Sedimentary Basins in the Eastern Desert of Jordan
First Geophysical Investigations and Insights

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Abstract

The Collaborative Research Centre 806 (CRC 806) “Our Way to Europe” concerns the history of mankind. It is designed to capture the complex nature of dispersal of Modern Man from Africa to Western Eurasia, and particularly to Europe. The CRC concentrates on the time gap between the dispersal of Modern Man from Africa (350,000 B.P.) and the permanent establishment of Man in Central Europe (40,000 B.P.). The CRC investigates archaeological sites, terrestrial and aquatic archives in the source region of Modern Man, along trajectories of dispersal and in sink areas (Fig. 1).

The Eastern Mediterranean has been the passageway for human migration between Africa, the Middle East, the Balkans and Europe. The Azraq, area around the former oasis Qa Al Azraq, in the eastern desert of Jordan has been a major spot for prehistoric settlements since the Middle Pleistocene. The former shorelines of the Qa’ Al Azraq are limned with stone artefacts, which were also found during the field survey (Fig. 2).

Very promising archives for palaeoclimatological reconstruction are sediment succecssions accumulated in dry clay lakes (Playa lakes). We utilized the Transient Electromagnetic (TEM), the Direct Current Resistivity (DCR) and the Radiomagnetostratigraphic (RMT) methods to identify the most complete sedimentary sequences inside the mudflat Qa’ Al Azraq and to derive suitable borehole locations for the palaeoclimatological reconstruction.

The Azraq Basin

The Azraq Basin is a tectonic structural depression. It covers an area of 13,000 km². The basin is drained by several Wads. Azraq is the main fresh water supplier to Jordan’s capital Amman and has immense economic importance due to its huge mineral deposits.

Four geomorphological units are present in the study area (Fig.3):
- Abed Olvine Phycic Basin (AOB): unconsolidated, earliest volcanism, most abundant, forms irregular shaped outliers (Fig. 4a)
- Um Rijam Chert Limestone Formation (URC) outliers
- Alluvial Mudflat (ALM): the basin centre (10x10 km²) consists of soft, silty hyper-saline clays and various evaporates. The alluvial mudflat is bounded to the north by the Al Bayda Fault (Fig. 4c).

Field Survey

Two profiles, 5 and 3 km long (Profile A and B), were investigated in a three week survey in March 2011 from the edge of the basin near the basait outcrops towards the basin centre, crossing three geological formations: AOB, AQ and ALM. Profile A crosses the Al Bayda Fault at station A42 and profile B crosses the Quaishah Fault (Fig. 3). TEM, DCR and RMT methods were utilized for the geophysical investigation.

TEM
- NT-20 transmitter, GDS-32 receiver (Zonge, 2002). We measured Nano-Tem (NT) and Zero-Tem (ZT) mode
- 102 stations, station distance 50 m
- T2=55x5m²; R2=10x10 m²
- rise-time: 1.9 µs to 19 ms

TCM
- ABEM SAS 4000 (Abem, 2002), Winner Long-Short configuration
- Inter-electrode spacing: 5 m
- RMF device from the University of Cologne
- 6 to 8 frequencies, 18 kHz to 1 MHz, only TEM-mode data available
- 118 stations along profile A between A1 and A42
- 10 m station distance

Correlation with Borehole Data

The geological models were correlated with ground truthing data (Fig. 6c). 1D Marquardt and Occam (first and second order roughness) inversion models were calculated (Fig. 6). Equivalent models define a confidence range for the resistivity and thickness of each resolved layer (Schull, 2005).

Conclusions & Outlook

Three geomorphological units are detected clearly: AOB, AQ and ALM. The boundaries of the basait stream, which were uncertain from the geological map, are determined by the geoelectrical results. The base of the alluvial mudflat and the URC formation beneath was not resolved, due to the low depth of investigation.

Suitable borehole locations for palaeoclimatological reconstruction can be found on the alluvial mudflat.

References