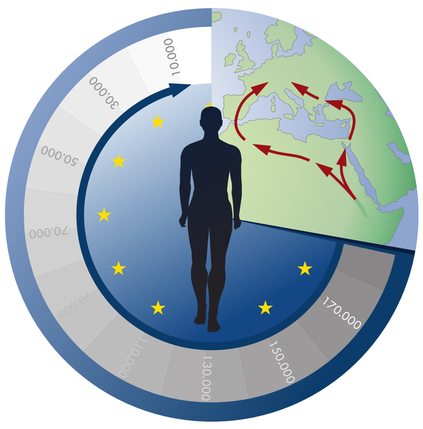

CRC 806 - Our Way to Europe

Application of Luminescence and Electron-Spin-Resonance Dating Techniques in Geoarchaeological Studies

Using R for Thermoluminescence dating - The Age of the Taibeh Heated Silex

David Strebler, Dominik Brill, Christoph Schmidt, Helmut Brückner

Introduction

Based on its typological and technological characteristics, the archaeological material from Taibeh (Jordan) belongs to the Masraqan technocomplex, a cultural unit which occurred at the onset of the Epipaleolithic in the Levant.
Previous datings of Masraqan artefacts provide a timeframe between 16 and 22 ka BP (MIS 2). However, while other sites have only one Masraqan layer, Taibeh has at least four of them (Fig. 1). Dating the Taibeh material will therefore greatly increase our knowledge about this technocomplex.
R is an highly extensible language and environment for statistical computing and graphics, which provide a wide variety of statistical and graphical tools. A package for luminescence dating is available since 2012 (Kreutzer *et al.*). Unfortunately, it mainly includes tools for OSL dating. The aim of this project is to implement new functions specifically designed for TL dating.

Fig. 1: General view of Taibeh 3 site after excavation (filled sediment bags visible).

Acknowledgement

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You can find more information about the CRC 806 on:
http://www.sfb806.uni-koeln.de/

Sample Preparation

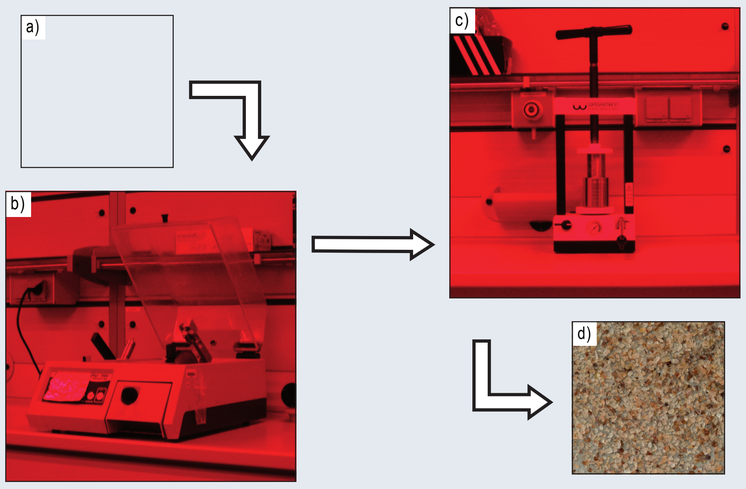

Fig 2: (a) Heated silex; (b) Precision saw; (c) Hydraulic press; (d) Quartz grains.

To avoid material partially bleached by sunlight or affected by α and β radiation coming from surrounding sediment, 2 mm of the external layer of each sample were removed with a precision saw (Fig. 2b).
The cores were then gently crushed in a hydraulic press until all remaining grains were less than 200 µm (Fig. 2c).
The grains between 100 and 200 µm were separated using dry sieving, and those between 4 and 11 µm using wet sieving. All the grains were treated with HCl (10%) to remove contaminants, especially carbonates.
The quartz grains (100-200 µm) were used to estimate the palaeodose, the fine grains (4-11 µm) to estimate the α-efficiency, and the remaining grains to estimate the internal dose rate.
Out of the 20 silex samples collected, only 6 were big enough to produce quartz grains for TL dating. For TAI 14, it was only possible to extract fine grains using a hand drill.

Palaeodose Estimation

The palaeodose was estimated using the Single Aliquot Regenerative Dose (SAR) protocol (Murray & Wintle 2000). If enough material was available, a modified Multiple Aliquot Additive Dose (MAAD) protocol was also used and the results compared. For this MAAD protocol, the same aliquots were used to estimate the palaeodose and the supralinearity correction. Futhermore, a test dose followed each additive and regenerated dose for normalisation.
The TL signal of heated silex can be very weak and close to the background due to black body radiation. Moreover, the position of the temperature peak can differ between the measurements. Two functions were written in R to correct these problems (Figs. 3a,b,c).
For the palaeodose estimation, a De plateau approach was used. Rather than directly integrating the signal based on the heating plateau test results, the signal for each temperature interval was processed separately and the results were integrated only at the end of the process (Figs. 3d,e).

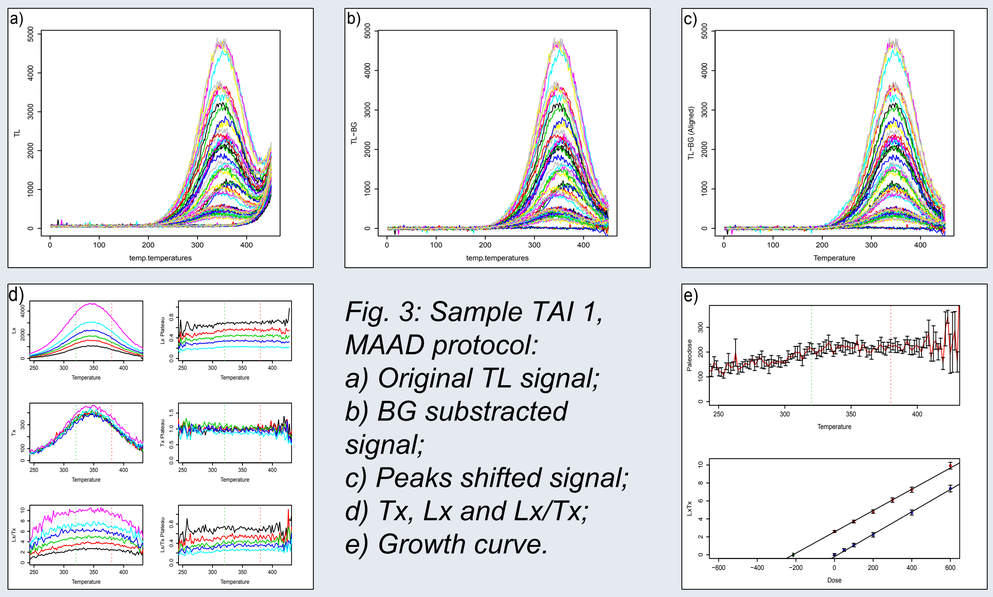

Fig. 3: Sample TAI 1, MAAD protocol:
a) Original TL signal;
b) BG substracted signal;
c) Peaks shifted signal;
d) Tx, Lx and Lx/Tx;
e) Growth curve.

Annual Dose Estimation

For heated silex, the annual dose can be devided between the internal dose, due to the radioelements inside the silex, and the environmental dose, due to the radioelements in the surrounding sediments and to cosmic rays.
The internal dose was estimated using ICP-MS on the remaining core material while the environmental one was estimated using HPGe γ-spectrometery on samples of the sediment surrounding each silex.
Unfortunately, the results for the annual dose rates are not yet known.

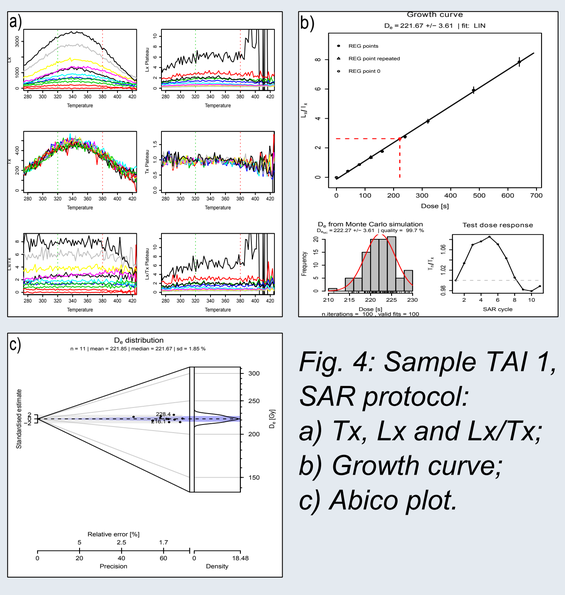

Fig. 4: Sample TAI 1, SAR protocol:
a) Tx, Lx and Lx/Tx;
b) Growth curve;
c) Abico plot.

First Results

Despite the lack of annual dose estimation, the first results obtained for the palaeodoses are very promising. They show that TL dating of heated silex should be possible even for a weak or bad quality luminescence signal. Moreover, the results for the MAAD and the SAR protocols, using the new functions developped in R, are coherent (Figs. 3e and 4b,c). Futhermore, these new functions provide results even when Analyst or the actual SAR-TL function of the luminescence R-package do not.
The next step will be to improve the uncertainty estimation using a Monte Carlo approach and to allow for non linear fittings for the growth curve.

Kreutzer *et al.* (2012). *Introducing an R package for luminescence dating analysis*. Ancient TL, Vol.30, No.1, 1-8.
Murray, A.S. & Wintle , A.G. (2000). *Luminescence dating of quartz using a improved single-aliquot regenerative-dose protocol*. Radiation Measurements 32, 57-73.

Institute of Geography, University of Cologne, Albertus-Magnus-Platz, D-50923 Köln - www.geographie-koeln.de
Contact: D. Strebler, david.strebler@uni-koeln.de, www.geographie.uni-koeln.de/index.995.de.html