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Project Description

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Controls of climate versus tectonic effects in Pleistocene mixed carbonate-siliciclastic sediments (Polis basin, NW Cyprus).

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Summary

An integrated sedimentary, geomorphological and neotectonic study of Pleistocene-to-Recent terrigenous and shallow-marine carbonate sediments that are located within an fault-active graben, near the coast of NW Cyprus.

The Polis basin NW Cyprus

Project background

Pleistocene-aged marine and fluvial sequences in the Mediterranean region provide a sedimentary archive of past sea level changes and global-to-regional tectonic and climatic processes. Cyprus has emerged as a key area to understand and decipher the roles of climatically controlled (i.e., glacio-eustatic) sea-level change, coeval with tectonic uplift, during the Pleistocene-Recent time. Its key location within the Eastern Mediterranean offers great sensitivity to palaeoceanographic and palaeoclimatic changes, which are relevant regionally. Current rapid climate change is known to influence sedimentation in many areas, and it is therefore urgent to better understand and quantify key sedimentary archives involving the interplay of tectonics versus environmental changes (i.e., glacio-eustatic sea level versus climate changes), particularly during the Quaternary. Cyprus is an active tectonically uplifting terrane related to convergence of the African and Eurasian plates and offers such an opportunity. Extensive exposures of Pleistocene sediments crop out in NW Cyprus as a series of raised coastal terraces, and also as fluvial channels and related terraces inland. Some marine terrace deposits that are composed of both terrigenous sediments and shallow-marine carbonate sediments, accumulated simultaneously, in places interfingering. The terrigenous sediments aid identification of clastic sedimentary sources, whereas the carbonates allow paleoenvironmental interpretation and age dating. In W Cyprus, coastal sediments can be correlated with erosional (geomorphic) surfaces inland. These were controlled by regional uplift but also modified by more local extensional faulting related to the Polis graben, an extensional basin that was active throughout the Pleistocene. The NW Cyprus coastal terraces are particularly useful as they are almost perpendicular to the axis of the active extensional basin (Polis graben) and so can help to document tectonic as well as sea-level effects. There is also an opportunity to determine the relative influences of regional up-doming of the Troodos Ophiolite (central Cyprus), compared to more local extensional subsidence (Polis graben) based on the patterns of sedimentation and geomorphology in NW Cyprus.

Research questions

1. What was the relative importance of terrigenous versus shallow-marine carbonate sediments in constructing coastal terraces in NW Cyprus (Polis basin)?
2. How did the sediments develop through time, especially during the last 15,000 ka?
3. Do the preserved transgressive cycles correlate with glacio-eustatic sea level changes (highs during high-latitude interglacials) or is the situation more complex as in some other regions?
4. How did the active Polis graben (i.e. active faults) influence sedimentation and geomorphology, compared to other active extensional areas (e.g. Gulf of Corinth, Greece).
5. What were the relative influences on sedimentation of regional domal uplift (Troodos Massif) compared to more local extensional subsidence related to the Polis graben, and with other Mediterranean, to global regions.

Methodology

Fieldwork will be carried out in the form of sedimentary logging, facies analysis and provenance analysis of easily accessible coastal deposits in NW Cyprus (near Polis). Production of detailed sedimentary logs and facies descriptions will help identify the facies, record the fabrics, textures, fossils and any sedimentary structures within the sediments. Petrographic study on thin sections of terrigenous sediments will allow source recognition and provide detailed information particularly concerning the minerals and microfossils in the outcrops studied. Field observations and satellite imagery (high-resolution DEMs) will be used to identify and correlate geomorphologic surfaces throughout the fluvial hinterland; i.e., the Polis extensional basin. This will help to provide information on the relative importance and influence of regional up-doming of the Troodos Ophiolite (central Cyprus), compared to more local extensional subsidence (Polis graben). Radiometric dating of marine corals (U-series) will be necessary to help produce an age model for the deposition of the mixed carbonate-siliciclastic sediments. The terraces are estimated to be c. 15,000-300,000 years old so that U-series dating is a suitable method. In addition, samples will be studied using the optically stimulated luminescence technique (OSL), in conjunction with Dr Tim Kinnaird (University of St. Andrews), building on previous research carried out when he was a PhD student in Edinburgh. This will allow age profiling of non-marine sediments c. 30,000 years old. Samples will also be studied using XRD and possibly XRF to identify the sources of fine-grained sediments (e.g. paleosols). The overall results will be used to determine the sedimentary provenance and palaeoenvironmental conditions, leading to 3D depositional models through time. Computer-based quantitative modelling may be carried out to test long-term tectonic vs. shorter-term glacio-eustatic effects on terrestrial to shallow-marine sediments within the basin, aided by regional to global comparisons.

Training

A comprehensive training programme will be provided comprising both specialist scientific training and generic transferable and professional skills.

The research training will involve detailed sedimentological and geomorphological analysis. This will take the form of sedimentary logging, quantification of lateral and vertical facies changes, provenance analysis and identification, mapping and correlation of hinterland geomorphic surfaces using digital data (DEMS). Critically important dating will be carried out using U-Series and ODL techniques. Computer modelling of climatic versus tectonically driven processes and regional to global comparisons will also be made. The data obtained will be synthesised to gain understanding of fundamental controls that hopefully will be applicable to comparable settings elsewhere (e.g., Mediterranean to globally). The training would be applicable to careers including environmental geoscience especially related to sedimentation and global climatic change. The first year of the research will involve refining the research questions (and relevant hypotheses to be tested), conducting a thorough literature review and travelling to Cyprus for the first fieldwork and data collection session (c. 2 weeks). Thin section and petrographic analysis, including XRD and XRF on paleosols, will enable preliminary facies identification, provenance and source recognition. Initial samples will be tested in the OSL laboratory in St Andrews, directed by Dr. Tim Kinnaird. The second year of the research project will consist of one fieldwork session (spring c. 4 weeks) allowing expensive data collection. Dating techniques will be central for this year and data analysis will continue with emphasis on petrographic analysis and DEM landscape analysis. The third year will include a short field season (1-2 weeks) to check and refine data collections. This will aid final data analysis, writing up of my thesis, and preparation of one or more papers for publication. The fieldwork may in part be carried out in conjunction with the undergraduate fieldtrip to Cyprus in April. The student will also assist with this fieldtrip (as demonstrator).

Requirements

A very good BSc (or equivalent), or an undergraduate or postgraduate Masters degree in geology or physical geogography, and a strong interest and aptitude for independent (but supervised) fieldwork. An interest in computer modelling of environmental change would be an asset.

References

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E4 supervisors are happy to hear from candidates who would wish to adapt the project to their own ideas and research background.

Application Process

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