CLIMATE CHANGES & THE ENVIRONMENT

As environmental issues become an increasingly acute concern for nations worldwide, Turkey is a country of prime interest in the field of climate studies. Due to its location, it presents an area ripe for exploring and understanding climate development and the history of global environmental change within the context of contemporary international relations. Lake sediments, tree-rings, speleothems and peat deposits represent valuable natural 'archives' of environmental change which have been under-explored in both Turkey and the wider Black Sea region. This research programme into the vegetation and climate history of the region focuses on changes in vegetation, water resources, landscape stability and hazards in Turkey, the Black Sea area and much of the wider Middle East over time. It also provides a key context of interaction concerning human use of the landscape from prehistory to the present day.

Pleistocene environments of the Gediz valley: stable isotope signatures from travertines

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Over the past 16 years, with the support of the British Institute at Ankara, we have established a reliable stratigraphy/chronology for the Gediz river terrace sequence (Gediz Valley Formation) that has yielded valuable insight into Pleistocene environmental changes (see, for example, Veldkamp et al. 2015; Maddy et al. 2017) and provided some context for early hominin dispersal in western Asia (Maddy et al. 2015). However, fluvial archives are not the only source of palaeoenvironmental data in the Gediz valley. Extensive outcrops of travertine appear at varying altitudes above the current river, each marking a former position of emergent sub-surface water. Within the Gediz valley north of Kula, there are extensive exposures of fissure travertines, mounds and cascades. Their altitudinal positions relate to former springs that emerged along fault lines exhumed at progressively lower altitudes as the river incised in response to regional uplift during the Quaternary. This close connection with river-valley incision allows the stratigraphy of the fluvial sequence to provide stratigraphical control on travertine deposition.

Travertine deposits beneath lavas on the İbrahimağa plateau. Inset shows drilling at the location marked by the white dot on the aerial photograph (the backdrop orthophoto was produced as part of our UAV-based aerial mapping programme).

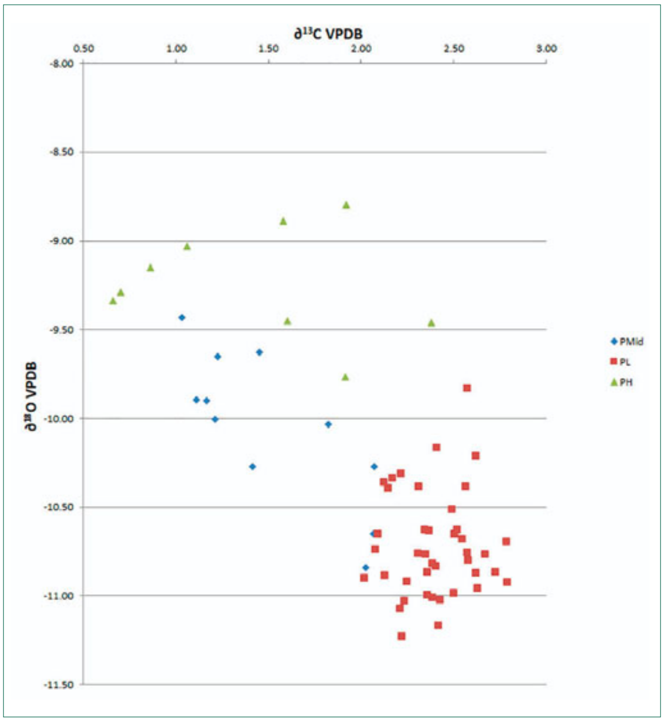
The aim of our latest BIAA-funded project is to decipher palaeoenvironmental signatures from the stable isotope chemistry of the Gediz valley travertines. Our objectives include the establishment of the distribution, morphology and internal structure of travertine deposits. This will involve detailed survey/mapping of travertine outcrops (using UAV-based methods) together with detailed description of the sedimentary architecture. We also aim to establish the sequence of stable isotope changes during travertine precipitation (in association with Ian Boomer of the University of Birmingham). Stable isotope changes could reflect meteoric water changes (cold-water travertines) or more deep-routed source changes (hot water). Either way, the results will provide significant palaeoenvironmental proxy data and insight into travertine formation. Furthermore, we intend to place travertine formation within a reliable chronological framework via correlation with our existing geochronological control on the Gediz terrace sequence.

During this, our first field season, we rapidly surveyed and sampled travertine deposits across the whole field area. An initial batch of 105 samples (including samples from the underlying Miocene carbonates) were drilled and brought back to the UK. These samples are now with Dr Boomer, awaiting measurement. These data should allow us to focus on a limited number of localities for more detailed sampling and analysis next year. These specific targets will be mapped at high resolution (using aerial survey and possibly LiDAR survey) and sampled for additional isotope analyses aimed at extracting the most informative environmental proxy signals.

We are optimistic that the data will be informative as we have previously investigated one such travertine mound close to Palankaya, but we did not develop that single-site study further. Only our recent fieldwork has revealed the true extent of travertine deposition in our field area, reigniting our interest. The figure above-right shows the range of values measured from the Palankaya mound. The $\partial^{13}C$ values indicate that this travertine is thermogenic; that is, it was deposited by a hot-water spring (Pentecost 2005). This is not unexpected given the likely timing of this deposition shortly after a phase of early Pleistocene volcanism.

However, there are systematic shifts in stable isotope content up through the profile with both $\partial^{13}C$ and $\partial^{18}O$ values becoming progressively lighter. These shifts reflect either changing water temperature or changing source waters. This could reflect either progressive increases in the input of meteoric (rain) isotopically lighter water after volcanism ceased or, more likely, changing environments, for example from flowing water directly from the vent to standing water in pools behind travertine curtains on the mound itself as it grows progressively higher.

As we gain greater insight into these processes as the new data arrives, we hope to make more meaningful interpretations. We also remain confident that some sampled outcrops represent meteoric sources, thus potentially recording changing atmospheric precipitation and temperature during the period of time represented by their deposition.



Stable isotope record from Palankaya. PL = samples from lower section; PMid = samples from middle section; PH = samples from highest section.

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