 154 UEQ 26 items for UX evaluation.

The evaluation of the users' experience was recorded and analyzed with the use of the UEQ (User Experience Questionnaire) tool. The UEQ is a questionnaire to measure the User Experience of interactive products, available in multiple languages. It offers rich supplementary material, such as benchmarks to compare a product with other standardized products on the market. The goal of this tool is to make the analysis of UEQ data as easy as possible for the researchers. The researcher enters the data obtained from the respondents into the provided Data worksheet (UEQ Data Analysis Tool Version 8) (Hinderks, Schrepp, & Thomaschewski, 2018). The tool then automatically calculates all statistics necessary to interpret the results. In addition, several graphs are formed, which can be used in presenting the results.

For our evaluations, we used all 26 items (Fig. 154), translated the questionnaire to the Greek language, and asked our users to fill it out at the end of their evaluation, as a fourth phase. The UEQ determines the UX of a system through six (6) scales, equally represented by the 26 items. These scales measured by the UEQ are the system's attractiveness, perspicuity, novelty, stimulation, dependability, and efficiency. The user rates each item from 1 to 7 on a negative-to-positive scale.

6.2 Laboratory setting & apparatus

Fig. 155 Projection setup with PC control station bellow.

The evaluations of the GLAUKO system were conducted in a laboratory environment. We tried to recreate a museum setting for our users, thus we set up the installation in the same space as a test rock sample collection (Fig. 156). The installation comprised of a wall projection of the WPF application from a desktop computer (PC) (Fig. 155). The application was connected to a Kinect 2.0 sensor. Each user would position themselves in front of the projection, at a 1.5-2 meters distance from the Kinect sensor facing the projection. Phase 1 took place in front of the GLAUKO projection. The rock sample station (exhibit) was set up on the left side of the room, where phase 2 took part. Phase 3, the short feedback interviews took place at the PC where the GLAUKO application was run. Phase 4 was placed at the back of the room were users answered the UEQ questionnaire on UX on a laptop computer. The UEQ was presented on a Google Form document where we had transferred the 26 items for rating. The answers were immediately submitted and stored on the Google Drive cloud for us to sort. From the form, we transferred the data onto the UEQ Data Analysis Tool version 8, provided freely by its creators.

We used two camera devices to record the evaluations sessions. The primary camera was a digital, mirrorless, single-lens reflex camera (SLR) set on a tripod located at the back-left corner of the room, and the second was a cellphone camera operated by the evaluator. The stable camera captured the user's interaction with the system (phase 1), and the user's rock learning quiz (phase 2). The secondary camera was a backup and was used to record the short interview sessions with the users (phase 3). Phase 4 did not need to be recorded.

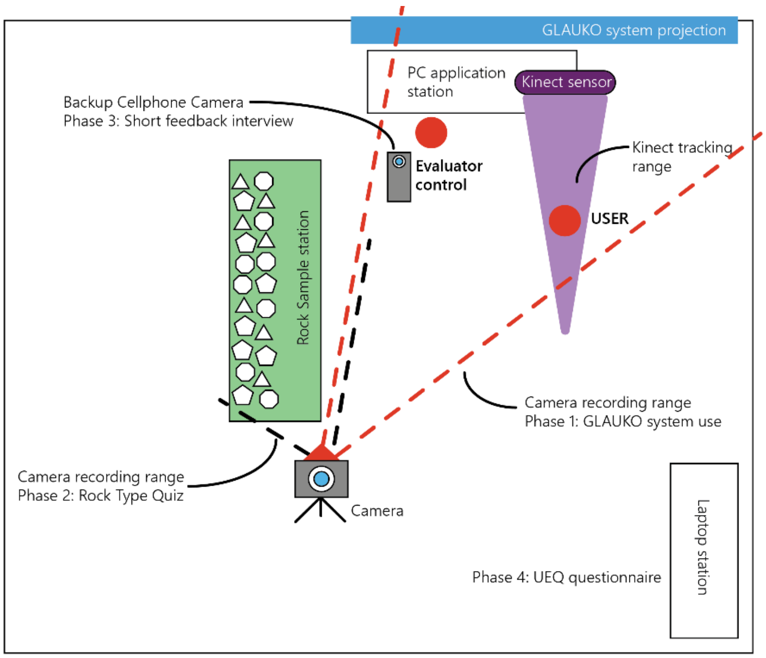

Fig. 156 Evaluation set up

The rock sample exhibit comprised of 22 rock samples from points of interest around Syros. They were gathered by the evaluator for the purpose of this evaluation. The rocks were numbered from 1 to 22 to help the users keep track and identify them (Fig. 157).

Fig. 157 Labeled rock samples.

In phase 1, we measured the user's experience, by recording their initial reactions to features of the system, we measured the time spent on the system, if they showed further interest on the geologic topics, if they could comprehend the content and information presented to them. The users provided their own feedback on the UEQ questionnaire during phase 4. In the rock type learning quiz, phase 2, we wanted to measure the amount of correct or partially correct answers given per question. Also, we wanted to see how easily the users remembered the information they had learnt during the previous phase. In the third phase, we wanted to measure how many of them were motivated to visit the POIs in the future after seeing them in the GLAUKO system. We also wanted to determine whether the content was overwhelming them, and what changes they would propose.

6.3 Empirical Evaluations

The empirical evaluations took place once the application was fully functioning, with all of the photographic and descriptive content gathered and translated into both English and Greek. The evaluation involved four phases. The first phase required the users to complete four tasks. Each of the first three tasks covered a different set of information for the user to learn. The second phase was to see if the users had learned or remembered anything from the system. The third phase was a brief interview with each user to provide verbal feedback. In the final phase the users simply filled out the user experience questionnaire by UEQ.

6.3.1 Phase 1: Using the GLAUKO system

All the users went through all the tasks in order and within each task they were asked to select the required photographs within each point of interest, in a given order. Within each image gallery they were asked to select specific photos, as to reduce the amount of time per POI and to avoid confusion with secondary information. Each image is connected to the next within the overall theme of the Task/POI. Task 1/Aerolithos is about learning of the two main geologic treasures that make Syros special in a global scale, eclogites and glaucophane. Task 2/ Lia is about learning of rock types in close relation to eclogites, serpentinite schists and lawsonite blueschists, and to start understanding the scale difference; from observing the landscape from afar to focusing on close up examination of an outcrop. Task 3/ Kampos is about introducing geologic processes with specific rock example of the metagabbro formation, as well as introducing them to another formation of glaucophane. Task 4/Abelaki is about showcasing a POI from full large scale (beach scale) down to close surface observation, with a focus on blueschists (Fig. 158, Fig. 159, Fig. 160, Fig. 161). By grouping the topics into tasks, the navigation would be more comprehensible, the users would be able to better grasp and understand the concepts, and remember the information.

Fig. 158 User exploring the interactive map of Syros.

Fig. 159 User observing a far-scale photo of Lia beach.

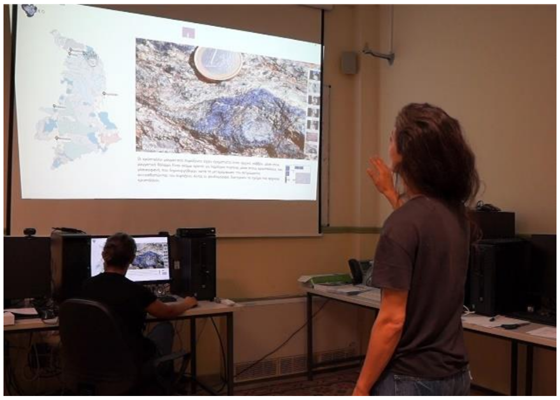

Fig. 160 User selecting a POI from the interactive map.

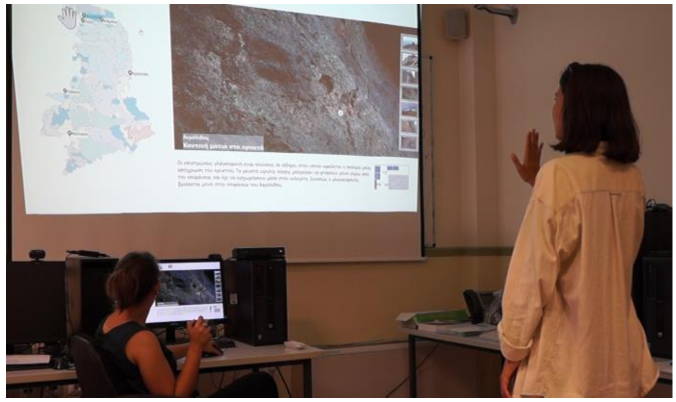

Fig. 161 User navigating through the Aerolithos POI.

6.3.2 Phase 2: Identifying rock types

The second section of the evaluation was a rock type quiz. The users, after having navigated through the points of interest of the interactive map and got the information about basic rock types of Syros, they were asked to identify the same rock types from a collection of 22 real rock samples (Fig. 162, Fig. 163). The goal for the second phase was to evaluate whether or not the users remembered any of the information they were exposed to during the first phase, and to see if the system was successful enough in providing suitable information to the users. Each user was given a set of seven (7) questions that asked for different rock types to be identified. The test is meant to score how well did the system "teach" the students. We are not scoring the users to grade their performance and knowledge. The success in the answers is scored in a three-point scale of Fully correct (2), Partially correct (1), Not correct (0). The first point is given if the answer provided is exactly the same as the answer checked by the geology expert, prof. Dr. Engi. The second point is given when the user has found some, yet not all correct options. The third is for questions that have either been answered without any success, or were not answered at all due to uncertainty or lack of memory.

Fig. 162 User examining a rock sample during the rock type learning quiz.

Fig. 163 User answering a question on rock samples.

Rock type learning quiz – answer and grading key

1. Find at least three rocks with garnet crystals.
    a. Correct answer: rocks 1,8,14,16,18,22
    b. Partially correct answer: at least one of the correct numbered-rocks
    c. Not correct answer: No answer at all, or wrong number(s) given
2. Identify the two purest eclogites (Hint: look for garnet and omfacite)
    a. Correct answer: rocks 16,18
    b. Partially correct answer: at least one of the correct numbered-rocks
    c. Not correct answer: No answer at all, or wrong number(s) given
3. Identify the three (partially or fully) metagabbro rocks.
    a. Correct answer: rocks 1,8,20
    b. Partially correct answer: at least one of the correct numbered-rocks
    c. Not correct answer: No answer at all, or wrong number(s) given
4. Choose three rocks with coarse-grained glaucophane crystals.
    a. Correct answer: rocks 1,8,9,11,15,21
    b. Partially correct answer: at least one of the correct numbered-rocks
    c. Not correct answer: No answer at all, or wrong number(s) given
5. Put the following rocks in order from magnesium-rich to iron rich (4,6,9,15)
    a. Correct answer: Order 6,15,4,9
    b. Partially correct answer: -
    c. Not correct answer: No answer at all, or wrong number(s) given
6. What will you look for to find a lawsonite? Find the one or more lawsonites.
    a. Correct answer: rocks 6,22
    b. Partially correct answer: at least one of the correct numbered-rocks
    c. Not correct answer: No answer at all, or wrong number(s) given
7. Examine the rocks 17,2,5. Which one is the serpentinite?
    a. Correct answer: rock 2
    b. Partially correct answer: -
    c. Not correct answer: No answer at all, or wrong number(s) given

6.3.3 Phase 3: Feedback Interview

The third phase of the evaluation was the short feedback interview. The users were asked to use the GLAUKO system once again, this time as a desktop application, to freely navigate through and explore the content (Fig. 164). During this task (5th user task. Previous four tasks took place during phase 1), the users selected any rock units of the interactive map, navigating to any Points of Interest they wished (Fig. 164). They made comments about their experience in using the system, the user interface, about the quality and quantity of the content, about features that they liked or that they would change (Fig. 165). They were encouraged to deliver any kind of feedback with few set questions. They were asked to comment on the means of interaction, comparing the large-scale interaction with kinaesthetic control that they experienced before to the present small-scale desktop application with mouse control. They were further asked whether they had previously been to any of the displayed POIs and noticed the outcrops. If so, they would be asked if they learned anything from the GLAUKO system regarding what they had seen. If they had not been to any of the POIs before, they would be asked if now they felt more interested and motivated to go and see the content in real life.

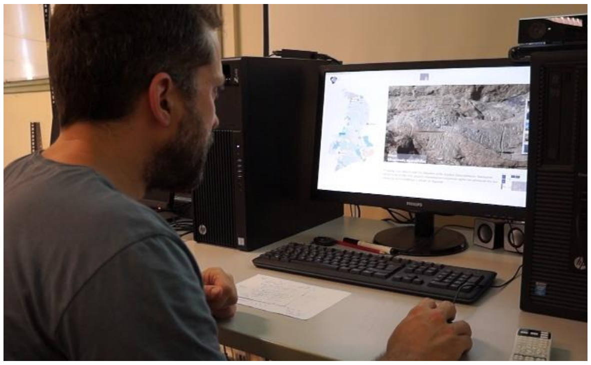

Fig. 164 User on desktop interaction with the application during open navigation during short feedback interview.

Fig. 165 User giving feedback during the short interview.

6.3.4 Phase 4: UEQ Questionnaire

The fourth and last phase of the evaluation was for the users to provide their feedback on the UEQ scale to rate the UX of the system through scoring the six provided scales; attractiveness, perspicuity, efficiency, dependability, stimulation, and novelty. They rated 26 items which equally represented each of the aforementioned scales, from 1 to 7 on a positive-to-negative spectrum. The questionnaire was presented to the user on a Google Form on the Laptop station.

6.4 Results

Overall good impression. Too much content to process. Needed better information-photo correlation to make sure they have understood what they were examining. Visual feedback would have been helpful in this. Loved the large-scale interaction, preferred it over a desktop application. The kinaesthetic interaction was tiresome after some time. Overall, the users seemed to have had a pleasant, engaging experience, yet some key feedback and control aspects would have made for a less cramped content and a less tedious interaction.

6.4.1 Initial responses to interacting to the GLAUKO interactive system

The initial responses of the users were recorded by video during the first phase of the evaluation session (Fig. 166). As the users first encountered the GLAUKO system and interacted with it, they made comments and had reactions to what they were experiencing. Here we present the most common remarks and reactions made during the initial interaction. This data is qualitative and simply a way to gather the users' comments on their experience. The official UX results come from the UEQ questionnaire at section 6.4.4.

Most users engaged highly with the interactive map of the system (12/16) and navigated easily to the correct POIs (12/16). Most users took their time to examine the content by reading the captions and observing the photos (11/16). Most users commented positively on the geosite images (12/16), while the minority (4/16) did not make any remarks on this. Most of the users (10/16) commented on the image sequence of scaling down frame-by-frame as a helpful way to understand the content. The other 5/16 did not make any comment on this feature. The majority of the users (12/16) initially were okay with the kinaesthetic interaction, while the rest 4/16 initially experienced difficulty. However, by the end of the phase all (16/16) described the midair interaction as tiresome, and 3/16 as also pointless for such precise selections. 11 of 16 users found the terminology in the content challenging, whereas the other 5/16 where either expert geologists or pre-exposed to the scientific lingo. Most users selected the correct thumbnails easily (13/16), however, this might have been due to the "wizard of oz" setting, as at least 8/16 of the users commented on having a hard time recognizing the thumbnail they had already selected. A small majority of the users (9/16) were able to understand the content connection, while 7/16 needed further clarification from the evaluator. A majority of 10/16 of users showed an increasing interest in the geology of Syros and in general, as they constantly asked relevant questions. The 6/10 minority either did not show such interest or where geology experts and pre-exposed users to the topic. On average the users spent about 18 minutes exploring the GLAUKO system.

Overall, we conclude that the users had positive initial responses to the system. They showed interest in the content and geologic topics regarding Syros. They engaged with the system relatively easily, however the midair interaction became a tedious task after some time, and they needed some more clarification on the content.

6.4.2 Rock Type Learning Results

During the rock type learning quiz, phase 2, we examined how much information the users were able to learn and remember from the content of the GLAUKO system (Fig. 167). We measured the correct and partially correct answers provided for seven (7) questions relating to rock types of Syros (**Error! Reference source not found.**). The Users were given these questions on paper and were asked to answer only in they felt confident with their answer (**Error! Reference source not found.**). Phase 2 was recorded to determine if the users had a hard time recalling the information or not, as well as the time spent on the activity.

The users spent an average of 7.5 minutes on the activity, examining the rock types in front of them to help them recall information and decide on their answers. A majority of 12/16 of the users showed low or medium difficulty in recalling information from the system, with 2 of those being either expert geologists. The questions were answered successfully in the following rates:

1. Find at least three rocks with garnet crystals. (13/16 users answered correctly or partially correct)
2. Identify the two purest eclogites (Hint: look for garnet and omfacite). (8/16 users answered correctly or partially correctly)
3. Identify the three (partially or fully) metagabbro rocks. (7/16 users answered correctly or partially correctly)
4. Choose three rocks with coarse-grained glaucophane crystals. (13/16 users answered correctly or partially correctly)
5. Put the following rocks in order from magnesium-rich to iron rich (4,6,9,15). (11/16 users answered correctly or partially correctly)
6. What will you look for to find a lawsonite? Find the one or more lawsonites. (9/16 users answered correctly or partially correctly)
7. Examine the rocks 17,2,5. Which one is the serpentinite? (8/16 users answered correctly or partially correctly)

This shows us that the majority (5/7) questions were at a good level for the majority of the users to answer correctly, thus they were able to sufficiently recall information learned from the GLAUKO system for these 5/7 questions. 1/16 users answered only one question correctly or partially correctly. 3/16 users answered two questions correctly or partially correctly. 3/16 users answered four questions correctly or partially correctly. 4/16 users answered five questions correctly or partially correctly. 3/16 users answered six questions correctly or partially correctly. 1/16 user answered all seven questions correctly or partially correctly (this user was a geology expert). Thusly, a majority of 11/16 users were able to answer the majority of the questions correctly or partially correctly.

These results show us that the users, despite experiencing some difficulty recalling the information they had learned, were able to correctly identify most of the rock types they encountered in the GLAUKO system, in a relatively short amount of time. As evidenced by the video recordings, all the users tended to examine the rock samples thoroughly before deciding on their answers, a practice necessary in the field of geology. This is another indication that they had been triggered enough to care about the rock types.

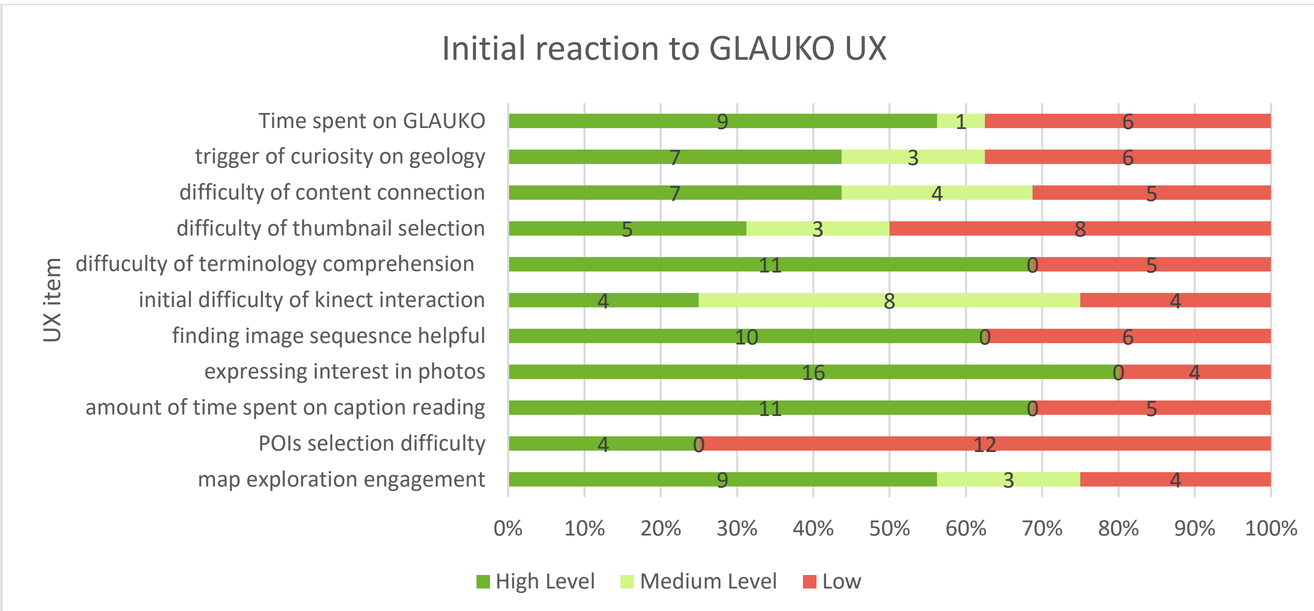

Fig. 166 Levels of effort/trigger experienced by the users on UX items.

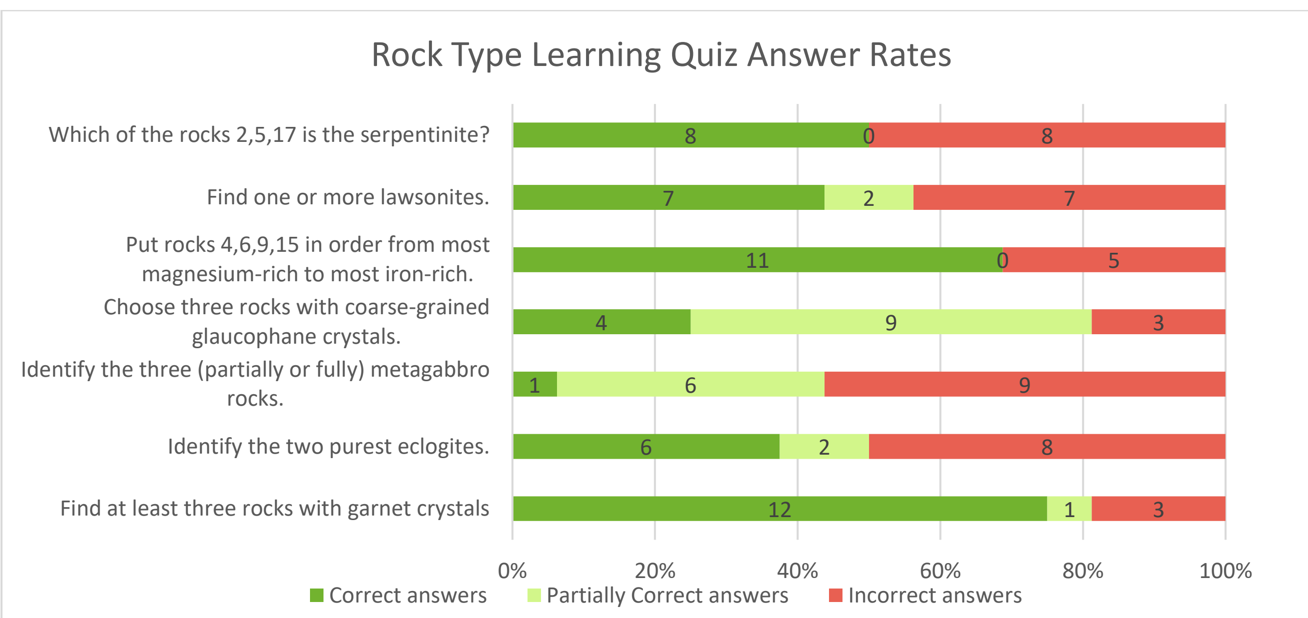

Fig. 167 Rates of successfully answered questions in the Rock type sample test.

Table 2 Short Interview questions.

Interview																
Two main interview guides. Have you ever been hiking to any of the places you saw here?	yes	no	no	yes	yes	yes	no	yes	no	yes	yes	yes	yes	yes	yes	no
If yes, where/which ones? Had you noticed some of the rock types shown here? Did the system help you understand questions that you had during that hike? Would you like to have seen additional things from those trails here?	Marmari. Triggered to go see the real outcrops now that she knows about them			kampos, lia, abelaki. The system helped understand things they had noticed during the hikes	expert geologist- n.a.	Aerolithos. The system helped understand things they had noticed during the hikes		Lia. The system helped understand things they had noticed during the hikes			Aerolithos, Lia, kampos. The system helped understand things they had noticed during the hikes	Abelaki. The system helped understand things they had noticed during the hikes	expert geologist- n.a.	Aerolithos, Kampos, Lia. The system helped understand things they had noticed during the hikes	Aerolithos, Kampos, Lia. The system helped understan d things they had noticed during the hikes	
If no, are you interested to go see the POIs from the system for real? Would you look for anything in particular that you learned from the system?	Yes. Motivated to go and see the POIs and outcrops	Yes. Would use GLAUKO as a guide beforehand and then go to the displayed POIs	Does not trigger visiting desire				Yes. Would use GLAUKO as a guide beforehand and then go to the displayed POIs	Yes. Motivated to go and see the POIs and outcrops	Yes. Motivated to go and see the POIs and outcrops	Yes. Motivated to go and see the POIs and outcrops (more interest in Abelaki)		Yes. Motivated to go and see the POIs and outcrops				Yes. Motivated to go and see the POIs and outcrops

Table 3 Commentary feedback.

Extra feedback																
Showing exhibit Legent	yes	-	yes	-	-	-	yes	-	-	-	yes	yes	yes	yes	yes	yes
liked the inclusion of non-geologic information, such as local folkore and historical facts	yes	-	-	yes	-		yes	yes	-	-	-	yes	-	yes	-	yes
had difficulty remembering or recognizing the selected thumbnail	yes	no	yes	no	no	yes	yes	no	yes	yes	-	no	no	no	yes	yes
had a hard time corelating the information they were reading about with what they were seing in the photographs.	yes	yes	yes	yes	no	yes	yes	yes	yes	yes	no	yes	no	no	yes	yes
UI aesthetics	liked	ok	not liked	ok	liked	ok	ok	ok	ok	not liked	-	liked	ok	liked	ok	liked
informative schematics/ animations to explain discribed processes	yes	-	-	yes	yes	-	yes	yes	yes	yes	-	yes	-	yes	yes	yes
large scale interaction	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	no	yes
kinect use	tyring	tyring	tyring	tyring	ok	tyring	tyring	tyring	tyring	tyring	tyring/pointless	ok	ok	pointless	tyring/poi ntless	tyring/poi ntless
amount of information	too much	too much	too much	too much	ok	too much	too much	ok	too much	too much	ok	ok	ok	ok	too much	ok

6.4.3 Short feedback interview

During the short feedback interview, phase 3, we recorded the users as they executed a task of free navigation through the GLAUKO system by using it as a desktop application. This was done to save time, and allow the users to explore the system in order to give us more thorough feedback. The short interview was partially planned with set questions and partially free commentary by the users. We prepared two main interview questions to test if the system motivated the users to go and visit points of geological interest in Syros (Table 2). 11/16 users had been hiking to at least one of the geosites presented on the map, 2 of those 12 being the geology experts thus the questions did not apply further to them. Of the rest 9 hikers, all had understood and learned something from the GLAUKO system regarding a feature they remembered from their hike. Three (3) of them also expressed that they felt motivated to go on more POIs because of what they saw in the GLAUKO system. Of the 5/16 users who had not hiked to any POI before, 4 were motivated to visit some of the geosites to observe for real the outcrops, 2 of them said that they would use GLAUKO as a guide beforehand to prepare for what they would see on a hike to a particular point of interest. Overall, the majority of the non-expert users (8/14) showed interest and motivation in visiting the geosites due to the GLAUKO system.

During the rest of the interview, the users navigated through the application and gave additional feedback (Table 3). 9/16 showed interest in having a legend for the exhibits' location in the museum. 7/16 showed interest in the non-geological information in the content, such as local history and folklore. 8/16 had difficulty remembering or recognizing the thumbnail they had selected. 12/16 users had a hard time corelating the information they read to the photographs they were shown; the users who did not have this issue were the 2 expert geologists and 2 users with sufficient knowledge of geology. 8/16 users had a neutral response to the UI aesthetics, not having a strong response to it. 11/16 users suggested schematics or animations to better convey some of the geologic information. 15/16 preferred the large-scale interaction to the small-scale desktop setting. 13/16 commented on the kinaesthetic interaction as tiring them and 3 of those 13 found it pointless for interaction that involves only selection. Finally, 9/16 users found the information too much and overwhelming. The other 7/16 were the geology experts and users pre-exposed to geology.

Overall, we conclude that the majority of the users were inspired and motivated to visit the POIs after having used the GLAUKO system. Most of them found it as a sufficient guide to the geology of Syros and would use it again to get better informed and learn more information. They found the large-scale interaction very engaging, but would prefer an alternative to kinaesthetic interaction. Most of the users also would prefer a more visual representation of part of the content to avoid feelings of overwhelming.

6.4.4 UEQ UX results

The users answered the UEQ questionnaire and rated 26 items of experience from a scale of 1 to 7 in order to rate the system's qualities (Table 4, Fig. 168). The scales are a means to quantify qualitative information on the system's attractiveness, perspicuity, novelty, stimulation, dependability, and efficiency (Fig. 169). The graphical representation of the answers gives us a better visualization of the results.

Here we present a general overview of the overall impression and experience that the users had by using the GLAUKO system. The system was perceived as a very attractive product, and this scale received the highest score of all six (Table 5, Fig. 169). it was not quite clear for the users as they rated its perspicuity about average. They seem to have found the system quite efficient, however since the evaluations were conducted with the "Wizard of Oz" protocol this scale is not been taken into account. Many users expressed that they were imagining themselves using it as a fully functioning kinaesthetic application, but it is not a valid means of measuring efficiency. The system was found quite dependable, rated overall as excellent, and allowing the users to fulfill their main goal, which was to learn about the geologic material. The users were also pleasantly surprised, and emotionally satisfied by the system, as the stimulation scale was rated good. Finally, novelty was rated the lowest of all six user experience scales, however its ranking was still above average.

The GLAUKO system created an overall positive experience to the users. It was received as an attractive product, providing a dependable framework for users, first-time learners and pre-exposed, to learn about the geologic character of Syros, and that stimulates their curiosity making them interested on geological topics relevant to the island's case or in general. Part of these questions, however, may have been a result of the information overload that most first-time learners experienced. Additionally, we had chosen based on our research not to go deeper into more scientific explanations as to avoid further confusion. These facts seem to have added to some of the users' confusion on the context, thus making GLAUKO less clear and perspicuous to the users. Finally, the GLAUKO system did not come across as a particularly innovative or novel system, as it did not surprise the users with its technological characteristics and possibilities. However, it was perceived as familiar or easy to understand how to work with, and did not distract from the learning process.

6.5 Chapter Overview

The GLAUKO interactive system was evaluated by sixteen (16) users through empirical evaluations. The evaluations took place in a laboratory setting simulating a geomuseum exhibition, with the interactive installation upon entry and a rock type sample exhibit as a follow up. The GLAUKO system was set up as a wall projection controlled by a Kinect sensor, however operated by the evaluator from a PC application, following the "wizard of oz" protocol. The users were subject to four phases within the evaluation process. The first phase tested their engagement in interacting with the GLAUKO system by taking the users through 4 tasks of exploring the interactive map, navigating to four points of interest, and going through certain images and content in each point's image gallery. In the second phase, the users used the newly acquired knowledge to identify rock types from the sample exhibit, and answer identification questions to the best of their abilities. In the third phase, the users were interviewed shortly by the evaluator as to provide feedback on their experience in using the GLAUKO system. In the fourth and final phase, the users completed a UX questionnaire ranking their experience on the system in a numerical scale.

The evaluation goals were met as following. The users had a strong engagement with the GLAUKO system. The users expressed interest in geological facts about Syros and in general geological knowledge throughout the process. They had a challenging experience in fully comprehending the content, thus it is an area for further improvement. The majority of the users were motivated to visit the geosites after they had used the GLAUKO system.

Table 4 UX Item table with all recorded scores from users from 1 to 7 numerical scale, for all six UX scales (multiple times represented by different items).

Nr	Item	1	2	3	4	5	6	7	Scale
1	annoying/enjoyable	0	0	0	2	6	3	5	Attractiveness
2	not understandable/understandable	0	1	2	1	3	5	4	Perspicuity
3	dull/creative	1	0	3	2	4	5	1	Novelty
4	difficult to learn/easy to learn	0	2	2	0	1	4	7	Perspicuity
5	inferior/valuable	0	0	2	2	2	3	7	Stimulation
6	boring/exciting	0	0	2	2	6	5	1	Stimulation
7	not interesting/interesting	0	0	0	2	3	5	6	Stimulation
8	unpredictable/predictable	0	1	0	3	1	4	7	Dependability
9	slow/fast	0	1	0	2	1	5	7	Efficiency
10	conventional/inventive	0	3	2	1	1	3	6	Novelty
11	obstructive/supportive	0	0	1	1	1	8	5	Dependability
12	bad/good	0	0	0	2	3	5	6	Attractiveness
13	complicated/easy	0	0	0	2	2	5	7	Perspicuity
14	unlikable/pleasing	0	0	0	0	3	5	8	Attractiveness
15	usual/leading edge	0	3	1	1	3	4	4	Novelty
16	unpleasant/pleasant	0	0	0	1	3	6	6	Attractiveness
17	not secure/secure	0	0	0	1	3	1	11	Dependability
18	demotivating/motivating	0	1	0	0	3	7	5	Stimulation
19	does not meet expectations/meets expectations	1	1	1	1	2	7	3	Dependability
20	inefficient/efficient	0	0	1	4	3	5	3	Efficiency
21	confusing/clear	0	2	1	0	6	2	5	Perspicuity
22	impractical/practical	0	0	1	0	5	3	7	Efficiency
23	cluttered/organized	0	0	1	1	1	2	11	Efficiency
24	unattractive/attractive	0	0	0	2	1	8	5	Attractiveness
25	unfriendly/friendly	0	0	0	0	2	5	9	Attractiveness
26	conservative/innovative	0	2	3	0	1	5	5	Novelty

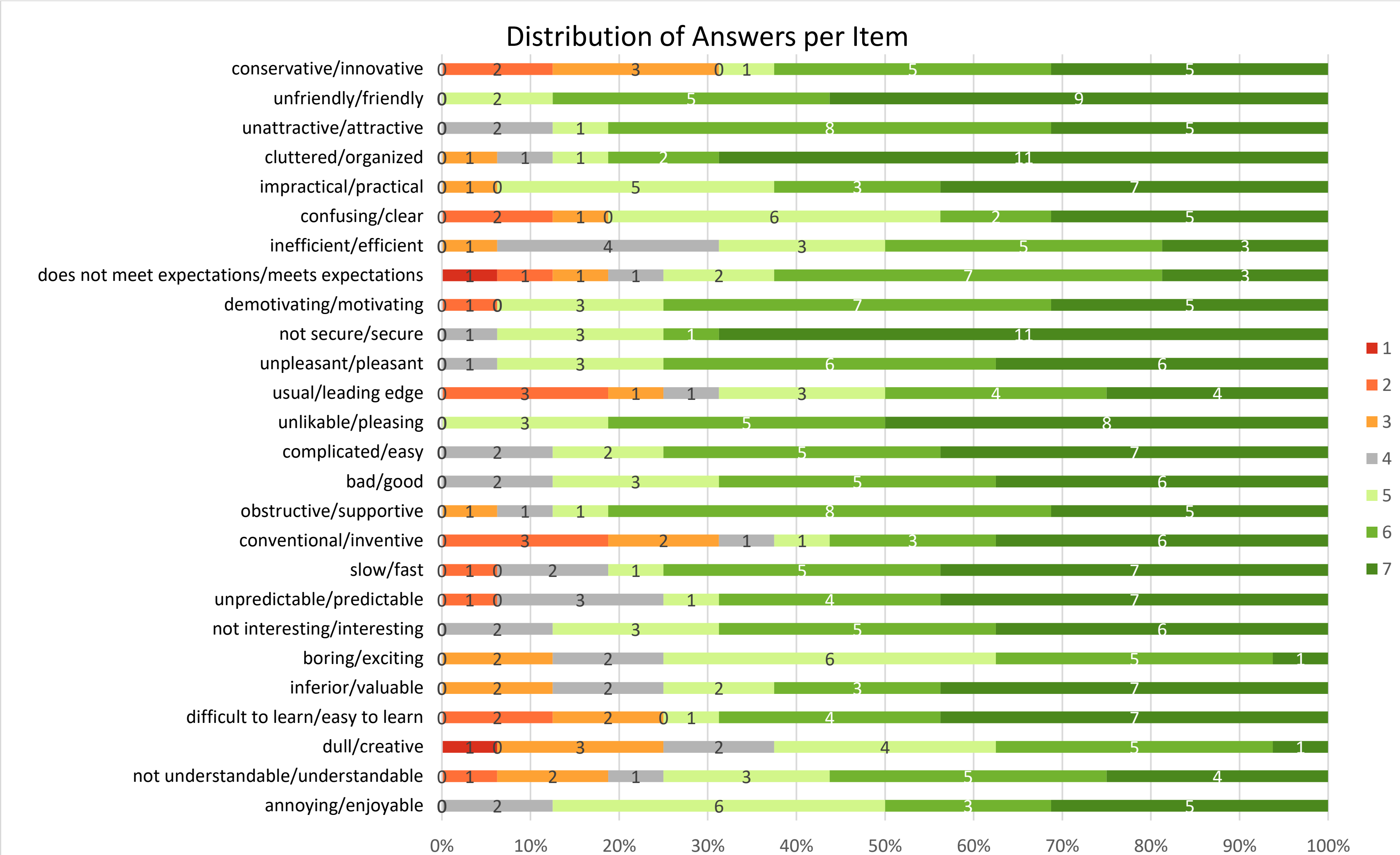

Fig. 168 UEQ's 26 items for sorting the User Experience (Item score from 1 to 7).

Table 5 Comparison of the GLAUKO UX results with the data in the benchmark set by UEQ data base.

Scale	Mean	Comparison to benchmark	Interpretation
Attractiveness	2.07	**Excellent**	In the range of the 10% best results
Perspicuity	1.53	**Above Average**	25% of results better, 50% of results worse
Efficiency	1.86	**Good**	In the range of the 10% best results
Dependability	1.81	**Excellent**	In the range of the 10% best results
Stimulation	1.64	**Good**	10% of results better, 75% of results worse
Novelty	0.98	**Above Average**	25% of results better, 50% of results worse

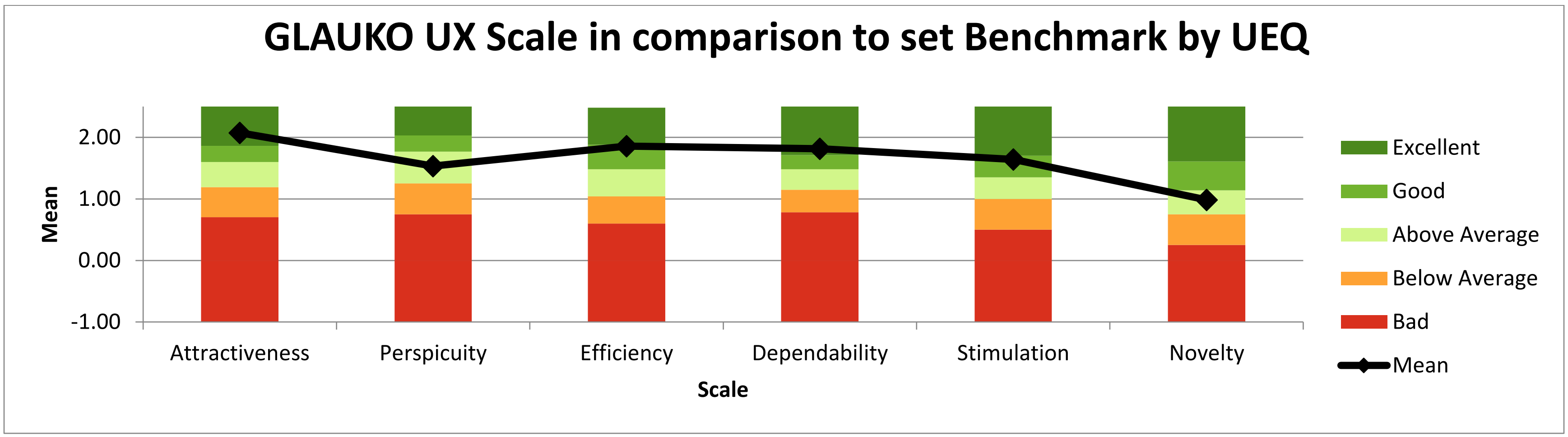

Fig. 169 GLAUKO UX rates in all six UEQ Scales with Mean comparison.

7 Conclusions

The present diploma thesis studied the topic of interactive installation design within the complex scientific context of geology, for a museum setting in service of geological heritage awareness. The topics of human-computer interaction, interaction design, kinaesthetic interaction, geotourism and conservation of the geologic heritage of Syros island (Greece), were studied collectively for the design and development of a prototype installation conceptualized as an interactive exhibit in a geomuseum setting. The interactive installation aims to help the users learn of the geological variety of Syros, to spark their curiosity, and motivate them to further explore the geology of Syros.

7.1 Overall Picture

The project focus was the (field) research, design and evaluation of the GLAUKO interactive system, that raises awareness about the petrological variety of Syros. The design process followed paths of research and feedback on geologic topics and installation design. These two phases of research were executed almost simultaneously, and their products were incorporated into the third phase, of Design and Development. Findings and content were incorporated into the Deign & Development for prototyping. Feedback was given as the development progressed. A final functional prototype was developed in WPF platform and was set up as a projection controlled by a Kinect sensor for evaluation by users.

The main goal for designing and developing this interactive system was to raise awareness and get people interested in the geology of Syros. This awareness would spark curiosity about the geologic uniqueness of Syros, and spark conservation of the geologic heritage of the island. Such is an approach for an alternative kind of ecotourism known as Geotourism. This form of tourism is encouraged and supported by UNESCO and the Global Geopark Network that has been created during the past decades. Geoparks and their included geomuseums, help locals and visitors become aware of the geological, natural, and cultural heritage of a particular place, though educational activities, geosite vitis, interactive exhibitions and much more.

For our field research we got into a geologist's shoes and take a look at Syros as first-time learners of geology. Through experiential learning, we managed to explore key geosites of the island, understand their significance, document the petrology and rock types, gather raw material for our application, and eventually create original content about said topics for our system. Working parallel to this, we also researched the state of the art for interactive installations in museums, means of interaction in installations, and look at specific examples of systems with a geological content. Modern interactive installations in museums deal with complex scientific themes. We studied numerous cases to understand the content view, the user experience, and the physical placement. We tried to pinpoint the level of scientific character of an interactive system in contrast to a more gamified experience. We concluded a medium was a best approach, yet we determined that since we are approaching a serious theme, we should keep the overall character of GLAUKO relatively simple, cohesive, and neutral.

Bringing together our findings from both areas of study, we incorporated them with plenty trials to our final GLAUKO application. With this method of heuristic, interlacing research we were able to have a higher understanding of the interconnectedness of themes within the same topic, and how well they could be transferred in a system concept.

As we better understood the context, design goals were set for the envisioned installation. We aimed at designing an engaging experience for introduction to Syros' geology, designing a learning system for the rock types of Syros, and designing a motivation trigger for further exploration of the geosites of Syros. Early conceptualization of the system led to mockups which were translated into rough prototypes. We prototyped a WPF application that would connect to a Kinect sensor, for midair interaction and to project in on a wall for large-scale experience. This physical concept was a low-cost implementation, it allowed for flexibility in future system updates and transfers, and could create an engaging experience for the users through visual awe.

Once we reached a satisfactory application, we evaluated the system by conducting empirical evaluations with sixteen (16) users. Technical problems in connecting the Kinect SDK to our application code led us to conducting the evaluations following the “Wizard of Oz” protocol. Users experienced the conceptualized installation, yet the one controlling the Kinect (hand cursor of the user) was the evaluator by running the application on a desktop computer. The evaluations aimed to test the engagement the system would trigger for the users, whether the system would trigger interests in geology, the ease of understanding and learning the content information provided by the GLAUKO system, and whether the system motivated the users to go and visit points of geological interest in Syros.

The evaluations were set up in a laboratory environment at the University, were recreated the flow of a museum. Upon entry, the user met the interactive installation in projection form and navigated to four points of interest on the interactive map. They observed photographs of various rock types and read about their geological value. Afterwards, they tested their knowledge by identifying the same rock types from a collection of rock samples set up as an exhibit in the room. Thirdly, they gave us feedback while examining the application in a desktop environment. Finally, they gave us their overall feedback on the system’s UX through a User Experience Questionnaire (UEQ) with numbered scales. We recorded via camera the three first stages of the evaluation for every user. The UEQ gave us quantifiable data for the UX and we used the video recordings to conclude more thoroughly their initial responses, engagement, experienced difficulties, and over all connection to the GLAUKO system.

7.2 Most Important Use Case findings

Our findings were insightful for our understanding and goal achievement. From the empirical evaluations we concluded that the users had positive initial responses to the system. They engaged relatively easily with the system, and showed interest in the content and geologic variety of Syros. They found the large-scale interaction very engaging and sparking their curiosity and interest in further exploring the rock types. The scientific terminology created confusion over the content and midair interaction posed a problem rather than a helpful feature, as it tired the users. The users experienced some difficulty recalling the information they had learned; however, they were able to correctly identify most of the rock types they encountered in the GLAUKO system. All uses showed curiosity over the rock types both during the system use and over the rock identification. Finally, the majority of them were inspired and motivated to visit the points of interest after having used the GLAUKO system.

The GLAUKO interactive installation was perceived as an attractive product, that provided a rich framework for users of various knowledge levels to learn and become aware of the geologic character of Syros. GLAUKO stimulated their curiosity making them interested on complex geological topics. The terminology was confusing to many, and we received feedback on how that can be improved with better image-information correlation to clarify the details. The system was not a particularly innovative or novel system, as it did not surprise the users with its technological characteristics. However, it was perceived as familiar or easy to understand how to work with, and did not distract from the learning process.

As for our research approach, we conclude that through the experiential learning in the field research we were able to gather sufficient content, and gain a deep understanding of a complex scientific context. With such an understanding, we were able to tell what was important enough to be included in the final application, and also to implement it in a meaningful way. We based the information flow of the system to the way we were taught the geological concepts. We rooted the visual narration to a scale-down observation, just like the one we learned during our hikes with professor Engi. We choose what content pieces to eliminate, change, and keep in our system. Development and design are equally important, and without a good balance between the two, any system is doomed to be one-sided, overly complex or overly simplified, and not stay true to the experience it wants to create for the users. We managed to take something extremely complex, dive into it, understand it at the core, and simplify it without losing its value. We managed to make sense of the chaos around us and keep only the truly necessary things.

7.3 Suggestions for further development

We aimed to create an interactive installation about the rock types of Syros. We ended up designing a system for the initial engagement of first-time learners in complex geological topics, based on the case of Syros island. Our methods and outcomes served their purpose as well as possible in the given context, and of course there is still plenty of room for further development. A future goal would be to further develop the GLAUKO system to be more interactive as a large-scale interactive system. Kinaesthetic interaction was not preferred amongst the users as, even in the pretend-use, they grew tired and bored with it. In order for GLAUKO to be a truly engaging interactive system, it needs to involve the user more in the content exploration. Another aspect that calls for further development is the content representation. Most of our users felt cramped and overwhelmed by the information and terminology they met. However, we do not believe that it would be wise to simplify the content itself; this would only lead to scientific inaccuracy and defuse the initial richness of the content, and flatten the multidimensional geologic context we tried to introduce our users to. We need to further develop the system with better image-information correlation, as to help the users visually understand the new information.

Overall, we were able to bring to the table curiosity for a very complex scientific field, in a quite understated example of the petrology of the island. In the beginning of this thesis we mentioned that we wanted to bring awareness to the geological heritage of Syros, in hopes of igniting the curiosity of the people for its geological features. There can be at least three powerful consequences of curiosity. First, by being curious we open ourselves up to the potential value of the things that would otherwise pass us by; this is the realm of beauty. Second, we become more aware of the potential value of the things we already have, we feel gratitude and contentment. Third, we can respond to the challenges we face with greater flexibility, less stuck in our habitual ways of seeing the world. Together, these three benefits of curiosity are an inner resource we can draw upon to explore and commit to what really matters (Wren-Lewis, 2019). In the case of this study, by sparking curiosity for the geological riches of Syros, people will start observing and looking closely at what lays beneath their feet. Observation brings an awareness and senses of discovering something valuable, in a personal or communal level. Finally, this can lead to a conservation domino effect that could change perspectives, eventually protecting the natural environment and all the treasures, geologic, cultural and natural, that it holds. We may be shooting for the stars, but if curiosity is the realm of beauty, beauty could one day save the world, as once remarked by Leo Tolstoy. Thus, sparking the curiosity of the people for a world hidden in plain sight, might just make all the difference for this little island called Syros.

8 Table of figures

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10 References

10.1 Appendix

Here is presented the full application content, including all the photographs that are displayed in every POI along with their title, subtitle and caption in both the English and Greek language, as presented in the respective application variations. The content is presented by alphabetical order of the POIs.

Abelaki

Title: Abelaki, **Subtitle:** High-Pressure Rocks, **Text:** Abelaki is a beach made up of meta-volcanic rocks. These had originally formed at the ocean floor, but when tectonic plates collided, one plate was pushed down into the Earth. There, rocks were transformed at very high pressure.

Τίτλος: Αμπελάκι, **Υπότιτλος:** Πετρώματα υψηλής πίεσης, **Κείμενο:** Το Αμπελάκι είναι μια παραλία που αποτελείται από μετα-ηφαιστειακά πετρώματα. Αυτά τα πετρώματα δημιουργήθηκαν αρχικά στον πυθμένα του ωκεανού, όμως όταν οι τεκτονικές πλάκες συγκρούστηκαν, η μία καταποντίστηκε προς το εσωτερικό της Γης. Τα πετρώματα που βρέθηκαν εκεί μεταμορφώθηκαν κάτω από πολύ υψηλές πιέσεις.

Title: Abelaki, **Subtitle:** A beach of blueschists, **Text:** Large bodies of blue-shaded rocks stand out the field. When these rocks were metamorphosed, old minerals were replaced by new ones. One of these is the blue mineral glaucophane, which is very abundant in these rocks called blueschist.

Τίτλος: Αμπελάκι, **Υπότιτλος:** Πετρώματα υψηλής πίεσης, **Κείμενο:** Το Αμπελάκι είναι μια παραλία που αποτελείται από μετα-ηφαιστειακά πετρώματα. Αυτά τα πετρώματα δημιουργήθηκαν αρχικά στον πυθμένα του ωκεανού, όμως όταν οι τεκτονικές πλάκες συγκρούστηκαν, η μία καταποντίστηκε προς το εσωτερικό της Γης. Τα πετρώματα που βρέθηκαν εκεί μεταμορφώθηκαν κάτω από πολύ υψηλές πιέσεις.

Title: Abelaki, **Subtitle:** Epidote Blueschist, **Text:** This body is a bright epidote-blueschist with tight folds, a typical deformation feature. The body is inhomogeneous, featuring two varieties of glaucophane that differ in composition: The dark blue one is rich in iron, whereas the lighter blue glaucophane is rich in magnesium.

Τίτλος: Αμπελάκι, **Υπότιτλος:** Επιδοτο-κυανοσχιστόλιθος, Κείμενο: Αυτός ο βράχος είναι ένας επιδοτο-κυανοσχιστόλιθος με έντονες πτυχώσεις, χαρακτηριστικό της έντονης παραμόρφωσης. Ο βράχος είναι ανομοιογενής, φέροντας δύο διαφορετικές μορφές γλαυκοφανή που διαφέρουν σε σύσταση. Ο σκούρος γλαυκοφανής είναι πλούσιος σε σίδηρο, ενώ ο ανοιχτόχρωμος φέρει μεγάλες ποσότητες μαγνησίου.

Title: Abelaki, **Subtitle:** Quartz veins, **Text:** Folds in dark blueschist that are torn apart by a series of fractures. These fractures cross all other structural features, so they were created very late, while the rock was on its way up from depth to the Earth's surface. The cracks are partly filled with fibers of quartz. These grew along the walls of the fractures as space opened up, allowing access to circulating hot solutions.

Τίτλος: Αμπελάκι, **Υπότιτλος:** Φλέβες χαλαζία, **Κείμενο:** Οι πτυχές στον σκούρο γλαυκοφανιτικό σχιστόλιθο σχίστηκαν και διαπερνώνται από ρωγμές. Οι ρωγμές διαπερνούν όλα τα υπόλοιπα χαρακτηριστικά του βράχου, οπότε συμπεραίνεται πως δημιουργήθηκαν αρκετά αργότερα, καθώς ο βράχος αναδυόταν στην επιφάνεια της Γης. Οι ρωγμές φέρουν μέσα τους ίνες χαλαζία. Οι ίνες αναπτύχθηκαν κατά μήκος των ρωγμών καθώς άνοιγαν και επέτρεπαν τη ροή καυτών διαλυμάτων.

Title: Abelaki, **Subtitle:** Layer deformation, **Text:** During high pressure metamorphism, layers of rigid material cannot deform plastically, so they break. Other layers can flow more easily. Here, a layer of eclogite has was fractured, and elipsoid clasts are trapped between glaucophane layers.

Τίτλος: Αμπελάκι, **Υπότιτλος:** Παραμόρφωση στρώσεων, **Κείμενο:** Κατά τη διάρκεια της μεταμόρφωσης υψηλής πίεσης, στρώσεις άκαμπτων υλικών δεν μπορούν να παραμορφωθούν πλαστικά, έτσι σπάνε. Άλλες στρώσεις ρέουν πιο εύκολα. Στην εικόνα, μία στρώση εκλογίτη έχει σπάσει και τα ελλειψοειδή κομμάτια παγιδεύτηκαν μεταξύ των στρώσεων γαυκοφανή.

Title: Abelaki, **Subtitle:** Eclogite clasts, **Text:** Eclogite clasts contain small grains of garnet, a reddish-brown mineral.

Τίτλος: Αμπελάκι, **Υπότιτλος:** Κομμάτια εκλογίτη, **Κείμενο:** Τα κομμάτια εκλογίτη περιέχουν μικρούς κόκκους γρανάτη, το κόκκινο-καφέ ορυκτό.

Title: Abelaki, **Subtitle:** Clast of high-pressure minerals, **Text:** Glaucophane turns extremely dark when it is rich in iron. The white concentrated mass contains lawsonite, garnet (dark brown) and white mica (shiny silvery).

Τίτλος: Αμπελάκι, **Υπότιτλος:** Σύμπλεγμα ορυκτών υψηλής πίεσης, **Κείμενο:** Ο Γλαυκοφανής γίνεται πολύ σκούρος όταν είναι πλούσιος σε σίδηρο. Η συγκεντρωμένη λευκή μάζα στην εικόνα περιλαμβάνει τα υψηλής πίεσης ορυκτά Λωσονίτη (άσπρο), γρανάτη (σκούρο καφέ), μαρμαρυγία (ασημένιο).

Title: Abelaki, **Subtitle:** Lawsonite Blueschist, **Text:** Blueschists sometimes include characteristic grains of a white, rhombohedral mineral called lawsonite. This mineral is typically found only in high-pressure rocks metamorphosed at relatively low temperature.

Τίτλος: Αμπελάκι, **Υπότιτλος:** Κυανοσχιστόλιθος με Λωσονίτη, **Κείμενο:** Οι κυανοσχιστόλιθοι κάποιες φορές περιέχουν ένα χαρακτηριστικό λευκό, ρομβοεδρές ορυκτό ονόματι Λωσονίτης. Το ορυκτό αυτό βρίσκεται τυπικά μόνο σε πετρώματα υψηλής πίεσης που μεταμορφώθηκαν υπό σχετικά χαμηλές θερμοκρασίες.

Aerolithos

Title: Aerolithos, **Subtitle:** Eclogite body in an open field, **Text:** Local folclore wants Aerolithos to be a body of rock that fell from the sky. In truth, it is a massive Eclogite body that comes up from the Earth's Mantle. Eclogites are high-pressure metamorphic rocks which lack a typical mineral of the Earth's crust, Feldspar.

Τίτλος: Αερόλιθος, **Υπότιτλος:** Εκλογίτης σε ανοιχτό πεδίο, **Κείμενο:** Τοπικοί μύθοι παρουσιάζουν τον Αερόλιθο να έχει πέσει στη γη από τον ουρανό, εξού και η ονομασία του βράχου. Στην πραγματικότητα πρόκειται για ένα μεγάλο σώμα εκλογίτη που προέρχεται από τα βάθη της γης, τον Μανδύα. Οι εκλογίτες είναι μεταμορφωμένα πετρώματα υψηλής πίεσης από τα οποία απουσιάζει ένα χαρακτηριστικό ορυκτό του γήινου φλοιού, ο άστριος (feldspar).

Title: Aerolithos, **Subtitle:** Eclogite origins, **Text:** Eclogites derive from Basic igneous rocks (high pH). Thus, a gabbro or a basalt were metamorphosed into eclogites, as they were moving towards the Earth's surface.

Τίτλος: Αερόλιθος, **Υπότιτλος:** Προέλευση του Εκλογίτη, **Κείμενο:** Οι εκλογίτες προέρχονται από βασικά πυριγενή πετρώματα (πτωχά σε διοξείδιο του πυριτίου SiO_2). Έτσι, ένας Γάββρος ή Βασάλτης μεταμορφώθηκαν σε εκλογίτες, καθώς αναδύθηκαν στην επιφάνεια της Γης.

Title: Aerolithos, **Subtitle:** Examining the surface, **Text:** During metamorphism, high-pressure fluids reacted with the rock's minerals (omphacite and garnet) and produced glaucophane. The layers of glaucophane that cover Aerolithos are where that reaction took place.

Τίτλος: Αερόλιθος, **Υπότιτλος:** Εξετάζοντας την επιφάνεια **Κείμενο:** Κατά τη μεταμόρφωση, ρευστά υψηλής πίεσης αντέδρασαν χημικά με τα ορυκτά του εκλογίτη (ομφακίτης και γρανάτης) παράγοντας το ορυκτό γλαυκοφανή. Οι επιστρώσεις γλαυκοφανή που καλύπτουν τον Αερόλιθο δείχνουν τις περιοχές που συνέβη η αντίδραση.

Title: Aerolithos, **Subtitle:** Close up of the surface minerals, **Text:** The glaucophane layers are rich in iron, thus giving a dark blue color. High-pressure fluids can only flow around the lense, not penetrate the rock. Thus, glaucophane is only found at the surface of Aerolithos, not the inside.

Τίτλος: Αερόλιθος, **Υπότιτλος:** Κοντινή ματιά στα ορυκτά, **Κείμενο:** Οι επιστρώσεις γλαυκοφανή είναι πλούσιες σε σίδηρο, στον οποίο οφείλεται η σκούρα μπλε απόχρωση του ορυκτού. Τα ρευστά υψηλής πίεσης μπόρεσαν να φτάσουν μόνο γύρω από την επιφάνεια, και όχι να εισχωρήσουν μέσα στον εκλογίτη. Συνεπώς ο γλαυκοφανής βρίσκεται μόνο στην επιφάνεια του Αερόλιθου.

Title: Aerolithos, **Subtitle:** View from below **Text:** All lenses around Aerolithos are eclogites. They were all part of the same body, but due to tectonic movements they broke off and spread down the valley. The eclogite bodies sit on a chlorite-serpentinite schist matrix.

Τίτλος: Αερόλιθος, **Υπότιτλος:** Θέα από χαμηλά, **Κείμενο:** Όλοι οι μεγάλοι βράχοι γύρω από τον Αερόλιθο είναι εκλογίτες. Αποτελούσαν όλοι μαζί το ίδιο σώμα, όμως λόγω τεκτονικών κινήσεων έσπασαν σε κομμάτια και σκόρπισαν στην κοιλάδα. Οι εκλογίτες εμπεριέχονται σε μια μάζα χλωριτικού – σερπεντινιτικού σχιστόλιθου.

Title: Aerolithos, **Subtitle:** Siderite overprint, **Text:** Eclogite lens also has a Siderite overprint (orange layer). The red mineral observed is iron carbonate, thus as it gets exposed to oxygen it "rusts".

Τίτλος: Αερόλιθος, **Υπότιτλος:** Επίστρωση σιδηρίτη, **Κείμενο:** Το σώμα του εκλογίτη είναι επίσης καλυμμένο από σιδερίτη σε ορισμένες περιοχές (πορτοκαλί επίστρωση). Το πορτοκαλί-κόκκινο ορυκτό που παρατηρείται είναι ανθρακικός σίδηρος, ο οποίος "σκουριάζει" σε επαφή με το οξυγόνο.

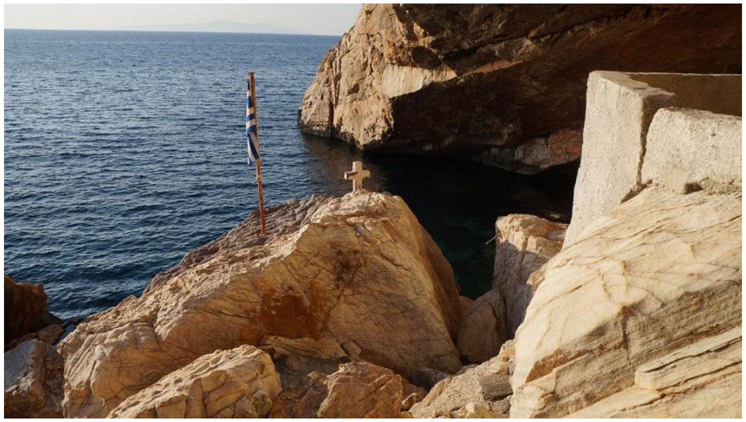
Title: Aerolithos, **Subtitle:** Closeup of the skin texture, **Text:** The glaucophane layers of Aerolithos are veins of hydration around the body of eclogite. Multiple veins make up a multilayered skin of minerals around Aerolithos.

Τίτλος: Αερόλιθος, **Υπότιτλος:** Επιφανειακή υφή σε κοντινή ματιά, **Κείμενο:** Οι επιστρώσεις γλαυκοφανή γύρω από τον Αερόλιθο είναι φλέβες ενυδάτωσης που έρευσαν γύρω από τον εκλογίτη στο εσωτερικό της γης. Πολλαπλές φλέβες σχηματίζουν πολλαπλές επιστρώσεις ορυκτών γύρω από τον Αερόλιθο.

Agios Stefanos

Title: Agios Stefanos, **Subtitle:** Path to Agios Stefanos **Text:** Agios Stefanos is accessible from the top of the hill via a hiking path. The mountain is closing in forming a cave at the level of the sea.

Τίτλος: Άγιος Στέφανος, **Υπότιτλος:** Μονοπάτι προς Άγιο Στέφανο, **Κείμενο:** Ο Άγιος Στέφανος έχει πρόσβαση από μονοπάτι που ξεκινάει από την κορυφή του λόφου, νότια του Γαλησσά. Το βουνό κλείνει προς τα μέσα σχηματίζοντας μια σπηλιά στο επίπεδο της θάλασσας.



Title: Agios Stefanos, **Subtitle:** Marble cave, **Text:** The area is dominated by pure and impure marble bodies of all sizes. Tectonic movement has deformed the cave and broke up the large rock bodies, bringing together the impure and pure marbles.

Τίτλος: Άγιος Στέφανος, **Υπότιτλος:** Σπηλιά από μάρμαρο, **Κείμενο:** Στην περιοχή δεσπόζουν καθαρά (λευκά) και μη-καθαρά (γκρι) μάρμαρα κάθε μεγέθους. Τεκτονικές κινήσεις έχουν παραμορφώσει τη σπηλιά και προκάλεσαν την αποκοπή μεγάλων τμημάτων του πετρώματος με αποτέλεσμα τη συνύπαρξη αυτών των δύο τύπων μαρμάρου.

Title: Agios Stefanos, **Subtitle:** A cave hosting a church, **Text:** The cave hosts a small church in honor of Saint Stefanos. Marble bands over and under the church differ slightly in composition and deformation intensity.

Τίτλος: Άγιος Στέφανος, **Υπότιτλος:** Η σπηλιά που φιλοξενεί μια εκκλησία, **Κείμενο:** Η σπηλιά φιλοξενεί ένα μικρό εκκλησάκι στο όνομα του Αγίου Στεφάνου. Οι ζώνες μαρμάρου πάνω και κάτω από την εκκλησία διαφέρουν ελαφρώς ως προς τη σύσταση και την ένταση της παραμόρφωσης που υπέστησαν.

Title: Agios Stefanos, **Subtitle:** Church of St. Stefanos built into the rock **Text:** Legend has it that a fisherman was saved by Saint Stefanos while fighting for his life with a giant squid. The fisherman found refuge in this cave and built the church in honor of his savior saint.

Τίτλος: Άγιος Στέφανος, **Υπότιτλος:** Η εκκλησία του Αγίου Στεφάνου χτισμένη μέσα στο βράχο, **Κείμενο:** Ο μύθος λέει πως κάποτε ένας ψαράς πάλευε στη θάλασσα με ένα γιγάντιο καλαμάρι, και τον έσωσε ο Άγιος Στέφανος. Ο ψαράς βρήκε καταφύγιο στη σπηλιά και έχτισε εδώ την εκκλησία προς τιμή του αγίου σωτήρα του.

Title: Agios Stefanos, **Subtitle:** Marble detail, **Text:** The cave falls at a shear zone between marble and schist rocks. It is made up of pure (white) and impure (non-white) marbles, while on the outside (background) the ground is a matrix of schists covered with vegetation.

Τίτλος: Άγιος Στέφανος, **Υπότιτλος:** Λεπτομέρεια μαρμάρου, **Κείμενο:** Η σπηλιά βρίσκεται σε μια ζώνη διάτμισης μεταξύ των μαρμάρων και των σχιστολίθων. Η ζώνη των μαρμάρων προς τη σπηλιά έχει καθαρά (λευκά) και μη (γκρι, καφέ) μάρμαρα, ενώ τριγύρω η περιοχή αποτελείται από σχιστόλιθους οι οποίοι καλύπτονται από βλάστηση.

Title: Agios Stefanos, **Subtitle:** Marble detail, **Text:** Marble is a soft mineral which flows easily when in the right temperatures. It has a high plasticity and can be easily deformed, creating a liquid-looking texture when cooled down.

Τίτλος: Άγιος Στέφανος, **Υπότιτλος:** Λεπτομέρεια μαρμάρου, **Κείμενο:** Το μάρμαρο είναι ένα "μαλακό", διαλυτό πέτρωμα το οποίο "ρέει" εύκολα στις κατάλληλες θερμοκρασίες. Έχει υψηλή πλαστικότητα και μπορεί να παραμορφωθεί πιο εύκολα από άλλα πετρώματα, δημιουργώντας μια υφή ρευστού στην επιφάνειά του αφού ψυχθεί.

Ano Syros

Title: Ano Syros, **Subtitle:** Path to Pigi **Text:** From Ano Syros starts the path to Pigi. Schists are constantly interchanging with Marble beds. Vegetation is rich over the schists; thus only marble is visible from afar.

Τίτλος: Άνω Σύρος, **Υπότιτλος:** Μονοπάτι προς την Πηγή, **Κείμενο:** Από την Άνω Σύρο ξεκινάει ένα μονοπάτι προς την Πηγή. Στο τοπίο, στρώματα μαρμάρων και σχιστόλιθων εναλλάσσονται διαρκώς. Οι ζώνες σχιστόλιθων είναι καλυμμένες από βλάστηση και έτσι μόνο τα μάρμαρα είναι ευδιάκριτα από μακριά.

Title: Ano Syros, **Subtitle:** Path to Pigi, **Text:** Marble is a hard rock for vegetation to grow, and does not provide the right minerals. Schists are soft metamorphic rocks, rich in potassium, providing a good environment for plants to grow.

Τίτλος: Άνω Σύρος, **Υπότιτλος:** Μονοπάτι προς την Πηγή, **Κείμενο:** Το μάρμαρο είναι ένα σκληρό πέτρωμα ακατάλληλο για να φιλοξενήσει φυτά καθώς δεν παρέχει κανένα χημικό στοιχείο για την ανάπτυξή τους. Οι σχιστόλιθοι είναι μαλακά μεταμορφωμένα πετρώματα, πλούσια σε κάλιο τα οποία δημιουργούν ένα φιλικό περιβάλλον για την ανάπτυξη των φυτών.

Title: Pigi, **Subtitle:** Deformed blueschist-eclogite contact, **Text:** Along the path to Pigi there are blueschists (or else glaucophane schists).

Τίτλος: Πηγή, **Υπότιτλος:** Παραμορφωμένη επαφή κυανοσχιστόλιθου με εκλογίτη, **Κείμενο:** Κατά μήκος του μονοπατιού προς την Πηγή υπάρχουν κυανοσχιστόλιθοι (ή αλλιώς γλαυκοφανιτικοί σχιστόλιθοι).

Title: Pigi, **Subtitle:** Omphacite lens in blueschist**Text:** Shown here is a folded lens of omphacite-zoisite (green) in glaucophane schist (blue surrounding), bearing grains of garnet (red-brown mineral at bottom of omphacite).

Τίτλος: Πηγή, **Υπότιτλος:** Φακοί από ομφακίτη μέσα σε κυανοσχιστόλιθο, **Κείμενο:** Στη φωτογραφία φαίνεται ένας πτυχωμένος φακός ομφακίτη-ζωισίτη (πράσινο) μέσα στον κυανοσχιστόλιθο (περιμετρική μπλε περιοχή). Ο φακός στο κάτω μέρος φέρει κόκκους γρανάτη (καφέ-κόκκινο ορυκτό).

Title: Pigi, **Subtitle:** Banded marble, **Text:** Shown here are strongly folded marble bands. Marble is a soft mineral, capable of bending and flowing under the right conditions of metamorphism and deformation.

Τίτλος: Πηγή, **Υπότιτλος:** Μάρμαρο σε ζώνες, **Κείμενο:** Στη φωτογραφία φαίνονται ισχυρά παραμορφωμένες ζώνες μαρμάρου. Το μάρμαρο είναι ένα σχετικά "μαλακό" πέτρωμα, που παραμορφώνεται και ρέει υπό τις κατάλληλες συνθήκες μεταμόρφωσης και παραμόρφωσης.

Title: Ano Syros, **Subtitle:** Layered rock types, **Text:** Over the Pigi path, varius schist interchange with layers of marble. Greenschist (weathering purple) within grey marble, topped by light marble. The colours are strong due to intense weathering.

Τίτλος: Άνω Σύρος, **Υπότιτλος:** Επιστρώσεις διαφορετικών πετρωμάτων, **Κείμενο:** Πάνω από το μονοπάτι της Πηγής, διάφορα είδη σχιστόλιθων εναλλάσσονται με στρώματα μαρμάρου. Πρασινοσχιστόλιθος (αλιωμένο μώβ) μέσα σε γκρι μάρμαρο, βρίσκεται κάτω από τη ζώνη ανοιχτού μαρμάρου. Τα χρώματα είναι έντονα λόγω της αιολικής διάβρωσης.

Title: Ano Syros, **Subtitle:** Greenschist-Marble mergence**Text:** The greenschist and the striped marble are interlayered due to intense semi-brittle deformation.

Τίτλος: Άνω Σύρος, **Υπότιτλος:** Συγχώνευση Πρασινοσχιστόλιθου με μάρμαρο, **Κείμενο:** Ο πρασινοσχιστόλιθος και το ριγωτό μάρμαρο εμπλέκονται λόγω ισχυρής ημι-εύθραυστης παραμόρφωσης.

Aspro Pounti

Title: Aspro Pounti, **Subtitle:** Conglomerate hillside, **Text:** Metaconglomerate is concentrated at the northern tip of Syros. It is a high-pressure rock type with coarse-grained marble pieces (centimeter-size) floating within a fine-grained matrix of impure marble.

Τίτλος: Άσπρο Πουντί, **Υπότιτλος:** Μετακροκαλοπαγής λόφος, **Κείμενο:** Το μετακροκαλοπαγές πέτρωμα συγκεντρώνεται στο βόρειο άκρο της Σύρου. Είναι ένα πέτρωμα υψηλής πίεσης με κομμάτια χονδρόκοκκου μαρμάρου (μεγέθους εκατοστών), να εμπεριέχονται μέσα σε μία μήτρα λεπτόκοκκου, μη-καθαρού μαρμάρου.

Title: Aspro Pounti, **Subtitle:** Composition, **Text:** The whole mixture is called a metaconglomerate. In the present case, it's mostly carbonate within carbonate, but locally the fragments are made of schist, and inside the carbonate matrix there is mica.

Τίτλος: Άσπρο Πουντί, **Υπότιτλος:** Σύσταση Μετακροκαλοπαγούς, **Κείμενο:** Όλο το μείγμα μαζί ονομάζεται μεταροκαλοπαγές. Το συγκεκριμένο δείγμα αποτελείται κυρίως από κομμάτια ανθρακικού άλατος μέσα σε ανθρακικό άλας, όμως τοπικά μπορούν να υπάρχουν κομμάτια σχιστόλιθου, όπως και μαρμαρυγία (ασημένιοι κόκκοι).

Title: Aspro Pounti, **Subtitle:** Composition **Text:** A metaconglomerate is a rock type consisting of two parts: More or less rounded pieces of rock (of any type) are surrounded by a matrix (of another type), typically with a grain size much smaller than the rounded fragments.

Τίτλος: Άσπρο Πουντί, **Υπότιτλος:** Σύσταση μετακροκαλοπαγούς, **Κείμενο:** Ένα μετακροκαλοπαγές είναι πέτρωμα που αποτελείται από δύο μέρη: Στρογγυλά κομμάτια πέτρας (οποιουδήποτε είδους) περιτρυγυρίζονται από μια μήτρα (άλλου είδους πέτρας), συνήθως από μικρότερος κόκκους από ότι τα στρογγυλά κομμάτια.

Title: Aspro Pounti, **Subtitle:** Schist in Marble, **Text:** Here bits of schist, most likely metavolcanics, are included in the matrix among the marble components.

Τίτλος: Άσπρο Πουντί, **Υπότιτλος:** Σχιστόλιθος σε Μάρμαρο, **Κείμενο:** Εδώ φαίνοται κομμάτια σχιστόλιθου, πιθανότατα μετα-ηφαιστειακά, που περιλαμβάνονται στην ίδια μήτρα με τα κομμάτια μαρμάρου.

Title: Aspro Pounti, **Subtitle:** Manganese-epidote, **Text:** Scattered purple clasts in the conglomerate are manganese-rich fragments containing the mineral piemontite (manganese-epidote).

Τίτλος: Άσπρο Πουντί, **Υπότιτλος:** Πιεμοντίτης, **Κείμενο:** Διάσπαρτες μωβ/ροζ κηλίδες στο κροκαλοπαγές είναι αποθέματα υλικού πλούσιο σε μαγγάνιο, που εμπεριέχουν το ορυκτό Πιεμοντίτη (Μαγγανιο-επίδοτο), υπεύθυνο για το ιδιαίτερο χρώμα.

Title: Aspro Pounti, **Subtitle:** Unit thrusting **Text:** The conglomerate unit is part of a meta-sedimentary complex, but its origin is not well understood. It may represent a submarine landslide, or it may have been tectonically created in the accretionary wedge of a subducting plate, beneath the overlying metavolcanic rocks (now on top).

Τίτλος: Άσπρο Πουντί, **Υπότιτλος:** Σύγκρουση Γεωλογικών ενοτήτων, **Κείμενο:** Η ενότητα του κροκαλοπαγούς είναι μέρος ενός συμπλέγματος μετα-ιζηματογενών πετρωμάτων, όμως το φαινόμενο και οι συνθήκες δημιουργίας της δεν έχουν κατανοηθεί. Πιθανώς να οφείλεται σε υποθαλάσσια καθίζηση εδάφους ή να έχει δημιουργηθεί τεκτονικά στη συσσωρευμένη σφήνα μιας πλάκας αγωγού, κάτω από τα υπερκείμενα μετα-ηφαιστειακά πετρώματα.

Title: Aspro Pounti, **Subtitle:** Fault between Units, **Text:** Across from the fault, starts a completely different unit with metavolcanic sandstones. The entire package is crosscut by steep fractures.

Τίτλος: Άσπρο Πουντί, **Υπότιτλος:** Ρήγμα μεταξύ των ενοτήτων, **Κείμενο:** Στην άλλη πλευρά του ρήγματος ξεκινάει μια εντελώς διαφορετική μονάδα με μετα-ηφαιστειακούς ψαμμίτες. Ολόκληρος ο λόφος διαπερνάται από απότομες διατμήσεις.

Title: Aspro Pounti, **Subtitle:** Inside the Fault, **Text:** Along such a fault, water rushing down to the sea has incised a spectacular channel, eroding the almost vertical flanks.

Τίτλος: Άσπρο Πουντί, **Υπότιτλος:** Μέσα στο ρήγμα, **Κείμενο:** Κατά μήκος του ρήγματος το νερό που ρέει ορμητικά προς τη θάλασσα, διαβρώνει στο πέρασμά του τις σχεδόν κάθετες πλευρές.

Fabrika

Title: Fabrika, **Subtitle:** Marble and Siderite **Text:** Fabrika has been intensly deformed. Faults (fractures) formed due to episodic tectonic movements. Such features have been related to seismicity (earthquakes). The photo shows a system of fractures that cut through beds of light-colored marble. Some fractures are filled with siderite, a rust-colored mineral (iron carbonate).

Τίτλος: Φάμπρικα, **Υπότιτλος:** Μάρμαρο και Σιδερίτης, **Κείμενο:** Η περιοχή της Φάμπρικας έχει υποστεί μεγάλες φυσικές παραμορφώσεις. Ρήγματα έχουν δημιουργηθεί λόγω τεκτονικών κινήσεων σχετιζόμενων με σεισμική δραστηριότητα. Στην εικόνα παρουσιάζεται ένα σύστημα διατμήσεων που διαπέρασε πολλαπλά στρώματα ανοιχτόχρωμου μαρμάρου. Πολλές ρωγμές έχουν γεμίσει με Σιδηρίτη, ένα ορυκτό στο χρώμα της σκουριάς (ανθρακικό σίδηρο).

Title: Fabrika, **Subtitle:** Fractures and Holes, **Text:** Small veins of siderite occur in marble, they are related to the larger fracture (above). As fracturing happened repeatedly, a system of filled veins developed. Here the Marble shows potholes and small siderite fracture fillings.

Τίτλος: Φάμπρικα, **Υπότιτλος:** Ρωγμές και οπές, **Κείμενο:** Μικρές φλέβες σιδερίτη στο μάρμαρο σχετίζονται με το μεγαλύτερο ρήγμα. Το δίκτυο ρωγμών αναπτυσσόταν λόγω των επανειλημμένων δονήσεων και διατμήσεων των πετρωμάτων. Το μάρμαρο στην εικόνα παρουσιάζει ρωγμές με σιδερίτη και λακκούβες.

Title: Fabrika, **Subtitle:** Erotion on Marble bed, **Text:** Potholes were created by mechanical erosion: As waves kept breaking over the marble beds, small rocks got carried into fractures where they got trapped. Water movement kept such rocks spinning inside their traps, which were slowly enlarged due to grinding along the walls. Thus, the holes grew in diameter and depth.

Τίτλος: Φάμπρικα, **Υπότιτλος:** Διάβρωση στο σώμα μαρμάρου, **Κείμενο:** Οι λακκούβες δημιουργήθηκαν με μηχανική διάβρωση. Μέχρι και σήμερα, τα κύματα της θάλασσας καθώς σκάνε πάνω στο μάρμαρο, φέρουν μαζί τους μικρά πετραδάκια τα οποία παγιδεύονται μέσα στις ήδη υπάρχουσες ρωγμές. Η παλινδρομική κίνηση του νερού κάνει τα πετραδάκια να στροβιλίζονται επιτόπου, "σκάβοντας" έτσι το μάρμαρο, δημιουργώντας και μεγαλώνοντας της λακκούβες.

Title: Fabrika, **Subtitle:** Deformed Eclogite **Text:** In Fabrika we find a heterogeneous mix of high-pressure rocks, including eclogites and various types of marble. Earthquakes and brittle deformation did not spare even very strong rocks, eclogites were also fractured and fragmented.

Τίτλος: Φάμπρικα, **Υπότιτλος:** Παραμορφωμένος εκλογίτης, **Κείμενο:** Στη Φάμπρικα βρίσκουμε ένα ετερογενές μείγμα από μεταμορφικά πετρώματα υψηλής πίεσης, όπως εκλογίτες, και διάφορους τύπους μαρμάρου. Οι σεισμοί και η θραυστική παραμόρφωση επηρέασαν ακόμα και πολύ ανθεκτικά πετρώματα, όπως τους εκλογίτες που απέκτησαν ρωγμές.

Title: Fabrika, **Subtitle:** Deformed Eclogite, **Text:** The bright green eclogite has been ruptured in the same way as the Marble. The fractures are filled with siderite as well, creating a colorful vein system throughout the rock. Such brittle fracturing often happened at late stages of deformation.

Τίτλος: Φάμπρικα, **Υπότιτλος:** Παραμορφωμένος εκλογίτης, **Κείμενο:** Ο ανοιχτοπράσινος εκλογίτης έχει υποστεί ρωγμές όπως ακριβώς και το μάρμαρο. Οι ρωγμές έχουν γεμίσει επίσης με σιδερίτη, δημιουργώντας ένα πολύχρωμο πλέγμα φλεβών στο βράχο. Τέτοιου τύπου διακλάσεις συχνά συμβαίνουν στα τελευταία στάδια της παραμόρφωσης.

Title: Fabrika, **Subtitle:** Eclogite with Marble overprint, **Text:** At earlier stages of deformation, while the rocks were still hotter and at greater depth, marble could still be plastically deformed. Here it got wrapped around a small fragment of eclogite, protecting the eclogite from further deformation and hydration. So, it remained unchanged eclogite, immersed as a "bean" in the marble "soup".

Τίτλος: Φάμπρικα, **Υπότιτλος:** Εκλογίτης με επίστρωση μαρμάρου, **Κείμενο:** Στα πρώτα στάδια της παραμόρφωσης, όσο τα πετρώματα είναι ακόμα σε υψηλές θερμοκρασίες και μεγάλα βάθη, το μάρμαρο μπορούσε ακόμα να παραμορφωθεί πλαστικά. Στην εικόνα φαίνεται πως το μάρμαρο έρευσε γύρω από κομμάτια εκλογίτη, προστατεύοντάς τα από περαιτέρω παραμόρφωση και ενυδάτωση. Έτσι ο εκλογίτης έμεινε ανεπηρέαστος από εξωτερικούς παράγοντες, παραμένοντας συμπαγής σαν “φασόλι” μέσα στη "σούπα" μαρμάρου.

Foinikas

Title: Foinikas, **Subtitle:** Lawsonite blueschist with greenschist overprint **Text:** A path of lawsonite blueschists sits next to the Foinikas port. Lawsonite is a mineral that forms at relatively low temperatures but only under high pressure conditions. Here lawsonite grew in blueschists, so these rock bodies would be expected to be blue.

Τίτλος: Φοίνικας, **Υπότιτλος:** Κυανοσχιστόλιθος με Λωσονίτη, με επιτύπωση πρασινοσχιστόλιθου, **Κείμενο:** Δίπλα στο λιμανάκι του Φοίνικα βρίσκεται ένα μονοπάτι από Κυανοσχιστόλιθους με Λωσονίτη. Ο Λωσονίτης είναι ένα ορυκτό που σχηματίζεται υπό συνθήκες σχετικά χαμηλής θερμοκρασίας, αλλά υψηλών πιέσεων. Στην εικόνα, ο λωσονίτης αναπτύχθηκε μέσα στον κυανοσχιστόλιθο, οπότε τα πετρώματα θα έπρεπε να έχουν χρώμα μπλε, όχι πράσινο.

Title: Foinikas, **Subtitle:** High to low pressure retrogression, **Text:** The green color is due to a partial greenschist overprint, which happened under lower pressures. So, these rocks show a transition from high-pressure blueschist to greenschist, in which lawsonite (the high-pressure mineral) was preserved.

Τίτλος: Φοίνικας, **Υπότιτλος:** Ανάδρομη μεταμόρφωση από υψηλές σε χαμηλές πιέσεις, **Κείμενο:** Το πράσινο χρώμα οφείλεται σε μερικό επιτύπωμα πρασινοσχιστόλιθου στον κυανοσχιστόλιθο, το οποίο συνέβαινε καθώς ο βράχος αναδυόταν στην επιφάνεια υπό συνθήκες χαμηλής πίεσης. Συνεπώς αυτά τα πετρώματα μας δείχνουν τη μετάβαση του πετρώματος από τη φάση του κυανοσχιστόλιθου (μεγάλο βάθος-υψηλή πίεση) στη φάση του πρασινοσχιστόλιθου που διατηρήθηκε ο λωσονίτης (μικρότερο βάθος-χαμηλή πίεση).

Title: Foinikas, **Subtitle:** Retrogression process, **Text:** Such a transition can occur at two stages: First, rocks that formed as greenschists under low pressures may be subducted deeper into the Earth and transform to blueschist. Then, if they are brought back up to lower pressures again, they may retrograde to greenschist. This is what to the rocks seen here!

Τίτλος: Φοίνικας, **Υπότιτλος:** Διαδικασία ανάδρομης μεταμόρφωσης, **Κείμενο:** Τέτοιου τύπου μετάβαση μπορεί να γίνει σε δύο στάδια. Αρχικά, τα πετρώματα που σχηματίστηκαν ως πρασινοσχιστόλιθοι υπό χαμηλή πίεση, βυθίστηκαν περισσότερο φτάνοντας σε βάθος υψηλότερης πίεσης, αλλάζοντας έτσι σε κυανοσχιστόλιθους. Σε δεύτερο στάδιο, εφόσον αναδύθηκαν ξανά και βρέθηκαν σε μικρό βάθος χαμηλών πιέσεων, πιθανόν να άλλαξαν πίσω σε πρασινοσχιστόλιθους. Αυτό ακριβώς συνέβη και στο πέτρωμα που βλέπουμε εδώ.

Title: Foinikas, **Subtitle:** Pseudomorphs, **Text:** Lawsonite once formed at high pressures often does not survive retrogression. As such high-pressure minerals become unstable, they can break down and be replaced by new minerals. Sometimes these grow in the shape of an old lawsonite grain. These shapes mimic the old lawsonite, so they are called pseudomorphs.

Τίτλος: Φοίνικας, **Υπότιτλος:** Ψευδομορφές, **Κείμενο:** Ο Λωσονίτης εφόσον δημιουργείται υπό υψηλή πίεση δεν μπορεί να αντέξει την ανάδρομη μεταμόρφωση σε πρασινοσχιστόλιθο. Καθώς τα ορυκτά υψηλών πιέσεων γίνονται ασταθή σε άλλες συνθήκες, αντικαθίστανται από άλλα ορυκτά. Τα νέα ορυκτά πολλές φορές αναπτύσσονται εντός του σχήματος του παλιού κόκκου λωσονίτη. Οι κόκκοι αυτοί πλέον μιμούνται το σχήμα του παλιού λωσονίτη, και ονομάζονται Ψευδομορφές.

Title: Foinikas, **Subtitle:** Retrogression intensity, **Text:** The intensity of retrogression from blueschist to greenschist varies, some outcrops show relatively little overprint. This one preserves largely blueschist character. It shows beautiful needles of glaucophane, which is the high-pressure mineral for which Syros is famous.

Τίτλος: Φοίνικας, **Υπότιτλος:** Ένταση ανάδρομης μεταμόρφωσης, **Κείμενο:** Η ένταση της ανάδρομης μεταμόρφωσης από κυανοσχιστόλιθο σε πρασινοσχιστόλιθο διαφοροποιείται, έτσι κάποιες εμφανίσεις παρουσιάζουν ελαφρύ επιτύπωμα. Εδώ ο βράχος διατηρεί καλά τα χαρακτηριστικά του κυανοσχιστόλιθου. Παρουσιάζει γλαυκοφανή, που είναι ορυκτό υψηλής πίεσης για το οποίο και φημίζεται η Σύρος.

Title: Foinikas, **Subtitle:** Metamorphic fluids, **Text:** Retrogression is strong, where water-rich fluid could enter the rocks during uplift from high-pressure conditions. Green veins are former fractures that show the entry of such fluids. These veins contain typical greenschist minerals such as epidote, albite and chlorite.

Τίτλος: Φοίνικας, **Υπότιτλος:** Μεταμορφικά ρευστά, **Κείμενο:** Η ανάδρομης μεταμόρφωσης ήταν ισχυρή στις περιοχές όπου έρεαν ρευστά με νερό, και μπόρεσαν να εισχωρήσουν στο βράχο κατά την ανάδυσή του προς την επιφάνεια. Οι πράσινες φλέβες στο βράχο είναι πρώην ρωγμές και δείχνουν το που εισχώρησαν τα ρευστά. Οι φλέβες φέρουν τυπικά ορυκτά πρασινοσχιστόλιθου όπως επίδοτο, αλβίτη, και χλωρίτη.

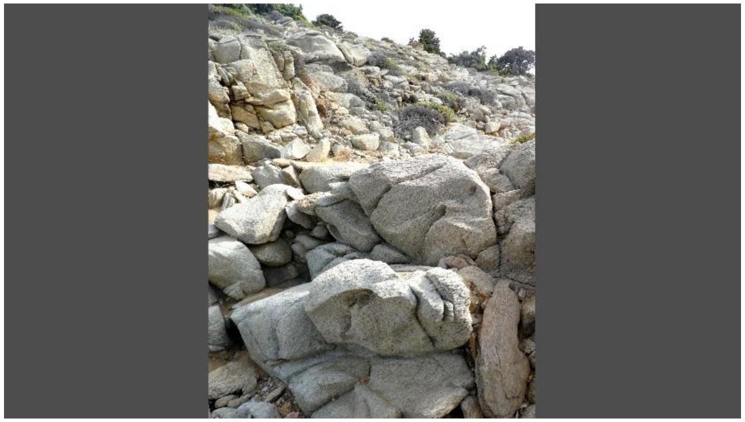
Gria Pounta

Title: Aerolithos, **Subtitle:** Granitic gneiss **Text:** Leukogneiss, the granitic protolith was metamorphosed at low temperature and pressure. Strongly sheared structure due to transport of the Vari unit over its basis. Cliffs S of Gria Pounta.

Τίτλος: Γριά Πούντα, **Υπότιτλος:** Γρανιτικός Γνεύσιος, **Κείμενο:** Ο Λευκογνεύσιος βρίσκεται στους απότομους βράχους της Γριάς Πούντας. Προέρχεται από γρανιτικό πρωτόλιθο που μεταμορφώθηκε υπό χαμηλές θερμοκρασίες και πιέσεις στο εσωτερικό της Γης. Παρουσιάζει ισχυρή διατμητική δομή λόγω μεταφοράς της γεωλογικής ενότητας της Βάρης πάνω από τη βάση της.

Title: Aerolithos, **Subtitle:** Granitic gneiss, **Text:** Vari leukogneiss cliffs at Kochlakàs N shore.

Τίτλος: Κόχλακας, **Υπότιτλος:** Γρανιτικός Γνεύσιος, **Κείμενο:** Λευκογνεύσιοι Βάρης βρισκονται στους γκρεμούς επί της Βόρειας ακτής του Κόχλακα.



Title: Trypa, **Subtitle:** Granitic gneiss, **Text:** Leukogneiss, strongly flattened bands of feldspar and quartz (both white) plus mica (here grey). N of Trypa.

Τίτλος: Τρύπα, **Υπότιτλος:** Γρανιτικός Γνεύσιος, **Κείμενο:** Λευκογνεύσιος του οποίου οι στρώσεις από άστριο, χαλαζία και μαρμαρυγία (ορυκτά) έχουν ισοπεδωθεί έντονα. Βρίσκεται στη βόρεια πλευρά της Τρύπας.

Title: Trypa, **Subtitle:** Granitic gneiss**Text:** Granitic gneiss with linear fabric due to stretched out feldspar. E of Trypa.

Τίτλος: Τρύπα, **Υπότιτλος:** Γρανιτικός Γνεύσιος, **Κείμενο:** Γρανιτικός γνεύσιος που παρουσιάζει ευθήγραμμη δομή υφής λόγω των τεντωμένων άστριων. Βρίσκεται στην ανατολική πλευρά της Τρύπας.

Title: Cape Fokia, **Subtitle:** Amphibolite, **Text:** Massive epidote-amphibolite gneiss form the steep cliffs at Cape Fokia.

Τίτλος: Ακρωτήρι της Φώκιας, **Υπότιτλος:** Αμφιβολίτης, **Κείμενο:** Γιγάντιο τμήμα επιδοτο-αμφιβολιτικού γνεύσιου σχηματίζει τους απότομους γκρεμούς στο ακρωτήρι της Φώκιας.

Title: Cape Fokia, **Subtitle:** Amphibolite, **Text:** Amphibolite with veins of epidote (light green), quartz (white) and iron carbonate (orange). Beach S of Cape Fokia.

Τίτλος: Ακρωτήρι της Φώκιας, **Υπότιτλος:** Αμφιβολίτης, **Κείμενο:** Αμφιβολίτης με φλέβες από επίδοτο (ανοιχτό πράσινο), χαλαζία (λευκό) και ανθρακικό σίδηρο (πορτοκαλί), βρίσκεται νότια του Ακρωτηρίου της Φώκιας.

Title: Cape Fokia, **Subtitle:** Amphibolite**Text:** Stack of cataklastic amphibolite at Cape Fokia, strongly disrupted during emplacement of the Vari unit over ist tectonic sole.

Τίτλος: Ακρωτήρι της Φώκιας, **Υπότιτλος:** Αμφιβολίτης, **Κείμενο:** Η μάζα του κατακλαστικού αμφιβολίτη στο Ακρωτήρι της Φώκιας, διακόπηκε έντονα κατά την τοποθέτηση της γεωλογικής ενότητας της Βάρης πάνω από την τεκτονική σόλα.

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Title: Cape Fokia, **Subtitle:** Amphibolite **Text:** Banded amphibolite (dark) with calcsilicate lenses (light green), Cape Fokia.

Τίτλος: Ακρωτήρι της Φώκιας, **Υπότιτλος:** Αμφιβολίτης, **Κείμενο:** Αμφιβολίτης σε ζώνες (σκούρο) με ασβεστοπυριτικούς κρυστάλλους (ανοιχτό πράσινο), στο Ακρωτήρι της Φώκιας.

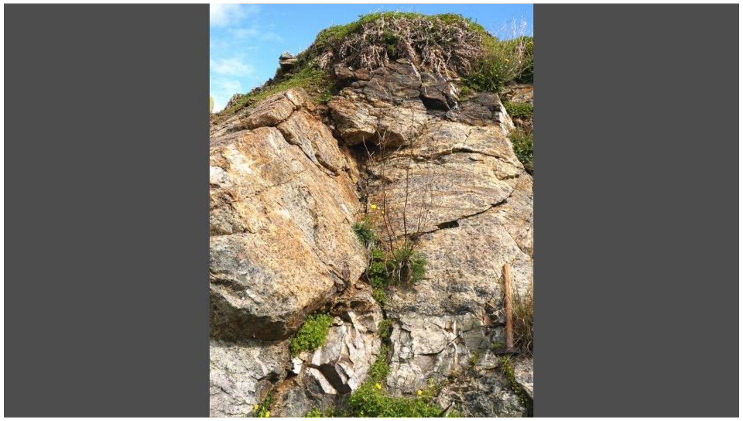
Kampos

Title: Kampos, **Subtitle:** Chlorite Serpentine schist, **Text:** Kampos is Eclogite Paradise, with massive lenses sticking out into the landscape. Here such a lens has a rim of chlorite-serpentine schist, marking the contact of the eclogite lens to the surrounding mass of serpentinite.

Τίτλος: Κάμπος, **Υπότιτλος:** Χλωριτικός-Σερπεντινιτικός σχιστόλιθος, **Κείμενο:** Η περιοχή του Κάμπου είναι ένας παράδεισος από Εκλογίτες, με μεγάλους βράχους να αναδύονται στην επιφάνεια σε όλη την περιοχή. Στην εικόνα ένας τέτοιος βράχος περιστοιχίζεται από μια μάζα Σερπεντινίτη.

Title: Kampos, **Subtitle:** Chlorite layers **Text:** As serpentine and eclogite have different chemical compositions, they reacted along the contact and formed this silvery coating of the eclogite body. Chlorite is but a thin skin (called blackwall) of the eclogite lens against neighbouring serpentinite.

Τίτλος: Κάμπος, **Υπότιτλος:** Επιστρώσεις χλωρίτη, **Κείμενο:** Καθώς ο σερπεντινίτης και ο εκλογίτης έχουν διαφορετική χημική σύσταση, υπήρξε χημική αντίδραση κατά την επαφή τους δημιουργώντας μια ασημένια επίστρωση γύρω από τον εκλογίτη. Ο χλωρίτης είναι μόνο ένα πολύ λεπτό στρώμα γύρω από τον εκλογίτη.



Title: Kampos, **Subtitle:** Eclogitic metagabro, **Text:** Eclogitic metagabbro is exposed along the main road. The partly deformed metagabbro (coarse-grained glaucophane-eclogite) was intruded by metadiorite (fine-grained eclogite). Both originated inside the same magma chamber, and they were metamorphosed together at high pressures.

Τίτλος: Κάμπος, **Υπότιτλος:** Εκλογιτικός μεταγάββρος, **Κείμενο:** Ο παρόν εκλογιτικός μεταγάββρος βρίσκεται πάνω στον κεντρικό δρόμο. Ο μεταγάββρος αυτός χαρακτηρίζεται ως χονδρόκοκκος γλαυκοφανιτικός-εκλογίτης. Είναι μερικώς αποσαθρωμένος λόγω της βίαιης παρεμβολής ενός μεταδιορίτη (λεπτόκοκκος εκλογίτης). Και τα δύο πετρώματα προέρχονται από τον ίδιο μαγματικό θάλαμο, και μεταμορφώθηκαν μαζί σε υψηλές πιέσεις.

Title: Kampos, **Subtitle:** Metagabbro and Dyke, **Text:** The contact of the metagabbro (top) and the intrusive metadiorite (bottom) is a primary magmatic phenomenon. It took place deep beneath the Earth surface, inside a magma chamber when the gabbro was still hot and plastic.

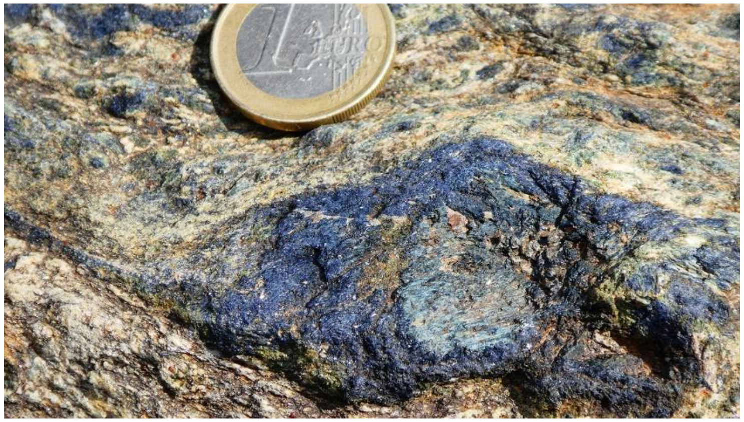
Τίτλος: Κάμπος, **Υπότιτλος:** Μεταγάββρος και παρεμβαλλόμενη φλέβα **Κείμενο:** Η επαφή του μεταγάββρου (επάνω) και του παρεμβαλλόμενου μεταδιορίτη (κάτω) είναι ένα πρωταρχικό μαγματικό φαινόμενο. Έλαβε χώρα βαθιά μέσα στη Γη, μέσα σε ένα μαγματικό θάλαμο όταν ακόμα ο μεταγάββρος ήταν καυτός και είχε πλαστικότητα.

Title: Kampos, **Subtitle:** Dyke intrusion **Text:** Despite metamorphism, the rocks' early magmatic history is preserved: Gabbro cooled very slowy from magma, so minerals had time to form large grains. Then new magma intruded into the space (magma chamber), forming a a diorite dyke. This magma had less time to cool, thus formed a finer grained rock.

Τίτλος: Κάμπος, **Υπότιτλος:** Παρεμβολή φλέβας, **Κείμενο:** Παρά τη μεταμόρφωση, η αρχική μαγματική ιστορία του πετρώματος έχει διατηρηθεί. Ο γάββρος ψύχθηκε πολύ αργά από τη μαγματική μορφή του, οπότε τα ορυκτά είχαν χρόνο να σχηματίσουν μεγαλύτερους κρυστάλλους /κόκκους. Έπειτα νέο μάγμα εισχώρησε βίαια μέσα στο μαγματικό θάλαμο του μεταγγάβρου, σχηματίζοντας τη φλέβα μεταδιορίτη. Το δεύτερο μάγμα είχε πολύ λιγότερο χρόνο ψύξης, οπότε και σχημάτισε πολύ μικρότερους κρυστάλλους.

Title: Kampos, **Subtitle:** Glaucophane crystals in Metagabbro, **Text:** Glaucophane (dark blue crystals) mimics the shape of magmatic pyroxene. These glaucophane pseudomorphs float in a matrix of garnet-omphacite-zoisite. The rock overall is an eclogitic metagabbro.

Τίτλος: Κάμπος, **Υπότιτλος:** Κρύσταλοι Γλαυκοφανή στον Μεταγάββρο, **Κείμενο:** Ο Γλαυκοφανής (σκούροι μπλε κρύσταλλοι) μιμείται το σχήμα των κρυστάλλων μαγματικού πυρόξενου. Οι ψευδομορφές γλαυκοφανή βρίσκονται μέσα σε μια μήτρα από ορυκτά γρανάτη-ομφακίτη-ζωισίτη. Όλο το πέτρωμα συνολικά ονομάζεται εκλογιτικός μεταγάββρος.



Title: Kampos, **Subtitle:** Pseudomorphs, **Text:** Crystals of magmatic pyroxene had formed in the gabbro. These are still visible as shiny cores in glaucophane that formed during metamorphism, when they largely replaced the pyroxene. These pseudomorphs retain the shape of the old crystals.

Τίτλος: Κάμπος, **Υπότιτλος:** Ψευδομορφές, **Κείμενο:** Οι κρύσταλλοι μαγματικού πυρόξενου είχαν σχηματιστεί στον αρχικό γάββρο, μέσα στον μαγματικό θάλαμο. Είναι ακόμα ορατοί ως λαμπεροί πυρήνες μέσα στους κρυστάλλους του γλαυκοφανή, που δημιουργήθηκαν κατά τη μεταμόρφωση του πετρώματος αντικαθιστώντας τον πυρόξενο. Αυτές οι ψευδομορφές διατηρούν το σχήμα του αρχικού κρυστάλλου.

Komito

Title: Komito, **Subtitle:** Komito Gneiss **Text:** Komito gneiss is unique to the South-West tip of Syros. It is a mixture of mica, quartz and feldspar. It originated as a granite that was metamorphosed under high pressures.

Τίτλος: Κόμητο, **Υπότιτλος:** Γνεύσιος Κόμητου, **Κείμενο:** Ο Γνεύσιος του Κόμητου είναι μοναδικός στην περιοχή της Νοτιοδυτικής Σύρου. Είναι ένα μείγμα από μαρμαρυγία, χαλαζία, και άστριο. Το αρχικό πέτρωμα είναι ένας γρανίτης ο οποίος μεταμορφώθηκε υπό υψηλές πιέσεις στο εσωτερικό της Γης.

Title: Komito, **Subtitle:** The Breccia, **Text:** Komito gneiss (brown) was strongly fractured and locally contains black tourmaline, a hydrothermal mineral that crystallized as fracture fillings.

Τίτλος: Κόμητο, **Υπότιτλος:** Λατυποπαγές, **Κείμενο:** Ο Γνεύσιος του Κόμητου (καφέ) διατιμήθηκε έντονα και τοπικά εμπεριέχει μαύρο Τουρμαλίνη, ένα υδροθερμικό ορυκτό που κρυσταλλώθηκε στις ρωγμές του Γνεύσιου και γέμισε τα κενά.

Title: Komito, **Subtitle:** Minerals, **Text:** This formation is called a hydrothermal breccia. Erosion has stripped away the gneiss, leaving massive fracture fillings of quartz and tourmaline weathering relics sticking out sharply.

Τίτλος: Κόμητο, **Υπότιτλος:** Ορυκτά, **Κείμενο:** Αυτού του είδους η δομή ονομάζεται υδροθερμικό λατυποπαγές. Ο γνεύσιος έχει διαβρωθεί, αφήνοντας πίσω του μεγάλα γεμίσματα από χαλαζία και τουρμαλίνη να προεξέχουν του βράχου.

Title: Komito, **Subtitle:** Fractures and fillings **Text:** A breccia is a rock consisting mostly of angular rock fragments. The fractured rock here is the Komito gneiss, and the fragments are cemented together by quartz and tourmaline.

Τίτλος: Κόμητο, **Υπότιτλος:** Ρωγμές και γέμισμα, **Κείμενο:** Το λατυποπαγές είναι μορφή πετρώματος που αποτελείται κυρίως από γωνιακά θραύσματα πετρωμάτων. Το θραυσμένο πέτρωμα εδώ είναι ο γνεύσιος του Κόμητου και τα θραύσματα έχουν συγκολληθεί με χαλαζία και τουρμαλίνη.

Title: Komito, **Subtitle:** Fractures and fillings, **Text:** Tourmaline and quartz were deposited here by hot aqueous solutions. These may point to a granitic intrusion at depth (but not visible at the surface).

Τίτλος: Κόμητο, **Υπότιτλος:** Ρωγμές και γέμισμα, **Κείμενο:** Ο τουρμαλίνης και ο χαλαζίας βρέθηκαν εδώ μέσω θερμών υδατικών διαλυμάτων. Αυτά μπορούν να αποτελούν ένδειξη μιας εισβολής γρανίτη σε μεγάλο βάθος, (που δεν είναι ορατή στην επιφάνεια).

Lakkoi

Title: Lakkoi, **Subtitle:** Glaucophane schist, **Text:** Lakkoi is rich in eclogites and other rock types containing minerals formed during high-pressure metamorphism. This eclogite lens is a metabasalt with water infiltrated along the border of the lens, forming the thin blue shell composed of glaucophane.

Τίτλος: Λάκκοι, **Υπότιτλος:** Γλαυκοφανιτικός σχιστόλιθος ορυκτά, **Κείμενο:** Η Περιοχή των Λάκκων είναι πλούσια σε εκλογίτες και άλλα μεταμορφωμένα πετρώματα υψηλής πίεσης. Ο παρόν βράχος εκλογίτη είναι ένας μεταβασάλτης γύρω από τον οποίο διαχύθηκε νερό το οποίο αντέδρασε χημικά με τον εκλογίτη, δημιουργώντας ένα λεπτό κέλυφος από γλαυκοφανή.

Title: Lakkoi, **Subtitle:** Blueschist **Text:** Glaucophane is stable under high pressure conditions, so it only forms deep inside the Earth. As it is hydrous mineral, it can only grow in environments where fluid is present.

Τίτλος: Λάκκοι, **Υπότιτλος:** Κυανοσχιστόλιθος, **Κείμενο:** Ο γλαυκοφανής είναι σταθερός υπό συνθήκες υψηλής πίεσης, οπότε και δημιουργείται μόνο βαθιά στο εσωτερικό της Γης. Καθώς είναι ένα ένυδρο ορυκτό, μπορεί να σχηματιστεί μόνο σε περιβάλλοντα όπου βρίσκονται μεταμορφικά ρευστά.

Title: Lakkoi, **Subtitle:** Chlorite Schist, **Text:** Eclogites here is coated by a thin layer of chlorite schist. Chlorite is a soft mineral. It resists weathering because it is not soluble in water. This made it a preferred rock type that ancient people used for carving.

Τίτλος: Λάκκοι, **Υπότιτλος:** Χλωριτικός σχιστόλιθος, **Κείμενο:** Ο εκλογίτης στην εικόνα επικαλύπτεται από μια λεπτή στρώση χλωριτικού σχιστόλιθου. Ο χλωρίτης είναι ένα μαλακό ορυκτό που αντιστέκεται στη διάβρωση καθώς δεν είναι διαλυτό στο νερό. Αυτό καθιστά το πέτρωμα ιδανικό για χαράξεις από αρχαίους πληθυσμούς.

Title: Lakkoi, **Subtitle:** Chlorite Schist, **Text:** The Lakkoi sight is an extraordinary location for ancient petroglyphs. Carved into the thin coatings of large eclogite bodies, incisions and scratching in chlorite schist show enigmatic patterns, messages we do not understand.

Τίτλος: Λάκκοι, **Υπότιτλος:** Χλωριτικός σχιστόλιθος, **Κείμενο:** Η περιοχή των Λάκκων είναι ένα θαυμάσιο πεδίο αρχαίων βραχογραφιών. Χαραγμένα σχήματα και μοτίβα στον χλωρίτη παρουσιάζουν αινιγματικά σχέδια και μηνύματα που δεν μπορούμε να καταλάβουμε τι μπορεί να σήμαιναν.

Title: Lakkoi, **Subtitle:** Petroglyphs **Text:** The age of these particular petroglyphs is not known, and direct dating probably is not possible. But the shapes show an evolution, so repeated activity of humans in the same area presumably over extended time periods.

Τίτλος: Λάκκοι, **Υπότιτλος:** Βραχογραφίες, **Κείμενο:** Η ηλικία των συγκεκριμένων βραχογραφιών είναι άγνωστη, και δεν είναι εφικτή η άμεση χρονολόγηση. Παρ' όλα αυτά, τα σχήματα που είναι χαραγμένα παρουσιάζουν μια εξέλιξη των μορφών, οπότε συμπεραίνεται ότι άνθρωποι έρχονταν εδώ ξανά και ξανά σε βάθος χρόνου και άφηναν το αποτύπωμά τους στο βράχο.

Lia

Title: Lia beach, **Subtitle:** Serpentinite schist, **Text:** At Lia beach a range of rock types meet: Various metavolcanic rocks, metasediments, marbles. Also, a body of serpentinite schist is well exposed. All are part of the Kampos shear zone.

Τίτλος: Λεία, **Υπότιτλος:** Σερπεντινιτικός Σχιστόλιθος, **Κείμενο:** Στην παραλία της Λίας συναντιούνται πολλά είδη πετρωμάτων: Διάφορα μετα-ηφαιστειακά (μετα-ηφαιστειογενή) πετρώματα, μεταιζηματογενή, και μάρμαρα. Ένα σώμα σερπεντινίτη ξεχωρίζει στη βόρεια πλευρά της παραλίας. Όλα τα πετρώματα εδώ ανήκουν στη ζώνη διάτμησης του Κάμπου.

Title: Lia beach, **Subtitle:** Serpentinite schist, **Text:** Only rarely does serpentinites surface as visible outcrops, but it is a common rock type in this zone, weathering back from the eclogite lenses (like the Aerolithos). These two rock types are intimately connected in this zone.

Τίτλος: Λεία, **Υπότιτλος:** Σερπεντινιτικός Σχιστόλιθος, **Κείμενο:** Ο σερπεντινίτης σπάνια εμφανίζεται στην επιφάνεια του εδάφους, όμως είναι πολύ σύνηθες πέτρωμα στην περιοχή του Κάμπου. Συνοδεύει πετρώματα εκλογίτη, όπως ο Αερόλιθος που βρίσκεται στο μονοπάτι προς τη Λία. Αυτά τα δύο είδη πετρωμάτων είναι άρρηκτα συνδεδεμένα σε αυτήν την περιοχή.

Title: Lia beach, **Subtitle:** Schist closeup **Text:** “Schist” is a structural term that denotes the texture of the rock: All schists have a strong parallel foliation.

Τίτλος: Λεία, **Υπότιτλος:** Κοντινή λήψη Σχιστόλιθου, **Κείμενο:** Ο όρος "Σχιστόλιθος" χαρακτηρίζει τη φόρμα και δηλώνει την υφή ενός πετρώματος. Όλοι οι σχιστόλιθοι παρουσιάζουν έντονο σχηματισμό λεπτών, παράλληλων στρώσεων ή "φύλλων".

Title: Lia beach, **Subtitle:** Phylus Texture **Text:** Serpentine is a soft mineral, and its crystal structure (sheet silicate) makes it a perfect candidate to produce schists. Outcrops of serpentinite schist thus are sensitive to breakage.

Τίτλος: Λεία, **Υπότιτλος:** Φυλλοειδής υφή, **Κείμενο:** Ο οφιοειδής, δηλαδή το ορυκτό που χαρακτηρίζει τον σερπεντινίτη, είναι μαλακό ορυκτό και η κρυσταλλική δομή του είναι πυριτικού φύλλου, κάτι που μπορεί πολύ εύκολα να αναπτυχθεί σε μορφή σχιστόλιθου. Συνεπώς, βράχοι από σερπεντινιτικό σχιστόλιθο είναι πολύ εύθραυστοι.

Title: Lia beach, **Subtitle:** Lawsonite-glaucophane schist, **Text:** Hydrated metabasalts are found on the south side of Lia beach. Former igneous rocks metamorphosed at high-pressure conditions along with metamorphic fluids produced these lawsonite-glaucophane schists.

Τίτλος: Λεία, **Υπότιτλος:** Λωσονιτικός-γλαυκοφανητικός σχιστόλιθος, **Κείμενο:** Στη Νότια πλευρά της παραλίας βρίσκονται ενυδατωμένοι μεταβασάλτες. Πρόκειται για αρχικά πυριγενή πετρώματα που μεταμορφώθηκαν υπό συνθήκες υψηλής πίεσης με τη βοήθεια μεταμορφικών ρευστών. Αυτή η αντίδραση μεταμόρφωσε τα πετρώματα σε λωσονιτικούς-γλαυκοφανητικούς σχιστόλιθους.

Title: Lia beach, **Subtitle:** Lawsonite **Text:** While glaucophane is responsible for the blue colour of the schists, the white rombohedral patches are the mineral lawsonite. Lawsonite is a high-pressure mineral typically found in low-temperature blueschists.

Τίτλος: Λεία, **Υπότιτλος:** Λωσονίτης, **Κείμενο:** Ο γλαυκοφανής είναι το ορυκτό που προσδίδει το μπλε χρώμα του πετρώματς ενώ τα λευκά ρομβόεδρα κομμάτια είναι κρύσταλλοι λωσονίτη. Ο λωσονίτης είναι ένα ορυκτό που σχηματίζεται υπό υψηλή πίεση και βρίσκεται συχνά σε κυανοσχιστόλιθους χαμηλών θερμοκρασιών.

Marmari

Title: Marmari, **Subtitle:** Marble quarry, **Text:** Marble quarry in the Metasedimentary Micaschist unit above Marmara Bay (below the path to Grammata).

Τίτλος: Μαρμάρι, **Υπότιτλος:** Λατομείο μαρμάρου, **Κείμενο:** Στην γεωλογική ενότητα των Μεταϊζηματογενών μαρμαρυγιακών Σχιστόλιθων βρίσκεται ένα παλιό λατομείο μαρμάρου, στο μονοπάτι προς τον κόλπο Μαρμάρι (νότια από τα Γράμματα).

Title: Marmari, **Subtitle:** Marble quarry, **Text:** Large blocks of precious white marble were selected to be mined for use in art works and noble architecture.

Τίτλος: Μαρμάρι, **Υπότιτλος:** Λατομείο μαρμάρου, **Κείμενο:** Μεγάλοι ογκόλιθοι πολύτιμου καθαρού μαρμάρου εξορύσσονταν από το λατομείο ως πρώτη ύλη για έργα τέχνης και αρχιτεκτονικής.

Title: Marmari, **Subtitle:** Marble excavation **Text:** Medium size blocks of marble were excavated and prepared for later transport just before mining stopped in the 1930s (reasons unknown).

Τίτλος: Μαρμάρι, **Υπότιτλος:** Εξόρυξη μαρμάρου, **Κείμενο:** Μεσαίου μεγέθους ογκόλιθοι μαρμάρου εξορύσσονταν και προετοιμάζονταν για μεταφορά λίγο πριν να εγκαταλειφθεί το λατομείο τη δεκαετία του 1930.

Title: Marmari, **Subtitle:** Worker's signature, **Text:** Quarry worker (late 19th century, probably from Tinos) left his signature in the white marble he helped to mine and prepare for transport.

Τίτλος: Μαρμάρι, **Υπότιτλος:** Υπογραφή εργάτη, **Κείμενο:** Ένας εργάτης του 19ου αιώνα, πιθανώς από την Τήνο, χάραξε όπως και πολύ άλλοι, την υπογραφή του σε ένα κομμάτι μαρμάρου έτοιμου για μεταφορά.

Title: Marmari, **Subtitle:** Marble transport, **Text:** Blocks of white marble were prepared for transport from a ramp (right). They probably would have been pushed onto wooden "rails" and down to the coast before being shipped away.

Τίτλος: Μαρμάρι, **Υπότιτλος:** Μεταφορά μαρμάρου ορυκτά, **Κείμενο:** Οι μαρμάρινοι ογκόλιθοι προετοιμάζονταν για μεταφορά με τη βοήθεια μίας ράμπας στα δεξιά. Πιθανώς να τους έσπρωχναν πάνω σε "ράγες" από ξύλινους κυλίνδρους ώσπου να τους κατεβάσουν στην παραλία από όπου και θα φορτώνονταν σε πλοία για περαιτέρω μεταφορά.

Title: Marmari, **Subtitle:** Lawsonite blueschist **Text:** Lawsonite-blueschist lying on top of massive marble beds

Τίτλος: Μαρμάρι, **Υπότιτλος:** Λωσονιτικός κυανοσχιστόλιθος, **Κείμενο:** Κοντά στο λατομείο δεσπόζουν και βράχοι λωσονιτικού-κυανοσχιστόλιθου.

Mavro Pounti

Title: Mavro Pounti, **Subtitle:** Metavolcanic Sandstones, **Text:** A series of banded metavolcanic rocks outcrops next to the conglomerate unit. The outcrop surface shows strong aeolian (wind) erosion with lots of pitholes. This north tip of Syros is very exposed to winds.

Τίτλος: Μαύρο Πουντί, **Υπότιτλος:** Μετα-ηφαιστειακοί Ψαμμίτες, **Κείμενο:** Σύμπλεγμα από στρώσεις μεταβολιστικών (μετα-ηφαιστειακών) πετρωμάτων εμφανίζεται δίπλα στην ενότητα του κροκαλοπαγούς. Τα πετρώματα της επιφάνειας έχουν υποστεί ισχυρή αιολική διάβρωση και φέρουν πολλές οπές και βαθουλώματα. Αυτή η διάβρωση οφείλεται στην μεγάλη έκθεση της βόρειας περιοχής του νησιού σε ισχυρούς ανέμους.

Title: Mavro Pounti, **Subtitle:** Metavolcanic rock sight, **Text:** All of these rocks were metamorphosed under high pressure beneath the Earth's surface for tens of millions of years, before slowly returning to the surface, where erosion started.

Τίτλος: Μαύρο Πουντί, **Υπότιτλος:** Μετα-ηφαιστειακό τοπίο, **Κείμενο:** Τα πετρώματα αυτά μεταμορφώθηκαν υπό συνθήκες υψηλής πίεσης στο εσωτερικό της Γης για δεκάδες εκατομμύρια χρόνια, προτού να επιστρέψουν στην επιφάνεια όπου και ξεκίνησε η διάβρωσή τους.

Title: Mavro Pounti, **Subtitle:** Aeolic erosion **Text:** Metavolcanic sandstone with aeolian erosion features. The outcrops have been sand-blasted by strong lateral winds.

Τίτλος: Μαύρο Πουντί, **Υπότιτλος:** Αιολική διάβρωση, **Κείμενο:** Οι μετα-ηφαιστειακοί ψαμμίτες σε αυτήν την περιοχή έχουν υποστεί φυσικές αμμοβολές από ισχυρούς πλευρικούς ανέμους.

Title: Mavro Pounti, **Subtitle:** A structure of holes, **Text:** Wind has been driving sand grains against and into the rocks' surface. These particles keep eating away the sandstones and have created a mesh structure of relics around holes. Folded quartz veins resist erosion and stand out sharply.

Τίτλος: Μαύρο Πουντί, **Υπότιτλος:** Κατασκευή από οπές, **Κείμενο:** Ο άνεμος ρίχνει κόκκους άμμου στην επιφάνεια των πετρωμάτων με μεγάλη ορμή. Τα σωματίδια αυτά διαρκώς "σκαλίζουν" και αποσπούν το υλικό του ψαμμίτη, έχοντας έτσι δημιουργήσει ένα πλέγμα από οπές. Οι φλέβες από χαλαζία που διατρέχουν τους ψαμμίτες αντιστέκονται στη διάβρωση και προεξέχουν έντονα από το υπόλοιπο πέτρωμα.

Title: Mavro Pounti, **Subtitle:** Unit contact, **Text:** Contact between two rock units: Metavolcanic (left) and Conglomerate (right), cut up by a steep fault. The flanks are being eroded and form a steep gulley that runs down to the sea.

Τίτλος: Μαύρο Πουντί, **Υπότιτλος:** Επαφή γεωλογικών ενοτήτων, **Κείμενο:** Επαφή μεταξύ δύο γεωλογικών ενοτήτων: Ενότητα μετα-ηφαιστειακών πετρωμάτων (αριστερά), και ενότητα Κροκαλοπαγούς (δεξιά), η οποία διακόπτεται από απότομο ρήγμα. Οι πλευρές του λόφου έχουν διαβρωθεί και δημιουργούν μια απότομη χαράδρα που οδηγεί στη θάλασσα.

Title: Mavro Pounti, **Subtitle:** Inside the fault **Text:** In between fault scarps metavolcanic sandstone layers(left) are in contact with conglomerate beds (right).

Τίτλος: Μαύρο Πουντί, **Υπότιτλος:** Μέσα στο Ρήγμα, **Κείμενο:** Επαφή μεταξύ δύο γεωλογικών ενοτήτων: Ενότητα μετα-ηφαιστειακών πετρωμάτων (αριστερά), και ενότητα Κροκαλοπαγούς (δεξιά), η οποία διακόπτεται από απότομο ρήγμα. Οι πλευρές του λόφου έχουν διαβρωθεί και δημιουργούν μια απότομη χαράδρα που οδηγεί στη θάλασσα.

Title: Mavro Pounti, **Subtitle:** Layer weathering, **Text:** Folded metavolcanic layers have been by modeled by episodic water torrents gushing towards the sea.

Τίτλος: Μαύρο Πουντί, **Υπότιτλος:** Διάβρωση στρωμάτων, **Κείμενο:** Πτυχωμένες στρώσεις μετα-ηφαιστειακών πετρωμάτων έχουν αναπλαστεί από επεισοδιακές ροές νερού που ρέει ορμητικά στη θάλασσα.

Title: Mavro Pounti, **Subtitle:** Smaller fracture system, **Text:** A series of small fractures runs parallel to the larger fault, they are a part of the same deformation system. They are partly filled with white quartz and black chlorite.

Τίτλος: Μαύρο Πουντί, **Υπότιτλος:** Μικρότερο σύστημα διατμήσεων, **Κείμενο:** Μια σειρά από ρωγμές εκτείνεται κατά μήκος του μεγάλου ρήγματος, καθώς είναι μέρος του ίδιου μεγάλου συστήματος παραμόρφωσης. Οι ρωγμές είναι μερικώς γεμάτες με χαλαζία και μαύρο χλωρίτη.

Megas Gialos

Title: Megas Gialos, **Subtitle:** Metavolcanic greenschist **Text:** A series of metasedimentary and metavolcanic greenschists outcrop along the road. They are all dark, strongly foliated and flattened.

Τίτλος: Μέγας Γυαλός, **Υπότιτλος:** Μετα-ηφαιστειακός πρασινοσχιστόλιθος, **Κείμενο:** Μια σειρά από μεταϊζηματογενείς και μετα-ηφαιστειογενείς πρασινοσχιστόλιθους βρίσκεται πάνω στο δρόμο. Είναι σκούροι, με ισχυρή φολίδωση και ισοπέδωση των στρώσεων.

Title: Megas Gialos, **Subtitle:** Clay-rich sentiments, **Text:** Layered stack of metasediments, mostly metapelites, formed from clay-rich sediments during metamorphism at relatively low temperatures and pressures.

Τίτλος: Μέγας Γυαλός, **Υπότιτλος:** Ιζήματα πλούσια σε άργιλο, **Κείμενο:** Στιβαγμένες στρώσεις μεταϊζηματογενών πετρωμάτων, κυρίως μεταπηλίτες, σχηματίστηκαν από ιζήματα (κόκκους) πλούσια σε άργιλο κατά τη διάρκεια μεταμόρφωσης υπό συνθήκες σχετικά χαμηλής θερμοκρασίας και πίεσης (σε μικρό βάθος μέσα στη Γη).

Title: Megas Gialos, **Subtitle:** Deformation structures, **Text:** Deformation structures in metasedimentary greenschists show that the layers were flattened and folded together with the white veins of hydrothermal quartz.

Τίτλος: Μέγας Γυαλός, **Υπότιτλος:** Δομές παραμόρφωσης, **Κείμενο:** Οι δομές παραμόρφωσης σε μεταϊζηματογενή πρασινοσχιστόλιθους δείχνουν ότι οι στρώσεις ισοπεδώθηκαν και αναδιπλώθηκαν μαζί με τις λευκές φλέβες υδροθερμικού χαλαζία.

Title: Megas Gialos, **Subtitle:** Flattened layers **Text:** Very strongly flattened and attenuated layers in greenschist with quartz veins.

Τίτλος: Μέγας Γυαλός, **Υπότιτλος:** Ισοπεδωμένες στρώσεις, **Κείμενο:** Πολύ έντονα ισοπεδωμένα και lept;a στρώματα πρασινοσχιστόλιθου με φλέβες χαλαζία ενδιάμεσα.

Title: Megas Gialos, **Subtitle:** Metapelites, **Text:** A similar stack of metapelites shows open, gentle folds only.

Τίτλος: Μέγας Γυαλός, **Υπότιτλος:** Μεταπηλίτες, **Κείμενο:** Παρόμοια εμφάνιση από μεταπηλίτες παρουσιάζει μόνο ανοιχτές, απαλές πτυχές.

Title: Megas Gialos, **Subtitle:** Metapelitic greenschist, **Text:** Flattening of the metapelitic greenschist caused the cm-thick quartz veins to be pulled apart.

Τίτλος: Μέγας Γυαλός, **Υπότιτλος:** Μεταπηλιτικός πρασινοσχιστόλιθος, **Κείμενο:** Ισοπέδωση των μεταπηλιτικών πρασινοσχιστόλιθων η οποία προξένησε τη διάσπαση των φλεβών χαλαζία (πάχους μερικών εκατοστών)

Vari

Title: Vari, **Subtitle:** Deformed greenschist **Text:** A very strongly deformed package of greenschist forms the base of the Vari unit. It includes very finely laminated phyllites (grey) and banded chlorite schists (green).

Τίτλος: Βάρη, **Υπότιτλος:** Παραμορφωμένος πρασινοσχιστόλιθος, **Κείμενο:** Ένας βράχος πρασινοσχιστόλιθου που έχει υποστεί πολύ ισχυρή παραμόρφωση, βρίσκεται στη βάση της γεωλογικής μονάδας της Βάρης. Περιέχει γυαλιστερούς φυλλίτες (γκρι) και χλωριτικούς σχιστόλιθους (πράσινο).

Title: Vari, **Subtitle:** Deformed greenschist **Text:** Both the bright phyllite (left) and the dark greenschist (right) are intensely disrupted by fracture several systems (more or less systematically oriented)

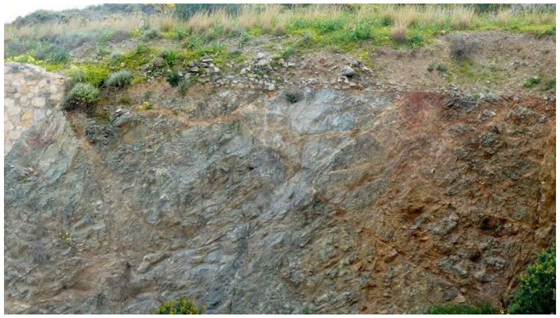
Τίτλος: Βάρη, **Υπότιτλος:** Παραμορφωμένος πρασινοσχιστόλιθος, **Κείμενο:** Ο γυαλιστερός φυλλίτης (αριστερά) και ο σκούρος πρασινοσχιστόλιθος (δεξιά) έχουν διαταραχθεί έντονα από σύστημα διακλάσεων (περισσότερο ή λιγότερο συστηματικά προσανατολισμένα).

Title: Vari, **Subtitle:** Mylonitic greenschist, **Text:** Mylonitic Vari detachment base: A cataclastic zone (left, reddish) cut through banded greenschist.

Τίτλος: Βάρη, **Υπότιτλος:** Μυλωνιτικός πρασινοσχιστόλιθος, **Κείμενο:** Η Μυλωνιτική βάση της Βάρης είναι μια κατακλαστική ζώνη (αριστερά, κόκκινη) που διαπερνά τον πρασινοσχιστόλιθο.

Title: Vari, **Subtitle:** Fractured greenschist **Text:** Strongly fractured light greenschists (left) envelop a massive serpentinite lens (right, dark green).

Τίτλος: Βάρη, **Υπότιτλος:** Διασπασμένος πρασινοσχιστόλιθος, **Κείμενο:** Έντονα διασπασμένοι πρασινοσχιστόλιθοι (αριστερά) τυλίγουν έναν τεράστιο σερπεντινίτη (δεξιά, σκούρο πράσινο).



Title: Vari, **Subtitle:** Banded greenscists, **Text:** A stack of banded greenschists shows intense brittle deformation, fractures and shear displacements.

Τίτλος: Βάρη, **Υπότιτλος:** Ζώνες πρασινοσχιστόλιθου, **Κείμενο:** Μια στοίβα ενωμένων πρασινοσχιστόλιθων δείχνει έντονη θραυστική παραμόρφωση, διακλάσεις και διατμητικές μετατοπίσεις.

Title: Vari, **Subtitle:** Reaction with water, **Text:** The dense fracture network in these rocks allowed surface water to enter and react with the along fractures. This caused oxidation and produced iron hydroxides, giving the rusty colors.

Τίτλος: Βάρη, **Υπότιτλος:** Αντίδραση με νερό, **Κείμενο:** Το πυκνό δίκτυο διακλάσεων σε αυτά τα πετρώματα επέτρεψε την είσοδο επιφανειακών υδάτων και την αντίδραση του πετρώματος με το νερό κατά μήκος των ρωγμών. Αυτό προκάλεσε οξείδωση και παρήγαγε υδροξείδια σιδήρου, δίνοντας τα σκουριασμένα χρώματα.

10.2 Syros Rock Types – Complete Research Content

This chapter contains all recorded information on the most distinct rock types of Syros, distinguished as such and provided by professor Martin Engi. The information is a product of on-sight note taking and audio recorded interviews. Martin Engi provided us with facts on the specific rock types of Syros, general information geological processes, relevant minerals, and the geological history and value of Syros. The guide and the student followed typical field observation procedures and techniques used by professional geologists. At the end there can be found a brief dictionary with term definitions and translations from English to Greek, as well as a basic geological taxonomy table.

10.2.1 Eclogitic Metagabbro

Penetrative structure. Angular fragments of glaucophane. Four minerals: Garnet (red), Glaucophane (blue), Omphacite (dark green), Zoisite (light green). These are the minerals of a glaucophane eclogite. A pure eclogite contains only garnet and omphacite.

First, we notice the texture, what is so special. There are angular fragments of glaucophane. They are called angular due to their sharp corners, like polygons. Inside them we see internal fractures parallel to each other, like crystals. This is what we call a pseudomorph of glaucophane after its precursor pyroxene. It lies about what it is. It pretends to be pyroxene by maintaining the shape of the crystal, but chemically it has changed to glaucophane. These angular fragments were once large grains of pyroxene in a matrix of plagioclase, a feldspar. Feldspars are a family of minerals and they make up 60% of the Earth's crust. Plagioclase is the most common feldspar and it's found in many rock types. In this case it is found in the protolith Gabbro. A gabbro is a deep analogous of the basalt. It is a plutonic rock, meaning that it has formed deep beneath the crust inside a magma chamber. Basalt on the other hand is a volcanic rock made by what comes out of the volcano, at Earth's surface.

The grains of pyroxene form in crystal first inside a magma chamber, which cools gradually thus allowing a slow crystallization. After that, the space fills up with plagioclase. Finally, all this mixture gets metamorphosed in High-pressure (HP), thus becoming a metagabbro.

A homogenous, fine-grained rock. It is made of garnet and omphacite, thus is a very fine-grained eclogite. It was a volcanic rock called Dike. The dike forced its way into the magma chamber as the gabbro was already cooling down. The dike moved through the gabbro before the HP metamorphism. All happened at sea level, so it's a typical oceanic magmatism. A gorgeous outcrop to see the old magmatic history and the HP overprint.

10.2.2 Observational geology process

Look at the forest before you look at the tree. Observe the overall scene and the outcrop from afar, then start observing more in detail. Look at the rock as if it's telling you a story.

What you see is not always what you want to show. You must decide on what you want to show and make a sketch of the area you are studying. Record time and place, in GPS coordinates if you can. It's better to go from a large scale to a smaller, more detailed one. Get rid of the shadows because they confuse the human eye in the photographs. Always use a known object as a scale, in sketch and photographs to make clearer the real dimensions of what you are showing. Thus way, when you and others later see the photos they will better understand if they are looking at something relatively large or small. A hammer, a knife, a pen, a coin, even a hand in the photo can indicate well the scale of things.

10.2.3 Magma Chamber

You have a magma chamber which is slowly cooling down and crystalizing, making the gabbro. More magma intrudes from beneath and forces its way through the gabbro. The new magma cools down faster and makes up the dike. So, there is a gabbro with intrusive features of a diorite dike inside it, and the events took place in the oceanic crust, making up its magmatic history.

The magma chamber was cooling slowly so the gabbro had a lot of time to form and pyroxene had time to form coarse-grained crystals. This first mixture of pyroxene and plagioclase was already significantly cool when new magma forced its way in. Thus, the new magma did not have as much time to cool, so it did not form large crystals, but rather became a fine-grained diorite dike.

The size of the grains tells us how long the material had time to cool. Large crystals need time to form, so when we see them, we know that the magma there cooled down slowly. Whereas fine-grained surfaces tell us that the magma only had a short period of time before it reached solidification temperatures.

10.2.3.1 Anatomy of a magma chamber

A magma chamber is not a hallow space with magma flowing around, but there was already something there. The magma coming up forced the other rocks apart, which is called “stoping”, or picked up other rocks and “digested” them making them part of the magmatic system, which is called “assimilation”, or it simply breaks it loose and comes up as magma. This may be happening well inside the mantle; stuff can go up for many kilometers. Pieces of matter can break loose from the rim and fall down into the chamber. The magma is replacing the fallen or eaten material. The magma chamber eats its way up and influences the existing material.

A gabbro is part of such an intrusive mass or body which we call a magma chamber. Some fractures can go all the way up into the surface and form a volcano. Some of the magma from the chamber overflows through the volcano and creates basalts and other igneous rocks. And the same material, but that which remains in the chamber, will slowly cool down and crystalize into a coarse-grain gabbro. If more magma intrudes and gets into the chamber as it cools down, then we get a dyke.

10.2.3.2 Gabbro – Dyke relation

The gabbro was forming at around 1500-1100oC. As the chamber was cooling down to 900oC, the new magma intruded into the chamber and the already solidifying gabbro. The span between the two temperature points could have been a million years, we don’t know. By 900 degrees the gabbro is well enough a solid rock, so the new magma gave off its heat to the gabbro very fast.

As the hotter material the magma was able to intrude the cooler gabbro and break into it. So, it cooled down fast and became a fine-grain rock inside a coarse-grain rock.

A fine-grain rock typically gets metamorphosed into another fine-grain product, and a coarse-grain rock into a coarse-grain product. So, these rocks kept the initial grain size, but their mineral composition changed. The gabbro protolith mixture was a plagioclase matrix with pyroxene crystals, and it metamorphosed into an omphacite matrix with glaucophane crystals. The diorite dike protolith was again a mixture of pyroxene and plagioclase, but with little time to cool down it metamorphosed into a fine-grain mixture of omphacite and garnet, in other words a pure eclogite. A gabbro is a family of HP rocks, so is a glaucophane schist.

10.2.4 Reading rock's history-Glaucophane pseudomorphs

The angular fragments of glaucophane have a light blue core with a parallel crystal structure, and a dark blue rim outside. The inner crystal was the original pyroxene crystal. The outer darker rim is larger because the chemical reaction responsible for pyroxene to turn into glaucophane requires more product, so it takes in material from around the crystal.

The glaucophane pseudomorphs inside the greenish matrix is overall a metagabbro. It has texture of a magmatic rock, the gabbro, but the mineralogy of a high-pressure metamorphic rock. So, we know its protolith, we know it was metamorphosed, and we know it's a HP rock because those minerals are not stable, unless under high pressure conditions. All this information can determine the naming of the rock type.

10.2.5 Hydration for producing Glaucophane

Omphacite plus H2O react to produce glaucophane. So, the more "hydration" we have as a rock metamorphoses the more glaucophane we get. By the term "hydration" we mean metamorphic fluids, not pure, distil water. In a tectonic scale, as one tectonic plate moves under the other, it subducts under the second plate and gets squeezed in between that and the mantle. Along that fracture system, or else the subduction zone, there are a lot of fluids circulating. That is where the metamorphic reactions produced glaucophane, not at toward the surface.

Some minerals contain no water in their atomic structure. Pyroxene is such a mineral group. Other groups may contain OAs instead of water. To make amphiboles, in this case glaucophane, you need to have somehow water though fractures or something else.

Glaucophane is a mineral, not a rock. But a glaucophane gabbro is a metagabbro rock. Glaucophane (+ blueschist vs. greenschist).

The only way to make omphacite in a vein is with metamorphism of CO2. So, CO2 from a carbonate has to become part of the fluid, destabilizes the hydrate, and makes an anhydrous mineral. So this was! A glaucophane vein, which in a CO2 rich environment was not stable, so it transformed back into omphacite. In a way, it's a dehydration because the water, or hydroxyl, that was caught up in the glaucophane was liberated when this retro transformed to omphacite. Thus, if you want to make glaucophane out of omphacite you need water. Not distil water, but an igneous solution with salts and other stuff dissolved in it.

10.2.6 Serpentinite chlorite schist

A serpentinite chlorite schist can be a typical shell between an eclogite and serpentine. The reaction between the serpentine and the eclogite can create a shiny coating over the bedrock. This shiny coating is chlorite. Serpentinite is a very soft rock type and thus weathers easily. You can even break it apart with your own hands.

Serpentinite derives from a mantle rock, not a crust rock, so it's extremely deep in origin, more than 25klm in depth. For comparison, in an oceanic environment the crust in typically 6-8 klm deep. So, whenever you see a serpentinite it's a hydrated piece of the earth's mantle.

The serpentinite schist in addition to the chlorite is what gives off the silvery green color. Both chlorite and mica are sheet silicates.

10.2.6.1 Serpentinite schist outcrop at Lia beach

Large body of Serpentinite schist at the beach. It's the matrix of that Aerolithos and the rest up on the hill sit on, but it's better exposed here. "Schist" is a structural term which describes the texture of the rock. A rock that is called a schist has a strong parallel foliation; hundreds of layers organized parallel to each other. The foliation in this body of rock is extremely strong because the rock is almost entirely pure serpentine. Serpentine is a sheet silicate, thus form strong foliation. This body is serpentinite asbestos, the only type safe for humans. Asbestos just means "very long needles" as layers, so it's another structural term, this time used for layers that are 100 times longer than they are wide. Structural terms according to layer thickness: phyllite – schist – gneiss – fells

10.2.7 Eclogites

All lenses around Aerolithos are eclogites. They were all part of the same body, but over time they broke off and rolled down spreading down the valley. Going closely, we can see layers of glaucophane covering the lens. That is where the metamorphic fluids reacted with the eclogite surface. Naturally, omphacite and garnet do not have water in their composition, so once they combine with high-pressure fluids the product of this reaction is glaucophane. These thin layers of glaucophane are veins of where the reaction took place. Dark blue glaucophane is rich in iron, hence the dark tone.

Then you have the eclogite which is a high-pressure metamorphic rock, but it can have any type of texture. It can be a schist, but it's rare, it can be a gneiss or a fels easily. If it's a pure eclogite, in composition, then it's a basic rock, so a gabbro or a basalt to start with and then became metamorphosed into an eclogite. Eclogites can have a big variety of minerals, but what distinguishes them from other HP metamorphic rocks is the absence of feldspar. "Eclogite" form the Greek word "eclogi" meaning choice.

It's not about what is or isn't true in the whole planet but what is true in Syros. That most coarse grain eclogites where once a gabbro. It's typical that it shows the protolith, despite that it has been highly metamorphosed. It still keeps the old information. A rock remembers something about its past, it's even pretending to be something else, but the old is still there. Metamorphic rocks have a memory and our job is to read that memory.

10.2.7.1 Aerolithos

A dike is a magmatic rock that comes up as a two-dimensional sheet. It's not a specific rock type, but rather an intrusive magmatic body.

Some areas on the body of Aerolithos are more exposed because large pieces of rock have fallen off and rolled down the valley. Essentially, Aerolithos is an eclogite lens with a glaucophane skin, sitting on a chlorite serpentinite schist matrix.

In Aerolithos the glaucophane skins are where the hydration took place. It's much easier for water to flow around the big lenses than inside them, where its solid. Not water nor magma could penetrate the body of rock they could only flow around it.

10.2.7.2 Minerals around Aerolithos

Blueschist with a lot of mica is called a Glaucophane Micaschist, and it usually has a strong foliated texture. It's a typical texture found in the Metabasite Unit. The red mineral observed is not garnet, but iron carbonate, or else Siderite.

Dark blue glaucophane is rich in iron, whereas light blue indicates a richness in magnesium.

Mica is a silicate. The atomic structure of a silicate is a tetrahedron, responsible for light reflection. Chlorite is a sheet silicate, meaning that the silicane atoms form parallel sheets, almost like mirrors, which form the crystal structure of the mineral. We also find a lot of talc around this area, which is the softest mineral and is very slippery. Talc is a hydrated form of serpentine. It derives from serpentine plus silicane-rich water.

Serpentinite is all in between the eclogite bodies. It's rarely exposed because it's soft and weathers easily. It can be in the form of a schist, with strong foliation and sheets only a few centimeters in size.

10.2.7.3 Lawsonite Blueschist

Lawsonite is a mineral that is typically found in High pressure such as blueschists, however is quite rare in a global scale. It has a distinct rhombohedron shape and is usually white. In general, we'd call this sample a Lawsonite schist, but since it has glaucophane the appropriate name is Lawsonite blueschist.

10.2.8 Explaining Rock units-Syros Morph

Geologists have marked Rock Units, not single rock types, as a means to make sense of the chaos. They try to identify which parts of the island have the same tectonic history and name each region as one unit. Within one unit (e.g. Metabasite), we can find all rock types mentioned before. They are just more dominant in said unit. Metabasite means that it comes from a basic, low pH, rock. "Meta" means that it derives from a basalt, essentially a volcanic rock, through metamorphosis.

The whole South coast of Syros from Ermoupoli due south, is a mixture of marble and Mavic metabasite rocks (dark colored) with one huge exception of the Vari hill. This separate unit was never at high pressure, so it sits on top of the others. You can find eclogites here too but not HP rocks. Fracture fillings of eclogite with siderite. Fractures due to earthquakes and movement.

10.2.9 Rock Taxonomies

We have three basic taxonomies or ways to classify rock types into categories. According to Genetics, meaning how something was formed. Here we find magmatic rocks, sedimentary rocks and metamorphic rocks.

Intrusive rocks: Intrusive rocks are one kind of magmatic rocks. The other types are extrusive rocks, they are the ones that that come out and flow. And the third type is explosive rocks, the ones that come out in explosive ways. These are all igneous rocks, but they are a subcategory of magmatic rocks.

Igneous rocks: Igneous rocks get divided into volcanic, or extrusive or the rest. Volcanic just means that it was made in a volcano or by a volcano. And that can be effusive, meaning to flow, explosive, or intrusive, meaning it goes into something else, like a dyke. Intrusive is not strictly a volcanic rock, but rather a subvolcanic because it comes from underneath the volcano. If it's a magmatic rock but not a volcanic, then it's a Plutonic rock meaning that it was made deep underneath.

Genetic Categorization: Depending on how things are formed, we have Volcanic, magmatic, sedimentary metamorphic rocks. This is an important taxonomy, but it's not a very descriptive one. Rock names or families that require an idea of what happened how something came to be, use this taxonomy.

Textural Categorization: Based on texture, it describes the texture or structure of the rock type. If its massive, it's called a Fels. If its course, meaning it has thick layers or slabs, then it's a gneiss, about a decimeter thick. If it's in centimeter scale, then it's called a schist. If it's in millimeter scale, it's called a phyllite.

Compositional Categorization: Based on chemical composition. We could call both a limestone and a marble Carbonates, but one is sedimentary and the other is metamorphic. Basic rocks, meaning high in pH, like a basalt or other volcanic rocks.

10.2.10 Epidote blueschist

The yellowish green is the epidote. Tectonic thrusting is responsible for how the rock bodies in the units fall one on top of the other. For Abelaki, this is where we see the metabasite body sit on top of a marble body. Here we see epidote blueschist at its best. The dark glaucophane is rick in iron, whereas the light blue glaucophane is rich in magnesium. Epidote is a mineral, like lawsonite or garnet or glaucophane.

In an epidote blueschist with "bubbles trapped". The foliation wraps around the small lenses. The green is now epidote, but the deformation is much older than the overprint.

The "bubbles" where a layer that could not be deformed plastically, so it broke into bits and pieces. So, we end up with a "sausage" or nuts shaped chain of lenses trapped in the glaucophane matrix.

Typically, we see veins of glaucophane and clasts of omphacite, but the rare reverse can happen. To get the reverse, glaucophane clasts trapped inside omphacite veins, we need "dehydration". The only way to make omphacite in a vein is with metamorphism of CO2. So, CO2 from a carbonate has to become part of the fluid, destabilizes the hydrate, and makes an anhydrous mineral. So this was! A glaucophane vein, which in a CO2 rich environment was not stable, so it transformed back into omphacite. In a way, it's a dehydration process. So, this rock must have gone under HP, thus is much older than the greenschist overprint, because the greenschist forms at much lower pressure, so later coming up to the surface.

10.2.11 Metabasites

Collectively, we'd call all these rocks in Abelaki just Metabasites, since they are all metavolcanics rocks. Hardly any metagabbro, so not the deep stuff. Many of them are fine or medium grained. What is particular here is that the eclogite and blueschist inprint is then! (afterwards in time) followed by the epidote greenschist.

10.2.11.1 Blue metabasite with quartz veins

Crazy, amazing metabasite. Look at the pattern altogether. Folds that are torn apart by a series of fractures. The fractures that are going across are partially filled with quartz and an iron rich carbonate, the brownish stuff mixed in with the quartz. These are very late fracture fillings. Very late meaning as a state of exhumation (exposure to the surface). Maybe even during the last kilometer or so, of coming to the surface. The way the quartz is deposited, or the carbonate, is just from pockets, from the fluids of the igneous solution.

So, silicate precipitates from a water-rich fluid just because of hot pressure (350oC), it's pressure-dependent. So, if a crack opens, the solubility (the capacity of dissolving) goes down, so immediately quartz is precipitated on the walls. Fibers of quartz going through the rock, grow into the open space.

10.2.12 Marble-Siderite Deformation & Weathering - Fabrika beach

What's the difference than before? This sight has a lot more veins. This deformation is not something special, it just broke by an earthquake. The veins here are not filled with quartz but with iron carbonate or else Siderite. Their rustic color is easily distinguishable and recognizable, due to the rusting of iron from water and oxygen. The small veins of siderite, found in marble, are just because of the larger fracture before. The breakage just went on and on, thus followed the filling.

Because of some movement the siderite squeezed in the further fractures that were there in the marble possibly an earthquake. The fractions grew due to external forces and movements, not because of the "strength" of the filling. System of veins.

10.2.12.1 Marble with eclogite

Here we find a heterogeneous mix of high-pressure rocks and various marbles. If you look into the marble sometimes there is an eclogite trapped. The mafic (basic pH) rocks means some of the movement was breaking up a massive marble?

There is no glaucophane in this one, so the "bubbles" happened during the early eclogite stage before glaucophane could become stable. (Or the amphibole is a hydrate and if its engulfed in carbohydrate. So, the surrounding fluid was richer in CO_2 than H_2O. Thus, the glaucophane may have become unstable). The eclogite was protected from fluids by the marble. Also, marble lows easily around, so eclogite got trapped in the marble soup.

10.2.12.2 Marble holes

We see a body of marble with thin veins of siderite running through the fractures. The other strange thing here you'll see if you walk on the surface of the marble bed, are those strange holes. What happened here is that the marble bed used to be underwater or at water level. So, the water waves would carry small rocks that found their way into the fractures of the marble. The continuous motion of the water back and forth would spin these small rocks inside their traps. As they spun around in place, they were scratching the fracture and expanding their trap, thus creating a hole. The bigger the hole got, bigger stones would get trapped in and carve away more material. With time the marble bed and the water got into different levels, however still to this day the waves are able to cover the bed and rocks continue to get trapped and scratch the holes more open.

10.2.13 Komito Gneiss

Komito gneiss has a lot of mica, quartz and feldspar. A former granite which has been metamorphosed at HP. Komito gneiss is a metagranitic K-feldspar-bearing augend gneisses exposed in the south at Komito Bay. Feldspar is a metamorphosed granite. Feldspar is 60% of the earth's crust yet eclogites "choose" not to have it which is very rare. We no longer see the fractures themselves, but just the filling. We would call this a hydrothermal Breccia. A breccia is a rock consisting entirely of angular fragments of another rock. Filled in with some topping here the topping is Tourmaline. If you look in detail, you'll see that there are bits of quartz in there. Erosion has stripped away the gneiss and the big fracture is sticking out. Tourmaline is pretty much found in just this corner of Syros. Tourmaline veins/ breccia inside the Komito gneiss.

10.2.14 Lawsonite blueschist with Greenschist overprint - Foinikas

Lawsonite blueschist with a greenschist overprint. Normally, it should be blue, as lawsonite belongs to the blueschists. Lawsonite is a mineral like epidote garnet, and glaucophane and a rock is made of many minerals, here lawsonite, chlorite some epidote and quartz. The lawsonite really belongs to the blueschist never the greenschist as it stabilizes in HP conditions like glaucophane. But if you retrograde a blueschist to greenschist, you may occasionally preserve the lawsonite. So, usually we have greenschist which forms under LP then it goes into HP deeper into the Earth and becomes a blueschist, and in this case it came back up through LP and retrograded into greenschist.

Now, to tell you the truth, none of this is lawsonite. They are all pseudomorphs after lawsonite. A mineral has a crystalize structure and a chemical composition. If now you look closely you can see that the core is in fact glassy as in the original lawsonite crystal, but all around there are little crystals of mica and quartz. So, they partially preserved the core of an old lawsonite. But most of it gets completely transformed to something else. Usually there is no lawsonite preserved at all. Most of the minerals add up to lawsonite here. A very local reaction got rid of the lawsonite, but kept the morph. So, it's a pseudomorph after all.

10.2.15 Chlorite schist Petroglyphs &Archeological dating

Chlorite schist with something you've never seen before, some very ancient petroglyphs. Chlorite schist is very soft very easy to work, and it does not weather it just stays the same. So, these petroglyphs have not been dated, but there are some indications that they could be as old as 20,000 years. Chlorite does not weather because it's not soluble. Unlike carbonate which dissolves in water chlorite resists all weathering. It's soft and very fine grained, so it stays the way it is and does not dissolve in water. But the chlorite is just on the outside. This body is an eclogite, covered with a thin layer of chlorite. Sometimes it's even a glaucophane schist covered with chlorite and outside of that will be serpentine; the same story as up North. Sometimes you'll see smaller bodies of glaucophane schist here and there all around just to remind us that they are the same as their brothers up North.

10.2.15.1 Petroglyphs.

So many generations of the same thing, patterns, that we are not sure what they might represent, go all the way up the rock. Some ideas suggest that they are astronomical or ritual, as nomadic people moved around and came back at a specific time. It's definitely an evolution of styles, so many generations, not just one.

In archeology context and dating are crucial issues. Normally, to date these petroglyphs archeologists would study by context, since there is no way for a chemical test to provide a creation time span. They wouldn't start the study at a remote place like this, but rather somewhere richer with other findings that can be dated more accurately. For example, in Mesopotamia, there are similar carvings almost exactly the same patterns as these here. So, it must have been a period of time when the mind had started to evolve, not into writing letters or depicting animals and nature scenes, like in Spain and France, but culturally in the eastern part of the Mediterranean it's a stage. In Mesopotamia you have a lot of things, an evolution that can be documented, sometimes with settlements (this is perhaps pre-settlement). So, to do this you have to come back every year, which is possible. It's much too primitive to be at the time of Kastri. Stone tools and great knowhow because they are very refined and clear. So, they must have known what they were doing.

10.2.16 Metaconglomerate

Conglomerate is concentrated at this Northern area of Syros. We know what the rock type can consist of, but the formation process responsible is still an enigma. There are little boulders, and bits and pieces of carbonate, of marble, and sometimes also schist, trapped in a matrix of carbonate. Sometimes the pieces of marble are strung out and deformed, and other times they are perfectly round. How does one make a conglomerate? Well, there is something round, so there must have been a rounding process of the pieces.

The whole mixture is called a conglomerate, or if it has been metamorphosed as in Aspro Pounti it is called a metaconglomerate. It's carbonate within carbonate, with a few bits of schist inside the carbonate matrix. Some of the material here is broken up pieces of schist. These bits of schist are metavolcanics, and these contain a mineral called zircon. Zircon can be dated; thus, we can determine roughly the age of the volcanism that produced this little piece that is now trapped in the marble. So, this piece is about 80.000 years old, because that's how old the volcanism was offshore.

Anything can make up a conglomerate. If you have rounded, coarse grain pieces of material in a fine grain matrix, then you get a conglomerate. This is a carbonate conglomerate imprint with a conglomerate matrix. The purple clasts in the conglomerate that we see here are pieces of manganese epidote which consist of the mineral Piemontite.

10.2.17 Metavolcanic Sandstone

Metavolcanic sandstone sight with Aeolic erosion. Just as we cross the Conglomerate unit, we come upon this sight of metavolcanic rocks. Here we have an erosional surface with a lot of holes. This area of Syros is very exposed to winds. This is basically a structure made of holes. High lateral wind traps small fragments of material and moves them around, carving the surface and forming the holes. These volcanic rocks have been metamorphosed under extreme high pressure beneath the earth's surface for tens of millions of years, and they have been eroded for the past five million years.

At the subduction fault. Here you have pieces of the same material that is at the thrust, out here in the open conglomerate. It must have been grounded up somehow. Inside the fault we see metavolcanic sandstone beds deformed by years of old water flow towards the sea. The fractures are of later deformation, filled with quartz and black chlorite. They are part of the larger fault system that thrusted the two rock units together.

10.3 Geological Term English-Greek Dictionary

Blueschist: Κυανοσχιστόλιθος
Breccia: Λατυποπαγές
Chlorite: Χλωρίτης
Deformation: Παραμόρφωση
Diorite: Διορίτης
Dyke: Φλέβα
Eclogite: Εκλογίτης
Epidote: Επίδοτο
Feldspar: Άστριοι
Foliation: Φολίδωση
Garnet: Γρανάτης
Glaucophane: Γλαυκοφανής
Gneiss: Γνεύσιος
Greenschist: Πρασινοσχιστόλιθος
Igneous rock: Εκρηξιγενές πέτρωμα
Lawsonite: Λωσονίτης
Magma Chamber: Θάλαμος Μάγματος
Magmatic History: Μαγματική ιστορία
Magmatic rock: Μαγματικό πέτρωμα

Marble: Μάρμαρο
Metabasite: Μεταβασικό πέτρωμα
Metamorphic rock: Μεταμορφικό πέτρωμα
Mica: Μαρμαρυγία
Omphacite: Ομφακίτης
Plagioclase: Πλαγιόκλαση
Plutonic rock: Πλουτώνειο πέτρωμα
Precipitation: Υγροποίηση/Κατακρήμνιση
Protolith: Πρωτόλιθος
Pseudomorph: Ψευδομορφικό
Quartz: Χαλαζίας
Schist: Σχιστόλιθος
Serpentinite: Σερπεντινίτης
Serpentine: Οφιοειδής
Sedimentary rock: Ιζηματογενές πέτρωμα
Siderite: Σιδερίτης
Subduction zone: Ζώνη υποβύθησης
Tourmaline: Τουρμαλίνης
Volcanic rock: Ηφαιστειακό πέτρωμα
Zoisite: Ζοϊσίτης

10.4 WPF Application Code

10.4.1 App.xaml

```
<Application x:Class="SyrosGeoMap_8_4_2020.App"
             xmlns="http://schemas.microsoft.com/winfx/2006/xaml/presentation"
             xmlns:x="http://schemas.microsoft.com/winfx/2006/xaml"
             xmlns:local="clr-namespace:SyrosGeoMap_8_4_2020"
             StartupUri="MainWindow.xaml">
    <Application.Resources>
        <Style x:Key="LocationButtonTemplate" TargetType="RadioButton">
            <Setter Property="Background" Value="White"/>
            <Setter Property="Foreground" Value="Black"/>
            <Setter Property="Template">
                <Setter.Value>
                    <ControlTemplate TargetType="RadioButton">
                        <Border CornerRadius="15" Background="{TemplateBinding
Background}" BorderThickness="3">
                            <ContentPresenter HorizontalAlignment="Center"
VerticalAlignment="Center">

                            </ContentPresenter>
                        </Border>
                        <ControlTemplate.Triggers>
                            <Trigger Property="IsMouseOver" Value="True">
                                <Setter Property="Background" Value="#FF64C5E5"/>
                                <Setter Property="BorderBrush" Value="#FF64C5E5"/>
                            </Trigger>
                            <Trigger Property="IsPressed" Value="True">
                                <Setter Property="BorderBrush" Value="#FF64C5E5" />
                                <Setter Property="Background" Value="#FF64C5E5" />
                            </Trigger>
                            <Trigger Property="IsChecked" Value="True">
                                <Setter Property="BorderBrush" Value="#FF64C5E5" />
                                <Setter Property="Background" Value="#FF64C5E5" />
                            </Trigger>
                            <Trigger Property="IsChecked" Value="False">
                                <Setter Property="BorderBrush" Value="White" />
                                <Setter Property="Background" Value="White" />
                            </Trigger>

                        </ControlTemplate.Triggers>
                    </ControlTemplate>
                </Setter.Value>
            </Setter>
        </Style>

    </Application.Resources>
</Application>
```

10.4.2 MainWindow.xaml

```
<Window x:Class="SyrosGeoMap_8_4_2020.MainWindow"
        xmlns="http://schemas.microsoft.com/winfx/2006/xaml/presentation"
        xmlns:x="http://schemas.microsoft.com/winfx/2006/xaml"
        xmlns:d="http://schemas.microsoft.com/expression/blend/2008"
        xmlns:k="http://schemas.microsoft.com/kinect/2014"
        xmlns:mc="http://schemas.openxmlformats.org/markup-compatibility/2006"
        xmlns:local="clr-namespace:SyrosGeoMap_8_4_2020"
        mc:Ignorable="d"
        Title="Syros rocks!" Height="810" Width="1440" Cursor="Hand"
        Loaded="Window_Loaded" Closed="Window_Closed">
<k:KinectRegion x:Name="_kinectRegion" >
        <Grid x:Name="GeneralGrid">
            <Grid.ColumnDefinitions>
                <ColumnDefinition Width="2*" />
                <ColumnDefinition Width="2*" />
                <ColumnDefinition Width="2*" />
            </Grid.ColumnDefinitions>
            <Grid.RowDefinitions>
                <RowDefinition Height="0.7*" />
                <RowDefinition Height="3*"/>
                <RowDefinition Height="3*" />
                <RowDefinition Height="1*" />
            </Grid.RowDefinitions>

            <k:KinectUserViewer Height="100" Grid.Column="1" Grid.Row="0"
                                HorizontalAlignment="Center"
                                VerticalAlignment="Top"
                                Width="80" Margin="10" OpacityMask="#FF2F9708" />

            <TextBlock Text="Syros rocks!" Grid.Row="0" Grid.Column="0"
Grid.ColumnSpan="1"
                       HorizontalAlignment="Center" Foreground="DeepSkyBlue"
FontSize="48" Margin="10"/>

            <Image x:Name="MyBackground" Stretch="UniformToFill" Visibility="Hidden"
                   Opacity="0.35" Grid.ColumnSpan="3" Grid.RowSpan="4" />

            <TextBlock x:Name ="RockUnitName" Grid.Column="0" Grid.Row="3"
Visibility="Hidden" Width="Auto"
                FontSize="36" Foreground="White" FontWeight="Bold" Margin="10"
TextAlignment="Center"
                   TextWrapping="Wrap" HorizontalAlignment="Center"
VerticalAlignment="Center" OpacityMask="Black" >
                <TextBlock.Background>
                    <SolidColorBrush Color="Gray" Opacity="0.5"/>
                </TextBlock.Background>
            </TextBlock>

            <!--<TextBlock Grid.Row="2" Grid.Column="0" Grid.ColumnSpan="1" Margin="10"
FontWeight="Bold" Text="Logo" HorizontalAlignment="left" VerticalAlignment="Center" />-->
            <!-- Created with Ai->XAML Export Plug-In Version 0.3 (PC/64) -->
            <!-- By Mike Swanson (http://blog.mikeswanson.com/)           -->


<!--Full Map is here -->
            <Viewbox x:Name="SyrosGeoMap" Margin="0,10,0,10"  Grid.ColumnSpan="3"
```

```
      Grid.RowSpan="3" Grid.Row="1" Visibility="Visible"
      MouseRightButtonDown="SyrosGeoMap_MouseRightButtonDown"
      xmlns="http://schemas.microsoft.com/winfx/2006/xaml/presentation"
      xmlns:x="http://schemas.microsoft.com/winfx/2006/xaml"
      k:KinectRegion.IsPressTarget="True">
      <Canvas Width="740.502" Height="1184.239" Margin="30" >

HERE WE PLACED IN THE ORIGINAL CODE THE <Canvas> generated in XAML by the open source plugin
for Adobe Illustrator. You will find the full XAML map in paths from page until the end of
the document. It is not included in this section as it is too vast and can confuse anyone
wanting to examine the full code.

<!—this code is inside the first <Canvas> tag that states the width, height, and margin of
the map. This code is placed right after all the paths of the map-->

<RadioButton x:Name="Aerolithos" Click="Aerolithos_Click"  Visibility="Hidden"
Height="45"  Width="Auto"
                            Style="{StaticResource LocationButtonTemplate}"
Canvas.Left="299" Canvas.Top="133" Grid.Row="1" VerticalContentAlignment="Center" >
                        <StackPanel Orientation="Horizontal">
                            <Image Source="Images/icons/pin.png" Stretch="Uniform"/>
                            <TextBlock Text="Aerolithos" FontSize="26"/>
                        </StackPanel>
                    </RadioButton>

                    <RadioButton x:Name="AsproPounti" Click="AsproPounti_Click"
Visibility="Hidden" Height="52"  Width="Auto"
                            Style="{StaticResource LocationButtonTemplate}"
Canvas.Left="163" Canvas.Top="-25" Grid.Row="1" >
                        <StackPanel Orientation="Horizontal">
                            <Image Source="Images/icons/pin.png" Stretch="Uniform"/>
                            <TextBlock Text="Aspro Pounti" FontSize="26"/>
                        </StackPanel>
                    </RadioButton>

                    <RadioButton x:Name="AgiosStefanos" Click="AgiosStefanos_Click"
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Canvas.Top="738" Grid.Row="1" Canvas.Left="26" >
                        <StackPanel Orientation="Horizontal">
                            <Image Source="Images/icons/pin.png" Stretch="Uniform"/>
                            <TextBlock Text="Agios Stefanos" FontSize="26"/>
                        </StackPanel>
                    </RadioButton>

                    <RadioButton x:Name="AnoSyros" Click="AnoSyros_Click"
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                           Style="{StaticResource LocationButtonTemplate}"
Canvas.Left="489" Canvas.Top="443" Grid.Row="1" >
                        <StackPanel Orientation="Horizontal">
                            <Image Source="Images/icons/pin.png" Stretch="Uniform"/>
                            <TextBlock Text="AnoSyros" FontSize="26"/>
                        </StackPanel>
                    </RadioButton>

                    <RadioButton x:Name="Abelaki" Click="Abelaki_Click"
Visibility="Hidden" Height="52" Width="Auto"
```

```
                             Style="{StaticResource LocationButtonTemplate}"
Canvas.Left="570" Canvas.Top="476" Grid.Row="1" >
                         <StackPanel Orientation="Horizontal">
                             <Image Source="Images/icons/pin.png" Stretch="Uniform"/>
                             <TextBlock Text="Abelaki" FontSize="26"/>
                         </StackPanel>
                     </RadioButton>

                     <RadioButton x:Name="Fabrika" Click="Fabrika_Click"
Visibility="Hidden" Height="52" Width="Auto"
                             Style="{StaticResource LocationButtonTemplate}"
Canvas.Left="600" Canvas.Top="901" Grid.Row="1" >
                         <StackPanel Orientation="Horizontal">
                             <Image Source="Images/icons/pin.png" Stretch="Uniform"/>
                             <TextBlock Text="Fabrika" FontSize="26"/>
                         </StackPanel>
                     </RadioButton>

                     <RadioButton x:Name="Foinikas" Click="Foinikas_Click"
Visibility="Hidden" Height="52" Width="Auto"
                            Style="{StaticResource LocationButtonTemplate}"
Canvas.Left="162" Canvas.Top="888" Grid.Row="1" >
                         <StackPanel Orientation="Horizontal">
                             <Image Source="Images/icons/pin.png" Stretch="Uniform"/>
                             <TextBlock Text="Foinikas" FontSize="26"/>
                         </StackPanel>
                     </RadioButton>

                     <RadioButton x:Name="GriaPounta" Click="GriaPounta_Click"
Visibility="Hidden" Height="45" Width="Auto"
                             Style="{StaticResource LocationButtonTemplate}"
Canvas.Left="694" Canvas.Top="834" Grid.Row="1" >
                         <StackPanel Orientation="Horizontal">
                             <Image Source="Images/icons/pin.png" Stretch="Uniform"/>
                             <TextBlock Text="Gria Pounta" FontSize="26"/>
                         </StackPanel>
                     </RadioButton>

                     <RadioButton x:Name="Kampos" Click="Kampos_Click" Visibility="Hidden"
Height="45" Width="Auto"
                              Style="{StaticResource LocationButtonTemplate}"
Canvas.Left="407" Canvas.Top="152" Grid.Row="1" >
                         <StackPanel Orientation="Horizontal">
                             <Image Source="Images/icons/pin.png" Stretch="Uniform"/>
                             <TextBlock Text="Kampos" FontSize="26"/>
                         </StackPanel>
                     </RadioButton>

                     <RadioButton x:Name="Komito" Click="Komito_Click" Visibility="Hidden"
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                              Style="{StaticResource LocationButtonTemplate}"
Canvas.Left="133" Canvas.Top="1039" Grid.Row="1" >
                         <StackPanel Orientation="Horizontal">
                             <Image Source="Images/icons/pin.png" Stretch="Uniform"/>
                             <TextBlock Text="Komito" FontSize="26"/>
                         </StackPanel>
                     </RadioButton>
```

```
                    <RadioButton x:Name="Lakkoi" Click="Lakkoi_Click" Visibility="Hidden"
Height="45" Width="Auto"
                             Style="{StaticResource LocationButtonTemplate}"
Canvas.Left="106" Canvas.Top="624" Grid.Row="1" >
                        <StackPanel Orientation="Horizontal">
                            <Image Source="Images/icons/pin.png" Stretch="Uniform"/>
                            <TextBlock Text="Lakkoi" FontSize="26"/>
                        </StackPanel>
                    </RadioButton>

                    <RadioButton x:Name="Lia" Click="Lia_Click" Visibility="Hidden"
Height="45" Width="Auto"
                             Style="{StaticResource LocationButtonTemplate}"
Canvas.Left="290" Canvas.Top="168" Grid.Row="1" >
                        <StackPanel Orientation="Horizontal">
                            <Image Source="Images/icons/pin.png" Stretch="Uniform"
Opacity="1"/>
                            <TextBlock Text="Lia " FontSize="26"/>
                        </StackPanel>
                    </RadioButton>

                    <RadioButton x:Name="Marmari" Click="Marmari_Click"
Visibility="Hidden" Height="52" Width="Auto"
                            Style="{StaticResource LocationButtonTemplate}"
Canvas.Left="306" Canvas.Top="77" Grid.Row="1" >
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                            <Image Source="Images/icons/pin.png" Stretch="Uniform"/>
                            <TextBlock Text="Marmari" FontSize="26"/>
                        </StackPanel>
                    </RadioButton>

                    <RadioButton x:Name="MavroPounti" Click="MavroPounti_Click"
Visibility="Hidden" Height="52" Width="Auto"
                            Style="{StaticResource LocationButtonTemplate}"
Canvas.Left="169" Canvas.Top="-31" Grid.Row="1" >
                        <StackPanel Orientation="Horizontal">
                            <Image Source="Images/icons/pin.png" Stretch="Uniform"/>
                            <TextBlock Text="Mavro Pounti" FontSize="26"/>
                        </StackPanel>
                    </RadioButton>

                    <RadioButton x:Name="MegasGialos" Click="MegasGialos_Click"
Visibility="Hidden" Height="52" Width="Auto"
                            Style="{StaticResource LocationButtonTemplate}"
Canvas.Left="324" Canvas.Top="970" Grid.Row="1" >
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                            <Image Source="Images/icons/pin.png" Stretch="Uniform"/>
                            <TextBlock Text="Megas Gialos" FontSize="26"/>
                        </StackPanel>
                    </RadioButton>

                    <RadioButton x:Name="Vari" Click="Vari_Click" Visibility="Hidden"
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                            Style="{StaticResource LocationButtonTemplate}"
Canvas.Left="542" Canvas.Top="845" Grid.Row="1" >
                        <StackPanel Orientation="Horizontal">
                            <Image Source="Images/icons/pin.png" Stretch="Uniform"/>
                            <TextBlock Text="Kampos" FontSize="26"/>
```

```
                        </StackPanel>
                    </RadioButton>
                </Canvas>
            </Viewbox>
<!--IMAGE GALLERY-->

            <StackPanel x:Name="ImageViewerPanel"  Grid.Column="1" Grid.ColumnSpan="2"
                        Grid.Row="1" Grid.RowSpan="3" Visibility="Hidden">

                <Grid Height="Auto" Margin="0,0,0,0">
                    <Grid.ColumnDefinitions>
                        <ColumnDefinition Width="10*" />
                        <ColumnDefinition Width="1*" />
                    </Grid.ColumnDefinitions>
                    <Grid.RowDefinitions>
                        <RowDefinition Height="10*" MinHeight="630" />
                        <RowDefinition Height="2*" MinHeight="60" />
                        <RowDefinition Height="1*" MinHeight="100" />
                    </Grid.RowDefinitions>

                    <StackPanel VerticalAlignment="Center" HorizontalAlignment="Center"
Grid.Row="0" Grid.RowSpan="2" Grid.ColumnSpan="2" Height="Auto" Width="Auto">

                        <!-- Add the first (or selected) image enlarged in the centre-->
                        <Image x:Name="ImageViewer" Stretch="Fill"
Source="Images/Abelaki/Abelaki2.jpg" MaxHeight="660" Width="Auto"/>
                    </StackPanel>
                    <StackPanel Grid.Row="1" MaxHeight="120" MaxWidth="600" Margin="40, -
40" HorizontalAlignment="Left">
                        <TextBlock x:Name="RockPhotoTitle" TextWrapping="Wrap" Text="Here
goes the title" FontSize="18" FontWeight="Bold" Foreground="White">
                            <TextBlock.Background>
                                <SolidColorBrush Color="DarkGray" Opacity="0.6"/>
                            </TextBlock.Background>
                        </TextBlock>
                        <TextBlock x:Name="RockPhotoSubTitle" TextWrapping="Wrap"
Text="Here goes the subtitle" FontSize="30" FontWeight="Bold" Foreground="White">
                            <TextBlock.Background>
                                <SolidColorBrush Color="DarkGray" Opacity="0.6"/>
                            </TextBlock.Background>
                        </TextBlock>
                    </StackPanel>

                    <StackPanel Grid.Row="2" MaxHeight="160" HorizontalAlignment="Left"
Margin="10,10,0,10" Grid.ColumnSpan="3" Orientation="Horizontal">
                        <TextBlock x:Name="RockInfo" TextWrapping="Wrap"
HorizontalAlignment="Left" VerticalAlignment="Center" FontSize="18" Width="1000"
                                   Text="Fabrika has been intensly deformed. Faults
(fractures) formed due to episodic tectonic movements. Such features have been related to
seismicity (earthquakes). The photo shows a system of fractures that cut through beds of
light-colored marble. Some fractures are filled with siderite, a rust-colored mineral
(iron carbonate) "  />
                        <Image x:Name="LocationInMuseum"
Source="Images/icons/ExhibitionLegent-01.png" Width="Auto" Height="Auto" Stretch="Fill"
Margin="10"/>
                    </StackPanel>
```

```xml
                    <StackPanel Orientation="Vertical" VerticalAlignment="Center"
Margin="0,0,0,0" Grid.Row="0" Grid.Column="2"
                            Grid.RowSpan="2" Width="Auto">
                        <StackPanel.Background>
                            <SolidColorBrush Color="White" Opacity="0.5"/>
                        </StackPanel.Background>

<!--Add 8 images in a row-->
                        <Border x:Name="BorderThumbNail1" BorderBrush="White"
BorderThickness="2">
                            <Image x:Name="ThumbNail1"
Source="Images/Abelaki/Abelaki1.jpg" Stretch="Fill"
                               MouseDown="ThumbNail_MouseDown" Margin="10,10,10,10"
                            RenderTransformOrigin="0.5,0.5" Width="100" Height="60"
                               MouseEnter="ThumbNail_MouseEnter"
MouseLeave="ThumbNail_MouseLeave" />
                        </Border>
                        <Border x:Name="BorderThumbNail2" BorderBrush="White"
BorderThickness="2">
                            <Image x:Name="ThumbNail2"
Source="Images/Abelaki/Abelaki1.jpg" Stretch="Fill"
                               MouseDown="ThumbNail_MouseDown" Margin="10,10,10,10"
                           RenderTransformOrigin="0.5,0.5" Width="100" Height="60"
                               MouseEnter="ThumbNail_MouseEnter"
MouseLeave="ThumbNail_MouseLeave"/>
                        </Border>
                        <Border x:Name="BorderThumbNail3" BorderBrush="White"
BorderThickness="2">
                            <Image x:Name="ThumbNail3"
Source="Images/Abelaki/Abelaki1.jpg" Stretch="Fill"
                               MouseDown="ThumbNail_MouseDown" Margin="10,10,10,10"
                           RenderTransformOrigin="0.5,0.5" Width="100" Height="60"
                               MouseEnter="ThumbNail_MouseEnter"
MouseLeave="ThumbNail_MouseLeave"/>
                        </Border>
                        <Border x:Name="BorderThumbNail4" BorderBrush="White"
BorderThickness="2">
                            <Image x:Name="ThumbNail4"
Source="Images/Abelaki/Abelaki1.jpg" Stretch="Fill"
                               MouseDown="ThumbNail_MouseDown" Margin="10,10,10,10"
                           RenderTransformOrigin="0.5,0.5" Width="100" Height="60"
                               MouseEnter="ThumbNail_MouseEnter"
MouseLeave="ThumbNail_MouseLeave"/>
                        </Border>
                        <Border x:Name="BorderThumbNail5" BorderBrush="White"
BorderThickness="2">
                            <Image x:Name="ThumbNail5"
Source="Images/Abelaki/Abelaki1.jpg" Stretch="Fill"
                               MouseDown="ThumbNail_MouseDown" Margin="10,10,10,10"
                           RenderTransformOrigin="0.5,0.5" Width="100" Height="60"
                               MouseEnter="ThumbNail_MouseEnter"
MouseLeave="ThumbNail_MouseLeave"/>
                        </Border>
                        <Border x:Name="BorderThumbNail6" BorderBrush="White"
BorderThickness="2">
                            <Image x:Name="ThumbNail6"
Source="Images/Abelaki/Abelaki1.jpg" Stretch="Fill"
                               MouseDown="ThumbNail_MouseDown" Margin="10,10,10,10"
```

```
                            RenderTransformOrigin="0.5,0.5" Width="100" Height="60"
                                MouseEnter="ThumbNail_MouseEnter"
MouseLeave="ThumbNail_MouseLeave"/>
                        </Border>
                        <Border x:Name="BorderThumbNail7" BorderBrush="White"
BorderThickness="2">
                            <Image x:Name="ThumbNail7"
Source="Images/Abelaki/Abelaki1.jpg" Stretch="Fill"
                                MouseDown="ThumbNail_MouseDown" Margin="10,10,10,10"
                            RenderTransformOrigin="0.5,0.5" Width="100" Height="60"
                                MouseEnter="ThumbNail_MouseEnter"
MouseLeave="ThumbNail_MouseLeave"/>
                        </Border>
                        <Border x:Name="BorderThumbNail8" BorderBrush="White"
BorderThickness="2">
                            <Image x:Name="ThumbNail8"
Source="Images/Abelaki/Abelaki1.jpg" Stretch="Fill"
                                MouseDown="ThumbNail_MouseDown" Margin="10,10,10,10"
                            RenderTransformOrigin="0.5,0.5" Width="100" Height="60"
                                MouseEnter="ThumbNail_MouseEnter"
MouseLeave="ThumbNail_MouseLeave"/>
                        </Border>
                    </StackPanel>
                </Grid>
            </StackPanel>


        </Grid>
    </k:KinectRegion>
</Window>
```

10.5 Class - RockInfo.cs

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using System.Threading.Tasks;

namespace SyrosGeoMap_8_4_2020
{
    class RockInfo
    {
        public string imageName;
        public string imageTitle;
        public string imageSubTitle;
        public string imageDescription;
        public string locationInMuseum;
        /*
        public RockInfo(string name, string infotxt)
        {
            this.imageName = name;
            this.imageDescription = infotxt;
            this.imageTitle = null;
        }
        */
        public RockInfo(string name, string imageTitle, string imageSubtitle, string
locationInMuseum, string infotxt)
        {
            this.imageName = name;
            this.imageDescription = infotxt;
            this.imageTitle = imageTitle;
            this.imageSubTitle = imageSubtitle;
            this.locationInMuseum = locationInMuseum;
        }
    }
}
```

10.5.1 MainWindow.xaml.cs

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using System.Threading.Tasks;
using System.Windows;
using System.Windows.Controls;
using System.Windows.Data;
using System.Windows.Documents;
using System.Windows.Input;
using System.Windows.Media;
using System.Windows.Media.Imaging;
using System.Windows.Navigation;
using System.Windows.Shapes;

using Microsoft.Kinect;
using Microsoft.Kinect.Wpf.Controls;
using Microsoft.Kinect.VisualGestureBuilder;
using Microsoft.Kinect.Input;

namespace SyrosGeoMap_8_4_2020
{
  /// <summary>
  /// Interaction logic for MainWindow.xaml
  /// </summary>
  public partial class MainWindow : Window
  {
    // constants
    public const String COLOR_OF_ROCK_VARI_GNEISS = "#FFF1D7BF";
    public const String COLOR_OF_ROCK_KOMITO_GNEISS = "#FFEDDFDA";
    public const String COLOR_OF_ROCK_CONGLOMERATE = "#FFF6F3F8";
    public const String COLOR_OF_ROCK_METABASITE = "#FF94C4CD";
    public const String COLOR_OF_ROCK_GREENSCHIST = "#FFC7E1D7";
    public const String COLOR_OF_ROCK_QUATERNARY_DEPOSITS = "#FFF9F8E6";
    public const String COLOR_OF_ROCK_METASEDIMENTARY_MICASCHIST = "#FFD0CFD1";
    public const String COLOR_OF_ROCK_ALT_MICASCHIST_MARBLE = "#FFE8E9E9";
    public const String COLOR_OF_ROCK_MARBLE = "#FFD8EEF9";
    public const String COLOR_OF_ROCK_MYLONITIC_GREENSCHIST = "#FFF1C2A2";

    List<RockInfo> RockInfoCollection = new List<RockInfo>();

    // Kinect variables
    KinectSensor _sensor = null;
```

```
Body[] _bodies;
BodyFrameReader _bodyReader;
//Double CONFIDENCE_THRESHOLD = 0.65;

public MainWindow()
{
  InitializeComponent();
  KinectRegion.SetKinectRegion(this, _kinectRegion);
  App app = ((App)Application.Current);

  _kinectRegion.KinectSensor = KinectSensor.GetDefault();
  //_kinectRegion.InputPointerManager.CompleteGestures();
  InitializeContent();
}
///////////////////////////
/// kinect functionality ///
//Event when the window opens
private void Window_Loaded(object sender, RoutedEventArgs e) {
  this.OpenSensor();
  //this.OpenBodyReader();
  this.SetupKinectUserViewer();
}

private void OpenSensor() {
  _sensor = KinectSensor.GetDefault();

  if (_sensor != null) {
    _sensor.Open();
  }
}

//Event when the window is closed
private void Window_Closed(object sender, EventArgs e) {
  if (this._sensor != null) {
    this._sensor.Close();
    this._sensor = null;
  }
}

private void OpenBodyReader() {
  if (this._bodies == null) {
    this._bodies = new Body[this._sensor.BodyFrameSource.BodyCount];
  }
```

```
        this._bodyReader = this._sensor.BodyFrameSource.OpenReader();

        //Event triggered for every time a frame is arrived
        this._bodyReader.FrameArrived += _bodyReader_FrameArrived;
    }

    // ---> trigered from OpenBodyReader() method
    //Event from every body frame arrived
    private void _bodyReader_FrameArrived(object sender, BodyFrameArrivedEventArgs e)
    {
        using (var frame = e.FrameReference.AcquireFrame())
        {
            if (frame != null)
            {
                frame.GetAndRefreshBodyData(this._bodies);
                var _trackedBody = this._bodies.Where(b => b.IsTracked).FirstOrDefault();

                if (_trackedBody != null)
                {
                    Joint handRight = _trackedBody.Joints[JointType.HandRight];
                    //_kinectRegion.InputPointerManager.HandlePointerAsCursor(handRight.Position            as
KinectPointerPoint, null);
                }
                else
                {
                    this._gestureSource_TrackingIdLost(null, null);
                }
            }
        }
    }

    private void _gestureSource_TrackingIdLost(object sender, TrackingIdLostEventArgs e)
    {
        //do anything else UI related ...
        //...
    }

    private void SetupKinectUserViewer() {
        KinectRegion.SetKinectRegion(this, _kinectRegion);
    }



    /// Content Functionality ///
```

```
////////////////////////////
public void InitializeContent() {

    //Εδώ είναι τα κείμενα που αναγράφονται σε κάθε φωτογραφία
    //Ανά τοποθεσία όπως στη σειρά φωτογραφικών φακέλων (Από Aerolithos ως Vari)

    RockInfo Aerolithos1 = new RockInfo("Aerolithos1", "Aerolithos", "Eclogite body in an open field", "/Images/icons/ExhibitionLegent-01.png",
        "Local folclore wants Aerolithos to be a body of rock that fell from the sky. In truth, it is a massive Eclogite body that comes up from the Earth's Mantle. Eclogites are high-pressure metamorphic rocks which lack a typical mineral of the Earth's crust, Feldspar.");
    RockInfo Aerolithos2 = new RockInfo("Aerolithos2", "Aerolithos", "Eclogite origins", "/Images/icons/ExhibitionLegent-01.png",
        "Eclogites derive from Basic igneous rocks (high pH). Thus, a gabbro or a basalt were metamorphosed into eclogites, as they were moving towards the Earth's surface.");
    RockInfo Aerolithos3 = new RockInfo("Aerolithos3", "Aerolithos", "Examining the surface", "/Images/icons/ExhibitionLegent-01.png",
        "During metamorphism, high-pressure fluids reacted with the rock's minerals (omphacite and garnet) and produced glaucophane. The layers of glaucophane that cover Aerolithos are where that reaction took place.");
    RockInfo Aerolithos4 = new RockInfo("Aerolithos4", "Aerolithos", "Close up of the surface minerals", "/Images/icons/ExhibitionLegent-01.png",
        "The glaucophane layers are rick in iron, thus giving a dark blue color. High-pressure fluids can only flow around the lense, not penetrate the rock. Thus, glaucophane is only found at the surface of Aerolithos, not the inside. ");
    RockInfo Aerolithos5 = new RockInfo("Aerolithos5", "Aerolithos", "View from below", "/Images/icons/ExhibitionLegent-01.png",
        "All lenses around Aerolithos are eclogites. They were all part of the same body, but due to tectonic movements they broke off and spread down the valley. The eclogite bodies sit on a chlorite-serpentinite schist matrix.");
    RockInfo Aerolithos6 = new RockInfo("Aerolithos6", "Aerolithos", "Siderite overprint", "/Images/icons/ExhibitionLegent-01.png",
        "Eclogite lens also has a Siderite overprint (orange layer). The red mineral observed is iron carbonate, thus as it gets exposed to oxygen it ''rusts''.");
    RockInfo Aerolithos7 = new RockInfo("Aerolithos7", "Aerolithos", "Closeup of the skin texture", "/Images/icons/ExhibitionLegent-01.png",
        "The glaucophane layers of Aerolithos are  veins of hydration around the body of eclogite. Multiple veins make up a multilayered skin of minerals around Aerolithos. ");

    RockInfoCollection.Add(Aerolithos1);
    RockInfoCollection.Add(Aerolithos2);
    RockInfoCollection.Add(Aerolithos3);
    RockInfoCollection.Add(Aerolithos4);
    RockInfoCollection.Add(Aerolithos5);
```

```
        RockInfoCollection.Add(Aerolithos6);
        RockInfoCollection.Add(Aerolithos7);
        //////////////////////////////////////////////////////////////////////

        RockInfo AsproPounti1 = new RockInfo("AsproPounti1", "Aspro Pounti ", "Conglomerate hillside", "/Images/icons/ExhibitionLegent-01.png",
            "Conglomerate is concentrated at the northern tip of Syros. It is a high-pressure rock type with coarse-grained marble pieces (centimeter-size) floating within a fine-grained matrix of impure marble. ");
        RockInfo AsproPounti2 = new RockInfo("AsproPounti2", "Aspro Pounti ", "Conglomerate Mixture", "/Images/icons/ExhibitionLegent-01.png",
            "The whole mixture is called a conglomerate. In the present case, it's mostly carbonate within carbonate, but locally the fragments are made of schist, and inside the carbonate matrix there is mica. ");
        RockInfo AsproPounti3 = new RockInfo("AsproPounti3", "Aspro Pounti ", "Composition", "/Images/icons/ExhibitionLegent-01.png",
            "A conglomerate is a rock type consisting of two parts: More or less rounded pieces of rock (of any type) are surrounded by a matrix (of another type), typically with a grain size much smaller than the rounded fragments. ");
        RockInfo AsproPounti4 = new RockInfo("AsproPounti4", "Aspro Pounti ", "Schist in Marble", "/Images/icons/ExhibitionLegent-01.png",
            "Here bits of schist, most likely metavolcanics, are included in the matrix among the marble components.");
        RockInfo AsproPounti5 = new RockInfo("AsproPounti5", "Aspro Pounti ", "Piemontite", "/Images/icons/ExhibitionLegent-01.png",
            "Scattered purple clasts in the conglomerate are manganese-rich fragments containing the mineral piemontite (manganese- epidote).");
        RockInfo AsproPounti6 = new RockInfo("AsproPounti6", "Aspro Pounti ", "Unit thrusting", "/Images/icons/ExhibitionLegent-01.png",
            "The conglomerate unit is part of a meta-sedimentary complex, but its origin is not well understood. It may represent a submarine landslide or it may have been tectonically created in the accretionary wedge of a subducting plate, beneath the overlying metavolcanic rocks (now on top).");
        RockInfo AsproPounti7 = new RockInfo("AsproPounti7", "Aspro Pounti ", "Fault between Units", "/Images/icons/ExhibitionLegent-01.png",
            "Across from the fault, starts a completely different unit with metavolcanic sandstones. The entire package is crosscut by steep fractures. ");
        RockInfo AsproPounti8 = new RockInfo("AsproPounti8", "Aspro Pounti ", "Inside the Fault", "/Images/icons/ExhibitionLegent-01.png",
            "Along such a fault, water rushing down to the sea has incised a spectacular channel, eroding the almost vertical flanks.  ");

        RockInfoCollection.Add(AsproPounti1);
        RockInfoCollection.Add(AsproPounti2);
        RockInfoCollection.Add(AsproPounti3);
        RockInfoCollection.Add(AsproPounti4);
        RockInfoCollection.Add(AsproPounti5);
```

```
        RockInfoCollection.Add(AsproPounti6);
        RockInfoCollection.Add(AsproPounti7);
        RockInfoCollection.Add(AsproPounti8);

        /////////////////////////////////////////////////////////////

        RockInfo AgiosStefanos1 = new RockInfo("AgiosStefanos1", "Agios Stefanos", "Path to Agios Stefanos", "/Images/icons/ExhibitionLegent-01.png",
            "Agios Stefanos is accessible from the top of the hill via a hiking path. The mountain is closing in forming a cave at the level of the sea.");
        RockInfo AgiosStefanos2 = new RockInfo("AgiosStefanos2", "Agios Stefanos", "Marble cave", "/Images/icons/ExhibitionLegent-01.png",
            "The area is dominated by pure and impure marble bodies of all sizes. Tectonic movement has deformed the cave and broke up the large rock bodies, bringing together the impure and pure marbles. ");
        RockInfo AgiosStefanos3 = new RockInfo("AgiosStefanos3", "Agios Stefanos", "A cave hosting a church", "/Images/icons/ExhibitionLegent-01.png",
            "The cave hosts a small church in honor of Saint Stefanos. Marble bands over and under the church differ slightly in composition and deformation intensity.");
        RockInfo AgiosStefanos4 = new RockInfo("AgiosStefanos4", "Agios Stefanos", "Church of St. Stefanos built into the rock", "/Images/icons/ExhibitionLegent-01.png",
            "Legent has it that a fisherman was saved by Saint Stefanos while fighting for his life with a giant squid. The fisherman found refuge in this cave and built the church in honor of his savior saint.");
        RockInfo AgiosStefanos5 = new RockInfo("AgiosStefanos5", "Agios Stefanos", "Marble detail", "/Images/icons/ExhibitionLegent-01.png",
            "The cave falls at a shear zone between marble and schist rocks. It is made up of pure (white) and impure (non-white) marbles, while on the outside (background) the ground is a matrix of schists covered with vegetation. ");
        RockInfo AgiosStefanos6 = new RockInfo("AgiosStefanos6", "Agios Stefanos", "Marble detail", "/Images/icons/ExhibitionLegent-01.png",
            "Marble is a soft mineral which flows easily when in the right temperatures. It has a high plasticity and can be easily deformmed, creating a liquid-looking texture when cooled down.");

        RockInfoCollection.Add(AgiosStefanos1);
        RockInfoCollection.Add(AgiosStefanos2);
        RockInfoCollection.Add(AgiosStefanos3);
        RockInfoCollection.Add(AgiosStefanos4);
        RockInfoCollection.Add(AgiosStefanos5);
        RockInfoCollection.Add(AgiosStefanos6);
        //////////////////////////////////////////////////////////////

        RockInfo AnoSyros1 = new RockInfo("AnoSyros1", "Ano Syros", "Path to Pigi", "/Images/icons/ExhibitionLegent-01.png",
```

```
		"From Ano Syros starts the path to Pigi. Schists are constantly interchanging with Marble beds. Vegetation is rich over the schists, thus only marble is visible from affar.  ");
	RockInfo AnoSyros2 = new RockInfo("AnoSyros2", "Ano Syros", "Path to Pigi", "/Images/icons/ExhibitionLegent-01.png",
		"Marble is a hard rock for vegetation to grow, and does not provide the right minerals. Schists are soft metamorphic rocks, rich in potasium, providing a good environment for plants to grow. ");
	RockInfo AnoSyros3 = new RockInfo("AnoSyros3", "Pigi", "Deformed blueschist-eclogite contact", "/Images/icons/ExhibitionLegent-01.png",
		"Along the path to Pigi there are blueschists (or else glaucophane schists).");
	RockInfo AnoSyros4 = new RockInfo("AnoSyros4", "Pigi", "Omphacite lense in blueschist", "/Images/icons/ExhibitionLegent-01.png",
		"Shown here is a folded lens of omphacite-zoisite (green) in glaucophane schist (blue surrounding), bearing grains of garnet (red-brown mineral at bottom of omphacite).");
	RockInfo AnoSyros5 = new RockInfo("AnoSyros5", "Pigi", "Banded marble", "/Images/icons/ExhibitionLegent-01.png",
		"Shown here are strongly folded marble bands. Marble is a soft mineral, capable of bending and flowing under the right conditions of metamorphism and deformation.");
	RockInfo AnoSyros6 = new RockInfo("AnoSyros6", "Ano Syros", "Layered rock types", "/Images/icons/ExhibitionLegent-01.png",
		"Over the Pigi path, varius schist interchange with layers of marble. Greenschist (weathering purple) within grey marble, topped by light marble. The colours are  strong due to intense weathering.");
	RockInfo AnoSyros7 = new RockInfo("AnoSyros7", "Ano Syros", "Greenschist-Marble mergence", "/Images/icons/ExhibitionLegent-01.png",
		"The greenschist and the striped marble are interlayered due to intense semi-brittle deformation.");

	RockInfoCollection.Add(AnoSyros1);
	RockInfoCollection.Add(AnoSyros2);
	RockInfoCollection.Add(AnoSyros3);
	RockInfoCollection.Add(AnoSyros4);
	RockInfoCollection.Add(AnoSyros5);
	RockInfoCollection.Add(AnoSyros6);
	RockInfoCollection.Add(AnoSyros7);
	////////////////////////////////////////////////////////////

	RockInfo Abelaki1 = new RockInfo("Abelaki1", "Abelaki", "High pressure rocks", "/Images/icons/ExhibitionLegent-01.png",
		"Abelaki is a beach made up of meta-volcanic rocks. These had originally formed at the ocean floor, but when tectonic plates collided, one plate was pushed down into the Earth. There, rocks were transformed at very high pressure. ");
	RockInfo Abelaki2 = new RockInfo("Abelaki2", "Abelaki", "A beach of blueschists", "/Images/icons/ExhibitionLegent-01.png",
```

```
"Large bodies of blue-shaded rocks stand out the field. When these rocks were metamorphosed, old minerals were replaced by new ones. One of these is the blue mineral glaucophane, which is very abundant in these rocks called blueschist.");
RockInfo Abelaki3 = new RockInfo("Abelaki3", "Abelaki", "Epidote Blueschist", "/Images/icons/ExhibitionLegent-01.png",
"This body is a bright epidote-blueschist with tight folds, a typical deformation feature. The body is inhomogeneous, featuring two varieties of glaucophane that differ in composition: The dark blue one is rich in iron, whereas the lighter blue glaucophane is rich in magnesium. ");
RockInfo Abelaki4 = new RockInfo("Abelaki4", "Abelaki", "Quartz veins", "/Images/icons/ExhibitionLegent-01.png",
"Folds in dark blueschist that are torn apart by a series of fractures. These fractures cross all other structural features, so they were created very late, while the rock was on its way up from depth to the Earth's surface. The cracks are partly filled with fibers of quartz. These grew along the walls of the fractures as space opened up, allowing access to circulating hot solutions. ");
RockInfo Abelaki5 = new RockInfo("Abelaki5", "Abelaki", "Layer deformation", "/Images/icons/ExhibitionLegent-01.png",
"During high pressure metamorphism, layers of rigid material cannot deform plastically, so they break. Other layers can flow more easily. Here, a layer of eclogite has was fractured, and elipsoid clasts are trapped between glaucophane layers.  ");
RockInfo Abelaki6 = new RockInfo("Abelaki6", "Abelaki", "Eclogite clasts", "/Images/icons/ExhibitionLegent-01.png",
"Eclogite clasts contain small grains of garnet, a reddish-brown mineral.");
RockInfo Abelaki7 = new RockInfo("Abelaki7", "Abelaki", "Clast of high-pressure minerals", "/Images/icons/ExhibitionLegent-01.png",
"Glaucophane turns extremely dark when it is rich in iron. The white concentrated mass contains lawsonite, garnet (dark brown) and white mica (shiny silvery).");
RockInfo Abelaki8 = new RockInfo("Abelaki8", "Abelaki", "Lawsonite Blueschist", "/Images/icons/ExhibitionLegent-01.png",
"Blueschists sometimes include characteristic grains of a white, rhombohedral mineral called lawsonite. This mineral is typically found only in high-pressure rocks metamorphosed at  relatively low temperature. ");

RockInfoCollection.Add(Abelaki1);
RockInfoCollection.Add(Abelaki2);
RockInfoCollection.Add(Abelaki3);
RockInfoCollection.Add(Abelaki4);
RockInfoCollection.Add(Abelaki5);
RockInfoCollection.Add(Abelaki6);
RockInfoCollection.Add(Abelaki7);
RockInfoCollection.Add(Abelaki8);

/////////////////////////////////////////////////////////////
```

```
RockInfo Fabrika1 = new RockInfo("Fabrika1", "Fabrika", "Marble and Siderite", "/Images/icons/ExhibitionLegent-01.png",
        "Fabrika has been intensly deformed. Faults (fractures) formed due to episodic tectonic movements. Such features have been related to seismicity (earthquakes). The photo shows a system of fractures that cut through beds of light-colored marble. Some fractures are filled with siderite, a rust-colored mineral (iron carbonate) ");
RockInfo Fabrika2 = new RockInfo("Fabrika2", "Fabrika", "Fractures and Holes", "/Images/icons/ExhibitionLegent-01.png",
        "Small veins of siderite occur in marble, they are related to the larger fracture (above). As fracturing happened repeatedly, a system of filled veins developed. Here the Marble shows potholes and small siderite fracture fillings.");
RockInfo Fabrika3 = new RockInfo("Fabrika3", "Fabrika", "Erotion on Marble bed", "/Images/icons/ExhibitionLegent-01.png",
        "Potholes were created by mechanical erosion: As waves kept breaking over the marble beds, small rocks got carried into fractures where they got trapped. Water movement kept such rocks spinning inside their traps, which were slowly enlarged due to grinding along the walls. Thus the holes grew in diameter and depth.");
RockInfo Fabrika4 = new RockInfo("Fabrika4", "Fabrika", "Deformed Eclogite", "/Images/icons/ExhibitionLegent-01.png",
        "In Fabrika we find a heterogeneous mix of high-pressure rocks, including eclogites and various types of marble. Earthquakes and brittle deformation did not spare even very strong rocks, eclogites were also fractured and fragmented. ");
RockInfo Fabrika5 = new RockInfo("Fabrika5", "Fabrika", "Deformed Eclogite", "/Images/icons/ExhibitionLegent-01.png",
        "The bright green eclogite has been ruptured in the same way as the Marble. The fractures are filled with siderite as well, creating a colourful vein system throughout the rock. Such brittle fracturing often happened at late stages of deformation.");
RockInfo Fabrika6 = new RockInfo("Fabrika6", "Fabrika", "Eclogite with Marble overprint", "/Images/icons/ExhibitionLegent-01.png",
        "At earlier stages of deformation, while the rocks were still hotter and at greater depth, marble could still be plastically deformed. Here it got wrapped around a small fragment of eclogite, protecting the eclogite from further deformation and hydration. So it remained unchanged eclogite, immersed as a 'bean' in the marble 'soup'.");

RockInfoCollection.Add(Fabrika1);
RockInfoCollection.Add(Fabrika2);
RockInfoCollection.Add(Fabrika3);
RockInfoCollection.Add(Fabrika4);
RockInfoCollection.Add(Fabrika5);
RockInfoCollection.Add(Fabrika6);
////////////////////////////////////////////////////////////

RockInfo Foinikas1 = new RockInfo("Foinikas1", "Foinikas", "Lawsonite blueschist with greenschist overprint", "/Images/icons/ExhibitionLegent-01.png",
```

"A path of lawsonite blueschists sits next to the Foinikas port. Lawsonite is a mineral that forms at relatively low temperatures but only under high pressure conditions. Here lawsonite grew in blueschists, so these rock bodies would be expected to be blue. ");

RockInfo Foinikas2 = new RockInfo("Foinikas2", "Foinikas", "High to low pressure retrogression", "/Images/icons/ExhibitionLegent-01.png",

"The green color is due to a partial greenschist overprint, which happened under lower pressures. So these rocks show a transition from high-pressure blueschist to greenschist, in which lawsonite (the high pressure mineral) was preserved.");

RockInfo Foinikas3 = new RockInfo("Foinikas3", "Foinikas", "Retrogression process", "/Images/icons/ExhibitionLegent-01.png",

"Such a transition can occur at two stages: First, rocks that formed as greenschists under low pressures may be subducted deeper into the Earth and transform to blueschist. Then, if they are brought back up to lower pressures again, they may retrograde to greenschist. This is what to the rocks seen here!");

RockInfo Foinikas4 = new RockInfo("Foinikas4", "Foinikas", "Pseudomorphs", "/Images/icons/ExhibitionLegent-01.png",

"Lawsonite once formed at high pressures often does not survive retrogression. As such high-pressure minerals become unstable, they can break down and be replaced by new minerals. Sometimes these grow in the shape of an old lawsonite grain. These shapes mimic the old lawsonite, so they are called pseudomorphs.");

RockInfo Foinikas5 = new RockInfo("Foinikas5", "Foinikas", "Retrogression intensity", "/Images/icons/ExhibitionLegent-01.png",

"The intensity of retrogression from blueschist to greenschist varies, some outcrops show relatively little overprint. This one preserves largely blueschist character. It shows beautiful needles of glaucophane, which is the high-pressure mineral for which Syros is famous. ");

RockInfo Foinikas6 = new RockInfo("Foinikas6", "Foinikas", "Metamorphic fluids", "/Images/icons/ExhibitionLegent-01.png",

"Retrogression is strong, where water-rich fluid could enter the rocks during uplift from high-pressure conditions. Green veins are former fractures that show the entry of such fluids. These veins contain typical greenschist minerals such as epidote, albite and chlorite.");

RockInfoCollection.Add(Foinikas1);
RockInfoCollection.Add(Foinikas2);
RockInfoCollection.Add(Foinikas3);
RockInfoCollection.Add(Foinikas4);
RockInfoCollection.Add(Foinikas5);
RockInfoCollection.Add(Foinikas6);
//

RockInfo GriaPounta1 = new RockInfo("GriaPounta1", "Gria Pounta", "Granitic gneiss", "/Images/icons/ExhibitionLegent-01.png",

"Leukogneiss, the granitic protolith was metamorphosed at low temperature and pressure. Strongly sheared structure due to transport of the Vari unit over its basis. Cliffs South of Gria Pounta.");

```
RockInfo GriaPounta2 = new RockInfo("GriaPounta2", "Kochlakas", "Granitic gneiss", "/Images/icons/ExhibitionLegent-01.png",
    "South of Gria Pounta, viewing towards the sea side, there are Vari leukogneiss cliffs at Kochlakàs North shore.");
RockInfo GriaPounta3 = new RockInfo("GriaPounta3", "Trypa", "Granitic gneiss", "/Images/icons/ExhibitionLegent-01.png",
    "Onward south there are bodies of Leukogneiss with strongly flattened bands of feldspar and quartz (both white) plus mica (here grey).");
RockInfo GriaPounta4 = new RockInfo("GriaPounta4", "Trypa", "Granitic gneiss", "/Images/icons/ExhibitionLegent-01.png",
    "Granitic gneiss with linear fabric due to stretched out feldspar. East of Trypa.");
RockInfo GriaPounta5 = new RockInfo("GriaPounta5", "Cape Fokia", "Granitic gneiss", "/Images/icons/ExhibitionLegent-01.png",
    "On the south side of Trypa hill, massive epidote-amphibolite gneiss can be spoted form the steep cliffs at Cape Fokia.");
RockInfo GriaPounta6 = new RockInfo("GriaPounta6", "Cape Fokia", "Amphibolite", "/Images/icons/ExhibitionLegent-01.png",
    "Amphibolite with veins of epidote (light green), quartz (white) and Fe-carbonate (orange). Beach South of Cape Fokia.");
RockInfo GriaPounta7 = new RockInfo("GriaPounta7", "Cape Fokia", "Amphibolite", "/Images/icons/ExhibitionLegent-01.png",
    "Stack of kataklastic amphibolite at Cape Fokia, strongly disrupted during emplacement of the Vari unit over its tectonic sole.");
RockInfo GriaPounta8 = new RockInfo("GriaPounta8", "Vari", "Amphibolite", "/Images/icons/ExhibitionLegent-01.png",
    "Banded amphibolite (dark) with calcsilicate lenses (light green), at Cape Fokia.");

RockInfoCollection.Add(GriaPounta1);
RockInfoCollection.Add(GriaPounta2);
RockInfoCollection.Add(GriaPounta3);
RockInfoCollection.Add(GriaPounta4);
RockInfoCollection.Add(GriaPounta5);
RockInfoCollection.Add(GriaPounta6);
RockInfoCollection.Add(GriaPounta7);
RockInfoCollection.Add(GriaPounta8);

////////////////////////////////////////////////////////////////

RockInfo Kampos1 = new RockInfo("Kampos1", "Kampos", "Chlorite Serpentine schist", "/Images/icons/ExhibitionLegent-01.png",
    "Kampos is Eclogite Paradise, with massive lenses sticking out into the landscape. Here such a lens has a rim of chlorite-serpentine schist, marking the contact of the eclogite lens to the surrounding mass of serpentinite.");
```

```
RockInfo Kampos2 = new RockInfo("Kampos2", "Kampos", "Chlorite layers", "/Images/icons/ExhibitionLegent-01.png",
    "As serpentine and eclogite have different chemical compositions, they reacted along the contact and formed this silvery coating of the eclogite body. Chlorite is but a thin skin (called blackwall) of the eclogite lens against neighbouring serpentinite.");
RockInfo Kampos3 = new RockInfo("Kampos3", "Kampos", "Eclogitic metagabro", "/Images/icons/ExhibitionLegent-01.png",
    "Eclogitic metagabbro is exposed along the main road. The partly deformed metagabbro (coarse-grained glaucophane-eclogite) was intruded by metadiorite (fine-grained eclogite). Both originated inside the same magma chamber, and they were metamorphosed together at high pressures.");
RockInfo Kampos4 = new RockInfo("Kampos4", "Kampos", "Metagabbro and Dyke", "/Images/icons/ExhibitionLegent-01.png",
    "The contact of the metagabbro (top) and the intrusive metadiorite (bottom) is a primary magmatic phenomenon. It took place deep beneath the Earth surface, inside a magma chamber when the gabbro was still hot and plastic.");
RockInfo Kampos5 = new RockInfo("Kampos5", "Kampos", "Dyke intrusion", "/Images/icons/ExhibitionLegent-01.png",
    "Despite metamorphism, the rocks' early magmatic history is preserved: Gabbro cooled very slowy from magma, so minerals had time to form large grains. Then new magma intruded into the space (magma chamber), forming a a diorite dyke. This magma had less time to cool, thus formed a finer grained rock.");
RockInfo Kampos6 = new RockInfo("Kampos6", "Kampos", "Glaucophane crystals in Metagabbro", "/Images/icons/ExhibitionLegent-01.png",
    "Glaucophane (dark blue crystals) mimics the shape of magmatic pyroxene. These glaucophane pseudomorphs float in a matrix of garnet-omphacite-zoisite. The rock overall is an eclogitic metagabbro.");
RockInfo Kampos7 = new RockInfo("Kampos7", "Kampos", "Pseudomorphs", "/Images/icons/ExhibitionLegent-01.png",
    "Crystals of magmatic pyroxene had formed in the gabbro. These are still visible as shiny cores in glaucophane that formed during metamorphism, when they largely replaced the pyroxene. These pseudomorphs retain the shape of the old crystals. ");

RockInfoCollection.Add(Kampos1);
RockInfoCollection.Add(Kampos2);
RockInfoCollection.Add(Kampos3);
RockInfoCollection.Add(Kampos4);
RockInfoCollection.Add(Kampos5);
RockInfoCollection.Add(Kampos6);
RockInfoCollection.Add(Kampos7);
////////////////////////////////////////////////////////////////////////

RockInfo Komito1 = new RockInfo("Komito1", "Komito", "Komito Gneiss", "/Images/icons/ExhibitionLegent-01.png",
```

"Komito gneiss is unique to the South-West tip of Syros. It is a mixture of mica, quartz and feldspar. It originated as a granite that was metamorphosed under high pressures. ");

RockInfo Komito2 = new RockInfo("Komito2", "Komito", "The Breccia", "/Images/icons/ExhibitionLegent-01.png",

"Komito gneiss (brown) was strongly fractured and locally contains black tourmaline, a hydrothermal mineral that crystallised as fracture fillings.");

RockInfo Komito3 = new RockInfo("Komito3", "Komito", "Minerals", "/Images/icons/ExhibitionLegent-01.png",

"This formation is called a hydrothermal breccia. Erosion has stripped away the gneiss, leaving massive fracture fillings of quartz and tourmaline weathering relics sticking out sharply. ");

RockInfo Komito4 = new RockInfo("Komito4", "Komito", "Fractures and fillings", "/Images/icons/ExhibitionLegent-01.png",

"A breccia is a rock consisting mostly of angular rock fragments. The fractured rock here is the Komito gneiss, and the fragments are cemented together by quartz and tourmaline. ");

RockInfo Komito5 = new RockInfo("Komito5", "Komito", "Fractures and fillings", "/Images/icons/ExhibitionLegent-01.png",

"Tourmaline and quartz were deposited here by hot aqueous solutions. These may point to a granitic intrusion at depth (but not visible at the surface). ");

RockInfoCollection.Add(Komito1);
RockInfoCollection.Add(Komito2);
RockInfoCollection.Add(Komito3);
RockInfoCollection.Add(Komito4);
RockInfoCollection.Add(Komito5);
///

RockInfo Lakkoi1 = new RockInfo("Lakkoi1", "Lakkoi", "Glaucophane schist", "/Images/icons/ExhibitionLegent-01.png",

"Lakkoi is rich in eclogites and other rock types containing minerals formed during high-pressure metamorphism. This eclogite lens is a metabasalt with water infiltrated along the border of the lens, forming the thin blue shell composed of glaucophane.");

RockInfo Lakkoi2 = new RockInfo("Lakkoi2", "Lakkoi", "Blueschist", "/Images/icons/ExhibitionLegent-01.png",

"Glaucophane is stable under high pressure conditions, so it only forms deep inside the Earth. As it is hydrous mineral, it can only grow in environments where fluid is present. ");

RockInfo Lakkoi3 = new RockInfo("Lakkoi3", "Lakkoi", "Chlorite Schist", "/Images/icons/ExhibitionLegent-01.png",

"Eclogites here is coated by a thin layer of chlorite schist. Chlorite is a soft mineral, it resists weathering because it is not soluble in water. This made it a preferred rock type that ancient people used for carving. ");

RockInfo Lakkoi4 = new RockInfo("Lakkoi4", "Lakkoi", "Chlorite Schist", "/Images/icons/ExhibitionLegent-01.png", "The Lakkoi sight is an extraordinary location for ancient petroglyphs. Carved into the thin coatings of large eclogite bodies, incisions and scratchings in chlorite schist show enigmatic patterns, messages we do not understand. ");

RockInfo Lakkoi5 = new RockInfo("Lakkoi5", "Lakkoi", "Petroglyphs", "/Images/icons/ExhibitionLegent-01.png",

"The age of these particular petroglyphs is not known, and direct dating probably is not possible. But the shapes show an evolution, so repeated activity of humans in the same area presumably over extended time periods. ");

RockInfoCollection.Add(Lakkoi1);
RockInfoCollection.Add(Lakkoi2);
RockInfoCollection.Add(Lakkoi3);
RockInfoCollection.Add(Lakkoi4);
RockInfoCollection.Add(Lakkoi5);

//

RockInfo Lia1 = new RockInfo("Lia1", "Lia beach", "Serpentinite schist", "/Images/icons/ExhibitionLegent-01.png",

"At Lia beach a range of rock types meet: Various metavolcanic rocks, metasediments, marbles. Also a body of serpentinite schist is well exposed. All are part of the Kampos shear zone. ");

RockInfo Lia2 = new RockInfo("Lia2", "Lia beach", "Serpentinite schist", "/Images/icons/ExhibitionLegent-01.png",

"Only rarely does serpentinites surface as visible outcrops, but it is a common rock type in this zone, weathering back from the eclogite lenses (like the Aerolithos). These two rock types are intimately connected in this zone.");

RockInfo Lia3 = new RockInfo("Lia3", "Lia beach", "Schist closeup", "/Images/icons/ExhibitionLegent-01.png",

"“Schist” is a structural term that denotes the texture of the rock: All schists have a strong parallel foliation.");

RockInfo Lia4 = new RockInfo("Lia4", "Lia beach", "Phylus Texture", "/Images/icons/ExhibitionLegent-01.png",

"Serpentine is a soft mineral, and its crystal structure (sheet silicate) makes it a perfect candidate to produce schists. Outcrops of serpentinite schist thus are sensitive to breakage. ");

RockInfo Lia5 = new RockInfo("Lia5", "Lia beach", "Lawsonite-glaucophane schist", "/Images/icons/ExhibitionLegent-01.png",

"Hydrated metabasalts are found on the south side of Lia beach. Former igneous rocks metamorphosed at high-pressure conditions along with metamorphic fluids produced these lawsonite-glaucophane schists. ");

RockInfo Lia6 = new RockInfo("Lia6", "Lia beach", "Lawsonite", "/Images/icons/ExhibitionLegent-01.png", "While glaucophane is responsible for the blue colour of the schists, the white rombohedral patches are the mineral lawsonite. Lawsonite is a high-pressure mineral typically found in low-temperature blueschists.");

```
RockInfoCollection.Add(Lia1);
RockInfoCollection.Add(Lia2);
RockInfoCollection.Add(Lia3);
RockInfoCollection.Add(Lia4);
RockInfoCollection.Add(Lia5);
RockInfoCollection.Add(Lia6);

/////////////////////////////////////////////////////////////////

RockInfo Marmari1 = new RockInfo("Marmari1", "Marmari", "Marble quarry", "/Images/icons/ExhibitionLegent-01.png",
    "Marble quarry in the Metasedimentary Micaschist unit above Marmara Bay (below the path to Grammata)");
RockInfo Marmari2 = new RockInfo("Marmari2", "Marmari", "Marble quarry", "/Images/icons/ExhibitionLegent-01.png",
    "Large blocks of precious white marble were selected to be mined for use in art works and noble architecture ");
RockInfo Marmari3 = new RockInfo("Marmari3", "Marmari", "Marble excavation", "/Images/icons/ExhibitionLegent-01.png",
    "Medium size blocks of marble were excavated and prepared for later transport just before mining stopped (reasons unknown)");
RockInfo Marmari4 = new RockInfo("Marmari4", "Marmari", "A worker's signature", "/Images/icons/ExhibitionLegent-01.png",
    "Quarry worker (late 19th century, probably from Tinos) left his signature in the white marble he helped to mine and prepare for transport");
RockInfo Marmari5 = new RockInfo("Marmari5", "Marmari", "Marble transport", "/Images/icons/ExhibitionLegent-01.png",
    "Blocks of white marble were prepared for transport from a ramp (right). They probably would have been pushed onto wooden “rails” and down to the coast before being shipped away");
RockInfo Marmari6 = new RockInfo("Marmari6", "Marmari", "Lawsonite blueschist", "/Images/icons/ExhibitionLegent-01.png",
    "Lawsonite-blueschist lying on top of massive marble beds");

RockInfoCollection.Add(Marmari1);
RockInfoCollection.Add(Marmari2);
RockInfoCollection.Add(Marmari3);
RockInfoCollection.Add(Marmari4);
RockInfoCollection.Add(Marmari5);
RockInfoCollection.Add(Marmari6);
/////////////////////////////////////////////////////////////////
```

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RockInfo MavroPounti1 = new RockInfo("MavroPounti1", "Mavro Pounti", "Metavolcanic Sandstones", "/Images/icons/ExhibitionLegent-01.png",
    "A series of banded metavolcanic rocks outcrops next to the conglomerate unit. The outcrop surface shows strong aeolian (wind) erosion with lots of pitholes. This north tip of Syros is very exposed to winds.");
RockInfo MavroPounti2 = new RockInfo("MavroPounti2", "Mavro Pounti", "Metavolcanic rock sight", "/Images/icons/ExhibitionLegent-01.png",
    "All of these rocks were metamorphosed under high pressure beneath the Earth’s surface for tens of millions of years, before slowly returning to the surface, where erosion started.");
RockInfo MavroPounti3 = new RockInfo("MavroPounti3", "Mavro Pounti", "Aeolic erosion", "/Images/icons/ExhibitionLegent-01.png",
    "Metavolcanic sandstone with aeolian erosion features. The outcrops have been sand-blasted by strong lateral winds.");
RockInfo MavroPounti4 = new RockInfo("MavroPounti4", "Mavro Pounti", "A structure of holes", "/Images/icons/ExhibitionLegent-01.png",
    "Wind has been driving sand grains against and into the rocks' surface. These particles keep eating away the sandstones and have created a mesh structure of relics around holes. Folded quartz veins resist erosion and stand out sharply.");
RockInfo MavroPounti5 = new RockInfo("MavroPounti5", "Mavro Pounti", "Unit contact", "/Images/icons/ExhibitionLegent-01.png",
    "Contact between two rock units: Metavolcanic (left) and Conglomerate (right), cut up by a steep fault. The flanks are being eroded and form a steep gulley that runs down to the sea.");
RockInfo MavroPounti6 = new RockInfo("MavroPounti6", "Mavro Pounti", "Inside the fault", "/Images/icons/ExhibitionLegent-01.png",
    "In between fault scarps metavolcanic sandstone layers(left) are in contact with conglomerate beds (right). ");
RockInfo MavroPounti7 = new RockInfo("MavroPounti7", "Mavro Pounti", "Layer weathering", "/Images/icons/ExhibitionLegent-01.png",
    "Folded metavolcanic layers have been by modelled by episodic water torrents gushing towards the sea.");
RockInfo MavroPounti8 = new RockInfo("MavroPounti8", "Mavro Pounti", "Smaller fracture system", "/Images/icons/ExhibitionLegent-01.png",
    "A series of small fractures runs parallel to the larger fault, they are a part of the same deformation system. They are partly filled with white quartz and black chlorite.");

RockInfoCollection.Add(MavroPounti1);
RockInfoCollection.Add(MavroPounti2);
RockInfoCollection.Add(MavroPounti3);
RockInfoCollection.Add(MavroPounti4);
RockInfoCollection.Add(MavroPounti5);
RockInfoCollection.Add(MavroPounti6);
RockInfoCollection.Add(MavroPounti7);
RockInfoCollection.Add(MavroPounti8);
```

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////////////////////////////////////////////////////////////

RockInfo MegasGialos1 = new RockInfo("MegasGialos1", "Megas Gialos", "Metavolcanic greenschist", "/Images/icons/ExhibitionLegent-01.png",
    "A series of metasedimentary and metavolcanic greenschists outcrop along the road. They are all dark, strongly foliated and flattened.");
RockInfo MegasGialos2 = new RockInfo("MegasGialos2", "Megas Gialos", "Clay-rich sentiments", "/Images/icons/ExhibitionLegent-01.png",
    "Layered stack of metasediments, mostly metapelites, formed from clay-rich sediments during metamorphism at relatively low temperatures and pressures. ");
RockInfo MegasGialos3 = new RockInfo("MegasGialos3", "Megas Gialos", "Deformation structures", "/Images/icons/ExhibitionLegent-01.png",
    "Deformation structures in metasedimentary greenschists show that the layers were flattened and folded together with the white veins of hydrothermal quartz ");
RockInfo MegasGialos4 = new RockInfo("MegasGialos4", "Megas Gialos", "Flattened layers", "/Images/icons/ExhibitionLegent-01.png",
    "Very strongly flattened and attenuated layers in greenschist with quartz veins");
RockInfo MegasGialos5 = new RockInfo("MegasGialos5", "Megas Gialos", "Metapelites", "/Images/icons/ExhibitionLegent-01.png",
    "A similar stack of metapelites shows open, gentle folds only");
RockInfo MegasGialos6 = new RockInfo("MegasGialos6", "Megas Gialos", "Metapelitic greenschist", "/Images/icons/ExhibitionLegent-01.png",
    "Flattening of the metapelitic greenschist caused the cm-thick quartz veins to be pulled apart ");

RockInfoCollection.Add(MegasGialos1);
RockInfoCollection.Add(MegasGialos2);
RockInfoCollection.Add(MegasGialos3);
RockInfoCollection.Add(MegasGialos4);
RockInfoCollection.Add(MegasGialos5);
RockInfoCollection.Add(MegasGialos6);

/////////////////////////////////////////////////////////////

RockInfo Vari1 = new RockInfo("Vari1", "Vari", "Deformed greenschist", "/Images/icons/ExhibitionLegent-01.png",
    "A very strongly deformed package of greenschist forms the base of the Vari unit. It includes very finely laminated phyllites (grey) and banded chlorite schists (green).");
RockInfo Vari2 = new RockInfo("Vari2", "Vari", "Deformed greenschist", "/Images/icons/ExhibitionLegent-01.png",
    "Both the bright phyllite (left) and the dark greenschist (right) are intensely disrupted by fracture several systems (more or less systematically oriented)");
RockInfo Vari3 = new RockInfo("Vari3", "Vari", "Mylonitic greenschist", "/Images/icons/ExhibitionLegent-01.png",
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            "Mylonitic Vari detachment base: A cataclastic zone (left, reddish) cut through banded greenschist.");
        RockInfo Vari4 = new RockInfo("Vari4", "Vari", "Fractured greenschist", "/Images/icons/ExhibitionLegent-01.png",
            "Strongly fractured light greenschists (left) envelop a massive serpentinite lens (right, dark green).");
        RockInfo Vari5 = new RockInfo("Vari5", "Vari", "Banded greenscists", "/Images/icons/ExhibitionLegent-01.png",
            "A stack of banded greenschists shows intense brittle deformation, fractures and shear displacements.");
        RockInfo Vari6 = new RockInfo("Vari6", "Vari", "Reaction with water", "/Images/icons/ExhibitionLegent-01.png",
            "The dense fracture network in these rocks allowed surface water to enter and react with the along fractures. This caused oxidation and produced iron hydroxides, giving the rusty colours.");

        RockInfoCollection.Add(Vari1);
        RockInfoCollection.Add(Vari2);
        RockInfoCollection.Add(Vari3);
        RockInfoCollection.Add(Vari4);
        RockInfoCollection.Add(Vari5);
        RockInfoCollection.Add(Vari6);
      }




      //MYLONITIC GREENSCHIST UNIT
      private void MyloniticGrenschist_MouseEnter(object sender, MouseEventArgs e)
      {
        MyloniticGrenschist.Fill = new SolidColorBrush(Colors.DimGray);
        MyBackground.Visibility = Visibility.Visible;
        RockUnitName.Visibility = Visibility.Visible;
        RockUnitName.Text = "Mylonitic Greenschist";
        MyBackground.Source = new BitmapImage(new Uri(@"/Images/BackgroundTextures/MyloniticGreenschist.png", UriKind.Relative));
      }

      private void MyloniticGrenschist_MouseLeave(object sender, MouseEventArgs e)
      {
        MyloniticGrenschist.Fill = new SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_MYLONITIC_GREENSCHIST));
        RockUnitName.Text = "";
        MyBackground.Source = new BitmapImage(new Uri(@"", UriKind.Relative));
```

```
        }

        private void MyloniticGrenschist_MouseDown(object sender, MouseButtonEventArgs e)
        {
            Vari.Visibility = Visibility.Visible;

            Aerolithos.Visibility = Visibility.Hidden;
            AgiosStefanos.Visibility = Visibility.Hidden;
            AnoSyros.Visibility = Visibility.Hidden;
            Abelaki.Visibility = Visibility.Hidden;
            Fabrika.Visibility = Visibility.Hidden;
            Foinikas.Visibility = Visibility.Hidden;
            GriaPounta.Visibility = Visibility.Hidden;
            Kampos.Visibility = Visibility.Hidden;
            Komito.Visibility = Visibility.Hidden;
            Lakkoi.Visibility = Visibility.Hidden;
            Lia.Visibility = Visibility.Hidden;
            Marmari.Visibility = Visibility.Hidden;
            MegasGialos.Visibility = Visibility.Hidden;
            AsproPounti.Visibility = Visibility.Hidden;
            MavroPounti.Visibility = Visibility.Hidden;


        }

        //VARI UNIT
        private void VariGneiss_MouseEnter(object sender, MouseEventArgs e)
        {
            VariGneiss.Fill = new SolidColorBrush(Colors.DimGray);
            MyBackground.Visibility = Visibility.Visible;
            RockUnitName.Visibility = Visibility.Visible;
            RockUnitName.Text = "Vari Gneiss";
            MyBackground.Source = new BitmapImage(new
Uri(@"Images/BackgroundTextures/VariGneiss.png", UriKind.Relative));

        }
        private void VariGneiss_MouseLeave(object sender, MouseEventArgs e)
        {
            VariGneiss.Fill = new
SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_VARI_GNEISS));
            RockUnitName.Text = "";
            MyBackground.Source = new BitmapImage(new Uri(@"", UriKind.Relative));
        }
```

```
        private void VariGneiss_MouseDown(object sender, MouseButtonEventArgs e)
        {
            Fabrika.Visibility = Visibility.Visible;
            GriaPounta.Visibility = Visibility.Visible;

            Aerolithos.Visibility = Visibility.Hidden;
            AgiosStefanos.Visibility = Visibility.Hidden;
            AnoSyros.Visibility = Visibility.Hidden;
            Abelaki.Visibility = Visibility.Hidden;
            Foinikas.Visibility = Visibility.Hidden;
            Kampos.Visibility = Visibility.Hidden;
            Komito.Visibility = Visibility.Hidden;
            Lakkoi.Visibility = Visibility.Hidden;
            Lia.Visibility = Visibility.Hidden;
            Marmari.Visibility = Visibility.Hidden;
            MegasGialos.Visibility = Visibility.Hidden;
            Vari.Visibility = Visibility.Hidden;
            AsproPounti.Visibility = Visibility.Hidden;
            MavroPounti.Visibility = Visibility.Hidden;

            MyBackground.Visibility = Visibility.Hidden;
            RockUnitName.Visibility = Visibility.Hidden;
        }

        //KOMITO UNIT
        private void KomitoGneiss_MouseEnter(object sender, MouseEventArgs e)
        {
            KomitoGneiss.Fill = new SolidColorBrush(Colors.DimGray);
            MyBackground.Visibility = Visibility.Visible;
            RockUnitName.Visibility = Visibility.Visible;
            RockUnitName.Text = "Komito Gneiss";
            MyBackground.Source = new BitmapImage(new
Uri(@"/Images/BackgroundTextures/Komito.png", UriKind.Relative));
        }

        private void KomitoGneiss_MouseLeave(object sender, MouseEventArgs e)
        {
            KomitoGneiss.Fill = new
SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_KOMITO_GNEISS));
            RockUnitName.Text = "";
            MyBackground.Source = new BitmapImage(new Uri(@"", UriKind.Relative));
        }

        private void KomitoGneiss_MouseDown(object sender, MouseButtonEventArgs e)
```

```
{
    Komito.Visibility = Visibility.Visible;
    Aerolithos.Visibility = Visibility.Hidden;
    AgiosStefanos.Visibility = Visibility.Hidden;
    AnoSyros.Visibility = Visibility.Hidden;
    Abelaki.Visibility = Visibility.Hidden;
    Fabrika.Visibility = Visibility.Hidden;
    Foinikas.Visibility = Visibility.Hidden;
    GriaPounta.Visibility = Visibility.Hidden;
    Kampos.Visibility = Visibility.Hidden;
    Lakkoi.Visibility = Visibility.Hidden;
    Lia.Visibility = Visibility.Hidden;
    Marmari.Visibility = Visibility.Hidden;
    MegasGialos.Visibility = Visibility.Hidden;
    Vari.Visibility = Visibility.Hidden;
    AsproPounti.Visibility = Visibility.Hidden;
    MavroPounti.Visibility = Visibility.Hidden;

    MyBackground.Visibility = Visibility.Hidden;
    RockUnitName.Visibility = Visibility.Hidden;
}

//CONGLOMERATE UNIT
private void Conglomerate_MouseEnter(object sender, MouseEventArgs e)
{
    Conglomerate.Fill = new SolidColorBrush(Colors.DimGray);
    MyBackground.Visibility = Visibility.Visible;
    RockUnitName.Visibility = Visibility.Visible;
    RockUnitName.Text = "Conglomerate";
    MyBackground.Source = new BitmapImage(new
Uri(@"/Images/BackgroundTextures/Conglomerate.png", UriKind.Relative));
}

private void Conglomerate_MouseLeave(object sender, MouseEventArgs e)
{
    Conglomerate.Fill = new
SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_CONGLOMERATE));
    RockUnitName.Text = "";
    MyBackground.Source = new BitmapImage(new Uri(@"", UriKind.Relative));
}

private void Conglomerate_MouseDown(object sender, MouseButtonEventArgs e)
{
    AsproPounti.Visibility = Visibility.Visible;
```

```
            Aerolithos.Visibility = Visibility.Hidden;
            AgiosStefanos.Visibility = Visibility.Hidden;
            AnoSyros.Visibility = Visibility.Hidden;
            Abelaki.Visibility = Visibility.Hidden;
            Fabrika.Visibility = Visibility.Hidden;
            Foinikas.Visibility = Visibility.Hidden;
            GriaPounta.Visibility = Visibility.Hidden;
            Kampos.Visibility = Visibility.Hidden;
            Komito.Visibility = Visibility.Hidden;
            Lakkoi.Visibility = Visibility.Hidden;
            Lia.Visibility = Visibility.Hidden;
            Marmari.Visibility = Visibility.Hidden;
            MegasGialos.Visibility = Visibility.Hidden;
            Vari.Visibility = Visibility.Hidden;
            MavroPounti.Visibility = Visibility.Hidden;

            MyBackground.Visibility = Visibility.Hidden;
            RockUnitName.Visibility = Visibility.Hidden;
        }

        //METASEDIMENTARY MICASCHIST UNIT
        private void MetasedimentaryMicaschist_MouseEnter(object sender, MouseEventArgs e)
        {
            MetasedimentaryMicaschist_1.Fill = new SolidColorBrush(Colors.DimGray);
            MetasedimentaryMicaschist_2.Fill = new SolidColorBrush(Colors.DimGray);
            MyBackground.Visibility = Visibility.Visible;
            RockUnitName.Visibility = Visibility.Visible;
            RockUnitName.Text = "Metasedimentary Micaschist";
            MyBackground.Source = new BitmapImage(new
Uri(@"/Images/BackgroundTextures/MetasedMicaschist.png", UriKind.Relative));
        }

        private void MetasedimentaryMicaschist_MouseLeave(object sender, MouseEventArgs e)
        {
            MetasedimentaryMicaschist_1.Fill = new
SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_METASEDIMENTARY_MIC
ASCHIST));
            MetasedimentaryMicaschist_2.Fill = new
SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_METASEDIMENTARY_MIC
ASCHIST));
            RockUnitName.Text = "";
            MyBackground.Source = new BitmapImage(new Uri(@"", UriKind.Relative));
        }
```

```
private void MetasedimentaryMicaschist_MouseDown(object sender, MouseButtonEventArgs e)
{
   Marmari.Visibility = Visibility.Visible;
   MavroPounti.Visibility = Visibility.Visible;
   Aerolithos.Visibility = Visibility.Hidden;
   AgiosStefanos.Visibility = Visibility.Hidden;
   AnoSyros.Visibility = Visibility.Hidden;
   Abelaki.Visibility = Visibility.Hidden;
   Fabrika.Visibility = Visibility.Hidden;
   Foinikas.Visibility = Visibility.Hidden;
   GriaPounta.Visibility = Visibility.Hidden;
   Kampos.Visibility = Visibility.Hidden;
   Komito.Visibility = Visibility.Hidden;
   Lakkoi.Visibility = Visibility.Hidden;
   Lia.Visibility = Visibility.Hidden;
   MegasGialos.Visibility = Visibility.Hidden;
   Vari.Visibility = Visibility.Hidden;
   AsproPounti.Visibility = Visibility.Hidden;

   MyBackground.Visibility = Visibility.Hidden;
   RockUnitName.Visibility = Visibility.Hidden;
}

//ALTERNATING METASEDIMENTARY MICASCHIST & MARBLE UNIT
private void Alternating_MouseEnter(object sender, MouseEventArgs e)
{
   Alternating_1.Fill = new SolidColorBrush(Colors.DimGray);
   Alternating_2.Fill = new SolidColorBrush(Colors.DimGray);
   Alternating_3.Fill = new SolidColorBrush(Colors.DimGray);
   Alternating_4.Fill = new SolidColorBrush(Colors.DimGray);

   MyBackground.Visibility = Visibility.Visible;
   RockUnitName.Visibility = Visibility.Visible;
   RockUnitName.Text = "Micaschists & Marbles";
   MyBackground.Source = new BitmapImage(new Uri(@"/Images/BackgroundTextures/AlterMicaschistMarble.png", UriKind.Relative));

}

private void Alternating_MouseLeave(object sender, MouseEventArgs e)
{
```

```
        Alternating_1.Fill = new SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_ALT_MICASCHIST_MARBLE));
        Alternating_2.Fill = new SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_ALT_MICASCHIST_MARBLE));
        Alternating_3.Fill = new SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_ALT_MICASCHIST_MARBLE));
        Alternating_4.Fill = new SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_ALT_MICASCHIST_MARBLE));

        RockUnitName.Text = "";
        MyBackground.Source = new BitmapImage(new Uri(@"", UriKind.Relative));
    }

    private void Alternating_MouseDown(object sender, MouseButtonEventArgs e)
    {
        AnoSyros.Visibility = Visibility.Visible;

        Aerolithos.Visibility = Visibility.Hidden;
        AgiosStefanos.Visibility = Visibility.Hidden;
        Abelaki.Visibility = Visibility.Hidden;
        Fabrika.Visibility = Visibility.Hidden;
        Foinikas.Visibility = Visibility.Hidden;
        GriaPounta.Visibility = Visibility.Hidden;
        Kampos.Visibility = Visibility.Hidden;
        Komito.Visibility = Visibility.Hidden;
        Lakkoi.Visibility = Visibility.Hidden;
        Lia.Visibility = Visibility.Hidden;
        Marmari.Visibility = Visibility.Hidden;
        MegasGialos.Visibility = Visibility.Hidden;
        Vari.Visibility = Visibility.Hidden;
        AsproPounti.Visibility = Visibility.Hidden;
        MavroPounti.Visibility = Visibility.Hidden;

        MyBackground.Visibility = Visibility.Hidden;
        RockUnitName.Visibility = Visibility.Hidden;
    }


    //QUATERNARY UNIT
    private void QuaternaryDeposits_MouseEnter(object sender, MouseEventArgs e)
```

```
        {
          /*
          QuaternaryDeposits_1.Fill = new SolidColorBrush(Colors.DimGray);
          QuaternaryDeposits_2.Fill = new SolidColorBrush(Colors.DimGray);
          QuaternaryDeposits_3.Fill = new SolidColorBrush(Colors.DimGray);
          QuaternaryDeposits_4.Fill = new SolidColorBrush(Colors.DimGray);
          QuaternaryDeposits_5.Fill = new SolidColorBrush(Colors.DimGray);
          QuaternaryDeposits_6.Fill = new SolidColorBrush(Colors.DimGray);

          RockUnitName.Text = "Exhibits and Hike Paths";
          */
        }

        private void QuaternaryDeposits_MouseLeave(object sender, MouseEventArgs e)
        {
          /*
          QuaternaryDeposits_1.Fill                                   =                                   new
    SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_QUATERNARY_DEPOSITS))
    ;
          QuaternaryDeposits_2.Fill                                   =                                   new
    SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_QUATERNARY_DEPOSITS))
    ;
          QuaternaryDeposits_3.Fill                                   =                                   new
    SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_QUATERNARY_DEPOSITS))
    ;
          QuaternaryDeposits_4.Fill                                   =                                   new
    SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_QUATERNARY_DEPOSITS))
    ;
          QuaternaryDeposits_5.Fill                                   =                                   new
    SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_QUATERNARY_DEPOSITS))
    ;
          QuaternaryDeposits_6.Fill                                   =                                   new
    SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_QUATERNARY_DEPOSITS))
    ;
          */
        }

        private void QuaternaryDeposits_MouseDown(object sender, MouseButtonEventArgs e)
        {
          /*
            SyrosGeoMap.SetValue(Grid.ColumnSpanProperty, 1);
            //SyrosGeoMap.SetValue(Grid.RowSpanProperty, 2);

            ImageViewerPanel.Visibility = Visibility.Visible;
```

```
            ImageViewer.Source = new BitmapImage(new Uri(@"/Images/icons/ExhibitionLegent-01.png",
UriKind.Relative));

            RockPhotoTitle.Text = null ;
            RockInfo.Text = "Exhibition Map and Hikes";

            ThumbNail1.Source = new BitmapImage(new Uri(@"/Images/icons/ExhibitionLegent-01.png",
UriKind.Relative));
            ThumbNail2.Source = new BitmapImage(new Uri(@"/Images/icons/ExhibitionLegent-03.png",
UriKind.Relative));
            BorderThumbNail1.Visibility = Visibility.Visible;
            BorderThumbNail2.Visibility = Visibility.Visible;

            //set image sources NULL and border visibility.collapsed
            ThumbNail3.Source = null;
            BorderThumbNail3.Visibility = Visibility.Collapsed;
            ThumbNail4.Source = null;
            BorderThumbNail4.Visibility = Visibility.Collapsed;
            ThumbNail5.Source = null;
            BorderThumbNail5.Visibility = Visibility.Collapsed;
            ThumbNail6.Source = null;
            BorderThumbNail6.Visibility = Visibility.Collapsed;
            ThumbNail7.Source = null;
            BorderThumbNail7.Visibility = Visibility.Collapsed;
            ThumbNail8.Source = null;
            BorderThumbNail8.Visibility = Visibility.Collapsed;

        }


        Aerolithos.Visibility = Visibility.Hidden;
        AgiosStefanos.Visibility = Visibility.Hidden;
        AnoSyros.Visibility = Visibility.Hidden;
        Abelaki.Visibility = Visibility.Hidden;
        Fabrika.Visibility = Visibility.Hidden;
        Foinikas.Visibility = Visibility.Hidden;
        GriaPounta.Visibility = Visibility.Hidden;
        Kampos.Visibility = Visibility.Hidden;
        Komito.Visibility = Visibility.Hidden;
        Lakkoi.Visibility = Visibility.Hidden;
        Lia.Visibility = Visibility.Hidden;
        Marmari.Visibility = Visibility.Hidden;
        MegasGialos.Visibility = Visibility.Hidden;
        Vari.Visibility = Visibility.Hidden;
```

```
            AsproPounti.Visibility = Visibility.Hidden;
            MavroPounti.Visibility = Visibility.Hidden;

            MyBackground.Visibility = Visibility.Hidden;
            RockUnitName.Visibility = Visibility.Hidden;
            }
        */
        }
        //METABASITE UNIT

        private void Metabasite_MouseEnter(object sender, MouseEventArgs e)
        {
            Metabasite_1.Fill = new SolidColorBrush(Colors.DimGray);
            Metabasite_2.Fill = new SolidColorBrush(Colors.DimGray);
            Metabasite_3.Fill = new SolidColorBrush(Colors.DimGray);
            Metabasite_4.Fill = new SolidColorBrush(Colors.DimGray);
            Metabasite_5.Fill = new SolidColorBrush(Colors.DimGray);
            Metabasite_6.Fill = new SolidColorBrush(Colors.DimGray);
            Metabasite_7.Fill = new SolidColorBrush(Colors.DimGray);
            Metabasite_8.Fill = new SolidColorBrush(Colors.DimGray);
            Metabasite_9.Fill = new SolidColorBrush(Colors.DimGray);
            Metabasite_10.Fill = new SolidColorBrush(Colors.DimGray);
            Metabasite_11.Fill = new SolidColorBrush(Colors.DimGray);
            Metabasite_12.Fill = new SolidColorBrush(Colors.DimGray);
            Metabasite_13.Fill = new SolidColorBrush(Colors.DimGray);
            Metabasite_14.Fill = new SolidColorBrush(Colors.DimGray);

            MyBackground.Visibility = Visibility.Visible;
            RockUnitName.Visibility = Visibility.Visible;
            RockUnitName.Text = "Metabasites";
            MyBackground.Source = new BitmapImage(new
Uri(@"/Images/BackgroundTextures/Metabasite.png", UriKind.Relative));
        }

        private void Metabasite_MouseLeave(object sender, MouseEventArgs e)
        {
            Metabasite_1.Fill = new
SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_METABASITE));
            Metabasite_2.Fill = new
SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_METABASITE));
            Metabasite_3.Fill = new
SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_METABASITE));
            Metabasite_4.Fill = new
SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_METABASITE));
```

```
            Metabasite_5.Fill = new SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_METABASITE));
            Metabasite_6.Fill = new SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_METABASITE));
            Metabasite_7.Fill = new SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_METABASITE));
            Metabasite_8.Fill = new SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_METABASITE));
            Metabasite_9.Fill = new SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_METABASITE));
            Metabasite_10.Fill = new SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_METABASITE));
            Metabasite_11.Fill = new SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_METABASITE));
            Metabasite_12.Fill = new SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_METABASITE));
            Metabasite_13.Fill = new SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_METABASITE));
            Metabasite_14.Fill = new SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_METABASITE));

            RockUnitName.Text = "";
            MyBackground.Source = new BitmapImage(new Uri(@"", UriKind.Relative));

        }

        private void Metabasite_MouseDown(object sender, MouseButtonEventArgs e)
        {
            MyBackground.Source = new BitmapImage(new Uri(@"", UriKind.Relative));

            Aerolithos.Visibility = Visibility.Visible;
            Kampos.Visibility = Visibility.Visible;
            Lia.Visibility = Visibility.Visible;
            Lakkoi.Visibility = Visibility.Visible;
            Abelaki.Visibility = Visibility.Visible;
            Foinikas.Visibility = Visibility.Visible;

            AgiosStefanos.Visibility = Visibility.Hidden;
            AnoSyros.Visibility = Visibility.Hidden;
            Fabrika.Visibility = Visibility.Hidden;
            GriaPounta.Visibility = Visibility.Hidden;
            Komito.Visibility = Visibility.Hidden;
            Marmari.Visibility = Visibility.Hidden;
            MegasGialos.Visibility = Visibility.Hidden;
```

```
            Vari.Visibility = Visibility.Hidden;
            AsproPounti.Visibility = Visibility.Hidden;
            MavroPounti.Visibility = Visibility.Hidden;

            MyBackground.Visibility = Visibility.Hidden;
            RockUnitName.Visibility = Visibility.Hidden;
        }

        //GREENSCHIST UNIT
        private void Greenschist_MouseEnter(object sender, MouseEventArgs e)
        {
            Greenschist.Fill = new SolidColorBrush(Colors.DimGray);
            // DropShadowBitmapEffect myDropShadowEffect = new DropShadowBitmapEffect();

            MyBackground.Visibility = Visibility.Visible;
            RockUnitName.Visibility = Visibility.Visible;
            RockUnitName.Text = "Greenschist";
            MyBackground.Source = new BitmapImage(new
Uri(@"/Images/BackgroundTextures/Greenschist.png", UriKind.Relative));
        }

        private void Greenschist_MouseLeave(object sender, MouseEventArgs e)
        {
            Greenschist.Fill = new
SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_GREENSCHIST));
            RockUnitName.Text = "";
            MyBackground.Source = new BitmapImage(new Uri(@"", UriKind.Relative));

        }

        private void Greenschist_MouseDown(object sender, MouseButtonEventArgs e)
        {
            MyBackground.Source = new BitmapImage(new Uri(@"", UriKind.Relative));

            MegasGialos.Visibility = Visibility.Visible;
            Aerolithos.Visibility = Visibility.Hidden;
            AgiosStefanos.Visibility = Visibility.Hidden;
            AnoSyros.Visibility = Visibility.Hidden;
            Abelaki.Visibility = Visibility.Hidden;
            Fabrika.Visibility = Visibility.Hidden;
            Foinikas.Visibility = Visibility.Hidden;
            GriaPounta.Visibility = Visibility.Hidden;
            Kampos.Visibility = Visibility.Hidden;
            Komito.Visibility = Visibility.Hidden;
```

```
            Lakkoi.Visibility = Visibility.Hidden;
            Lia.Visibility = Visibility.Hidden;
            Marmari.Visibility = Visibility.Hidden;
            Vari.Visibility = Visibility.Hidden;
            AsproPounti.Visibility = Visibility.Hidden;
            MavroPounti.Visibility = Visibility.Hidden;

            MyBackground.Visibility = Visibility.Hidden;
            RockUnitName.Visibility = Visibility.Hidden;
        }

        //MARBLE UNIT
        private void Marble_MouseEnter(object sender, MouseEventArgs e)
        {
            Marble_1.Fill = new SolidColorBrush(Colors.DimGray);
            Marble_2.Fill = new SolidColorBrush(Colors.DimGray);
            Marble_3.Fill = new SolidColorBrush(Colors.DimGray);
            Marble_4.Fill = new SolidColorBrush(Colors.DimGray);
            Marble_5.Fill = new SolidColorBrush(Colors.DimGray);
            Marble_6.Fill = new SolidColorBrush(Colors.DimGray);
            Marble_7.Fill = new SolidColorBrush(Colors.DimGray);
            Marble_8.Fill = new SolidColorBrush(Colors.DimGray);

            MyBackground.Visibility = Visibility.Visible;
            RockUnitName.Visibility = Visibility.Visible;
            RockUnitName.Text = "Marble";
            MyBackground.Source = new BitmapImage(new
Uri(@"/Images/BackgroundTextures/Marble.png", UriKind.Relative));
        }

        private void Marble_MouseLeave(object sender, MouseEventArgs e)
        {
            Marble_1.Fill = new
SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_MARBLE));
            Marble_2.Fill = new
SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_MARBLE));
            Marble_3.Fill = new
SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_MARBLE));
            Marble_4.Fill = new
SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_MARBLE));
            Marble_5.Fill = new
SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_MARBLE));
            Marble_6.Fill = new
SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_MARBLE));
```

```
        Marble_7.Fill                                   =                                   new
SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_MARBLE));
        Marble_8.Fill                                   =                                   new
SolidColorBrush((Color)ColorConverter.ConvertFromString(COLOR_OF_ROCK_MARBLE));
        RockUnitName.Text = "";
        MyBackground.Source = new BitmapImage(new Uri(@"", UriKind.Relative));
    }

    private void Marble_MouseDown(object sender, MouseButtonEventArgs e)
    {
        MyBackground.Source = new BitmapImage(new Uri(@"", UriKind.Relative));

        AgiosStefanos.Visibility = Visibility.Visible;
        Aerolithos.Visibility = Visibility.Hidden;
        AnoSyros.Visibility = Visibility.Hidden;
        Abelaki.Visibility = Visibility.Hidden;
        Fabrika.Visibility = Visibility.Hidden;
        Foinikas.Visibility = Visibility.Hidden;
        GriaPounta.Visibility = Visibility.Hidden;
        Kampos.Visibility = Visibility.Hidden;
        Komito.Visibility = Visibility.Hidden;
        Lakkoi.Visibility = Visibility.Hidden;
        Lia.Visibility = Visibility.Hidden;
        Marmari.Visibility = Visibility.Hidden;
        MegasGialos.Visibility = Visibility.Hidden;
        Vari.Visibility = Visibility.Hidden;
        AsproPounti.Visibility = Visibility.Hidden;
        MavroPounti.Visibility = Visibility.Hidden;

        MyBackground.Visibility = Visibility.Hidden;
        RockUnitName.Visibility = Visibility.Hidden;
    }

    //LOCATION BUTTONS
    private void Aerolithos_Click(object sender, RoutedEventArgs e)
    {
        SyrosGeoMap.SetValue(Grid.RowSpanProperty, 2);
        SyrosGeoMap.SetValue(Grid.ColumnSpanProperty, 1);

        ImageViewerPanel.Visibility = Visibility.Visible;
        ImageViewer.Source    =    new    BitmapImage(new    Uri(@"/Images/Aerolithos/Aerolithos1.jpg",
UriKind.Relative));

        showImageGalery("Aerolithos");
```

```
            foreach (RockInfo it in RockInfoCollection)
            {
                if (it.imageName.Contains("Aerolithos1") == true)
                {
                    RockInfo.Text = it.imageDescription;
                }
            }
        }

        private void AgiosStefanos_Click(object sender, RoutedEventArgs e)
        {
            SyrosGeoMap.SetValue(Grid.RowSpanProperty, 2);
            SyrosGeoMap.SetValue(Grid.ColumnSpanProperty, 1);

            ImageViewerPanel.Visibility = Visibility.Visible;
            ImageViewer.Source = new BitmapImage(new Uri(@"/Images/AgiosStefanos/AgiosStefanos1.jpg",
    UriKind.Relative));

            showImageGalery("AgiosStefanos");

            foreach (RockInfo it in RockInfoCollection)
            {
                if (it.imageName.Contains("AgiosStefanos1") == true)
                {
                    RockInfo.Text = it.imageDescription;
                }
            }
        }

        private void AsproPounti_Click(object sender, RoutedEventArgs e)
        {
            SyrosGeoMap.SetValue(Grid.RowSpanProperty, 2);

            SyrosGeoMap.SetValue(Grid.ColumnSpanProperty, 1);

            ImageViewerPanel.Visibility = Visibility.Visible;
            ImageViewer.Source = new BitmapImage(new Uri(@"/Images/AsproPounti/AsproPounti1.jpg",
    UriKind.Relative));
            MyBackground.Source = new BitmapImage(new Uri(@"", UriKind.Relative));

            showImageGalery("AsproPounti");

            foreach (RockInfo it in RockInfoCollection)
```

```
        {
            if (it.imageName.Contains("AsproPounti1") == true)
            {
                RockInfo.Text = it.imageDescription;
            }
        }
    }

    private void AnoSyros_Click(object sender, RoutedEventArgs e)
    {
        SyrosGeoMap.SetValue(Grid.RowSpanProperty, 2);

        SyrosGeoMap.SetValue(Grid.ColumnSpanProperty, 1);

        ImageViewerPanel.Visibility = Visibility.Visible;
        ImageViewer.Source = new BitmapImage(new Uri(@"/Images/AnoSyros/AnoSyros1.jpg",
UriKind.Relative));

        showImageGalery("AnoSyros");

        foreach (RockInfo it in RockInfoCollection)
        {
            if (it.imageName.Contains("AnoSyros1") == true)
            {
                RockInfo.Text = it.imageDescription;
            }
        }
    }

    private void Foinikas_Click(object sender, RoutedEventArgs e)
    {
        SyrosGeoMap.SetValue(Grid.RowSpanProperty, 2);

        SyrosGeoMap.SetValue(Grid.ColumnSpanProperty, 1);

        ImageViewerPanel.Visibility = Visibility.Visible;
        ImageViewer.Source = new BitmapImage(new Uri(@"/Images/Foinikas/Foinikas1.jpg",
UriKind.Relative));

        showImageGalery("Foinikas");

        foreach (RockInfo it in RockInfoCollection)
        {
            if (it.imageName.Contains("Foinikas1") == true)
```

```
            {
               RockInfo.Text = it.imageDescription;
            }
         }
      }

      private void Abelaki_Click(object sender, RoutedEventArgs e)
      {
         SyrosGeoMap.SetValue(Grid.RowSpanProperty, 2);

         SyrosGeoMap.SetValue(Grid.ColumnSpanProperty, 1);

         ImageViewerPanel.Visibility = Visibility.Visible;
         ImageViewer.Source = new BitmapImage(new Uri(@"/Images/Abelaki/Abelaki1.jpg",
UriKind.Relative));

         showImageGalery("Abelaki");

         foreach (RockInfo it in RockInfoCollection)
         {
            if (it.imageName.Contains("Abelaki1") == true)
            {
               RockInfo.Text = it.imageDescription;
            }
         }
      }

      private void Fabrika_Click(object sender, RoutedEventArgs e)
      {
         SyrosGeoMap.SetValue(Grid.RowSpanProperty, 2);

         SyrosGeoMap.SetValue(Grid.ColumnSpanProperty, 1);

         ImageViewerPanel.Visibility = Visibility.Visible;
         ImageViewer.Source = new BitmapImage(new Uri(@"/Images/Fabrika/Fabrika1.jpg",
UriKind.Relative));

         showImageGalery("Fabrika");

         foreach (RockInfo it in RockInfoCollection)
         {
            if (it.imageName.Contains("Fabrika1") == true)
            {
               RockInfo.Text = it.imageDescription;
```

```
            }
        }
    }

    private void GriaPounta_Click(object sender, RoutedEventArgs e)
    {
        SyrosGeoMap.SetValue(Grid.RowSpanProperty, 2);

        SyrosGeoMap.SetValue(Grid.ColumnSpanProperty, 1);

        ImageViewerPanel.Visibility = Visibility.Visible;
        ImageViewer.Source = new BitmapImage(new Uri(@"/Images/GriaPounta/GriaPounta1.jpg",
UriKind.Relative));

        showImageGalery("GriaPounta");

        foreach (RockInfo it in RockInfoCollection)
        {
            if (it.imageName.Contains("GriaPounta1") == true)
            {
                RockInfo.Text = it.imageDescription;
                RockPhotoTitle.Text = "Eriana";
            }
        }
    }

    private void Kampos_Click(object sender, RoutedEventArgs e)
    {
        SyrosGeoMap.SetValue(Grid.RowSpanProperty, 2);

        SyrosGeoMap.SetValue(Grid.ColumnSpanProperty, 1);

        ImageViewerPanel.Visibility = Visibility.Visible;
        ImageViewer.Source = new BitmapImage(new Uri(@"/Images/Kampos/Kampos1.jpg",
UriKind.Relative));

        showImageGalery("Kampos");

        foreach (RockInfo it in RockInfoCollection)
        {
            if (it.imageName.Contains("Kampos1") == true)
            {
                RockInfo.Text = it.imageDescription;
            }
```

```
        }
    }

    private void Komito_Click(object sender, RoutedEventArgs e)
    {
        SyrosGeoMap.SetValue(Grid.RowSpanProperty, 2);

        SyrosGeoMap.SetValue(Grid.ColumnSpanProperty, 1);

        ImageViewerPanel.Visibility = Visibility.Visible;
        ImageViewer.Source = new BitmapImage(new Uri(@"/Images/Komito/Komito1.jpg",
UriKind.Relative));

        showImageGalery("Komito");

        foreach (RockInfo it in RockInfoCollection)
        {
            if (it.imageName.Contains("Komito1") == true)
            {
                RockInfo.Text = it.imageDescription;
            }
        }
    }

    private void Lakkoi_Click(object sender, RoutedEventArgs e)
    {
        SyrosGeoMap.SetValue(Grid.RowSpanProperty, 2);

        SyrosGeoMap.SetValue(Grid.ColumnSpanProperty, 1);

        ImageViewerPanel.Visibility = Visibility.Visible;
        ImageViewer.Source = new BitmapImage(new Uri(@"/Images/Lakkoi/Lakkoi1.jpg",
UriKind.Relative));

        showImageGalery("Lakkoi");

        foreach (RockInfo it in RockInfoCollection)
        {
            if (it.imageName.Contains("Lakkoi1") == true)
            {
                RockInfo.Text = it.imageDescription;
            }
        }
    }
```

```
        private void Lia_Click(object sender, RoutedEventArgs e)
        {
            SyrosGeoMap.SetValue(Grid.RowSpanProperty, 2);

            SyrosGeoMap.SetValue(Grid.ColumnSpanProperty, 1);

            ImageViewerPanel.Visibility = Visibility.Visible;
            ImageViewer.Source = new BitmapImage(new Uri(@"/Images/Lia/Lia1.jpg", UriKind.Relative));

            showImageGalery("Lia");

            foreach (RockInfo it in RockInfoCollection)
            {
                if (it.imageName.Contains("Lia1") == true)
                {
                    RockInfo.Text = it.imageDescription;
                }
            }
        }

        private void Marmari_Click(object sender, RoutedEventArgs e)
        {
            SyrosGeoMap.SetValue(Grid.RowSpanProperty, 2);

            SyrosGeoMap.SetValue(Grid.ColumnSpanProperty, 1);

            ImageViewerPanel.Visibility = Visibility.Visible;
            ImageViewer.Source = new BitmapImage(new Uri(@"/Images/Marmari/Marmari1.jpg",
UriKind.Relative));

            showImageGalery("Marmari");

            foreach (RockInfo it in RockInfoCollection)
            {
                if (it.imageName.Contains("Marmari1") == true)
                {
                    RockInfo.Text = it.imageDescription;
                }
            }
        }

        private void MavroPounti_Click(object sender, RoutedEventArgs e)
        {
```

```
            SyrosGeoMap.SetValue(Grid.RowSpanProperty, 2);

            SyrosGeoMap.SetValue(Grid.ColumnSpanProperty, 1);

            ImageViewerPanel.Visibility = Visibility.Visible;
            ImageViewer.Source = new BitmapImage(new Uri(@"/Images/MavroPounti/MavroPounti1.jpg",
UriKind.Relative));

            showImageGalery("MavroPounti");

            foreach (RockInfo it in RockInfoCollection)
            {
                if (it.imageName.Contains("MavroPounti1") == true)
                {
                    RockInfo.Text = it.imageDescription;
                }
            }
        }

        private void MegasGialos_Click(object sender, RoutedEventArgs e)
        {
            SyrosGeoMap.SetValue(Grid.RowSpanProperty, 2);

            SyrosGeoMap.SetValue(Grid.ColumnSpanProperty, 1);

            ImageViewerPanel.Visibility = Visibility.Visible;
            ImageViewer.Source = new BitmapImage(new Uri(@"/Images/MegasGialos/MegasGialos1.jpg",
UriKind.Relative));

            showImageGalery("MegasGialos");

            foreach (RockInfo it in RockInfoCollection)
            {
                if (it.imageName.Contains("MegasGialos1") == true)
                {
                    RockInfo.Text = it.imageDescription;
                }
            }
        }

        private void Vari_Click(object sender, RoutedEventArgs e)
        {
            SyrosGeoMap.SetValue(Grid.RowSpanProperty, 2);
```

```
    SyrosGeoMap.SetValue(Grid.ColumnSpanProperty, 1);

    ImageViewerPanel.Visibility = Visibility.Visible;
    ImageViewer.Source = new BitmapImage(new Uri(@"/Images/Vari/Vari1.jpg", UriKind.Relative));

    showImageGalery("Vari");

    foreach (RockInfo it in RockInfoCollection)
    {
        if (it.imageName.Contains("Vari1") == true)
        {
            RockInfo.Text = it.imageDescription;
        }
    }
}

private void SyrosGeoMap_MouseRightButtonDown(object sender, MouseButtonEventArgs e)
{
    SyrosGeoMap.SetValue(Grid.ColumnSpanProperty, 3);

    AgiosStefanos.Visibility = Visibility.Hidden;
    Aerolithos.Visibility = Visibility.Hidden;
    AnoSyros.Visibility = Visibility.Hidden;
    Abelaki.Visibility = Visibility.Hidden;
    Fabrika.Visibility = Visibility.Hidden;
    Foinikas.Visibility = Visibility.Hidden;
    Kampos.Visibility = Visibility.Hidden;
    Komito.Visibility = Visibility.Hidden;
    Lakkoi.Visibility = Visibility.Hidden;
    Lia.Visibility = Visibility.Hidden;
    Marmari.Visibility = Visibility.Hidden;
    MegasGialos.Visibility = Visibility.Hidden;
    Vari.Visibility = Visibility.Hidden;
    ImageViewerPanel.Visibility = Visibility.Hidden;
}


private void showImageGalery(string location)
{
    ImageViewerPanel.Visibility = Visibility.Visible;
    //int count = 1;
    MyBackground.Visibility = Visibility.Hidden;

    if (location == "Aerolithos")
```

```
        {
           //set image sources and border visibility.visible
           ImageViewer.Visibility = Visibility.Visible;
           ImageViewer.Source = new BitmapImage(new Uri(@"/Images/Aerolithos/Aerolithos1.jpg",
UriKind.Relative));
           setRockImageData(ImageViewer);

           ThumbNail1.Source = new BitmapImage(new Uri(@"/Images/Aerolithos/Aerolithos1.jpg",
UriKind.Relative));
           ThumbNail2.Source = new BitmapImage(new Uri(@"/Images/Aerolithos/Aerolithos2.jpg",
UriKind.Relative));
           ThumbNail3.Source = new BitmapImage(new Uri(@"/Images/Aerolithos/Aerolithos3.jpg",
UriKind.Relative));
           ThumbNail4.Source = new BitmapImage(new Uri(@"/Images/Aerolithos/Aerolithos4.jpg",
UriKind.Relative));
           ThumbNail5.Source = new BitmapImage(new Uri(@"/Images/Aerolithos/Aerolithos5.jpg",
UriKind.Relative));
           ThumbNail6.Source = new BitmapImage(new Uri(@"/Images/Aerolithos/Aerolithos6.jpg",
UriKind.Relative));
           ThumbNail7.Source = new BitmapImage(new Uri(@"/Images/Aerolithos/Aerolithos7.jpg",
UriKind.Relative));
           BorderThumbNail1.Visibility = Visibility.Visible;
           BorderThumbNail2.Visibility = Visibility.Visible;
           BorderThumbNail3.Visibility = Visibility.Visible;
           BorderThumbNail4.Visibility = Visibility.Visible;
           BorderThumbNail5.Visibility = Visibility.Visible;
           BorderThumbNail6.Visibility = Visibility.Visible;
           BorderThumbNail7.Visibility = Visibility.Visible;
           //set image sources NULL and border visibility.collapsed
           ThumbNail8.Source = null;
           BorderThumbNail8.Visibility = Visibility.Collapsed;
        }

        if (location == "AsproPounti")
        {
           //set image sources and border visibility.visible
           ImageViewer.Visibility = Visibility.Visible;
           ImageViewer.Source = new BitmapImage(new Uri(@"/Images/AsproPounti/AsproPounti1.jpg",
UriKind.Relative));
           setRockImageData(ImageViewer);

           ThumbNail1.Source = new BitmapImage(new Uri(@"/Images/AsproPounti/AsproPounti1.jpg",
UriKind.Relative));
```

```
            ThumbNail2.Source = new BitmapImage(new Uri(@"/Images/AsproPounti/AsproPounti2.jpg",
UriKind.Relative));
            ThumbNail3.Source = new BitmapImage(new Uri(@"/Images/AsproPounti/AsproPounti3.jpg",
UriKind.Relative));
            ThumbNail4.Source = new BitmapImage(new Uri(@"/Images/AsproPounti/AsproPounti4.jpg",
UriKind.Relative));
            ThumbNail5.Source = new BitmapImage(new Uri(@"/Images/AsproPounti/AsproPounti5.jpg",
UriKind.Relative));
            ThumbNail6.Source = new BitmapImage(new Uri(@"/Images/AsproPounti/AsproPounti6.jpg",
UriKind.Relative));
            ThumbNail7.Source = new BitmapImage(new Uri(@"/Images/AsproPounti/AsproPounti7.jpg",
UriKind.Relative));
            ThumbNail8.Source = new BitmapImage(new Uri(@"/Images/AsproPounti/AsproPounti8.jpg",
UriKind.Relative));
            BorderThumbNail1.Visibility = Visibility.Visible;
            BorderThumbNail2.Visibility = Visibility.Visible;
            BorderThumbNail3.Visibility = Visibility.Visible;
            BorderThumbNail4.Visibility = Visibility.Visible;
            BorderThumbNail5.Visibility = Visibility.Visible;
            BorderThumbNail6.Visibility = Visibility.Visible;
            BorderThumbNail7.Visibility = Visibility.Visible;
            BorderThumbNail8.Visibility = Visibility.Visible;

            MyBackground.Source = new BitmapImage(new Uri(@"", UriKind.Relative));
        }

        if (location == "AgiosStefanos")
        {
            //set image sources and border visibility.visible
            ImageViewer.Visibility = Visibility.Visible;
            ImageViewer.Source = new BitmapImage(new
Uri(@"/Images/AgiosStefanos/AgiosStefanos1.jpg", UriKind.Relative));
            setRockImageData(ImageViewer);

            ThumbNail1.Source = new BitmapImage(new
Uri(@"/Images/AgiosStefanos/AgiosStefanos1.jpg", UriKind.Relative));
            ThumbNail2.Source = new BitmapImage(new
Uri(@"/Images/AgiosStefanos/AgiosStefanos2.jpg", UriKind.Relative));
            ThumbNail3.Source = new BitmapImage(new
Uri(@"/Images/AgiosStefanos/AgiosStefanos3.jpg", UriKind.Relative));
            ThumbNail4.Source = new BitmapImage(new
Uri(@"/Images/AgiosStefanos/AgiosStefanos4.jpg", UriKind.Relative));
            ThumbNail5.Source = new BitmapImage(new
Uri(@"/Images/AgiosStefanos/AgiosStefanos5.jpg", UriKind.Relative));
```

```
            ThumbNail6.Source = new BitmapImage(new Uri(@"/Images/AgiosStefanos/AgiosStefanos6.jpg", UriKind.Relative));
            BorderThumbNail1.Visibility = Visibility.Visible;
            BorderThumbNail2.Visibility = Visibility.Visible;
            BorderThumbNail3.Visibility = Visibility.Visible;
            BorderThumbNail4.Visibility = Visibility.Visible;
            BorderThumbNail5.Visibility = Visibility.Visible;
            BorderThumbNail6.Visibility = Visibility.Visible;

            //set image sources NULL and border visibility.collapsed

            ThumbNail7.Source = null;
            BorderThumbNail7.Visibility = Visibility.Collapsed;
            ThumbNail8.Source = null;
            BorderThumbNail8.Visibility = Visibility.Collapsed;
          }

          if (location == "AnoSyros")
          {
            //set image sources and border visibility.visible
            ImageViewer.Visibility = Visibility.Visible;
            ImageViewer.Source = new BitmapImage(new Uri(@"/Images/AnoSyros/AnoSyros1.jpg", UriKind.Relative));
            setRockImageData(ImageViewer);

            ThumbNail1.Source = new BitmapImage(new Uri(@"/Images/AnoSyros/AnoSyros1.jpg", UriKind.Relative));
            ThumbNail2.Source = new BitmapImage(new Uri(@"/Images/AnoSyros/AnoSyros2.jpg", UriKind.Relative));
            ThumbNail3.Source = new BitmapImage(new Uri(@"/Images/AnoSyros/AnoSyros3.jpg", UriKind.Relative));
            ThumbNail4.Source = new BitmapImage(new Uri(@"/Images/AnoSyros/AnoSyros4.jpg", UriKind.Relative));
            ThumbNail5.Source = new BitmapImage(new Uri(@"/Images/AnoSyros/AnoSyros5.jpg", UriKind.Relative));
            ThumbNail6.Source = new BitmapImage(new Uri(@"/Images/AnoSyros/AnoSyros6.jpg", UriKind.Relative));
            ThumbNail7.Source = new BitmapImage(new Uri(@"/Images/AnoSyros/AnoSyros7.jpg", UriKind.Relative));
            BorderThumbNail1.Visibility = Visibility.Visible;
            BorderThumbNail2.Visibility = Visibility.Visible;
            BorderThumbNail3.Visibility = Visibility.Visible;
            BorderThumbNail4.Visibility = Visibility.Visible;
            BorderThumbNail5.Visibility = Visibility.Visible;
```

```
            BorderThumbNail6.Visibility = Visibility.Visible;
            BorderThumbNail7.Visibility = Visibility.Visible;
            //set image sources NULL and border visibility.collapsed

            ThumbNail8.Source = null;
            BorderThumbNail8.Visibility = Visibility.Collapsed;
        }

        if (location == "Abelaki")
        {
            //set image sources and border visibility.visible
            ImageViewer.Visibility = Visibility.Visible;
            ImageViewer.Source = new BitmapImage(new Uri(@"/Images/Abelaki/Abelaki1.jpg",
UriKind.Relative));
            setRockImageData(ImageViewer);

            ThumbNail1.Source = new BitmapImage(new Uri(@"/Images/Abelaki/Abelaki1.jpg",
UriKind.Relative));
            ThumbNail2.Source = new BitmapImage(new Uri(@"/Images/Abelaki/Abelaki2.jpg",
UriKind.Relative));
            ThumbNail3.Source = new BitmapImage(new Uri(@"/Images/Abelaki/Abelaki3.jpg",
UriKind.Relative));
            ThumbNail4.Source = new BitmapImage(new Uri(@"/Images/Abelaki/Abelaki4.jpg",
UriKind.Relative));
            ThumbNail5.Source = new BitmapImage(new Uri(@"/Images/Abelaki/Abelaki5.jpg",
UriKind.Relative));
            ThumbNail6.Source = new BitmapImage(new Uri(@"/Images/Abelaki/Abelaki6.jpg",
UriKind.Relative));
            ThumbNail7.Source = new BitmapImage(new Uri(@"/Images/Abelaki/Abelaki7.jpg",
UriKind.Relative));
            ThumbNail8.Source = new BitmapImage(new Uri(@"/Images/Abelaki/Abelaki8.jpg",
UriKind.Relative));

            BorderThumbNail1.Visibility = Visibility.Visible;
            BorderThumbNail2.Visibility = Visibility.Visible;
            BorderThumbNail3.Visibility = Visibility.Visible;
            BorderThumbNail4.Visibility = Visibility.Visible;
            BorderThumbNail5.Visibility = Visibility.Visible;
            BorderThumbNail6.Visibility = Visibility.Visible;
            BorderThumbNail7.Visibility = Visibility.Visible;
            BorderThumbNail8.Visibility = Visibility.Visible;
        }

        if (location == "Fabrika")
```

```
{
   //set image sources and border visibility.visible
   ImageViewer.Visibility = Visibility.Visible;
   ImageViewer.Source = new BitmapImage(new Uri(@"/Images/Fabrika/Fabrika1.jpg",
UriKind.Relative));
   setRockImageData(ImageViewer);

   ThumbNail1.Source = new BitmapImage(new Uri(@"/Images/Fabrika/Fabrika1.jpg",
UriKind.Relative));
   ThumbNail2.Source = new BitmapImage(new Uri(@"/Images/Fabrika/Fabrika2.jpg",
UriKind.Relative));
   ThumbNail3.Source = new BitmapImage(new Uri(@"/Images/Fabrika/Fabrika3.jpg",
UriKind.Relative));
   ThumbNail4.Source = new BitmapImage(new Uri(@"/Images/Fabrika/Fabrika4.jpg",
UriKind.Relative));
   ThumbNail5.Source = new BitmapImage(new Uri(@"/Images/Fabrika/Fabrika5.jpg",
UriKind.Relative));
   ThumbNail6.Source = new BitmapImage(new Uri(@"/Images/Fabrika/Fabrika6.jpg",
UriKind.Relative));
   BorderThumbNail1.Visibility = Visibility.Visible;
   BorderThumbNail2.Visibility = Visibility.Visible;
   BorderThumbNail3.Visibility = Visibility.Visible;
   BorderThumbNail4.Visibility = Visibility.Visible;
   BorderThumbNail5.Visibility = Visibility.Visible;
   BorderThumbNail6.Visibility = Visibility.Visible;
   //set image sources NULL and border visibility.collapsed
   ThumbNail7.Source = null;
   BorderThumbNail7.Visibility = Visibility.Collapsed;
   ThumbNail8.Source = null;
   BorderThumbNail8.Visibility = Visibility.Collapsed;
}

if (location == "Foinikas")
{
   //set image sources and border visibility.visible
   ImageViewer.Visibility = Visibility.Visible;
   ImageViewer.Source = new BitmapImage(new Uri(@"/Images/Foinikas/Foinikas1.jpg",
UriKind.Relative));
   setRockImageData(ImageViewer);

   ThumbNail1.Source = new BitmapImage(new Uri(@"/Images/Foinikas/Foinikas1.jpg",
UriKind.Relative));
   ThumbNail2.Source = new BitmapImage(new Uri(@"/Images/Foinikas/Foinikas2.jpg",
UriKind.Relative));
```

```
            ThumbNail3.Source = new BitmapImage(new Uri(@"/Images/Foinikas/Foinikas3.jpg",
UriKind.Relative));
            ThumbNail4.Source = new BitmapImage(new Uri(@"/Images/Foinikas/Foinikas4.jpg",
UriKind.Relative));
            ThumbNail5.Source = new BitmapImage(new Uri(@"/Images/Foinikas/Foinikas5.jpg",
UriKind.Relative));
            ThumbNail6.Source = new BitmapImage(new Uri(@"/Images/Foinikas/Foinikas6.jpg",
UriKind.Relative));
            BorderThumbNail1.Visibility = Visibility.Visible;
            BorderThumbNail2.Visibility = Visibility.Visible;
            BorderThumbNail3.Visibility = Visibility.Visible;
            BorderThumbNail5.Visibility = Visibility.Visible;
            BorderThumbNail5.Visibility = Visibility.Visible;
            BorderThumbNail6.Visibility = Visibility.Visible;

            //set image sources NULL and border visibility.collapsed
            ThumbNail7.Source = null;
            BorderThumbNail7.Visibility = Visibility.Collapsed;
            ThumbNail8.Source = null;
            BorderThumbNail8.Visibility = Visibility.Collapsed;
        }

        if (location == "GriaPounta")
        {
            //set image sources and border visibility.visible
            ImageViewer.Visibility = Visibility.Visible;
            ImageViewer.Source = new BitmapImage(new Uri(@"/Images/GriaPounta/GriaPounta1.jpg",
UriKind.Relative));
            setRockImageData(ImageViewer);

            ThumbNail1.Source = new BitmapImage(new Uri(@"/Images/GriaPounta/GriaPounta1.jpg",
UriKind.Relative));
            ThumbNail2.Source = new BitmapImage(new Uri(@"/Images/GriaPounta/GriaPounta2.jpg",
UriKind.Relative));
            ThumbNail3.Source = new BitmapImage(new Uri(@"/Images/GriaPounta/GriaPounta3.jpg",
UriKind.Relative));
            ThumbNail4.Source = new BitmapImage(new Uri(@"/Images/GriaPounta/GriaPounta4.jpg",
UriKind.Relative));
            ThumbNail5.Source = new BitmapImage(new Uri(@"/Images/GriaPounta/GriaPounta5.jpg",
UriKind.Relative));
            ThumbNail6.Source = new BitmapImage(new Uri(@"/Images/GriaPounta/GriaPounta6.jpg",
UriKind.Relative));
            ThumbNail7.Source = new BitmapImage(new Uri(@"/Images/GriaPounta/GriaPounta7.jpg",
UriKind.Relative));
```

```
            ThumbNail8.Source = new BitmapImage(new Uri(@"/Images/GriaPounta/GriaPounta8.jpg",
UriKind.Relative));

            BorderThumbNail1.Visibility = Visibility.Visible;
            BorderThumbNail2.Visibility = Visibility.Visible;
            BorderThumbNail3.Visibility = Visibility.Visible;
            BorderThumbNail5.Visibility = Visibility.Visible;
            BorderThumbNail5.Visibility = Visibility.Visible;
            BorderThumbNail6.Visibility = Visibility.Visible;
            BorderThumbNail7.Visibility = Visibility.Visible;
            BorderThumbNail8.Visibility = Visibility.Visible;


            //set image sources NULL and border visibility.collapsed

        }

        if (location == "Kampos")
        {
            //set image sources and border visibility.visible
            ImageViewer.Visibility = Visibility.Visible;
            ImageViewer.Source = new BitmapImage(new Uri(@"/Images/Kampos/Kampos1.jpg",
UriKind.Relative));
            setRockImageData(ImageViewer);

            ThumbNail1.Source = new BitmapImage(new Uri(@"/Images/Kampos/Kampos1.jpg",
UriKind.Relative));
            ThumbNail2.Source = new BitmapImage(new Uri(@"/Images/Kampos/Kampos2.jpg",
UriKind.Relative));
            ThumbNail3.Source = new BitmapImage(new Uri(@"/Images/Kampos/Kampos3.jpg",
UriKind.Relative));
            ThumbNail4.Source = new BitmapImage(new Uri(@"/Images/Kampos/Kampos4.jpg",
UriKind.Relative));
            ThumbNail5.Source = new BitmapImage(new Uri(@"/Images/Kampos/Kampos5.jpg",
UriKind.Relative));
            ThumbNail6.Source = new BitmapImage(new Uri(@"/Images/Kampos/Kampos6.jpg",
UriKind.Relative));
            ThumbNail7.Source = new BitmapImage(new Uri(@"/Images/Kampos/Kampos7.jpg",
UriKind.Relative));
            BorderThumbNail1.Visibility = Visibility.Visible;
            BorderThumbNail2.Visibility = Visibility.Visible;
            BorderThumbNail3.Visibility = Visibility.Visible;
            BorderThumbNail4.Visibility = Visibility.Visible;
            BorderThumbNail5.Visibility = Visibility.Visible;
```

```
            BorderThumbNail6.Visibility = Visibility.Visible;
            BorderThumbNail7.Visibility = Visibility.Visible;
            //set image sources NULL and border visibility.collapsed
            ThumbNail8.Source = null;
            BorderThumbNail8.Visibility = Visibility.Collapsed;
        }

        if (location == "Komito")
        {
            //set image sources and border visibility.visible
            ImageViewer.Visibility = Visibility.Visible;
            ImageViewer.Source = new BitmapImage(new Uri(@"/Images/Komito/Komito1.jpg",
UriKind.Relative));
            setRockImageData(ImageViewer);

            ThumbNail1.Source = new BitmapImage(new Uri(@"/Images/Komito/Komito1.jpg",
UriKind.Relative));
            ThumbNail2.Source = new BitmapImage(new Uri(@"/Images/Komito/Komito2.jpg",
UriKind.Relative));
            ThumbNail3.Source = new BitmapImage(new Uri(@"/Images/Komito/Komito3.jpg",
UriKind.Relative));
            ThumbNail4.Source = new BitmapImage(new Uri(@"/Images/Komito/Komito4.jpg",
UriKind.Relative));
            ThumbNail5.Source = new BitmapImage(new Uri(@"/Images/Komito/Komito5.jpg",
UriKind.Relative));
            BorderThumbNail1.Visibility = Visibility.Visible;
            BorderThumbNail2.Visibility = Visibility.Visible;
            BorderThumbNail3.Visibility = Visibility.Visible;
            BorderThumbNail4.Visibility = Visibility.Visible;
            BorderThumbNail5.Visibility = Visibility.Visible;
            //set image sources NULL and border visibility.collapsed
            ThumbNail6.Source = null;
            BorderThumbNail6.Visibility = Visibility.Collapsed;
            ThumbNail7.Source = null;
            BorderThumbNail7.Visibility = Visibility.Collapsed;
            ThumbNail8.Source = null;
            BorderThumbNail8.Visibility = Visibility.Collapsed;
        }

        if (location == "Lakkoi")
        {
            //set image sources and border visibility.visible
            ImageViewer.Visibility = Visibility.Visible;
```

```
            ImageViewer.Source = new BitmapImage(new Uri(@"/Images/Lakkoi/Lakkoi1.jpg",
UriKind.Relative));
            setRockImageData(ImageViewer);

            ThumbNail1.Source = new BitmapImage(new Uri(@"/Images/Lakkoi/Lakkoi1.jpg",
UriKind.Relative));
            ThumbNail2.Source = new BitmapImage(new Uri(@"/Images/Lakkoi/Lakkoi2.jpg",
UriKind.Relative));
            ThumbNail3.Source = new BitmapImage(new Uri(@"/Images/Lakkoi/Lakkoi3.jpg",
UriKind.Relative));
            ThumbNail4.Source = new BitmapImage(new Uri(@"/Images/Lakkoi/Lakkoi4.jpg",
UriKind.Relative));
            ThumbNail5.Source = new BitmapImage(new Uri(@"/Images/Lakkoi/Lakkoi5.jpg",
UriKind.Relative));

            BorderThumbNail1.Visibility = Visibility.Visible;
            BorderThumbNail2.Visibility = Visibility.Visible;
            BorderThumbNail3.Visibility = Visibility.Visible;
            BorderThumbNail4.Visibility = Visibility.Visible;
            BorderThumbNail5.Visibility = Visibility.Visible;

            //set image sources NULL and border visibility.collapsed
            ThumbNail6.Source = null;
            BorderThumbNail6.Visibility = Visibility.Collapsed;
            ThumbNail7.Source = null;
            BorderThumbNail7.Visibility = Visibility.Collapsed;
            ThumbNail8.Source = null;
            BorderThumbNail8.Visibility = Visibility.Collapsed;
        }

        if (location == "Lia")
        {
            //set image sources and border visibility.visible
            ImageViewer.Visibility = Visibility.Visible;
            ImageViewer.Source = new BitmapImage(new Uri(@"/Images/Lia/Lia1.jpg", UriKind.Relative));
            setRockImageData(ImageViewer);

            ThumbNail1.Source = new BitmapImage(new Uri(@"/Images/Lia/Lia1.JPG", UriKind.Relative));
            ThumbNail2.Source = new BitmapImage(new Uri(@"/Images/Lia/Lia2.JPG", UriKind.Relative));
            ThumbNail3.Source = new BitmapImage(new Uri(@"/Images/Lia/Lia3.jpg", UriKind.Relative));
            ThumbNail4.Source = new BitmapImage(new Uri(@"/Images/Lia/Lia4.jpg", UriKind.Relative));
            ThumbNail5.Source = new BitmapImage(new Uri(@"/Images/Lia/Lia5.jpg", UriKind.Relative));
            ThumbNail6.Source = new BitmapImage(new Uri(@"/Images/Lia/Lia6.jpg", UriKind.Relative));
            BorderThumbNail1.Visibility = Visibility.Visible;
```

```
            BorderThumbNail2.Visibility = Visibility.Visible;
            BorderThumbNail3.Visibility = Visibility.Visible;
            BorderThumbNail4.Visibility = Visibility.Visible;
            BorderThumbNail5.Visibility = Visibility.Visible;
            BorderThumbNail6.Visibility = Visibility.Visible;

            //set image sources NULL and border visibility.collapsed
            ThumbNail7.Source = null;
            BorderThumbNail7.Visibility = Visibility.Collapsed;
            ThumbNail8.Source = null;
            BorderThumbNail8.Visibility = Visibility.Collapsed;
        }

        if (location == "Marmari")
        {
            //set image sources and border visibility.visible
            ImageViewer.Visibility = Visibility.Visible;
            ImageViewer.Source = new BitmapImage(new Uri(@"/Images/Marmari/Marmari1.jpg",
UriKind.Relative));
            setRockImageData(ImageViewer);

            ThumbNail1.Source = new BitmapImage(new Uri(@"/Images/Marmari/Marmari1.jpg",
UriKind.Relative));
            ThumbNail2.Source = new BitmapImage(new Uri(@"/Images/Marmari/Marmari2.jpg",
UriKind.Relative));
            ThumbNail3.Source = new BitmapImage(new Uri(@"/Images/Marmari/Marmari3.jpg",
UriKind.Relative));
            ThumbNail4.Source = new BitmapImage(new Uri(@"/Images/Marmari/Marmari4.jpg",
UriKind.Relative));
            ThumbNail5.Source = new BitmapImage(new Uri(@"/Images/Marmari/Marmari5.jpg",
UriKind.Relative));
            ThumbNail6.Source = new BitmapImage(new Uri(@"/Images/Marmari/Marmari6.jpg",
UriKind.Relative));

            BorderThumbNail1.Visibility = Visibility.Visible;
            BorderThumbNail2.Visibility = Visibility.Visible;
            BorderThumbNail3.Visibility = Visibility.Visible;
            BorderThumbNail4.Visibility = Visibility.Visible;
            BorderThumbNail5.Visibility = Visibility.Visible;
            BorderThumbNail6.Visibility = Visibility.Visible;
            //set image sources NULL and border visibility.collapsed

            ThumbNail7.Source = null;
            BorderThumbNail7.Visibility = Visibility.Collapsed;
```

```
            ThumbNail8.Source = null;
            BorderThumbNail8.Visibility = Visibility.Collapsed;
        }

        if (location == "MavroPounti")
        {
            //set image sources and border visibility.visible
            ImageViewer.Visibility = Visibility.Visible;
            ImageViewer.Source = new BitmapImage(new Uri(@"/Images/MavroPounti/MavroPounti1.jpg",
UriKind.Relative));
            setRockImageData(ImageViewer);

            ThumbNail1.Source = new BitmapImage(new Uri(@"/Images/MavroPounti/MavroPounti1.jpg",
UriKind.Relative));
            ThumbNail2.Source = new BitmapImage(new Uri(@"/Images/MavroPounti/MavroPounti2.jpg",
UriKind.Relative));
            ThumbNail3.Source = new BitmapImage(new Uri(@"/Images/MavroPounti/MavroPounti3.jpg",
UriKind.Relative));
            ThumbNail4.Source = new BitmapImage(new Uri(@"/Images/MavroPounti/MavroPounti4.jpg",
UriKind.Relative));
            ThumbNail5.Source = new BitmapImage(new Uri(@"/Images/MavroPounti/MavroPounti5.jpg",
UriKind.Relative));
            ThumbNail6.Source = new BitmapImage(new Uri(@"/Images/MavroPounti/MavroPounti6.jpg",
UriKind.Relative));
            ThumbNail7.Source = new BitmapImage(new Uri(@"/Images/MavroPounti/MavroPounti7.jpg",
UriKind.Relative));
            ThumbNail8.Source = new BitmapImage(new Uri(@"/Images/MavroPounti/MavroPounti8.jpg",
UriKind.Relative));
            BorderThumbNail1.Visibility = Visibility.Visible;
            BorderThumbNail2.Visibility = Visibility.Visible;
            BorderThumbNail3.Visibility = Visibility.Visible;
            BorderThumbNail4.Visibility = Visibility.Visible;
            BorderThumbNail5.Visibility = Visibility.Visible;
            BorderThumbNail6.Visibility = Visibility.Visible;
            BorderThumbNail7.Visibility = Visibility.Visible;
            BorderThumbNail8.Visibility = Visibility.Visible;
        }

        if (location == "MegasGialos")
        {
            //set image sources and border visibility.visible
            ImageViewer.Visibility = Visibility.Visible;
            ImageViewer.Source = new BitmapImage(new Uri(@"/Images/MegasGialos/MegasGialos1.jpg",
UriKind.Relative));
```

```
            setRockImageData(ImageViewer);

            ThumbNail1.Source = new BitmapImage(new Uri(@"/Images/MegasGialos/MegasGialos1.jpg",
UriKind.Relative));
            ThumbNail2.Source = new BitmapImage(new Uri(@"/Images/MegasGialos/MegasGialos2.jpg",
UriKind.Relative));
            ThumbNail3.Source = new BitmapImage(new Uri(@"/Images/MegasGialos/MegasGialos3.jpg",
UriKind.Relative));
            ThumbNail4.Source = new BitmapImage(new Uri(@"/Images/MegasGialos/MegasGialos4.jpg",
UriKind.Relative));
            ThumbNail5.Source = new BitmapImage(new Uri(@"/Images/MegasGialos/MegasGialos5.jpg",
UriKind.Relative));
            ThumbNail6.Source = new BitmapImage(new Uri(@"/Images/MegasGialos/MegasGialos6.jpg",
UriKind.Relative));
            BorderThumbNail1.Visibility = Visibility.Visible;
            BorderThumbNail2.Visibility = Visibility.Visible;
            BorderThumbNail3.Visibility = Visibility.Visible;
            BorderThumbNail4.Visibility = Visibility.Visible;
            BorderThumbNail5.Visibility = Visibility.Visible;
            BorderThumbNail6.Visibility = Visibility.Visible;

            //set image sources NULL and border visibility.collapsed
            ThumbNail7.Source = null;
            BorderThumbNail7.Visibility = Visibility.Collapsed;
            ThumbNail8.Source = null;
            BorderThumbNail8.Visibility = Visibility.Collapsed;
          }


          if (location == "Vari")
          {
            //set image sources and border visibility.visible
            ImageViewer.Visibility = Visibility.Visible;
            ImageViewer.Source = new BitmapImage(new Uri(@"/Images/Vari/Vari1.jpg",
UriKind.Relative));
            setRockImageData(ImageViewer);

            ThumbNail1.Source = new BitmapImage(new Uri(@"/Images/Vari/Vari1.jpg", UriKind.Relative));
            ThumbNail2.Source = new BitmapImage(new Uri(@"/Images/Vari/Vari2.jpg", UriKind.Relative));
            ThumbNail3.Source = new BitmapImage(new Uri(@"/Images/Vari/Vari3.jpg", UriKind.Relative));
            ThumbNail4.Source = new BitmapImage(new Uri(@"/Images/Vari/Vari4.jpg", UriKind.Relative));
            ThumbNail5.Source = new BitmapImage(new Uri(@"/Images/Vari/Vari5.jpg", UriKind.Relative));
            ThumbNail6.Source = new BitmapImage(new Uri(@"/Images/Vari/Vari6.jpg", UriKind.Relative));
            ThumbNail1.Visibility = Visibility.Visible;
```

```
            ThumbNail2.Visibility = Visibility.Visible;
            ThumbNail3.Visibility = Visibility.Visible;
            ThumbNail4.Visibility = Visibility.Visible;
            ThumbNail5.Visibility = Visibility.Visible;
            ThumbNail6.Visibility = Visibility.Visible;

            //set image sources NULL and border visibility.collapsed
            ThumbNail7.Source = null;
            ThumbNail7.Visibility = Visibility.Collapsed;
            ThumbNail8.Source = null;
            ThumbNail8.Visibility = Visibility.Collapsed;
        }
    }


    private void ThumbNail_MouseDown(object sender, MouseButtonEventArgs e)
    {
        Image img = (Image)sender;
        ImageViewer.Source = img.Source; //η εικόνα που παίρνει ο ImageViewer να γίνει η εικόνα που
έχει το thumbnail1
        setRockImageData(img);
    }

    private void setRockImageData(Image img) {
        String[] strings = new String[4];
        strings = ShowImageInfo(img);
        RockPhotoTitle.Text = strings[0];
        RockPhotoSubTitle.Text = strings[1];
        RockInfo.Text = strings[2];
        LocationInMuseum.Source = new BitmapImage(new Uri(strings[3], UriKind.Relative));
    }


    public String[] ShowImageInfo(Image ClickedThumbnail)
    {
        String[] strings = new String[4];

        int found = 0;
        string txt = "";

        found = ClickedThumbnail.Source.ToString().LastIndexOf("/");
        txt = ClickedThumbnail.Source.ToString().Substring(found + 1); //η διεύθυνση της εικόνας ΧΩΡΙΣ το
(τελευταίο) / (π.χ AnoSyros1.JPG)
```

```
        txt = txt.Substring(0, txt.Length - 4); // από το κείμενο που έχει θα αφαιρέσει τους τελευταίους χαρακτήρες  (π.χ AnoSyros1.JPG --> AnoSyros1)

        foreach (RockInfo it in RockInfoCollection) //διατρέχει όλη την λίστα RockInfoCollection για κάθε ένα αντικείμενο της κλάσης RockInfo που περιέχει αυτή η λίστα
        {
          if (it.imageName.Contains(txt) == true) //το κείμενο txt (π.χ AnoSyros1) ταιριάζει (ισούται/επαληθεύται) με το όνομα κάποιου αντικείμενο της κλάσης RockInfo που περιέχει αυτή η λίστα
          {
            strings[0] = it.imageTitle;
            strings[1] = it.imageSubTitle;
            strings[2] = it.imageDescription;
            strings[3] = it.locationInMuseum;
          }
        }

        return strings; //επεστρέψε το στο πόγραμμα
      }

      private void ThumbNail_MouseEnter(object sender, MouseEventArgs e)
      {
        Image img = (Image)sender;
        if (img.Name.Equals("ThumbNail1"))
        {
          BorderThumbNail1.BorderBrush = new SolidColorBrush(Colors.DeepSkyBlue);
        }
        else if (img.Name.Equals("ThumbNail2"))
        {
          BorderThumbNail2.BorderBrush = new SolidColorBrush(Colors.DeepSkyBlue);
        }
        else if (img.Name.Equals("ThumbNail3"))
        {
          BorderThumbNail3.BorderBrush = new SolidColorBrush(Colors.DeepSkyBlue);
        }
        else if (img.Name.Equals("ThumbNail4"))
        {
          BorderThumbNail4.BorderBrush = new SolidColorBrush(Colors.DeepSkyBlue);
        }
        else if (img.Name.Equals("ThumbNail5"))
        {
          BorderThumbNail5.BorderBrush = new SolidColorBrush(Colors.DeepSkyBlue);
        }
        else if (img.Name.Equals("ThumbNail6"))
        {
```

```
            BorderThumbNail6.BorderBrush = new SolidColorBrush(Colors.DeepSkyBlue);
        }
        else if (img.Name.Equals("ThumbNail7"))
        {
            BorderThumbNail7.BorderBrush = new SolidColorBrush(Colors.DeepSkyBlue);
        }
        else if (img.Name.Equals("ThumbNail8"))
        {
            BorderThumbNail8.BorderBrush = new SolidColorBrush(Colors.DeepSkyBlue);
        }
    }

    private void ThumbNail_MouseDown(object sender, MouseEventArgs e)
    {
        Image img = (Image)sender;
        if (img.Name.Equals("ThumbNail1"))
        {
            BorderThumbNail1.BorderBrush = new SolidColorBrush(Colors.DeepSkyBlue);

        }
        else if (img.Name.Equals("ThumbNail2"))
        {
            BorderThumbNail2.BorderBrush = new SolidColorBrush(Colors.DeepSkyBlue);
        }
        else if (img.Name.Equals("ThumbNail3"))
        {
            BorderThumbNail3.BorderBrush = new SolidColorBrush(Colors.DeepSkyBlue);
        }
        else if (img.Name.Equals("ThumbNail4"))
        {
            BorderThumbNail4.BorderBrush = new SolidColorBrush(Colors.DeepSkyBlue);
        }
        else if (img.Name.Equals("ThumbNail5"))
        {
            BorderThumbNail5.BorderBrush = new SolidColorBrush(Colors.DeepSkyBlue);
        }
        else if (img.Name.Equals("ThumbNail6"))
        {
            BorderThumbNail6.BorderBrush = new SolidColorBrush(Colors.DeepSkyBlue);
        }
        else if (img.Name.Equals("ThumbNail7"))
        {
            BorderThumbNail7.BorderBrush = new SolidColorBrush(Colors.DeepSkyBlue);
        }
```

```
    else if (img.Name.Equals("ThumbNail8"))
    {
        BorderThumbNail8.BorderBrush = new SolidColorBrush(Colors.DeepSkyBlue);
    }
}

private void ThumbNail_MouseLeave(object sender, MouseEventArgs e)
{

    Image img = (Image)sender;
    if (img.Name.Equals("ThumbNail1"))
    {
        BorderThumbNail1.BorderBrush = new SolidColorBrush(Colors.White);
    }
    else if (img.Name.Equals("ThumbNail2"))
    {
        BorderThumbNail2.BorderBrush = new SolidColorBrush(Colors.White);
    }
    else if (img.Name.Equals("ThumbNail3"))
    {
        BorderThumbNail3.BorderBrush = new SolidColorBrush(Colors.White);
    }
    else if (img.Name.Equals("ThumbNail4"))
    {
        BorderThumbNail4.BorderBrush = new SolidColorBrush(Colors.White);
    }
    else if (img.Name.Equals("ThumbNail5"))
    {
        BorderThumbNail5.BorderBrush = new SolidColorBrush(Colors.White);
    }
    else if (img.Name.Equals("ThumbNail6"))
    {
        BorderThumbNail6.BorderBrush = new SolidColorBrush(Colors.White);
    }
    else if (img.Name.Equals("ThumbNail7"))
    {
        BorderThumbNail7.BorderBrush = new SolidColorBrush(Colors.White);
    }
    else if (img.Name.Equals("ThumbNail8"))
    {
        BorderThumbNail8.BorderBrush = new SolidColorBrush(Colors.White);
    }

} } }
```

10.5.2 FULL XAML MAP OF SYROS IN PATHS

```
<Canvas>
<!-- Mylonitic Greenschist/<Path> -->
                         <Path x:Name="MyloniticGrenschist" StrokeThickness="0.5"
Stroke="#ff503611" StrokeMiterLimit="1.0" Fill="#fff1c2a2" Data="F1 M 569.338,903.820 C
561.338,903.820 558.857,896.262 560.338,895.820 C 564.063,894.710 562.717,890.627
562.338,888.820 C 561.498,884.817 563.848,873.965 563.512,871.662 C 564.994,870.991
566.432,871.223 567.849,871.874 C 568.487,871.485 568.873,869.898 569.056,869.742 C
576.338,870.820 573.757,855.524 577.729,852.505 C 574.003,850.722 566.661,849.889
566.944,849.234 C 566.468,848.845 565.992,848.456 565.516,848.067 C 565.150,848.280
564.785,848.493 564.418,848.706 C 564.077,849.047 563.736,849.387 563.396,849.728 C
563.189,850.770 562.187,851.408 561.338,850.820 C 555.726,850.994 555.878,851.407
557.115,856.306 C 557.023,856.455 556.993,856.615 557.024,856.787 C 555.452,857.549
553.842,858.243 552.318,859.090 C 550.561,860.067 549.076,860.968 547.942,858.210 C
547.137,856.254 545.804,857.931 544.670,858.135 C 543.590,858.330 542.159,860.530
541.441,857.727 C 540.631,857.670 539.782,857.422 539.141,858.195 C 539.248,859.970
538.169,860.399 536.669,860.429 C 533.154,860.500 529.784,860.861 527.926,864.549 C
527.784,864.831 529.128,865.818 530.529,866.168 C 530.529,866.168 530.529,866.168
530.530,866.168 C 530.505,866.683 530.479,867.199 530.455,867.714 C 530.688,867.960
530.920,868.206 531.153,868.452 C 531.308,870.785 530.078,872.996 530.547,875.357 C
530.933,875.878 531.319,876.400 531.705,876.922 C 533.420,877.351 535.122,877.839
536.852,878.195 C 539.970,878.838 543.920,876.919 543.435,873.746 C 543.276,872.705
542.338,869.820 544.338,870.820 C 544.338,870.820 547.338,872.820 551.129,869.475 C
551.400,869.792 553.119,876.703 554.679,879.534 C 555.954,881.851 555.782,883.827
553.572,885.458 C 550.182,887.961 549.696,891.287 551.199,894.924 C 552.160,897.253
552.696,899.638 553.046,902.087 C 553.949,908.410 553.338,909.820 553.338,918.820 C
553.393,918.806 552.749,923.663 552.026,923.789 C 551.507,925.960 550.803,928.108
550.516,930.311 C 550.203,932.715 550.356,935.297 553.120,936.269 C 555.771,937.201
557.723,935.633 558.958,933.478 C 560.463,930.852 562.536,930.575 564.980,931.609 C
568.011,932.891 571.030,934.232 573.941,935.762 C 577.551,937.660 581.416,938.611
584.338,934.820 C 584.586,931.590 581.907,929.912 579.516,928.529 C 578.023,927.666
573.338,924.464 573.338,919.820 C 573.338,914.820 572.850,909.355 572.338,907.820 C
571.338,904.820 569.338,903.820 569.338,903.820 Z"
                          MouseEnter="MyloniticGrenschist_MouseEnter"
MouseLeave="MyloniticGrenschist_MouseLeave"
                              MouseDown="MyloniticGrenschist_MouseDown" />
                    </Canvas>

<Canvas>
<!-- Gneiss of Vari/one -->
                        <Path x:Name="VariGneiss" StrokeThickness="0.5" Stroke="#ff503611"
StrokeMiterLimit="1.0" Fill="#fff1d7bf" Data="F1 M 696.824,866.295 C 696.002,868.369
694.600,869.529 692.522,870.028 C 691.012,870.391 689.912,869.932 689.715,868.299 C
689.334,865.147 688.094,863.908 685.127,865.996 C 684.576,866.383 683.946,867.046
683.414,866.089 C 683.108,865.539 683.459,864.934 683.964,864.557 C 685.092,863.715
686.245,862.905 687.388,862.081 L 687.388,862.081 C 688.306,862.203 689.261,862.548
690.134,862.404 C 692.420,862.027 691.515,861.147 690.336,860.326 C 690.880,858.049
693.772,856.814 693.137,854.014 C 693.712,852.750 696.923,850.102 696.821,850.112 C
697.975,852.363 696.020,854.565 696.707,856.812 C 695.924,857.602 693.962,857.577
694.320,859.008 C 694.714,860.581 696.419,859.228 697.447,859.675 C 697.263,861.880
697.693,864.104 696.824,866.295 Z M 583.321,928.083 C 583.532,925.521 594.446,925.660
595.791,928.814 C 597.343,932.454 596.158,933.467 594.636,936.437 C 591.722,942.126
589.103,948.476 589.789,955.356 C 590.070,955.702 590.350,956.048 590.631,956.394 C
591.052,956.572 591.468,956.726 591.878,956.856 C 590.270,958.700 588.761,961.276
588.133,962.849 C 590.451,964.891 593.271,965.175 596.180,965.151 C 595.454,964.122
596.582,959.833 596.510,957.068 C 597.780,956.698 598.980,955.920 600.102,954.619 C
```

601.008,953.568 602.297,953.281 603.401,954.607 C 603.254,954.952 603.107,955.297
602.960,955.642 C 604.063,956.434 604.927,955.379 605.914,955.260 C 610.494,954.026
615.074,952.793 619.655,951.559 C 619.528,949.788 620.033,948.133 620.582,946.484 C
621.030,945.901 621.479,945.315 621.927,944.729 C 622.856,944.729 623.785,944.742
624.714,944.722 C 625.394,944.707 626.214,944.820 626.490,944.001 C 626.826,943.000
626.075,942.555 625.315,942.182 C 626.748,941.665 628.095,940.121 629.562,940.651 C
632.808,941.826 634.393,940.004 636.530,938.098 C 638.412,936.418 639.020,934.371
639.685,932.325 C 640.678,929.271 642.386,928.017 645.522,928.882 C 645.070,929.746
643.043,930.427 644.636,931.525 C 645.975,932.448 647.007,931.172 647.540,929.820 L
647.836,929.820 C 647.836,929.820 647.818,929.538 647.821,929.537 C 647.994,929.400
648.190,929.298 648.404,929.232 C 649.264,929.418 649.542,929.008 649.450,928.213 C
649.513,928.064 649.624,927.960 649.779,927.905 L 649.779,927.905 C 650.586,927.822
651.454,927.903 652.189,927.628 C 655.799,926.277 658.635,927.701 659.584,931.477 C
659.813,932.386 659.805,933.357 660.062,934.255 C 660.344,935.245 661.040,935.810
662.161,935.819 C 663.566,935.831 664.076,935.131 663.951,933.819 C 664.785,933.765
665.154,933.489 665.064,932.492 C 664.756,929.101 667.263,924.798 670.281,923.896 C
672.049,923.367 674.107,923.063 675.421,925.059 C 676.626,926.889 677.791,926.586
679.594,925.655 C 682.256,924.280 685.048,922.729 688.348,924.340 C 689.522,924.912
691.051,924.616 691.470,922.933 C 692.093,920.430 694.331,919.289 696.194,919.145 C
699.490,918.891 700.996,916.805 702.435,914.574 C 703.905,912.297 705.948,910.405
706.928,907.792 C 707.368,906.619 708.305,905.879 709.603,905.708 C 711.009,906.516
712.222,905.809 713.404,905.169 C 716.001,903.762 718.574,902.311 721.148,900.863 C
722.676,900.003 724.242,899.602 725.856,900.557 C 727.431,901.489 728.749,901.414
729.804,899.792 C 730.308,899.018 731.164,898.973 731.945,898.703 C 733.138,898.290
735.118,899.357 735.386,897.161 C 735.597,895.438 733.651,895.476 732.872,894.530 C
733.268,893.860 733.664,893.189 734.060,892.521 C 733.393,888.067 737.347,888.670
739.881,887.591 C 737.016,886.293 731.515,883.422 729.338,881.680 C 724.338,877.680
716.866,876.238 713.904,877.077 C 711.214,874.318 710.907,870.484 709.687,867.122 C
708.583,864.080 707.154,861.502 704.782,859.388 C 706.929,854.714 704.106,850.592
703.319,846.244 C 704.488,847.246 705.576,846.919 705.359,845.478 C 704.797,841.757
707.258,839.847 709.576,837.963 C 711.526,836.378 711.144,835.259 709.496,833.948 C
709.153,834.646 708.660,835.195 707.848,835.377 C 704.719,833.220 704.029,833.475
703.028,837.329 C 702.741,838.435 702.711,839.607 702.562,840.747 C 702.300,841.714
701.773,842.395 700.698,842.490 C 700.507,842.958 699.823,844.232 699.672,844.399 C
700.281,845.073 700.281,845.073 699.672,844.401 C 698.382,845.366 693.436,843.115
691.718,842.411 C 693.701,840.985 693.469,836.622 697.593,837.958 C 697.721,838.000
698.231,837.339 698.319,836.951 C 698.768,834.954 699.137,832.939 699.653,830.327 C
697.090,831.464 695.166,832.277 693.287,833.181 C 692.880,833.377 692.250,833.559
692.544,834.427 C 693.430,837.040 691.841,839.220 688.940,839.515 C 687.985,838.262
688.978,836.017 686.831,835.369 C 685.025,838.727 681.493,837.239 678.838,838.215 C
678.136,839.186 677.433,840.158 676.731,841.130 C 675.677,844.349 673.123,846.087
670.339,847.598 C 670.217,849.106 663.754,852.420 661.213,852.776 C 661.239,853.365
655.906,855.428 653.675,855.490 C 653.852,857.315 653.058,858.276 651.224,858.643 C
648.279,859.233 645.335,860.798 642.545,858.254 C 642.288,859.518 641.867,860.773
641.800,862.047 C 641.512,867.503 641.550,867.505 646.526,870.697 C 642.489,870.582
639.146,869.647 636.031,871.096 C 637.912,873.278 633.101,876.918 632.337,877.734 C
631.224,878.352 612.060,866.221 611.832,865.078 C 611.350,862.672 610.768,860.285
610.228,857.890 C 609.514,858.038 608.802,858.136 608.319,857.411 C 607.055,855.514
606.758,855.821 605.418,857.756 C 603.795,860.101 600.660,858.384 598.187,858.441 C
595.972,858.491 596.569,856.570 596.193,855.347 C 596.001,855.027 595.808,854.706
595.616,854.386 C 595.616,854.386 595.715,854.222 595.717,854.221 C 594.200,854.841
592.683,855.460 591.165,856.079 C 590.917,856.388 590.669,856.697 590.421,857.006 C
590.160,857.389 589.899,857.773 589.637,858.157 C 589.518,857.991 589.459,861.848
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526.010,526.032 528.050,521.286 C 528.423,520.419 528.763,519.537 529.117,518.662 C
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540.842,512.602 541.859,511.424 544.869,511.428 C 548.343,511.433 550.322,509.142
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554.202,510.114 552.527,512.317 L 552.276,515.019 C 552.234,515.467 552.106,517.258
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563.262,518.841 563.426,518.837 563.615,518.832 C 564.019,518.636 564.423,518.439
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568.895,519.783 570.528,520.089 C 570.369,519.535 570.299,518.545 570.041,518.494 C
566.605,517.807 567.531,515.181 567.486,512.983 C 567.482,512.703 568.372,511.922
568.406,511.735 C 569.207,507.382 571.590,503.974 574.703,500.984 C 575.357,500.356
575.486,499.553 575.387,498.691 C 576.504,497.119 575.714,497.191 574.245,495.722 C
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593.122,476.647 593.872,475.562 C 594.533,474.607 593.566,473.887 593.077,473.145 C
593.532,472.184 593.808,471.069 594.476,470.291 C 596.171,468.319 597.036,465.141
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599.626,430.946 C 601.463,430.394 601.963,428.421 603.390,427.406 C 605.817,425.681
606.340,423.501 605.365,420.581 C 604.022,416.558 602.940,412.424 602.100,408.267 C
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603.418,378.706 603.714,375.879 602.144,372.726 C 601.315,371.061 600.909,369.185
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605.527,365.952 605.599,365.643 602.901,363.129 C 602.045,362.331 601.017,361.688
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595.173,358.764 C 595.460,357.651 595.213,355.890 595.392,355.500 C 596.361,353.382
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596.571,347.484 596.324,347.479 596.078,347.475 C 594.502,347.647 592.170,347.246
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593.680,354.181 593.374,355.221 C 593.222,355.735 593.154,356.773 593.247,357.721 C
592.531,357.474 591.826,357.414 591.213,357.695 C 587.490,359.407 584.818,367.094
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558.448,386.848 557.438,386.637 C 554.806,386.087 551.991,385.815 549.645,384.641 C
545.711,382.671 545.623,380.756 548.516,375.547 C 546.643,374.922 545.368,375.939
544.102,376.926 C 541.697,378.803 539.235,380.072 535.985,378.995 C 534.249,378.419
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571.037,386.059 568.225,387.562 567.062,385.232 C 569.816,385.440 573.593,383.905
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583.213,405.964 C 583.186,406.936 582.635,407.364 581.706,407.396 C 581.453,407.414
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576.667,406.496 C 576.506,406.968 576.345,407.440 576.184,407.912 C 576.876,407.969
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571.792,408.079 C 571.807,408.312 571.812,408.546 571.807,408.780 C 572.148,408.891
572.490,409.003 572.831,409.115 C 573.683,408.917 573.845,409.500 573.973,410.123 C
573.687,410.170 573.400,410.218 573.114,410.265 C 571.050,410.922 569.303,412.340
567.078,412.646 C 565.610,412.849 565.812,413.984 566.063,415.036 C 566.438,415.157

566.860,415.162 567.272,415.192 C 566.860,415.162 566.438,415.157 566.063,415.036 C
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561.826,415.253 C 561.814,414.774 561.802,414.295 561.790,413.817 C 559.158,412.781
561.970,410.853 561.093,409.530 C 560.427,409.336 559.771,409.083 559.092,408.958 C
554.641,408.139 552.424,410.915 553.993,415.320 C 554.013,415.984 554.033,416.647
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556.816,419.049 556.820,419.478 C 560.241,421.121 560.359,421.604 557.808,423.849 C
556.862,424.681 556.196,425.961 554.673,425.933 C 553.523,428.420 549.725,428.636
549.152,428.292 C 546.487,426.690 543.467,429.112 541.031,427.039 C 539.897,426.075
538.391,426.929 538.143,428.063 C 537.386,431.524 535.362,431.181 532.895,430.278 C
532.372,430.087 531.728,430.225 531.139,430.215 C 531.096,431.242 530.475,431.565
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523.726,439.369 521.927,442.993 C 519.591,447.697 517.079,452.521 520.885,457.744 C
521.187,458.158 521.079,458.869 521.155,459.446 C 523.072,459.676 524.036,462.673
524.087,462.972 C 525.003,468.387 531.188,470.115 532.563,475.170 C 533.402,474.909
531.836,479.311 528.257,479.413 C 527.021,479.449 524.529,480.968 524.149,480.959 C
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508.069,472.946 504.743,472.463 C 504.437,474.650 502.454,476.250 502.592,478.594 C
500.101,478.862 497.718,478.322 495.357,477.623 C 496.289,471.621 492.152,467.953
488.857,464.019 C 487.262,462.115 486.180,460.505 487.607,458.144 C 488.066,457.108
488.995,457.318 489.839,457.302 C 490.049,456.879 490.259,456.455 490.470,456.032 C
490.450,455.390 490.497,454.779 491.187,454.463 C 491.170,453.861 491.280,453.323
491.902,453.042 L 491.906,453.038 C 492.201,452.368 492.792,452.311 493.411,452.310 C
493.616,452.104 493.822,451.898 494.028,451.693 C 494.012,450.469 493.995,449.245
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495.668,442.803 495.492,442.191 C 495.000,442.123 495.000,442.123 495.492,442.191 C
497.862,437.943 500.232,433.696 502.602,429.449 C 502.811,429.231 503.020,429.013
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510.057,418.625 512.410,411.278 508.030,403.251 C 507.452,402.192 507.211,401.000
508.491,400.125 C 508.406,398.740 508.321,397.356 508.236,395.971 C 507.411,395.302
507.421,394.591 508.131,393.846 C 508.326,392.164 507.888,390.136 510.393,389.722 C
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505.687,384.064 505.936,383.595 506.186,383.126 C 505.288,382.858 504.391,382.589
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500.864,383.424 500.631,383.714 500.398,384.005 C 500.816,387.192 502.902,389.494
504.645,391.974 C 505.293,392.896 506.535,393.498 506.186,394.935 L 506.186,394.935 C
505.552,394.726 504.918,394.517 504.283,394.307 C 500.748,396.763 499.119,396.667
496.178,393.831 C 495.150,393.826 494.440,393.346 494.042,392.400 C 493.463,392.099

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476.739,383.879 C 477.432,382.701 477.686,381.564 477.633,380.275 C 477.057,379.977
476.913,379.456 476.904,378.864 C 475.372,378.673 475.501,377.802 475.857,376.638 C
476.360,374.991 476.932,373.573 479.055,373.850 C 481.328,370.591 484.553,371.751
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491.582,362.988 490.147,358.149 C 488.969,354.178 486.393,353.297 482.472,354.934 C
482.228,355.036 481.846,354.804 481.503,354.722 C 481.391,352.879 483.641,352.919
483.974,351.222 C 480.783,350.156 474.648,335.184 473.554,332.478 C 471.347,327.020
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462.233,312.597 459.422,310.482 459.372,307.404 C 459.356,306.415 458.193,306.279
457.324,305.867 C 455.392,304.951 452.724,306.316 451.357,303.887 C 451.554,303.674
451.752,303.461 451.949,303.248 C 451.964,302.955 452.015,302.698 452.091,302.465 C
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461.229,306.878 C 461.218,307.062 461.212,307.246 461.210,307.430 C 461.247,308.243
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464.013,309.702 465.681,308.755 465.382,306.675 C 465.071,304.510 465.345,301.534
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457.815,300.709 457.516,297.992 C 457.082,298.065 456.648,298.138 456.214,298.211 C
455.964,297.997 455.713,297.782 455.462,297.568 C 453.873,297.107 452.157,296.801
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448.555,290.673 447.829,288.676 C 447.559,287.934 448.322,286.509 448.753,286.643 C
452.084,287.680 455.379,285.030 458.657,286.655 C 459.340,286.994 459.767,287.472
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470.032,279.387 469.239,276.515 C 468.945,275.452 469.761,274.199 470.868,273.583 C
472.206,272.837 473.433,273.504 474.474,274.290 C 475.781,275.276 476.278,276.720
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478.035,279.058 478.346,279.695 C 479.519,280.020 481.258,277.542 481.919,280.409 C
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499.026,282.542 C 499.506,287.200 495.217,287.217 492.706,288.893 C 491.967,289.386
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545.018,339.209 C 546.751,337.371 545.565,334.808 546.677,332.864 C 547.160,332.020
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433.895,100.104 C 433.691,99.968 433.487,99.832 433.283,99.696 C 432.817,100.312 431.943,100.905 431.607,100.077 C 429.826,95.690 428.786,99.033 427.521,100.375 C 426.578,101.376 426.404,102.503 426.322,103.898 C 426.034,108.776 423.355,111.638 419.897,111.180 C 419.596,111.656 419.294,112.131 418.992,112.605 C 416.987,117.133 416.062,122.096 413.451,126.380 C 413.221,126.866 412.971,126.869 412.702,126.410 C 412.281,126.265 411.860,126.119 411.439,125.973 C 411.177,127.164 410.915,128.354 410.653,129.545 C 410.456,129.612 410.298,129.669 410.213,129.695 C 410.047,129.747 409.899,129.817 409.761,129.897 C 409.630,129.898 409.499,129.899 409.368,129.900 C 409.304,130.068 409.259,130.235 409.201,130.403 C 408.818,130.898 408.646,131.576 408.646,132.356 C 407.944,135.566 408.221,138.789 409.197,142.023 C 409.910,142.048 410.489,142.265 410.674,143.049 C 409.256,144.522 407.376,144.146 405.632,144.313 C 405.632,144.313 405.632,144.313 405.632,144.312 C 405.618,143.782 405.605,143.254 405.592,142.725 C 405.004,142.443 404.886,141.909 404.839,141.337 C 402.595,140.713 402.506,136.666 399.177,137.765 C 398.465,138.737 398.799,139.698 399.052,140.762 C 399.450,142.435 399.065,143.864 397.027,144.213 C 396.803,144.812 396.578,145.410 396.354,146.007 L 396.354,146.007 C 395.420,146.351 394.240,146.383 394.136,147.769 C 390.496,146.361 391.027,143.733 391.911,140.794 C 392.657,138.317 394.674,135.355 392.603,133.218 C 389.663,130.187 387.946,126.533 385.729,123.124 C 384.809,121.709 382.937,120.841 383.404,118.704 C 381.197,118.611 379.109,119.202 377.028,119.827 C 376.595,121.263 381.078,122.626 377.702,123.503 C 374.791,124.260 372.084,126.372 368.739,125.644 C 367.256,125.321 365.697,125.642 364.199,126.177 C 362.058,126.942 360.693,130.060 362.222,131.651 C 363.921,133.418 364.958,135.440 365.970,137.581 C 366.838,139.419 368.115,140.369 369.919,138.460 C 369.917,140.138 371.769,139.699 372.380,140.612 C 372.948,141.461 374.872,140.848 374.509,142.435 C 374.266,143.498 373.288,144.133 372.086,144.162 C 367.927,143.137 363.803,142.065 362.699,137.022 C 362.502,137.024 362.306,137.026 362.110,137.029 C 361.862,137.026 361.615,137.024 361.367,137.021 C 361.363,136.546 361.359,136.070 361.354,135.595 C 361.114,135.326 360.873,135.057 360.633,134.788 C 360.438,134.587 360.244,134.386 360.050,134.185 C 359.218,134.190 358.346,134.322 357.794,133.464 C 356.878,133.429 356.390,132.966 356.363,132.039 C 355.758,132.033 355.238,131.866 354.938,131.283 C 354.944,131.095 354.950,130.908 354.956,130.722 C 352.841,132.257 350.867,131.294 348.543,129.717 C 348.817,130.856 348.946,131.282 349.019,131.717 C 349.190,132.735 349.735,133.974 348.585,134.608 C 347.377,135.274 346.550,134.120 345.967,133.329 C 344.170,130.894 341.631,131.340 339.179,131.345 C 337.546,131.858 335.912,132.371 334.279,132.885 C 333.851,133.509 333.253,133.512 332.608,133.343 C 326.024,135.389 319.441,137.434 312.857,139.480 C 312.583,139.775 312.337,139.744 312.118,139.415 C 311.830,139.116 311.542,138.817 311.254,138.518 C 308.192,137.856 306.280,135.612 304.299,133.464 C 302.846,133.639 301.991,132.610 300.886,131.939 C 298.015,130.194 295.897,124.745 291.379,129.728 C 291.044,130.098 289.975,129.706 289.314,129.898 C 288.091,130.255 286.852,128.611 285.685,129.977 C 287.936,133.288 291.583,135.332 293.678,138.785 C 293.249,139.666 292.626,139.933 291.748,139.393 C 291.997,137.129 289.743,137.306 288.717,136.286 C 287.932,136.340 287.083,136.163 286.488,136.904 C 285.781,136.924 285.073,136.945 284.365,136.965 C 283.017,138.431 281.729,139.960 280.305,141.349 C 277.766,143.825 275.425,146.412 274.368,149.903 C 276.030,150.388 276.301,148.971 276.915,148.032 C 278.871,145.040

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354.951,191.236 C 354.948,191.239 354.944,191.242 354.941,191.244 C 356.365,189.149
357.790,189.225 359.218,191.239 C 362.088,191.739 362.984,192.979 360.459,195.107 C
358.820,196.488 358.479,198.968 356.284,199.817 C 356.088,200.021 364.614,208.670
364.869,208.366 C 365.132,206.688 366.470,206.472 367.784,206.222 C 368.296,205.275
369.342,203.811 369.990,204.419 C 372.387,206.668 375.864,205.804 378.238,207.733 C
378.407,207.870 378.178,208.608 378.015,209.019 C 377.748,209.696 376.638,210.346
377.870,211.027 C 378.491,211.370 379.267,211.201 379.869,210.722 C 380.629,210.118
380.761,209.331 380.314,208.512 C 379.753,207.481 378.054,205.444 377.833,205.418 C
376.452,205.384 375.290,205.000 374.806,203.529 C 373.959,203.368 373.157,203.096
373.021,202.106 C 372.943,201.533 373.409,201.355 373.914,201.272 C 381.568,200.024
388.698,200.983 394.822,206.208 C 395.775,206.821 396.728,207.434 397.681,208.047 C
397.098,210.179 398.941,209.391 399.792,209.799 C 401.207,209.720 402.621,209.641
404.036,209.561 C 404.036,209.561 404.036,209.561 404.036,209.561 C 404.652,212.110
407.055,212.866 408.910,213.759 C 413.368,215.907 417.775,218.307 422.742,219.217 C
423.081,219.280 423.467,219.409 423.707,219.637 C 426.466,222.270 429.056,223.018
431.294,219.049 C 431.518,218.842 431.742,218.635 431.966,218.428 C 431.794,215.732
433.650,215.055 435.746,214.807 C 437.131,214.644 438.551,214.776 439.957,214.776 C
440.611,214.337 441.263,213.898 441.916,213.457 C 442.161,211.906 442.992,211.243
444.048,210.898 C 446.538,211.936 451.892,217.695 461.213,217.695 C 465.466,217.695
471.915,212.537 475.191,212.267 C 474.649,213.739 474.787,215.284 475.520,216.894 C
477.033,216.943 478.637,217.144 479.533,218.388 C 480.183,219.290 479.215,220.035

478.350,220.492 L 478.338,220.481 C 475.477,221.182 473.639,222.583 473.154,225.865 C
472.892,227.642 471.898,229.657 469.866,230.574 C 469.551,230.717 469.041,230.896
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457.270,258.724 C 455.539,261.496 452.646,263.434 451.628,266.673 C 452.537,266.673
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450.753,273.276 450.235,273.819 449.946,273.255 C 448.201,269.841 447.056,273.592
445.617,273.563 C 445.788,274.301 445.508,274.458 444.865,274.146 C 444.708,274.329
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432.557,298.064 434.452,296.940 C 435.061,296.578 435.510,297.548 435.652,298.252 C
435.811,298.248 435.970,298.243 436.127,298.238 C 438.081,296.692 439.438,299.460
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384.495,272.855 386.147,273.591 386.390,272.656 C 383.356,269.981 380.389,267.224
377.255,264.672 C 376.083,263.718 374.511,263.154 373.481,265.133 C 372.465,264.747
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365.291,262.072 365.138,260.877 367.677,259.124 C 368.800,258.348 369.655,257.461
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388.321,256.821 390.296,254.059 390.027,251.396 C 389.669,247.865 391.468,250.673
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399.649,249.408 398.365,252.196 396.361,253.519 C 396.330,251.478 398.531,249.053
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394.658,247.237 395.589,246.939 C 398.484,248.154 401.437,249.269 403.994,251.140 C
404.980,251.861 405.901,251.887 406.928,251.391 C 407.613,250.388 408.664,249.969
409.759,249.621 C 411.131,248.259 411.546,249.478 412.045,250.469 C 412.053,250.928
412.062,251.386 412.070,251.844 C 413.402,252.809 414.689,253.824 415.019,255.566 C
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425.134,263.456 425.646,263.717 426.157,263.978 C 427.824,263.067 428.803,264.998
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430.322,257.968 430.544,256.045 C 430.345,255.847 430.146,255.650 429.947,255.453 C
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424.846,246.877 C 423.106,245.448 421.047,244.289 420.554,241.803 C 420.349,241.597
420.143,241.392 419.938,241.187 C 419.457,240.299 418.766,239.732 417.704,239.740 C
417.705,239.746 417.707,239.750 417.707,239.756 C 416.659,239.781 415.630,239.779
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404.162,231.900 C 403.503,231.580 403.420,230.990 403.439,230.351 C 403.247,230.156
403.056,229.962 402.864,229.769 C 400.384,228.680 398.099,227.367 397.016,224.674 C
396.302,223.563 395.413,222.630 394.269,221.952 C 392.159,222.107 391.243,221.091
391.280,219.018 C 391.295,218.157 390.991,217.332 389.979,217.199 C 389.124,217.086
388.883,217.887 388.424,218.404 C 386.191,220.914 384.161,223.635 381.289,225.505 C
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374.820,239.038 369.299,238.190 C 368.234,238.027 367.378,237.718 366.387,238.515 C
365.337,239.360 364.424,239.140 364.207,237.615 C 364.209,237.615 364.212,237.616
364.214,237.616 C 364.218,237.616 364.221,237.617 364.224,237.617 C 364.224,237.617
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362.781,236.887 C 362.783,236.891 362.785,236.892 362.787,236.896 C 358.325,236.093
353.589,236.562 349.503,234.019 C 347.897,233.019 345.961,233.299 344.795,234.184 C
342.601,235.851 339.859,235.488 337.610,236.763 C 336.834,237.203 335.718,237.020
335.681,238.322 C 337.169,238.718 339.248,237.310 340.063,239.760 C 340.240,239.756
340.416,239.749 340.592,239.738 C 340.854,239.978 341.115,240.219 341.377,240.459 C
346.319,240.503 349.327,241.704 349.778,245.612 C 350.229,249.521 353.458,250.697
354.954,253.397 C 354.264,253.428 353.740,255.035 353.250,255.925 C 352.893,256.576
345.537,256.826 346.569,255.962 C 339.359,253.950 332.136,255.326 324.911,255.854 C
323.114,255.986 315.024,258.033 315.145,257.646 C 312.042,256.929 309.517,259.361
306.851,259.472 C 301.714,259.686 296.669,262.202 291.445,260.306 C 291.011,259.638
290.577,258.972 290.143,258.306 C 288.864,258.237 286.975,256.858 287.123,259.793 C
287.176,260.848 286.395,261.211 285.458,261.091 C 284.158,260.924 283.123,260.107
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286.259,251.560 286.461,251.158 C 286.224,250.922 285.988,250.686 285.752,250.450 C
284.726,250.441 283.997,249.986 283.605,249.026 C 282.264,248.807 280.975,248.516
280.681,246.870 C 280.446,246.868 280.212,246.865 279.977,246.861 C 279.484,247.072

278.991,247.283 278.499,247.494 C 279.351,249.441 281.963,250.153 282.132,252.531 C 282.200,253.496 282.664,254.854 281.274,255.269 C 280.168,

255.599 279.621,254.610 279.211,253.739 C 278.464,252.150 277.365,250.707 277.179,248.883 C 276.723,248.986 274.774,252.286 276.019,253.753 C 277.891,255.957 276.295,256.447 274.495,256.835 C 273.671,257.012 272.693,256.537 272.124,257.106 C 272.966,258.070 279.026,263.404 279.327,263.994 C 281.900,264.445 283.927,262.168 286.522,262.587 C 288.279,262.871 289.990,262.650 289.635,265.541 C 289.414,267.342 290.502,269.165 292.963,267.530 C 295.809,265.639 299.498,265.235 302.337,265.238 C 304.496,265.240 314.713,265.862 314.671,266.097 C 317.835,266.925 319.791,263.859 322.867,263.625 C 325.394,263.433 327.097,263.958 329.297,265.277 C 324.312,268.720 318.934,268.272 313.655,268.314 C 313.372,268.573 311.789,269.433 310.020,270.341 C 307.585,269.725 303.404,269.144 302.194,269.676 C 301.404,270.024 300.850,271.164 299.697,270.465 C 296.281,268.395 294.105,270.697 291.629,272.508 C 293.187,274.506 295.457,271.162 296.701,273.509 C 296.034,274.960 292.464,274.712 294.341,277.325 C 295.718,279.242 297.727,278.266 299.448,277.451 C 300.389,277.005 301.074,276.021 302.273,276.121 C 302.436,276.127 302.599,276.132 302.763,276.135 C 303.686,273.807 303.430,272.751 300.593,273.866 C 299.743,274.200 298.147,274.447 298.074,272.896 C 298.013,271.580 299.433,271.995 300.302,271.829 C 301.718,271.558 304.823,271.794 307.465,271.620 C 306.309,272.183 305.313,272.645 304.834,272.826 C 305.690,274.296 306.688,274.765 308.123,274.029 C 309.641,273.251 311.238,273.362 312.902,273.510 C 316.101,273.793 319.329,273.754 322.528,274.038 C 324.449,274.208 326.094,273.498 327.420,272.457 C 328.332,271.742 327.869,270.700 330.202,271.035 C 332.783,271.405 335.727,271.850 338.532,271.846 C 338.481,269.399 339.788,269.310 341.494,270.254 C 347.580,273.621 354.630,274.293 360.862,277.241 C 361.841,277.704 362.694,277.060 363.608,276.952 C 366.341,276.627 368.952,276.442 370.747,279.357 C 371.907,281.243 373.796,282.088 376.223,281.911 C 378.384,281.754 380.446,282.390 381.459,284.692 C 381.459,284.692 379.217,286.099 378.939,287.994 C 381.864,288.442 384.513,287.715 387.148,286.868 C 389.028,286.502 390.334,288.349 392.165,288.169 C 392.441,289.466 393.446,298.060 393.259,301.150 C 393.260,301.166 393.262,301.185 393.263,301.201 C 391.067,300.460 389.325,300.382 389.073,300.420 C 388.875,300.609 388.676,300.798 388.478,300.986 C 388.478,300.987 388.478,300.987 388.478,300.988 C 386.362,302.588 383.084,300.504 381.327,303.243 C 381.489,303.242 381.652,303.241 381.815,303.240 C 381.656,303.241 381.497,303.242 381.338,303.243 C 380.957,304.888 380.237,306.262 378.481,306.805 C 376.520,311.370 372.339,312.115 368.173,312.410 C 364.296,312.686 360.370,312.393 356.590,313.535 C 355.079,313.992 354.057,313.284 353.931,312.061 C 353.778,310.571 355.284,311.335 356.061,311.066 C 360.837,309.407 365.783,309.531 370.729,309.586 C 371.594,309.595 371.936,308.998 372.054,308.230 C 366.835,307.209 361.662,307.024 356.515,308.758 C 355.370,309.144 353.858,309.485 353.513,307.515 C 351.336,306.851 349.201,306.465 346.940,307.382 C 343.706,308.695 340.248,307.426 336.869,308.087 C 334.660,308.518 332.741,309.624 330.472,309.926 C 326.883,310.403 323.468,310.776 320.077,309.100 C 318.470,308.306 316.671,308.108 314.863,308.234 C 314.706,308.226 314.549,308.220 314.392,308.216 C 313.170,310.708 311.943,309.853

310.715,308.234 C 307.885,308.559 305.639,307.712 304.298,305.038 C 303.462,303.371
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282.159,296.067 C 280.849,298.115 281.379,299.915 282.538,301.921 C 285.118,306.393
289.343,309.700 291.262,314.665 C 291.761,315.956 293.355,316.877 295.131,316.457 C
298.048,315.768 298.988,317.755 299.252,319.941 C 299.431,321.430 299.632,322.695
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328.075,338.818 329.265,338.086 C 331.661,336.612 332.262,337.466 331.873,339.887 C
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476.108,463.209 476.816,463.737 C 477.321,464.006 477.827,464.275 478.332,464.544 C
478.336,465.224 478.341,465.903 478.345,466.583 C 478.345,466.583 478.341,466.588
478.341,466.588 C 475.312,467.995 472.082,469.207 469.181,466.838 C 467.326,465.324
465.484,465.084 463.365,465.157 C 461.354,462.047 457.545,462.014 454.799,460.161 C
454.799,460.161 454.800,460.161 454.800,460.161 C 454.566,459.928 454.333,459.695
454.100,459.462 C 453.929,459.454 453.768,459.435 453.618,459.407 C 453.768,459.435
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451.960,457.309 C 451.966,456.711 451.825,456.188 451.245,455.886 C 450.014,452.501
448.903,449.096 447.963,445.601 C 447.255,442.973 447.022,439.665 444.092,437.989 C
443.621,437.096 442.935,436.417 442.054,435.931 C 441.789,435.690 441.525,435.449
441.261,435.208 C 441.075,433.380 439.619,432.542 438.389,431.528 C 437.610,430.648
436.019,430.961 435.563,429.606 C 434.081,428.976 434.081,428.975 435.563,429.605 C
435.347,427.631 434.310,426.187 432.680,425.124 C 432.240,424.683 431.800,424.243
431.360,423.802 C 431.173,423.799 431.009,423.780 430.865,423.747 C 431.009,423.780
431.173,423.799 431.358,423.802 C 431.219,422.825 430.823,422.029 429.843,421.645 C
428.559,418.395 427.587,415.059 426.974,411.615 C 426.748,410.348 426.494,409.032
424.855,408.802 C 424.852,408.195 424.702,407.669 424.082,407.400 C 423.343,405.630
422.212,404.162 420.691,402.993 C 420.399,401.806 420.107,400.618 419.814,399.431 C
421.731,398.864 420.727,396.639 418.427,396.599 L 418.427,396.599 C 418.415,395.568
418.000,394.649 418.093,393.514 C 418.400,389.750 420.721,385.227 415.050,383.152 C
414.838,383.074 414.892,382.432 414.670,382.194 C 410.748,377.981 406.910,373.637
400.866,372.415 C 400.912,373.842 400.978,375.268 401.038,376.695 C 399.983,376.769
398.594,376.900 398.550,376.792 C 394.145,374.530 389.769,372.201 384.918,370.983 C
384.883,369.637 383.703,369.027 383.068,368.063 C 379.971,363.357 375.294,359.247
377.075,352.641 C 379.777,351.618 382.339,350.373 384.266,348.118 C 382.061,346.588
379.540,345.822 376.810,345.057 C 378.017,348.266 375.627,347.425 374.093,347.586 C
373.534,347.560 372.976,347.535 372.418,347.509 C 372.099,347.720 371.781,347.931
371.462,348.142 C 371.258,348.522 371.131,349.136 370.834,349.235 C 370.109,349.476
369.989,348.726 369.728,348.261 C 368.956,348.244 368.185,348.227 367.413,348.210 C
366.525,348.169 356.705,347.717 354.670,343.025 C 354.467,343.220 354.264,343.414
354.061,343.609 C 354.061,343.609 354.061,343.609 354.061,343.609 C 353.569,344.606
353.342,348.667 352.755,349.626 C 351.521,351.643 351.566,353.841 351.335,356.084 C
350.850,360.805 355.051,370.267 356.392,370.220 C 358.163,374.190 360.390,377.985

361.221,382.321 C 361.621,384.406 361.658,386.941 359.094,387.183 C 355.383,387.534
351.441,388.287 347.865,386.672 C 342.414,384.210 336.397,383.060 331.400,379.562 L
331.393,379.569 C 330.796,379.575 330.269,379.440 329.969,378.854 C 327.181,377.505
324.755,375.833 324.247,372.448 C 324.246,372.448 324.282,372.416 324.282,372.416 C
322.928,368.086 319.324,365.007 317.798,360.746 C 317.427,359.711 316.118,359.319
315.028,359.741 C 312.385,360.765 309.623,360.035 306.951,360.451 C 305.664,358.548
307.619,358.693 308.432,358.207 C 309.012,357.860 309.947,357.813 309.707,356.884 C
309.482,356.012 308.588,356.021 307.950,356.286 C 305.820,357.167 305.444,355.880
304.869,354.244 C 304.069,351.967 304.024,349.223 301.029,347.154 C 301.594,351.156
303.817,354.043 303.598,357.455 C 301.610,357.309 299.636,357.393 297.624,357.082 C
292.697,356.319 288.335,354.098 283.791,352.332 C 283.597,350.244 287.008,348.671
285.341,346.925 C 284.168,345.697 281.667,347.496 279.700,347.384 C 279.585,347.377
279.472,347.349 279.357,347.332 C 278.849,347.628 278.341,347.925 277.832,348.222 C
278.130,348.600 278.608,348.895 278.410,349.497 C 273.918,349.312 269.529,350.708
265.021,350.356 C 263.730,350.256 262.308,350.540 262.059,348.673 C 261.680,348.939
260.992,349.464 260.966,349.434 C 258.317,346.281 257.186,350.056 255.378,350.637 C
258.032,351.959 260.729,353.172 263.621,353.889 C 263.623,354.387 263.626,354.885
263.628,355.383 C 263.631,355.570 263.632,355.757 263.632,355.944 C 261.207,358.078
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251.272,353.019 250.905,353.308 250.715,353.862 C 254.943,355.863 257.657,361.637
263.734,359.101 C 263.871,359.044 264.225,359.508 264.479,359.728 C 264.341,360.911
261.993,361.175 263.115,362.828 C 263.830,363.882 264.713,363.361 265.501,362.779 C
266.069,362.046 266.774,361.907 267.599,362.301 C 269.409,359.080 272.757,357.816
275.648,355.971 C 276.341,355.431 277.033,354.891 277.726,354.351 C 281.514,357.792
286.629,357.902 291.112,359.563 C 296.280,361.479 301.340,363.235 303.663,368.862 C
303.837,368.859 304.009,368.856 304.182,368.852 C 304.818,368.842 305.407,368.931
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306.251,370.061 306.524,370.307 C 306.957,370.309 307.388,370.311 307.820,370.312 C
312.405,378.663 317.951,386.347 324.032,393.659 C 325.732,395.703 327.265,398.273
330.469,395.795 C 330.470,395.796 330.471,395.796 330.472,395.796 C 331.448,397.046
332.967,396.287 334.072,396.748 C 336.674,397.836 339.974,396.056 342.119,398.782 C
341.432,398.869 340.730,398.893 340.062,399.055 C 338.450,399.447 335.578,397.626
335.426,400.260 C 335.268,402.993 338.464,401.067 339.890,401.991 C 341.118,401.588
342.350,401.522 343.589,401.943 C 345.711,401.564 347.828,401.716 349.944,402.011 C
349.946,402.376 349.948,402.741 349.950,403.106 C 353.589,405.322 355.671,408.801
357.483,412.476 C 359.809,417.194 364.625,427.146 364.825,427.345 C 365.322,428.219
366.009,428.798 367.072,428.793 C 367.304,429.025 367.537,429.258 367.769,429.490 C
367.777,430.091 368.661,436.834 370.158,439.226 C 371.416,441.237 371.391,443.283
370.948,445.640 C 370.518,447.928 369.380,450.886 372.768,452.327 C 373.068,452.913
373.596,453.045 374.191,453.044 C 374.269,454.468 375.285,454.492 376.327,454.475 C
376.474,457.051 375.198,456.450 373.749,455.645 C 372.572,454.991 372.050,453.146
369.620,453.471 C 373.687,458.919 385.816,471.809 384.254,476.830 C 383.638,478.811
381.032,482.005 379.835,483.580 C 376.845,487.511 373.310,491.111 371.775,496.030 C
371.243,497.737 370.150,499.005 368.067,497.544 C 367.520,497.160 366.747,496.941

366.208,497.744 C 370.570,502.343 370.406,503.833 365.006,508.750 C 364.587,509.198
364.169,509.645 363.752,510.092 C 358.352,510.805 354.729,507.518 350.967,504.473 C
348.588,502.548 346.382,499.961 342.733,501.595 C 341.533,503.965 338.710,502.337
337.164,503.856 C 335.831,506.960 333.841,507.025 331.561,504.947 C 330.303,503.800
327.828,504.054 327.697,501.622 C 327.696,501.612 327.697,501.604 327.696,501.595 L
327.696,501.595 C 327.634,501.082 326.865,499.928 326.541,499.865 C 324.807,500.106
323.178,499.902 321.784,498.725 C 321.068,498.156 320.376,497.524 319.341,497.796 C
319.341,497.797 319.341,497.797 319.341,497.798 C 318.387,496.762 316.186,497.161
316.166,495.046 C 316.788,494.492 317.513,486.457 315.747,482.808 C 315.700,482.007
315.652,481.206 315.604,480.405 L 315.604,480.405 C 315.290,478.703 328.358,478.979
329.213,477.695 C 331.213,474.695 324.445,468.347 325.694,467.087 C 325.529,465.410
326.515,465.043 327.910,465.141 C 326.395,463.005 326.103,460.628 326.525,458.110 C
323.907,457.068 324.236,453.746 322.070,452.356 C 321.796,451.886 321.522,451.416
321.246,450.946 C 319.681,449.696 317.960,448.561 316.518,447.264 C 313.868,444.879
310.329,445.927 307.621,444.247 C 308.030,443.416 308.876,443.201 309.622,442.886 C
311.091,442.265 311.572,441.446 310.752,439.870 C 309.892,438.216 308.808,438.329
307.596,439.196 C 305.257,440.869 303.811,440.165 302.726,437.693 C 302.211,436.518
301.362,435.490 300.665,434.395 C 300.436,434.025 300.207,433.655 299.979,433.285 C
298.558,432.700 297.559,431.706 297.032,430.253 C 295.424,429.819 295.838,428.473
295.729,427.363 C 295.272,427.267 294.815,427.170 294.358,427.073 C 294.082,428.006
293.805,428.938 293.529,429.870 C 297.990,433.704 301.641,438.125 303.598,443.772 C
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302.906,443.693 C 298.586,439.977 287.428,435.333 287.187,435.854 C 287.149,436.127
287.111,436.399 287.073,436.672 C 288.124,437.815 288.662,439.234 289.171,440.659 C
289.578,441.799 290.811,443.048 289.519,444.143 C 288.425,445.070 287.101,444.334
285.910,443.806 C 285.177,443.481 283.593,443.448 283.593,443.641 C 283.593,443.641
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280.272,441.304 279.038,439.505 281.608,437.317 C 282.329,436.447 284.144,438.065
284.382,436.098 C 277.884,438.020 284.792,430.428 289.714,430.962 C 289.645,430.141
289.575,429.321 289.506,428.499 C 287.868,427.959 286.196,427.500 284.601,426.853 C
283.343,426.342 281.368,426.840 281.175,424.650 C 282.211,422.847 284.025,425.078
285.179,423.878 C 285.180,423.879 285.180,423.879 285.181,423.879 C 286.298,424.543
287.223,425.798 288.798,425.054 C 288.634,423.075 282.265,420.581 281.466,418.792 C
278.904,417.705 279.984,416.299 281.123,414.886 C 282.260,411.927 279.985,411.705
278.126,411.149 C 276.962,411.885 277.219,413.691 275.802,414.237 C 275.814,416.119
274.734,415.224 273.999,414.895 C 270.369,413.271 261.564,409.135 260.213,409.695 C
259.808,409.620 256.239,415.506 256.213,415.695 C 255.873,415.790 245.134,423.118
246.213,423.695 C 246.306,424.307 248.287,426.644 248.381,427.255 C 249.360,427.379
250.342,427.573 251.293,427.119 C 254.459,425.265 258.103,424.815 261.499,423.636 C
261.500,423.636 261.500,423.636 261.500,423.636 C 263.897,424.704 265.198,428.109
268.626,426.981 C 269.591,427.973 270.415,429.596 271.546,429.849 C 275.733,430.787
276.631,434.167 277.564,437.405 C 278.709,441.377 280.068,444.816 284.335,446.648 C
287.323,447.930 287.251,450.051 284.849,452.372 C 283.774,453.411 282.370,454.272
282.249,456.014 C 279.419,453.848 276.031,454.820 272.900,454.351 C 272.006,454.161

271.113,453.970 270.220,453.780 C 270.339,455.711 271.268,456.520 273.296,456.623 C
275.716,456.745 281.122,470.188 279.268,475.812 C 279.122,476.100 278.975,476.389
278.829,476.678 C 278.829,476.678 278.722,476.760 278.722,476.760 C 278.647,477.413
278.573,478.066 278.498,478.719 C 280.166,478.609 281.757,477.940 283.514,478.842 C
284.964,479.587 285.139,477.065 286.541,477.143 C 286.541,477.143 286.541,477.142
286.541,477.142 C 287.425,477.916 288.308,478.690 289.192,479.464 C 290.199,477.768
292.411,478.880 294.291,480.544 C 294.583,480.802 294.788,481.707 294.727,481.740 C
291.154,483.656 295.382,485.018 295.060,486.673 C 295.060,486.673 295.060,486.673
295.059,486.673 C 293.873,488.210 292.807,490.951 293.599,490.719 C 299.361,489.024
309.808,488.985 311.415,490.975 C 312.766,492.647 311.127,495.258 308.853,495.607 C
306.011,496.044 303.866,498.082 303.526,500.671 C 302.958,504.982 303.979,506.324
308.545,507.275 C 308.536,507.531 308.528,507.786 308.519,508.041 C 308.758,509.105
309.199,510.060 310.004,510.819 C 310.125,509.612 309.651,508.095 311.568,507.827 C
312.479,507.874 313.391,507.922 314.303,507.970 C 314.673,508.636 315.247,508.732
315.920,508.546 C 316.912,508.481 317.736,508.900 318.518,509.441 C 319.260,509.450
320.002,509.460 320.745,509.469 C 320.960,508.977 321.144,508.557 320.746,509.470 C
321.869,511.239 322.094,513.154 321.672,515.174 C 322.527,517.691 324.404,520.084
324.426,518.670 C 324.832,518.671 325.237,518.671 325.643,518.672 C 327.964,518.252
329.382,520.298 331.357,520.773 C 336.256,521.951 341.007,523.464 345.409,526.003 C
347.115,526.987 349.125,526.516 350.999,526.508 C 352.682,526.500 354.203,526.841
354.733,528.538 C 355.334,530.460 353.420,531.051 352.312,531.497 C 347.325,533.507
342.445,535.920 336.983,536.494 C 336.785,536.924 336.589,537.354 336.392,537.784 C
336.345,539.208 333.758,540.492 333.543,540.706 C 333.424,541.692 333.240,542.552
332.050,541.481 C 331.524,541.513 330.999,541.545 330.474,541.577 C 330.474,541.577
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327.073,540.690 323.604,541.749 324.051,537.112 C 324.156,536.020 322.896,536.630
322.343,537.297 C 322.608,538.464 322.589,539.616 322.159,540.746 C 322.111,541.468
322.063,542.191 322.015,542.914 C 322.341,545.570 322.172,548.181 321.312,550.730 C
317.295,549.668 313.278,548.605 309.261,547.543 C 309.021,547.667 308.781,547.792
308.540,547.916 C 308.590,548.538 308.639,549.160 308.688,549.782 C 307.986,550.915
306.911,551.372 305.634,551.463 C 305.426,551.677 305.219,551.892 305.011,552.108 C
304.888,553.789 303.462,553.866 302.325,554.397 C 300.933,555.047 299.028,555.071
298.602,557.084 C 297.636,557.068 296.671,557.053 295.705,557.038 C 295.903,554.506
293.741,554.539 292.356,554.457 C 290.226,554.332 288.220,553.740 286.145,553.447 C
284.745,554.239 283.346,555.031 281.947,555.822 C 281.162,555.878 280.554,556.223
280.157,556.915 C 281.229,558.719 282.776,560.287 282.951,562.537 C 282.917,562.913
282.883,563.288 282.849,563.662 C 286.983,567.821 288.198,573.245 289.364,578.690 C
289.340,579.244 288.945,580.135 289.567,580.259 C 290.753,580.495 300.394,597.850
300.963,607.481 C 301.069,609.276 302.698,618.118 304.292,623.513 C 306.572,631.232
308.642,639.027 311.904,646.435 C 312.836,648.551 314.891,653.549 316.166,655.516 C
316.993,656.790 317.169,658.444 318.411,659.495 C 318.458,658.951 318.504,658.406
318.551,657.862 C 318.631,656.466 319.285,655.213 320.659,655.178 C 322.187,655.140
322.104,656.622 322.134,657.768 C 322.367,658.001 322.601,658.234 322.834,658.466 C
323.937,658.400 324.908,658.539 325.088,659.912 C 325.486,660.143 325.884,660.374

326.281,660.605 C 326.979,660.841 327.113,661.405 327.121,662.042 C 328.114,662.417
328.488,663.230 328.638,664.200 C 328.840,664.409 329.041,664.617 329.242,664.825 C
330.823,666.109 332.080,667.857 334.105,664.910 C 335.385,663.047 337.789,665.478
339.735,664.828 C 341.738,664.160 343.437,664.005 343.249,667.118 C 343.195,668.022
344.612,667.664 345.373,667.706 C 346.655,667.776 360.439,666.010 360.632,666.204 C
361.239,666.596 361.392,667.189 361.369,667.861 C 362.047,668.533 362.724,669.205
363.402,669.877 C 364.028,669.870 364.610,669.956 364.926,670.596 C 365.974,670.578
367.013,670.573 367.073,672.035 L 367.058,672.021 C 367.297,672.259 367.535,672.496
367.774,672.734 C 372.408,673.768 372.234,678.058 373.583,681.317 C 374.258,681.758
374.933,682.199 375.607,682.641 C 376.978,682.852 377.873,683.675 378.480,684.869 C
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386.408,682.716 C 386.853,682.032 387.299,681.347 387.744,680.663 C 390.697,677.628
392.097,677.633 396.351,680.693 C 397.172,680.450 398.002,679.182 398.805,680.263 C
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390.436,686.432 C 388.978,686.226 387.710,687.248 387.521,688.921 C 387.220,691.582
385.638,693.358 383.717,695.009 C 382.039,696.451 381.016,698.271 381.295,700.607 C
382.118,700.587 382.941,700.536 383.763,700.556 C 384.907,700.584 386.464,700.301
386.676,701.798 C 386.893,703.323 385.582,703.942 384.186,704.130 C 383.358,705.623
381.936,706.354 380.393,706.185 C 375.477,705.645 370.757,704.365 366.535,701.648 C
365.897,701.238 365.656,700.591 365.634,699.854 C 365.041,699.854 364.514,699.721
364.215,699.137 C 363.292,699.110 362.796,698.654 362.783,697.714 C 361.667,697.766
360.657,697.670 360.634,696.180 C 359.723,695.267 358.812,694.353 357.901,693.439 C
355.340,692.814 355.044,690.493 354.432,688.546 C 353.907,686.876 353.798,685.076
353.505,683.334 C 353.305,683.135 353.106,682.936 352.907,682.737 C 351.922,682.737
350.937,682.736 349.952,682.736 C 349.867,683.276 349.843,683.960 349.073,683.795 C
348.824,683.742 348.698,683.112 348.518,682.735 C 347.919,682.735 347.389,682.602
347.090,682.009 C 344.514,680.600 341.929,679.207 339.365,677.777 C 336.860,676.378
334.207,675.417 331.386,674.890 C 330.103,674.650 328.761,674.421 328.542,672.747 C
327.613,672.724 327.131,672.254 327.113,671.317 C 325.312,670.809 324.685,669.361
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322.130,665.865 321.421,665.633 C 325.367,674.203 329.370,682.746 333.219,691.359 C
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352.824,734.088 C 353.647,735.955 355.304,739.809 356.464,742.013 C 358.522,745.924
376.960,765.715 381.357,769.333 C 383.191,770.842 387.318,773.889 389.439,775.108 C
393.137,777.232 396.711,779.572 400.323,781.844 C 401.254,782.429 405.074,784.498
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564.282,233.902 565.162,232.413 562.645,231.315 C 561.998,228.478 560.238,226.707
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547.071,235.832 546.948,236.390 546.947,237.016 C 545.997,237.018 545.554,237.525
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552.214,205.889 551.337,206.403 C 550.644,206.886 549.952,207.369 549.260,207.852 C

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545.859,208.981 C 545.576,209.879 546.666,209.895 547.349,209.983 C 546.929,210.643
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541.962,207.772 C 541.836,206.646 542.481,205.139 540.541,204.912 C 538.542,202.106
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525.553,215.620 C 522.970,217.584 522.232,221.457 518.556,222.308 C 516.233,222.846
514.660,224.425 513.376,226.337 C 513.160,226.545 512.945,226.753 512.731,226.961 C
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523.483,236.607 525.800,236.947 C 526.996,237.123 528.793,237.737 529.133,235.514 C
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533.339,231.857 534.005,231.689 534.666,231.509 C 534.399,234.318 535.391,237.839
537.559,239.936 C 537.806,240.175 537.650,240.829 537.675,241.297 C 536.089,241.215
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534.957,250.211 536.478,252.674 C 537.286,253.982 536.881,255.086 535.471,255.444 C
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557.870,294.068 559.501,292.857 561.147,291.407 C 562.368,290.333 565.228,290.409

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574.052,289.816 C 574.056,289.815 574.060,289.814 574.063,289.814 C 573.235,292.851
571.607,294.949 568.280,295.697 C 565.552,296.309 564.186,299.611 564.988,302.892 C
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563.519,325.274 C 562.250,325.770 560.947,325.788 561.223,327.611 C 561.219,327.610
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546.802,332.989 C 545.690,334.933 546.876,337.496 545.143,339.334 C 545.017,339.467
545.521,340.469 545.943,340.778 C 546.518,341.197 547.028,340.698 547.381,340.187 C
547.904,339.428 548.492,338.031 549.412,338.682 C 551.353,340.057 553.153,339.738
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542.951,339.178 C 542.146,337.994 540.894,338.135 539.750,338.539 C 539.011,338.800
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490.900,290.644 C 490.808,289.425 492.092,289.511 492.831,289.018 C 495.340,287.343
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482.044,280.534 C 481.383,277.667 479.644,280.145 478.471,279.820 C 478.159,279.183
477.579,279.099 476.963,279.094 C 476.756,278.888 476.550,278.681 476.345,278.474 C
476.403,276.845 475.906,275.401 474.599,274.415 C 473.558,273.629 472.331,272.962
470.993,273.708 C 469.886,274.324 469.070,275.577 469.364,276.640 C 470.157,279.512
470.020,282.836 472.781,284.908 C 472.785,285.224 472.789,285.538 472.792,285.852 C
470.248,287.860 467.339,289.236 464.461,290.668 C 464.133,290.851 464.133,290.851
464.460,290.667 C 464.096,290.616 463.733,290.564 463.372,290.513 C 463.193,290.520
463.016,290.524 462.839,290.528 C 462.751,289.624 462.292,289.105 461.350,289.091 C
461.048,288.511 460.524,288.374 459.929,288.376 C 459.892,287.597 459.465,287.119
458.782,286.780 C 455.504,285.155 452.209,287.805 448.878,286.768 C 448.447,286.634
447.684,288.059 447.954,288.801 C 448.680,290.798 448.966,293.157 451.372,294.093 C
451.605,294.326 451.839,294.560 452.072,294.793 C 452.282,296.926 453.998,297.232
455.587,297.692 C 455.838,297.907 456.089,298.122 456.339,298.336 C 456.773,298.263
457.207,298.190 457.641,298.117 C 457.940,300.833 460.284,300.625 462.071,301.215 L
462.055,301.226 C 462.482,300.952 462.482,300.952 462.055,301.226 C 465.472,301.650
465.195,304.632 465.507,306.800 C 465.807,308.885 464.130,309.833 462.057,309.774 C
462.059,309.777 462.061,309.779 462.062,309.782 C 461.197,309.245 461.372,308.365 461.335,

307.555 C 461.337,307.371 461.343,307.187 461.354,307.003 C 459.355,302.345
457.562,301.585 452.346,303.287 C 450.962,302.587 448.522,301.492 445.838,300.306 C
444.123,300.728 442.364,301.311 441.382,299.076 C 439.566,299.593 438.209,296.815
436.250,298.363 C 436.250,298.363 436.250,298.363 436.250,298.363 C 436.093,298.369
435.935,298.373 435.777,298.377 C 435.635,297.673 435.186,296.703 434.577,297.065 C

432.682,298.189 431.449,296.745 429.973,296.223 C 430.058,295.041 429.810,293.934
429.425,292.806 C 429.059,291.732 429.136,290.657 430.686,290.522 C 430.686,290.522
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432.692,292.247 432.830,292.772 432.826,293.368 C 435.298,294.097 437.430,291.397
439.953,292.652 C 440.561,291.276 441.708,291.121 443.011,291.320 C 442.861,289.015
441.097,287.355 440.566,285.204 C 440.532,284.245 440.397,283.261 441.239,282.524 C
441.334,279.517 443.230,277.236 444.415,274.667 C 444.641,274.586 444.833,274.454
444.990,274.271 C 445.633,274.583 445.913,274.426 445.747,273.685 C 447.181,273.717
448.326,269.966 450.071,273.380 C 450.360,273.944 450.878,273.401 451.119,273.016 C
452.338,271.075 453.537,269.121 454.974,266.798 C 453.570,266.798 452.662,266.798
451.755,266.799 C 452.771,263.559 455.664,261.621 457.395,258.849 C 457.967,257.933
457.736,253.860 461.021,256.712 C 461.452,257.086 461.794,256.095 461.880,255.535 C
462.020,254.619 462.134,253.698 462.259,252.779 C 462.293,251.228 468.046,237.915
469.130,231.246 C 469.166,231.021 469.676,230.842 469.991,230.699 C 472.023,229.782
473.017,227.767 473.279,225.990 C 473.764,222.708 475.602,221.307 478.463,220.606 C
478.463,220.606 478.475,220.617 478.475,220.617 C 479.340,220.160 480.308,219.415
479.658,218.513 C 478.762,217.269 477.158,217.068 475.645,217.019 C 474.608,214.742
474.733,212.592 476.338,210.601 C 476.337,210.554 476.339,210.507 476.338,210.460 C
481.365,209.111 492.436,204.249 492.997,200.986 C 493.667,197.088 496.239,193.465
495.595,189.223 C 497.040,188.130 496.981,186.490 497.145,184.933 C 497.338,184.747
497.529,184.561 497.720,184.376 L 497.720,184.376 C 499.997,184.473 498.820,185.830
498.639,186.853 C 498.026,190.315 499.785,194.081 502.718,195.644 C 503.041,196.289
503.630,196.373 504.258,196.372 C 504.481,196.442 504.671,196.562 504.830,196.733 C
506.597,197.343 508.402,196.059 510.179,196.174 C 508.402,196.059 506.597,197.343
504.830,196.735 C 504.938,197.227 505.047,197.717 505.154,198.209 C 504.191,200.097
502.736,200.132 500.954,199.459 C 499.767,199.010 498.728,199.493 498.634,200.821 C
498.532,202.262 499.804,202.076 500.689,202.036 C 502.369,201.960 504.042,201.748
505.718,201.593 C 503.721,203.351 501.489,204.586 499.355,205.973 C 498.420,206.581
497.066,207.488 498.181,208.756 C 499.006,209.693 500.427,209.385 501.413,208.583 C
502.033,208.078 502.403,207.278 502.955,206.673 C 506.767,202.496 511.881,202.264
517.004,202.074 C 519.381,198.142 522.006,194.347 523.668,190.019 C 523.668,190.019
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527.553,183.794 527.736,182.785 528.870,183.080 C 529.839,183.332 530.014,184.118
530.063,184.969 C 534.572,185.213 539.191,184.137 543.559,185.880 C 544.493,186.253
546.833,186.155 545.560,188.477 C 546.787,190.061 547.585,188.281 548.552,188.039 C
549.317,187.848 550.387,187.436 550.308,186.517 C 550.186,185.109 548.861,185.740
548.027,185.576 C 543.891,184.758 540.918,182.168 538.010,179.322 C 535.053,176.427
537.667,173.564 537.703,170.692 C 537.703,170.692 537.697,170.696 537.697,170.696 C
539.551,167.857 539.416,167.630 535.548,167.088 C 535.549,167.091 535.551,167.094
535.552,167.097 C 535.312,166.856 535.071,166.615 534.830,166.374 C 534.830,166.374
534.849,166.397 534.849,166.397 C 534.601,166.127 534.352,165.857 534.104,165.586 C
534.172,164.869 533.958,164.057 534.781,163.597 C 534.222,162.250 532.985,161.627

532.076,162.655 C 530.479,164.460 528.775,163.695 527.023,163.501 C 527.037,164.082
525.427,165.265 524.611,165.343 C 521.336,165.659 521.341,165.665 519.450,163.507 C
519.312,163.349 519.040,163.294 518.820,163.225 C 514.023,161.711 509.457,159.501
504.503,158.457 C 503.879,158.503 503.251,158.562 502.783,158.010 C 502.331,157.895
501.878,157.780 501.426,157.665 C 500.705,158.741 499.527,158.972 498.409,159.379 C
496.269,160.158 494.224,161.081 493.428,163.534 C 492.495,166.410 488.563,166.036
487.563,168.869 C 488.179,170.377 488.796,171.885 489.512,173.636 C 488.157,173.554
486.457,173.198 487.081,175.458 C 487.641,175.656 488.202,175.854 488.762,176.052 C
490.967,175.191 493.173,174.330 495.379,173.469 C 495.427,173.919 495.475,174.370
495.523,174.820 C 496.094,174.858 496.665,174.898 497.236,174.937 C 497.492,174.323
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491.020,180.844 490.323,185.118 490.254,189.678 C 490.185,194.181 489.104,195.862
487.338,199.820 C 487.338,201.820 484.800,203.737 483.338,203.820 C 483.097,204.213
477.538,208.244 475.276,210.019 C 474.908,210.016 474.540,210.014 474.172,210.012 C
473.002,210.027 471.832,210.043 470.662,210.058 C 469.707,213.247 466.162,215.452
461.608,215.691 C 461.303,215.952 460.998,216.213 460.693,216.474 C 461.120,218.068
461.120,218.068 460.693,216.474 C 457.600,215.528 458.102,212.073 456.321,210.211 C
455.608,209.908 454.896,209.605 454.183,209.302 C 451.693,210.237 449.041,210.228
446.456,210.593 C 444.465,210.873 442.447,211.006 442.041,213.582 C 444.167,212.923
444.167,212.923 442.040,213.584 C 441.388,214.023 440.736,214.462 440.084,214.901 C
439.901,215.730 439.900,215.730 440.082,214.901 C 438.676,214.901 437.256,214.769
435.871,214.932 C 433.775,215.180 431.919,215.857 432.091,218.553 C 431.867,218.760
431.643,218.967 431.419,219.174 C 430.945,221.712 430.945,221.712 431.419,219.174 C
429.181,223.143 426.591,222.395 423.832,219.762 C 423.592,219.534 423.206,219.405
422.867,219.342 C 417.900,218.432 413.493,216.032 409.035,213.884 C 407.180,212.991
404.777,212.235 404.161,209.686 C 402.746,209.766 401.332,209.845 399.917,209.924 C
399.066,209.516 397.223,210.304 397.806,208.172 C 396.854,207.560 395.901,206.947
394.947,206.333 L 394.947,206.333 C 388.823,201.108 381.693,200.149 374.039,201.397 C
373.534,201.480 373.068,201.658 373.146,202.231 C 373.282,203.221 374.084,203.493
374.931,203.654 C 375.415,205.125 376.577,205.509 377.957,205.544 C 378.179,205.569
379.878,207.606 380.439,208.637 C 380.886,209.456 380.754,210.243 379.994,210.847 C
379.392,211.326 378.616,211.495 377.995,211.152 C 376.763,210.471 377.873,209.821
378.140,209.144 C 378.303,208.733 378.532,207.995 378.363,207.858 C 375.989,205.929
372.512,206.793 370.115,204.544 C 369.467,203.936 368.421,205.400 367.909,206.347 C
366.595,206.597 365.257,206.813 364.995,208.491 C 364.785,208.741 356.283,200.074
356.409,199.942 C 358.604,199.093 358.945,196.613 360.584,195.232 C 363.109,193.104
362.213,191.864 359.343,191.364 C 359.198,190.272 359.034,189.460 358.857,188.864 C
360.226,189.250 361.606,189.760 362.992,190.319 C 365.823,191.459 376.391,190.231
376.338,189.820 C 376.370,189.477 375.918,186.356 375.950,186.014 C 375.949,186.013
375.949,186.012 375.949,186.012 C 376.676,183.868 376.688,181.727 375.940,179.587 C
376.136,179.466 374.357,178.014 373.569,178.001 C 373.132,177.844 372.696,177.687
372.259,177.531 C 370.161,176.790 368.095,175.936 365.959,175.331 C 360.863,173.890
357.953,175.150 355.156,179.832 C 354.164,181.493 352.741,182.679 351.140,183.746 C
348.517,185.495 346.171,187.561 344.636,190.395 C 345.231,190.753 345.827,191.112

346.423,191.471 C 349.745,188.280 353.238,187.757 356.823,188.393 C 356.220,189.263
355.608,190.568 355.059,191.378 C 355.064,191.378 355.069,191.378 355.074,191.378 C
354.809,193.537 354.570,195.729 351.427,194.233 C 350.927,194.273 349.452,197.313
349.331,197.222 C 349.351,197.360 349.361,197.499 349.362,197.639 C 349.192,199.196
348.694,200.564 347.209,201.361 L 347.225,201.345 C 345.047,202.700 345.310,204.594
346.438,206.719 C 342.338,202.820 336.480,205.426 335.149,205.778 C 333.854,206.121
331.828,206.132 332.234,208.483 C 331.110,208.220 328.514,209.291 330.376,206.347 C
331.103,205.198 329.886,205.209 329.309,204.730 C 328.008,203.651 325.472,203.726
325.739,201.106 C 321.162,201.342 318.596,205.344 314.760,206.967 C 316.388,208.151
315.534,208.960 314.344,209.719 C 314.426,211.934 311.440,213.027 312.228,215.500 C
313.776,215.106 315.420,216.231 317.046,217.073 C 314.449,217.723 311.877,218.491
309.279,219.148 C 306.610,219.823 303.903,220.378 303.020,223.558 C 301.411,223.497
300.048,224.164 298.745,225.006 L 298.745,225.005 C 298.440,225.102 298.135,225.198
297.830,225.295 C 297.295,221.831 294.763,222.396 292.395,222.576 C 291.465,222.646
290.527,222.610 289.593,222.623 C 289.025,223.573 288.457,224.523 287.889,225.474 C
287.889,225.474 287.889,225.474 287.890,225.475 C 286.150,226.111 285.339,227.695
284.272,229.018 C 280.231,228.677 278.509,232.175 275.845,234.112 C 272.458,234.416
268.977,233.505 265.677,234.869 C 263.761,235.661 262.098,236.835 263.539,239.103 C
264.831,241.135 267.838,242.594 264.790,245.480 C 264.581,245.678 265.163,246.748
265.419,247.396 C 267.364,252.330 267.873,257.079 263.675,261.237 C 262.631,261.334
261.553,261.646 260.551,261.485 C 258.368,261.135 257.332,268.231 255.531,269.885 C
251.823,273.290 251.669,279.801 254.962,283.339 C 257.218,285.763 260.305,287.064
262.762,289.211 C 263.268,290.192 264.165,290.169 265.076,290.114 C 266.001,289.496
266.926,288.879 267.851,288.261 C 267.851,288.261 267.851,288.261 267.851,288.261 C
270.747,289.689 273.546,291.028 276.354,287.887 C 277.413,286.702 279.007,285.976
280.407,285.124 C 281.262,284.604 282.211,284.543 283.036,285.261 C 283.934,286.042
283.732,286.884 283.149,287.772 C 282.444,288.847 281.628,289.884 281.571,291.257 C
281.808,292.902 282.046,294.547 282.284,296.192 C 286.408,297.314 289.924,299.553
293.335,302.042 C 294.248,302.708 295.482,302.934 296.570,303.359 C 297.651,305.359
299.245,305.002 300.754,304.090 C 301.175,303.836 301.559,303.673 301.912,303.593 C
302.548,303.732 303.166,303.920 303.760,304.173 C 304.001,304.430 304.221,304.759
304.423,305.163 C 305.764,307.837 308.010,308.684 310.840,308.359 C 312.068,309.978
313.295,310.833 314.516,308.342 C 314.674,308.345 314.831,308.351 314.988,308.359 C
316.796,308.233 318.595,308.431 320.202,309.225 C 323.593,310.901 327.008,310.528
330.597,310.051 C 332.866,309.749 334.785,308.643 336.994,308.212 C 340.373,307.551
343.831,308.820 347.065,307.507 C 349.326,306.590 351.461,306.975 353.638,307.640 C
353.983,309.610 355.495,309.269 356.640,308.883 C 361.787,307.149 366.960,307.334
372.179,308.355 C 372.061,309.122 371.719,309.720 370.854,309.711 C 365.908,309.656
360.962,309.532 356.186,311.191 C 355.409,311.460 353.903,310.696 354.056,312.186 C
354.182,313.409 355.204,314.117 356.715,313.660 C 360.495,312.518 364.421,312.811
368.298,312.535 C 372.464,312.240 376.645,311.494 378.606,306.930 C 380.365,306.386
381.085,305.008 381.465,303.358 C 381.463,303.358 381.462,303.358 381.460,303.357 C
383.219,300.636 386.490,302.711 388.603,301.113 C 388.801,300.923 389.000,300.734
389.199,300.544 C 390.675,300.321 392.032,300.783 393.384,301.275 C 393.571,298.185

392.566,289.591 392.290,288.294 C 390.459,288.474 389.153,286.627 387.273,286.994 C
384.638,287.840 381.989,288.567 379.064,288.119 C 379.342,286.224 381.584,284.817
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372.032,281.368 370.872,279.482 C 369.077,276.567 366.466,276.752 363.733,277.077 C
362.819,277.185 361.966,277.829 360.987,277.366 C 354.755,274.418 347.705,273.746
341.619,270.379 C 339.913,269.435 338.606,269.524 338.657,271.971 C 335.852,271.975
332.908,271.530 330.327,271.160 C 327.994,270.825 328.457,271.867 327.545,272.582 C
326.219,273.623 324.574,274.333 322.653,274.163 C 319.454,273.879 316.226,273.918
313.027,273.635 C 311.363,273.487 309.766,273.376 308.248,274.154 C 306.813,274.890
305.815,274.421 304.959,272.951 C 306.477,272.377 307.971,271.812 309.466,271.247 C
309.808,270.260 324.437,268.845 329.422,265.402 C 327.222,264.083 325.519,263.558
322.992,263.750 C 319.916,263.984 317.960,267.050 314.796,266.222 C 314.735,266.355
304.759,265.365 302.462,265.363 C 299.623,265.360 295.934,265.764 293.088,267.655 C
290.627,269.290 289.539,267.467 289.760,265.666 C 290.115,262.775 288.404,262.996
286.647,262.712 C 284.052,262.293 282.025,264.570 279.453,264.119 C 279.151,263.529
273.091,258.195 272.249,257.231 C 272.818,256.662 273.796,257.137 274.620,256.960 C
276.420,256.572 278.016,256.082 276.144,253.878 C 274.899,252.411 276.848,249.111
277.304,249.008 C 277.490,250.832 278.589,252.275 279.336,253.864 C 279.746,254.735
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290.268,258.431 C 290.702,259.097 291.136,259.763 291.570,260.429 C 296.794,262.327
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332.261,255.451 339.484,254.075 346.695,256.087 C 348.228,256.207 353.018,256.701
353.375,256.050 C 353.865,255.160 354.389,253.553 355.079,253.522 C 353.583,250.822
350.354,249.646 349.903,245.737 C 349.452,241.829 346.444,240.628 341.502,240.584 C
341.241,240.344 340.979,240.103 340.717,239.863 C 340.541,239.874 340.365,239.881
340.189,239.885 C 340.189,239.885 340.188,239.885 340.188,239.885 C 339.373,237.435
337.294,238.843 335.806,238.447 C 335.843,237.145 336.959,237.328 337.735,236.888 C
339.984,235.613 342.726,235.976 344.920,234.309 C 346.086,233.424 348.022,233.144
349.628,234.144 C 353.716,236.688 358.455,236.218 362.920,237.022 C 362.919,237.019
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364.333,237.724 364.331,237.725 364.329,237.727 C 364.542,239.265 365.458,239.488
366.512,238.640 C 367.503,237.843 368.359,238.152 369.424,238.315 C 374.945,239.163
375.484,238.746 376.467,233.435 C 376.508,233.212 376.469,232.973 376.466,232.742 C
377.267,232.765 378.097,232.875 378.605,232.026 C 380.429,231.768 380.524,230.288
380.788,228.928 C 380.741,228.874 380.695,228.819 380.648,228.765 C 380.920,227.575
381.259,225.796 381.414,225.630 C 384.286,223.760 386.316,221.039 388.549,218.529 C
389.008,218.012 389.249,217.211 390.104,217.324 C 391.116,217.457 391.420,218.282

391.405,219.143 C 391.368,221.216 392.284,222.232 394.394,222.077 C 392.918,220.507
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402.989,229.894 C 403.181,230.087 403.372,230.281 403.564,230.474 C 403.702,230.568 403.819,

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403.564,230.476 C 403.545,231.118 403.627,231.711 404.293,232.029 C 404.293,232.027
404.292,232.024 404.292,232.022 C 408.167,234.028 412.435,235.335 415.691,238.438 C
415.946,238.444 415.946,238.444 415.691,238.438 C 415.691,238.438 415.691,238.438
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415.745,239.915 416.792,239.906 417.850,239.881 C 417.847,239.875 417.843,239.872
417.841,239.866 L 417.841,239.866 C 417.840,239.864 417.839,239.862 417.838,239.860 C
417.839,239.862 417.840,239.864 417.841,239.866 C 418.896,239.863 419.583,240.427
420.063,241.312 C 420.268,241.517 420.474,241.722 420.679,241.927 C 421.254,242.168
421.254,242.169 420.679,241.928 C 421.172,244.414 423.231,245.573 424.971,247.002 C
425.208,248.479 425.665,249.824 427.113,250.574 C 427.835,252.398 427.424,254.891
430.072,255.578 C 430.271,255.775 430.470,255.972 430.669,256.169 C 431.702,257.646
431.702,257.647 430.669,256.170 C 430.447,258.093 431.140,259.887 431.683,261.635 C
432.205,263.319 431.865,264.333 430.381,265.093 C 428.928,265.123 427.949,263.192
426.282,264.103 C 425.771,263.842 425.259,263.581 424.748,263.320 L 424.575,263.383 L
424.497,263.223 C 423.031,262.721 421.703,261.738 420.033,261.949 C 418.154,260.059
415.700,258.625 415.144,255.691 C 414.814,253.949 413.527,252.934 412.195,251.969 C
412.187,251.511 412.178,251.053 412.170,250.594 C 411.671,249.603 411.256,248.384
409.884,249.746 C 408.789,250.094 407.738,250.513 407.053,251.517 C 406.026,252.012
405.105,251.986 404.119,251.265 C 401.562,249.394 398.609,248.279 395.714,247.065 C
394.783,247.362 393.597,245.496 393.004,247.072 C 392.416,248.634 394.238,248.727
395.042,248.809 C 398.656,249.178 396.455,251.603 396.486,253.644 C 398.490,252.321
399.774,249.533 402.348,251.991 C 403.364,252.960 403.838,253.381 402.349,254.224 C
399.879,255.623 397.455,257.107 395.042,258.603 C 393.046,259.840 392.179,258.981
392.036,256.985 C 391.593,250.798 389.794,247.990 390.152,251.521 C 390.421,254.184
388.446,256.946 390.697,259.575 C 391.286,260.263 390.460,261.318 389.630,261.936 C
388.592,262.708 387.603,263.546 386.593,264.355 C 386.357,262.202 384.616,260.909
383.658,259.174 C 382.088,256.331 380.697,253.390 379.230,250.490 C 376.957,251.785
375.497,253.965 373.613,255.683 C 372.648,256.563 371.810,257.674 370.393,256.410 C
369.780,257.586 368.925,258.473 367.802,259.249 C 365.263,261.002 365.416,262.197
368.189,263.372 C 368.946,263.693 369.768,263.859 370.560,264.096 C 371.968,263.454
372.590,264.872 373.606,265.258 C 374.636,263.279 376.208,263.843 377.380,264.797 C
380.514,267.349 383.481,270.106 386.514,272.781 C 386.272,273.716 384.620,272.980
384.770,274.026 C 384.941,275.222 386.196,275.023 387.073,275.054 C 388.802,275.116
389.693,273.751 390.746,272.692 L 390.976,272.743 L 391.212,272.739 C 391.520,274.390
393.530,269.597 393.132,265.637 C 392.884,263.169 397.728,265.848 397.149,267.679 C
401.728,268.156 402.729,270.191 400.699,274.896 C 402.544,282.469 400.997,289.907
398.882,298.211 C 401.182,296.709 401.449,295.245 402.162,294.106 C 402.407,294.113
402.651,294.120 402.895,294.126 C 402.906,294.957 403.408,295.243 404.128,295.591 C
409.921,298.393 415.662,296.340 421.418,295.517 C 423.340,297.655 426.179,298.982

427.046,302.082 C 427.189,302.595 428.093,303.146 428.711,303.236 C 434.410,304.068
445.237,303.008 446.339,301.961 C 448.867,302.806 450.626,303.363 451.778,303.693 C
451.679,303.799 451.581,303.905 451.482,304.012 C 452.849,306.441 455.517,305.076
457.449,305.992 C 458.318,306.404 459.481,306.540 459.497,307.529 C 459.547,310.607
462.358,312.722 462.204,315.829 C 462.144,317.032 462.891,317.841 463.849,318.374 C
469.473,321.503 471.472,327.145 473.679,332.603 C 474.773,335.309 480.908,350.281
484.099,351.347 C 483.766,353.044 481.516,353.004 481.628,354.847 C 481.971,354.929
482.353,355.161 482.597,355.059 C 486.518,353.422 489.094,354.303 490.272,358.274 C
491.707,363.113 493.141,368.045 491.738,373.204 C 490.263,373.357 489.055,372.367
487.680,372.213 C 484.678,371.876 481.453,370.716 479.180,373.975 L 479.180,373.975 C
477.057,373.698 476.485,375.116 475.982,376.763 C 475.626,377.927 475.497,378.798
477.029,378.989 L 477.029,378.989 C 477.038,379.581 477.182,380.102 477.758,380.400 C
477.811,381.689 477.557,382.826 476.864,384.004 C 476.133,385.245 475.436,386.881
477.753,387.539 C 478.242,390.137 480.268,390.317 482.306,390.358 C 486.033,390.434
489.782,390.116 493.446,391.106 L 493.454,391.098 L 493.454,391.098 C 493.454,391.098
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494.565,393.471 495.275,393.951 496.303,393.956 L 496.312,393.947 L 496.312,393.947 C
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504.408,394.433 C 505.043,394.642 505.677,394.851 506.311,395.060 C 506.660,393.623
505.418,393.021 504.770,392.099 C 503.027,389.619 500.941,387.317 500.523,384.129 C
500.756,383.839 500.989,383.549 501.222,383.259 C 501.569,382.693 503.321,382.481
503.618,382.446 C 504.516,382.714 505.413,382.983 506.311,383.251 C 506.061,383.720
505.812,384.189 505.563,384.658 C 506.069,384.907 506.575,385.156 507.081,385.406 C
507.506,385.405 507.931,385.405 508.357,385.404 C 509.300,385.401 509.843,385.827
509.871,386.808 C 511.449,387.094 511.735,387.795 510.561,388.967 C 510.546,389.261
510.532,389.554 510.517,389.847 C 508.013,390.261 508.451,392.290 508.256,393.971 C
508.291,394.679 508.326,395.387 508.361,396.096 C 508.446,397.481 508.531,398.865
508.616,400.250 C 507.336,401.125 507.577,402.317 508.155,403.376 C 512.535,411.403
510.182,418.750 505.989,425.943 C 505.340,427.056 504.718,428.209 504.813,429.578 C
504.899,429.635 504.980,429.697 505.054,429.762 C 504.980,429.697 504.900,429.635
504.813,429.578 C 504.353,429.324 503.891,429.069 503.430,428.813 L 503.355,428.919 C
503.145,429.138 502.936,429.357 502.726,429.575 C 500.357,433.821 497.987,438.068
495.617,442.316 C 495.793,442.928 495.969,443.541 496.145,444.155 C 494.508,444.937
494.186,446.832 492.941,447.946 C 493.329,448.012 493.716,448.080 494.104,448.147 C
494.260,448.298 494.394,448.449 494.507,448.600 C 494.394,448.449 494.260,448.298
494.104,448.147 C 494.120,449.370 494.137,450.594 494.153,451.817 C 494.281,451.662
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492.031,453.163 L 492.027,453.167 C 491.405,453.448 491.295,453.986 491.312,454.588 C
490.622,454.904 490.575,455.515 490.595,456.155 C 490.384,456.580 490.174,457.004
489.964,457.427 C 489.120,457.443 488.191,457.233 487.732,458.268 C 486.305,460.630
487.387,462.240 488.982,464.144 C 492.061,467.820 494.875,474.818 494.470,480.619 C
494.117,480.579 493.764,480.540 493.412,480.501 C 493.516,481.852 489.842,480.536
486.684,479.590 C 486.756,479.580 486.823,479.563 486.899,479.558 C 486.902,479.556

486.904,479.554 486.906,479.551 C 486.904,479.554 486.903,479.556 486.901,479.558 C
487.299,479.490 487.695,479.421 488.090,479.353 C 487.960,479.214 487.901,477.341
488.462,476.774 C 488.334,476.401 488.334,476.400 488.462,476.773 C 488.932,476.779
489.402,476.784 489.872,476.790 C 490.538,474.511 491.470,471.543 488.046,471.379 C
486.065,471.285 481.672,467.442 478.465,465.976 C 478.463,465.541 478.460,465.105
478.457,464.669 C 477.952,464.400 477.446,464.131 476.941,463.862 C 476.233,463.334
476.267,462.858 477.041,462.435 C 478.675,460.743 480.429,459.147 481.430,456.949 C
481.398,456.675 481.365,456.402 481.332,456.128 C 478.813,452.173 476.322,448.208
477.038,443.180 C 477.400,440.634 475.567,438.529 475.610,436.048 C 473.885,435.855
473.048,434.748 472.665,433.175 C 472.227,432.727 471.789,432.280 471.352,431.832 C
470.810,431.474 470.616,430.947 470.615,430.325 C 470.374,430.055 470.134,429.784
469.894,429.514 C 469.453,429.080 469.012,428.646 468.572,428.212 C 466.839,428.364
465.674,427.556 464.915,426.060 C 464.324,426.049 463.796,425.912 463.486,425.340 C
459.451,422.958 454.612,421.942 451.367,418.214 C 450.409,418.185 449.937,417.680
449.920,416.730 C 449.648,416.476 449.376,416.222 449.103,415.968 C 446.313,416.075
443.376,414.488 444.927,413.901 C 443.824,412.086 441.825,410.718 442.084,408.222 C
440.073,407.117 440.725,404.866 439.948,403.230 C 439.372,402.927 439.230,402.404
439.229,401.810 C 438.466,401.722 437.771,401.359 437.878,400.555 C 438.175,398.317
436.866,396.866 435.586,395.367 C 435.381,395.163 435.176,394.959 434.971,394.754 C
433.140,393.256 431.559,388.297 431.860,387.840 C 430.718,386.692 427.453,389.067
427.823,385.409 C 426.395,385.323 425.609,384.388 424.969,383.259 C 424.047,383.225
423.560,382.754 423.535,381.821 L 423.553,381.838 C 423.309,381.594 423.064,381.350
422.819,381.105 L 422.840,381.126 C 422.595,380.881 422.351,380.637 422.106,380.392 L
422.127,380.412 C 421.888,380.174 421.650,379.935 421.411,379.697 C 421.390,379.697
421.372,379.693 421.351,379.692 C 421.372,379.693 421.390,379.696 421.411,379.697 L
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421.114,379.104 420.582,378.969 419.982,378.968 C 419.571,376.954 417.972,376.917
416.405,376.829 C 416.167,376.590 415.928,376.352 415.690,376.113 L 415.705,376.129 C
415.467,375.890 415.228,375.651 414.990,375.413 C 414.982,372.867 415.964,373.051
417.796,374.158 C 421.144,376.182 424.717,377.793 428.774,377.474 C 430.033,377.375
431.633,376.972 431.756,375.487 C 431.845,374.405 431.806,372.756 429.970,372.551 C
429.904,371.967 430.029,371.249 429.733,370.828 C 425.896,365.367 424.899,358.787
422.426,352.800 C 421.601,350.805 421.699,348.085 419.269,346.874 C 419.071,345.143
417.707,345.312 416.628,345.469 C 413.409,345.936 410.286,345.569 407.184,344.740 C
406.871,342.697 405.523,341.921 403.593,341.859 C 403.583,341.844 403.574,341.829
403.564,341.814 C 403.333,341.396 403.102,340.978 402.872,340.561 C 402.867,340.561
402.863,340.560 402.859,340.560 C 402.505,339.541 400.236,352.586 400.709,352.590 C
400.771,354.341 401.211,355.902 402.853,356.859 C 402.600,360.585 403.916,363.212
407.859,363.998 C 408.093,364.232 408.327,364.466 408.561,364.700 C 407.460,365.849
411.847,367.062 408.520,368.185 C 408.955,368.880 409.410,369.558 409.889,370.214 C
409.409,369.558 408.954,368.880 408.520,368.183 C 408.064,367.290 407.369,366.634
406.499,366.152 C 406.498,366.152 406.497,366.152 406.496,366.152 C 406.497,366.152
406.498,366.152 406.498,366.152 C 405.280,363.248 399.491,363.018 396.457,362.791 C
396.441,361.942 396.608,361.042 395.726,360.428 C 395.497,358.764 396.416,356.935

395.015,355.440 C 395.008,354.496 394.535,354.014 393.594,353.998 C 393.585,353.402
393.456,352.868 392.862,352.570 C 392.862,352.571 392.862,352.572 392.862,352.574 C
392.630,352.341 392.397,352.108 392.165,351.876 C 390.734,349.082 391.080,345.553
388.574,343.207 C 388.377,343.007 388.181,342.808 387.984,342.610 C 387.420,341.806
386.583,341.837 385.744,341.873 C 385.695,341.094 385.248,340.744 384.543,340.394 C
381.493,338.878 355.510,339.366 355.001,341.275 C 352.207,341.729 349.414,342.182
346.620,342.636 C 344.580,342.620 342.571,342.332 340.994,340.952 C 339.005,339.213
337.213,339.287 335.446,341.176 C 333.426,343.335 332.505,342.302 331.998,340.012 C
331.998,340.012 331.998,340.012 331.998,340.012 C 332.387,337.591 331.786,336.737
329.390,338.211 C 328.200,338.943 326.835,339.392 325.548,339.969 C 322.509,339.899
320.388,338.499 319.347,335.609 C 318.910,334.394 318.057,333.354 316.910,333.231 C
312.766,332.785 308.713,331.450 304.477,331.883 C 303.748,332.708 302.739,332.587
301.826,332.557 C 296.946,332.400 292.068,332.172 287.188,331.986 C 284.604,331.888
281.993,331.552 279.519,332.686 C 277.851,332.560 276.120,332.322 275.883,334.735 C
267.398,336.177 259.131,335.013 250.963,332.656 C 251.202,333.588 245.138,332.443
246.386,337.004 C 247.164,339.846 245.128,341.919 244.987,344.201 C 244.840,346.571
249.287,347.516 248.836,350.862 C 248.390,351.235 247.944,351.608 247.498,351.981 C
245.976,352.887 244.454,353.793 242.933,354.700 C 241.845,355.349 240.386,355.756
241.066,357.560 C 238.181,357.023 235.288,356.527 232.415,355.936 C 230.530,355.548
229.498,356.539 228.790,358.028 C 228.231,359.203 227.533,360.820 228.941,361.532 C
232.405,363.283 234.367,366.370 236.612,369.242 C 238.044,371.075 239.391,371.265
241.370,369.706 C 243.586,367.959 244.795,365.925 245.078,363.174 C 245.272,361.295
245.556,359.385 247.136,358.045 C 248.204,357.140 247.938,355.898 248.043,354.744 C
248.888,354.170 249.757,353.683 250.840,353.987 C 252.338,352.820 255.771,353.910
257.054,355.516 C 259.109,358.090 261.332,358.203 263.757,356.070 C 263.757,355.883
263.756,355.696 263.753,355.508 C 263.751,355.010 263.748,354.512 263.746,354.014 C
260.854,353.297 258.157,352.084 255.505,350.763 C 257.311,350.181 258.442,346.406
261.091,349.559 C 261.117,349.589 262.232,348.538 262.184,348.798 C 262.433,350.665
263.855,350.381 265.146,350.481 C 269.654,350.833 274.043,349.437 278.535,349.622 C
278.733,349.020 278.255,348.725 277.957,348.347 C 278.466,348.050 278.974,347.753
279.482,347.457 C 279.597,347.474 279.710,347.502 279.825,347.509 C 281.792,347.621
284.293,345.822 285.466,347.050 C 287.133,348.796 283.722,350.369 283.915,352.457 C
288.460,354.223 292.822,356.444 297.749,357.207 C 299.761,357.518 301.735,357.434
303.723,357.580 C 303.942,354.168 301.719,351.281 301.154,347.279 C 304.149,349.348
304.194,352.092 304.994,354.369 C 305.569,356.005 305.945,357.292 308.075,356.411 C
308.713,356.146 309.607,356.137 309.832,357.009 C 310.072,357.938 309.137,357.985
308.557,358.332 C 307.744,358.818 305.789,358.673 307.075,360.577 C 309.748,360.160
312.510,360.890 315.153,359.866 C 316.243,359.444 317.552,359.836 317.923,360.871 C
319.449,365.132 323.053,368.211 324.407,372.541 L 324.371,372.573 C 324.880,375.958
327.306,377.630 330.094,378.979 C 330.394,379.565 330.921,379.700 331.518,379.694 C
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347.990,386.797 C 351.566,388.412 355.508,387.659 359.219,387.308 C 360.900,387.149
363.599,386.593 365.153,385.644 C 365.335,390.023 365.837,394.349 368.056,398.387 C
370.259,400.899 370.778,404.125 368.932,402.883 C 368.761,407.355 372.375,409.819

374.375,413.139 C 374.287,413.668 374.056,414.745 373.659,414.351 C 370.537,411.257
370.276,415.883 368.440,416.324 C 367.359,416.583 368.939,417.419 369.218,418.040 C
370.893,417.896 372.569,417.751 374.245,417.606 C 374.333,417.071 374.251,416.349
375.055,416.373 C 375.820,416.396 375.711,417.160 375.899,417.655 C 379.118,422.710
381.789,428.248 385.701,432.693 C 390.162,437.762 390.275,443.050 388.864,448.857 C
388.471,450.473 388.418,452.089 388.127,453.639 C 386.860,460.383 387.801,467.438
386.644,474.190 C 383.632,467.936 373.050,458.023 369.745,453.596 C 372.175,453.271
372.697,455.116 373.874,455.770 C 375.323,456.575 376.599,457.176 376.452,454.600 C
375.410,454.617 374.394,454.593 374.316,453.169 C 373.721,453.170 373.193,453.038
372.893,452.452 C 369.505,451.011 370.643,448.053 371.073,445.765 C 371.516,443.408
371.541,441.362 370.283,439.351 C 368.786,436.959 367.902,430.216 367.894,429.615 C
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364.950,427.470 C 364.750,427.271 359.934,417.319 357.608,412.601 C 355.796,408.926
353.714,405.447 350.075,403.231 C 350.073,402.866 350.071,402.501 350.069,402.136 C
347.953,401.841 345.836,401.689 343.714,402.068 C 342.475,401.647 341.243,401.713
340.015,402.116 C 338.589,401.192 335.393,403.118 335.551,400.385 C 335.703,397.751
338.575,399.572 340.187,399.180 C 340.855,399.018 341.557,398.994 342.244,398.907 C
340.099,396.181 336.799,397.961 334.197,396.873 C 333.092,396.412 331.573,397.171
330.597,395.921 C 327.390,398.398 325.857,395.828 324.157,393.784 C 318.076,386.472
312.530,378.788 307.945,370.437 C 307.513,370.436 307.082,370.434 306.650,370.432 C
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302.650,369.628 299.836,373.579 298.684,373.200 C 295.271,372.078 291.916,370.777
288.569,369.469 C 288.272,369.353 288.187,368.697 288.007,368.283 C 287.992,368.283
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287.454,367.024 286.395,366.745 285.150,366.833 C 285.152,366.839 285.156,366.843
285.158,366.849 C 282.535,366.849 280.082,365.884 277.530,365.511 C 275.292,365.184
273.051,365.440 270.879,366.128 C 270.615,366.366 270.351,366.605 270.087,366.844 C
269.758,366.827 269.013,366.868 269.011,366.868 C 268.222,366.866 267.432,366.863
266.641,366.861 C 266.235,367.633 265.674,368.321 264.753,368.267 C 261.420,368.070
259.022,370.310 256.209,371.456 C 254.328,372.223 253.536,373.674 253.767,375.701 C
253.981,377.577 253.955,379.496 254.839,381.240 C 253.683,383.513 252.526,385.785
251.370,388.058 C 250.287,389.761 247.589,390.389 248.015,393.096 C 247.662,394.209
247.813,395.558 246.534,396.234 C 246.586,396.435 246.634,396.637 246.679,396.840 C
247.449,397.073 248.219,397.307 248.989,397.541 C 250.759,397.322 252.446,397.364
253.636,398.997 C 253.529,396.924 253.847,395.284 256.583,396.113 C 256.665,395.999
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261.413,398.779 262.538,398.770 263.663,398.762 C 263.726,398.304 263.789,397.845
263.852,397.387 C 263.553,396.983 263.253,396.579 262.953,396.177 C 261.795,395.840
260.638,395.503 259.480,395.168 C 259.487,394.988 259.492,394.811 259.494,394.633 C
260.856,394.625 262.166,394.486 263.048,393.248 L 263.050,393.247 C 265.603,393.136

268.559,393.668 268.707,389.710 C 273.996,391.573 278.544,394.531 282.585,398.453 C
287.642,403.360 292.773,408.213 298.592,412.256 C 299.019,412.552 299.186,413.222
299.473,413.718 C 300.795,414.211 302.108,413.649 303.426,413.685 C 303.426,413.685
303.467,413.669 303.469,413.668 C 303.469,413.667 303.470,413.667 303.470,413.667 C
303.552,413.812 304.628,414.043 305.067,414.026 C 305.971,413.464 306.927,413.085
308.020,413.191 C 308.975,413.551 309.931,413.911 310.886,414.269 C 311.609,414.433
312.333,414.595 313.057,414.757 C 315.587,414.148 318.130,413.647 320.755,413.811 C
322.447,413.384 324.139,412.957 325.832,412.530 C 326.297,415.686 327.990,418.179
330.111,420.439 C 330.111,420.439 330.111,420.439 330.111,420.439 C 330.089,420.651
330.078,420.864 330.077,421.078 C 327.381,420.816 325.046,422.219 322.525,422.764 C
319.913,423.330 319.953,424.798 321.678,426.502 C 320.564,427.384 320.529,428.753
320.921,429.754 C 322.325,433.339 323.171,436.944 322.839,440.834 C 322.733,442.085
323.414,443.480 322.788,444.648 C 321.833,446.431 320.798,443.087 319.566,444.667 C
320.114,445.979 321.485,446.235 322.552,446.864 C 326.200,449.013 330.664,450.494
329.639,456.261 C 329.505,457.015 330.420,457.933 330.781,458.803 C 331.115,459.610
331.972,460.392 330.988,461.423 C 329.121,460.960 329.468,457.358 326.651,458.236 C
326.228,460.753 326.520,463.130 328.035,465.266 C 328.624,465.598 328.624,465.598
328.035,465.266 C 326.640,465.168 325.654,465.535 325.819,467.215 C 324.570,468.472
324.898,469.744 325.991,470.807 C 327.096,471.882 327.237,473.181 327.300,474.560 C
328.857,474.855 329.668,475.684 329.305,477.355 C 325.592,476.210 321.441,478.336
317.891,475.839 C 317.685,475.694 315.637,475.025 314.787,475.423 C 315.101,477.126
315.415,478.828 315.729,480.530 C 315.777,481.330 315.825,482.132 315.872,482.933 C
317.638,486.582 316.913,494.617 316.291,495.171 C 316.311,497.287 318.513,496.887
319.466,497.923 C 320.501,497.649 321.193,498.281 321.909,498.850 C 323.303,500.027
324.932,500.231 326.665,499.990 C 326.990,500.053 327.759,501.207 327.821,501.720 C
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331.686,505.072 C 333.966,507.150 335.956,507.085 337.289,503.981 C 338.835,502.462
341.658,504.090 342.858,501.720 C 346.507,500.086 348.713,502.673 351.092,504.598 C
354.854,507.643 358.477,510.931 363.877,510.217 C 364.294,509.770 364.712,509.323
365.131,508.875 C 370.531,503.958 370.695,502.468 366.333,497.869 C 366.872,497.066
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376.970,487.636 379.960,483.705 C 380.687,482.748 383.024,481.513 384.886,480.247 C
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388.267,482.925 390.365,483.035 C 392.550,483.149 393.704,483.788 393.592,486.134 C
393.539,487.239 393.230,488.629 395.010,488.831 C 395.188,489.235 395.267,489.764
395.574,490.008 C 396.165,490.479 397.456,490.320 397.393,491.308 C 397.316,492.521
395.974,492.137 395.202,492.504 C 393.401,493.361 391.891,494.556 391.440,496.664 C
389.539,496.442 388.722,497.632 388.094,499.164 C 387.339,501.005 388.203,502.744
388.679,504.335 C 390.181,509.356 392.122,514.212 397.878,515.935 C 397.878,515.932
397.876,515.929 397.876,515.925 C 400.958,516.919 400.839,520.133 402.127,522.318 C

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407.584,551.556 407.572,552.578 C 405.172,553.214 400.725,555.267 395.838,558.088 C
392.201,560.188 389.059,562.288 386.962,563.953 C 386.325,563.263 385.056,563.048
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381.353,566.292 380.754,566.584 C 380.744,567.175 380.617,567.707 380.036,568.011 C
379.739,568.596 379.207,568.723 378.616,568.736 C 378.616,569.233 378.616,569.731
378.617,570.228 C 378.244,570.950 377.038,571.111 377.267,572.238 C 377.017,572.251
376.766,572.265 376.516,572.278 C 375.901,572.564 375.747,573.095 375.746,573.709 C
374.803,573.723 374.345,574.222 374.320,575.151 C 374.326,575.151 374.329,575.149
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373.743,588.345 370.568,585.840 C 368.488,584.199 367.822,584.340 367.887,587.024 C
367.903,587.690 367.723,588.884 367.423,588.956 C 363.618,589.866 367.008,595.226
367.338,596.820 C 367.564,597.913 359.811,593.975 355.855,593.673 C 355.659,593.158
355.471,592.675 355.301,592.255 C 356.506,588.817 358.159,585.437 356.499,581.634 C
355.302,581.797 354.482,581.365 354.159,580.150 C 352.613,580.148 351.069,580.145
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342.077,586.521 342.231,587.396 C 342.231,587.441 331.880,585.245 330.913,585.100 C
329.528,586.095 328.185,585.362 326.903,584.903 C 325.130,584.268 324.499,585.034
324.378,586.654 C 324.180,586.855 323.981,587.055 323.782,587.255 C 322.267,587.174
320.776,587.314 319.235,586.908 C 316.143,586.095 314.351,587.508 313.679,590.927 C
313.477,591.131 313.275,591.333 313.073,591.535 C 311.487,591.636 309.832,591.617
309.407,593.689 C 307.177,595.115 307.166,596.541 309.403,597.967 C 309.402,598.564
309.537,599.091 310.120,599.393 C 310.206,600.740 310.912,601.468 312.274,601.541 C
312.512,601.780 312.750,602.018 312.989,602.257 C 312.989,602.257 312.968,602.237
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313.682,602.951 313.682,602.951 C 313.921,603.189 314.159,603.428 314.398,603.667 C
314.436,604.133 314.309,604.717 314.542,605.045 C 316.280,607.487 317.240,609.904
315.343,612.782 L 317.867,616.496 C 318.967,618.981 319.144,621.626 319.576,624.273 C
320.132,627.687 319.103,631.684 322.269,634.441 C 322.469,634.642 322.669,634.843
322.869,635.044 C 322.869,635.044 322.869,635.044 322.870,635.044 C 325.068,637.131
326.482,639.372 325.192,642.625 C 325.137,642.765 325.090,642.920 325.050,643.080 C
324.067,644.296 322.679,647.010 321.436,650.288 C 320.685,652.268 320.110,654.128
319.756,655.637 C 319.080,656.103 318.732,657.005 318.676,657.986 C 318.629,658.531
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320.580,664.556 320.863,665.260 321.546,665.758 C 322.255,665.990 322.964,666.221
323.673,666.452 C 323.688,667.039 323.811,667.571 324.388,667.874 C 324.810,669.486
325.436,670.934 327.238,671.441 C 327.255,672.379 327.738,672.849 328.667,672.872 C
328.886,674.546 330.228,674.775 331.511,675.015 C 334.332,675.542 336.985,676.503
339.490,677.902 C 342.054,679.332 344.639,680.725 347.215,682.134 C 347.514,682.727
348.044,682.860 348.643,682.860 C 348.823,683.237 348.949,683.867 349.198,683.920 C
349.968,684.085 349.992,683.401 350.077,682.861 C 351.062,682.861 352.047,682.862
353.031,682.862 C 353.231,683.061 353.430,683.260 353.630,683.459 C 353.923,685.201
354.032,687.001 354.557,688.671 C 355.169,690.618 355.465,692.939 358.025,693.564 C

358.937,694.478 359.848,695.392 360.759,696.305 C 360.782,697.795 361.792,697.891
362.908,697.839 C 362.921,698.779 363.417,699.235 364.340,699.262 C 364.639,699.846
365.166,699.979 365.759,699.978 C 365.781,700.716 366.022,701.363 366.660,701.773 C
370.882,704.490 375.602,705.770 380.518,706.310 C 382.061,706.479 383.483,705.747
384.311,704.255 C 385.707,704.067 387.018,703.448 386.801,701.923 C 386.589,700.426
385.032,700.709 383.888,700.681 C 383.066,700.661 382.243,700.712 381.421,700.731 C
381.141,698.396 382.164,696.576 383.842,695.134 C 385.763,693.483 387.345,691.707
387.646,689.046 C 387.835,687.373 389.103,686.351 390.561,686.557 C 394.225,687.073
396.256,685.161 397.911,682.361 C 398.300,681.702 399.544,681.213 398.930,680.388 C
398.127,679.307 397.297,680.575 396.476,680.818 C 392.222,677.758 390.822,677.753
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385.699,682.838 384.731,682.723 384.206,683.451 C 382.721,685.511 380.768,685.566
378.605,684.994 C 377.998,683.800 377.103,682.977 375.732,682.767 C 375.058,682.324
374.383,681.883 373.708,681.442 C 372.359,678.183 372.533,673.892 367.899,672.859 C
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364.153,669.995 363.528,670.002 C 362.849,669.330 362.172,668.658 361.494,667.986 C
361.517,667.314 361.364,666.721 360.757,666.331 C 360.564,666.135 346.780,667.901
345.498,667.831 C 344.737,667.789 343.320,668.147 343.374,667.243 C 343.562,664.130
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332.205,667.982 330.948,666.234 329.367,664.951 C 329.166,664.742 328.965,664.534
328.763,664.325 C 328.613,663.355 328.239,662.542 327.246,662.167 C 327.238,661.530
327.104,660.966 326.408,660.731 C 326.009,660.499 325.611,660.268 325.213,660.037 C
325.033,658.664 324.062,658.525 322.959,658.591 C 322.726,658.359 322.492,658.126
322.259,657.893 C 322.245,657.335 322.254,656.700 322.094,656.197 C 322.790,654.872
323.538,653.204 324.241,651.352 C 325.030,649.273 325.624,647.325 325.973,645.777 C
326.514,645.746 326.988,645.592 327.239,645.041 C 329.644,642.434 331.586,639.316
335.086,637.913 C 335.338,638.245 335.589,638.576 335.841,638.907 C 337.166,638.647
337.703,637.838 337.498,636.517 C 337.493,636.518 337.224,636.418 337.224,636.418 C
336.134,635.835 336.596,635.251 337.223,634.666 C 337.223,634.666 337.185,634.398
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352.818,627.117 352.190,624.256 C 352.205,624.091 352.215,623.926 352.223,623.760 C
351.075,623.697 351.075,623.696 352.222,623.759 C 351.149,621.688 349.233,621.489
347.223,621.499 C 346.624,618.176 345.820,615.033 341.494,614.977 C 341.290,614.782
341.086,614.587 340.882,614.392 C 340.725,614.392 340.571,614.386 340.424,614.367 C
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339.364,613.654 C 339.126,613.415 338.888,613.177 338.650,612.938 L 338.667,612.955 C
338.424,612.712 338.180,612.469 337.937,612.225 L 337.953,612.242 C 337.715,612.003
337.477,611.765 337.238,611.527 C 337.238,611.527 337.238,611.527 337.238,611.527 L
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334.851,609.142 334.616,608.908 334.381,608.673 C 334.396,606.455 333.120,604.976
331.527,603.678 C 331.438,602.115 331.426,600.646 333.686,600.790 C 334.684,600.853
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337.871,596.720 338.085,593.757 337.275,590.599 C 336.971,589.412 336.303,588.745

335.086,588.631 C 335.100,588.242 340.338,588.820 341.338,589.820 C 342.338,590.820
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338.421,598.364 337.953,599.087 337.941,600.114 C 337.704,600.351 337.468,600.588
337.231,600.825 C 336.991,601.065 336.752,601.304 336.512,601.544 C 336.512,601.544
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338.240,607.119 338.765,607.259 339.368,607.244 C 339.369,608.197 339.876,608.642
340.799,608.670 C 341.108,609.301 341.684,609.385 342.296,609.394 C 343.188,609.872
343.873,610.557 344.351,611.448 C 344.361,612.400 344.808,612.931 345.784,612.955 C
345.810,613.929 346.336,614.381 347.290,614.388 C 348.491,614.919 348.747,616.157
349.348,617.136 C 351.114,619.615 353.446,621.186 356.503,621.591 C 356.500,621.761
361.517,617.629 362.756,614.350 C 361.417,614.191 360.925,613.069 360.906,612.090 C
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356.782,596.223 C 358.685,597.363 362.035,599.022 367.931,601.436 C 368.412,603.881
368.894,606.326 369.375,608.770 C 371.472,608.510 373.826,607.512 375.615,608.136 C
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392.796,611.572 C 394.403,611.288 395.589,610.978 396.429,610.650 C 396.610,610.615
396.792,610.576 396.965,610.560 C 396.998,610.490 397.042,610.426 397.078,610.357 C
397.937,609.903 398.196,609.418 398.006,608.916 C 399.065,607.508 400.322,606.218
400.692,604.393 C 399.797,604.385 399.104,603.995 398.724,603.189 C 397.604,600.816
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455.975,558.713 454.006,557.218 C 453.275,556.663 451.906,556.636 451.859,555.573 C
451.803,554.307 447.249,553.099 446.523,551.307 C 445.857,549.661 444.358,548.441
444.229,546.567 C 443.275,546.535 442.321,546.502 441.367,546.470 C 439.579,546.024
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