CLIMATE AND ITS HISTORICAL & CURRENT IMPACT

With environmental issues becoming an increasingly acute concern for countries 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.

Quaternary environments in the upper catchment of the Kura river, northeastern Turkey: a context for early hominin occupation and migration

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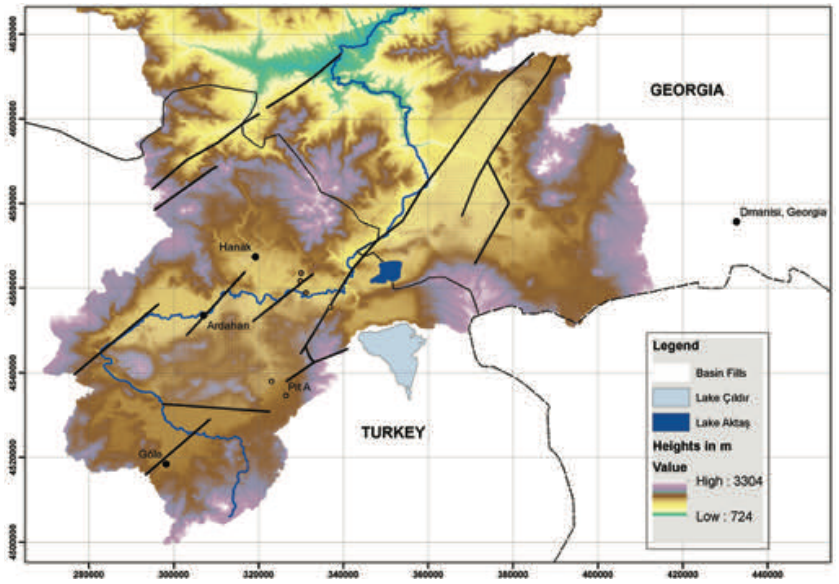
In recent years, substantial evidence for the early human occupation of the Caucasus during the Quaternary (the last 2.58 million years) has emerged in the literature. The importance of this region for early hominin migration cannot be underestimated. Finds of *Homo erectus* (thought to be the first hominin to leave Africa), found close to the Georgian village of Dmanisi (see figure 1, over the page) and associated with volcanic deposits with age estimates of around 1.7–1.8 million years, have ignited debates around the topic of 'the first Eurasians' (Gabunia et al. 2000). Within Turkey, the oldest known hominin locality is that of Kocabaş, in the Büyük Menderes valley in western Anatolia, where fragments of a cranium, tentatively attributed to *Homo erectus*, have been found in travertine deposits dated to around 490–510 thousand years (Kappelman et al. 2008). However, earlier hominins are known to have occupied Turkey, as evidenced by finds of Lower Palaeolithic artefacts (Harmankaya, Tanindi 1996), but their chronology is often poorly constrained and the region generally remains poorly understood in terms of hominin dispersal.

This three-year pilot project is designed to help initiate renewed efforts to investigate the record of hominin occupation and migration in Turkey. Specifically, we will investigate the environmental changes which provide the context for early hominin occupation in northeastern Turkey by exploiting the palaeoenvironmental archives contained within sedimentary records. Our study area, the upper catchment of the Kura river, spans the Turkish-Georgian border and lies within 100km of the hominin site of Dmanisi (see the maps over the page), and thus there is every reason to believe that hominins would have been present in the area, early in the Quaternary.

The Kura river rises in northeastern Turkey and traverses the Lesser Caucasus mountain range, passing the Turkish-Georgian border en route, and ultimately flows through the Transcaucasus depression, through Georgia and on into Azerbaijan where it debouches into the Caspian Sea (see figure 1). The catchment spans a highly active tectonic zone. The mountain ranges of the Caucasus testify to the large-scale continental collision (compressional tectonics) and uplift of the Arabian and Eurasian plates which started in the Oligocene (~ 34–23 million years ago) and continued into the Miocene (~ 23–5 million years ago). However, since the Middle Pliocene (~ the last four million years) the Lesser Caucasus and much of the east Anatolian plateau have been subjected to an extensional tectonic regime dominated by strike-slip faulting which has been accompanied by extensive alkali volcanism (Koçyiğit et al. 2001). These transform motions have created a series of pull-apart basins which have subsequently filled with sediment (figure 2). More recently, some of these basins have experienced uplift, with active inversion of the basin fill sequences, forcing rivers to incise through their thick sedimentary fills, in response to the uplift. The Kura river, in our Turkish field area, traverses the still deepening (subsiding) Ardahan Basin, but also flows across areas where extensive river terrace sequences have formed in response to localised uplift (for example along the southern edges of the Hanak Basin). The development of this river system is complicated further by extensive localised faulting (normal and oblique, see figure 3), which often offsets river terraces, and the frequent incursion of basaltic lava flows into the developing valley floors from nearby eruption centres.

1. General location of the Kura river. LC: Lake Çıldır (Turkey), LS: Lake Sevan (Armenia). Coordinates are for UTM Zone 38T (100km grid squares). Background Digital Elevation Model uses the 90m SRTM data



2. Digital Elevation Model of the upper catchment of the Kura river based upon the GDEM 30m dataset (heights are in metres). Black solid lines show the position of major strike-slip faults (after Koçyiğit et al. 2001). Stippled areas are subsiding basins. All coordinates are UTM Zone 38T (20km grid squares)

The evolution of the Kura river catchment is a direct response to these large-scale tectonic motions, but also reflects changes in water and sediment supplies as a consequence of the climate and associated vegetation changes of the Quaternary. The upper catchment of the Kura lies generally at, or above, 2,000m, and as a consequence receives ample precipitation fed largely from the southern Black Sea region. The higher parts of the catchment, i.e. above 2,600m, display clear evidence of glaciation; thus the discharge (water and sediment) regime of this river system would have, at times, been heavily influenced by the waxing and waning of upland glaciation during the Quaternary. Therefore, despite the overwhelming tectonic controls on fluvial system development, climate change also has a key role to play.

Significant for the context of hominin occupation, the weathering of the Tertiary/Quaternary volcanic strata, driven largely by changing climates, produces extensive areas of fertile soils. Wetter periods during the Quaternary would have been ideal for rapid plant growth, fuelled by ample water supply and high nutrient status. Healthy plant communities would, in turn, have been capable of supporting a diverse fauna, including hominins. The presence of such plentiful resources undoubtedly would have made these riverine environments, together with occasionally extensive lakes forming within the subsiding depressions, attractive to early hominins.

Our goal is to reconstruct the sequence of environmental changes via systematic investigation of the sedimentary deposits found in and around the current valley of the Kura river and its tributaries. Although preliminary geological maps, at a scale of 1:50,000, are available, these often present only very crude representations of the deposits on the ground and lack the detail, both in terms of sediment body geometry and detailed sedimentary information, necessary for accurate interpretations. Our initial observations in July 2013 have confirmed the need to carry out our own detailed mapping and sediment descriptions, as existing interpretations do not seem sufficiently robust. Such field studies are time-consuming and it will be many months before a clearer picture of the sedimentary sequence emerges from the data.

Our approach to this work has a rather traditional geological flavour. Underlying all modern investigation is the necessity to establish a firm lithostratigraphical framework. This will involve detailed mapping in key target areas where extensive fluvial deposits can be identified and there is sufficient exposure to establish a comparatively detailed understanding of the processes of deposition. Hopefully, some of these sediments will yield key biostratigraphical data, perhaps in the form of

3. Exposure of an oblique slip fault plane (right) with a drape of slope sediment (left) from near the centre of the Ardahan Basin. Such localised movements add to the complexity of the stratigraphy and lead to differential responses to relative motion along different reaches of the river

faunal records (for example fossils with well-constrained time ranges) or floral records of key species indicative of specific climate/environmental conditions. Although it might be possible to recover hominin remains, a more likely scenario is the discovery of artefacts (for example flakes) which clearly signal the presence of hominins.

Our fieldwork in 2013 did produce significant observations which lead us to be very optimistic about the outcome of this pilot project. We were able to confirm areas where extensive fluvial deposits are present. Figure 4 shows an outcrop in a fluvial terrace close to the village of Hasköy (Pit A, figure 2). These sediments clearly indicate the presence of a large river system (somewhat different to the modern descendent). Several potential flakes and cores were observed in this deposit and these will be systematically investigated at a later date when we obtain the relevant permissions. For now it is sufficient for us to know that there is probable contemporary hominin occupation around the time of deposition of this particular unit. Further possible artefacts were observed elsewhere but our investigations are currently at too early a stage to begin suggesting whether patterns can be observed. We also noted outcrops of fluvial deposits which appear to contain vegetation imprints. This is encouraging, as it suggests a high probability of preservation of palaeo-vegetation data such as pollen and macrofossils within these sediments. In parallel with the work to establish a robust lithostratigraphy and biostratigraphy, we are sampling key volcanic deposits for age estimation using Ar-Ar techniques. Fortunately we have already identified a number of locations where lava flows directly relate to the fluvial sequence and basalt samples taken from these localities are now at an Ar-Ar measurement facility in Amsterdam. These age estimates will prove critical in targeting future investigations, but results from these samples are not expected until late 2014.

Pioneering research is always challenging and, at the outset, the complexity of these sedimentary records can seem confusing. Although a deep understanding of these archives will take many years, our initial observations provide many reasons to be optimistic that this sequence will yield significant insight into the presence and movements of early hominins in northeastern Turkey. The widespread availability of materials suitable for age estimation gives us good reason to believe that we can place these events within a robust chronological time frame.

References

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4. Exposure of a thick fluvial sequence forming an extensive terraced landscape in a tributary which drains the eastern part of the mapped Ardahan Basin (Pit A, figure 2). This locality has probable flakes within the fluvial sequence