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Fine and coarse-quartz SAR-OSL dating of Last Glacial loess in Southern Romania

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ABSTRACT

Previous single aliquot regenerative optically stimulated luminescence (SAR-OSL) dating studies of representative loess sections in southeastern Romania revealed severe discrepancies among the ages obtained on fine (4–11 μm) and coarse (63–90 μm) grains of quartz. The current study aims at expanding these investigations by extending the area of study to the more westerly loess deposits in the Lower Danube Basin. The luminescence properties of the grain sizes of quartz extracted from 18 samples collected from the Last Glacial loess layer at Lunca section (Wallachian Plain) are examined and compared. Investigations confirm the reliability of the SAR-OSL protocol previously applied to Romanian loess (preheat at 220 °C for 10 s, cutheat at 180 °C and elevated temperature OSL). Despite this, the obtained equivalent doses on coarse quartz are higher than those obtained on fine material for most samples, as in the case of our previous studies. These results into fine quartz OSL ages that are significantly lower compared to the coarse quartz age results. However, the ages obtained for the uppermost two samples are in very good agreement. Ages spanning from 19 ± 2 ka to 43 ± 4 ka on fine quartz and from 20 ± 2 ka to 54 ± 6 ka on coarse quartz have been obtained for the loess deposited during Last Glacial period. Based on the fine as well as the coarse quartz chronology significantly low sedimentation rates were computed for the Last Glacial Maximum period and MIS 3. OSL ages and magnetic susceptibility measurements indicate that the loess layer corresponding to the Early Glacial period (MIS 4) is very thin at this site and affected by pedogenesis. Regarding the investigation into the cause of the observed age discrepancy we present evidence through time resolved investigations that the observed behaviour is typical of quartz and cannot be accounted by feldspar contamination. We confirm once more that the growth of the OSL signal in nature does not correspond to the laboratory generated SAR dose response curve that is best described by a sum of two saturating exponential functions. The differences observed between the natural and the laboratory dose response for the two quartz fractions are believed to be a cause for the different chronologies reported.

1. Introduction

The loess palaeosol deposits in southeastern Europe are thought to be the best preserved, most complete and detailed archives of paleoclimate of the Upper Quaternary on the continent (Marković et al., 2011). However, this region is presently under-reported, compared to more westerly parts of Europe. Only in the past five years, numerical dating at higher resolution, especially using Optically Stimulated Luminescence (OSL) methods, has been applied in this region (Schmidt et al., 2010; Timar et al., 2010; Stevens et al., 2011; Timar-Gabor et al., 2011; Vasiliniuc et al., 2011; Schatz et al., 2012; Constantin et al., 2014). However, there is still insufficient information to reconstruct a comprehensive regional picture of paleoenvironmental conditions during the late Pleistocene.

The Last Glacial Maximum (LGM) represents the most recent climatic episode when the global ice sheets reached their maximum integrated volume. This period is conventionally defined

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Fig. 1. **A** Map of Europe with the Romanian territory highlighted. **B** Loess distribution in Romania. The present study focuses on Lunca section shown as a filled star. Filled circles indicate site locations that have been the subject of high resolution quartz luminescence dating studies on loess: Mostiştea (Vasiliniuc et al., 2011; Timar-Gabor et al., 2012), Mircea-Vodă (Timar et al., 2010; Timar-Gabor et al., 2011, 2012). Filled triangle points to Urluia study site (Fitzsimmons and Hambach, 2014).

based on sea-level records and it spans from approximately 26.5-19 ka, with a maximum at 20 ka (Clark et al., 2009). The palaeoenvironmental conditions in southeastern Europe during this period are poorly characterised, and few numerical data are available, all the more so in Romania. The terrestrial sediments with the highest potential in recording such climatic changes and providing numerical chronologies in the region are the alternating loess-palaeosol sediment sequences. Amongst the previous high-resolution OSL studies on Romanian loess, only two works have been able to obtain age estimates that cover this time period (Timar-Gabor et al., 2011; Fitzsimmons and Hambach, 2014).

High-resolution OSL chronologies of quartz have been presented for Romanian loess, but only for the significant loess sections located in the southeastern part of the country (Timar-Gabor et al., 2011; Vasiliniuc et al., 2011; Timar-Gabor et al., 2012; Constantin et al., 2014). These studies revealed in all the investigated sections a severe age discrepancy among the ages yielded by different quartz fractions. The cause of this phenomenon, though thoroughly documented (Timar-Gabor et al., 2012; Timar-Gabor and Wintle, 2013), remains a matter of investigation.

As more sites from different regions need to be investigated in order to determine the areal spread of this phenomenon, in this study an approach based on OSL dating of 4–11 μm and 63–90 μm quartz is presented to establish a reliable luminescence chronology of the Upper Pleistocene for the Lunca loess section in southwest Romania. Luminescence investigations include documenting the behaviour of the two grain sizes investigated in the SAR protocol, the study of the thermal stability of the signals by pulse anneal experiments, investigations into the laboratory saturation characteristics of the dose response, a comparison of the natural and laboratory generated growth curves as well as the applications of TR-OSL methods in order to prove the observed behaviour is typical of quartz. The numerical chronology derived is accompanied by rock magnetic susceptibility measurements and a time-depth model.

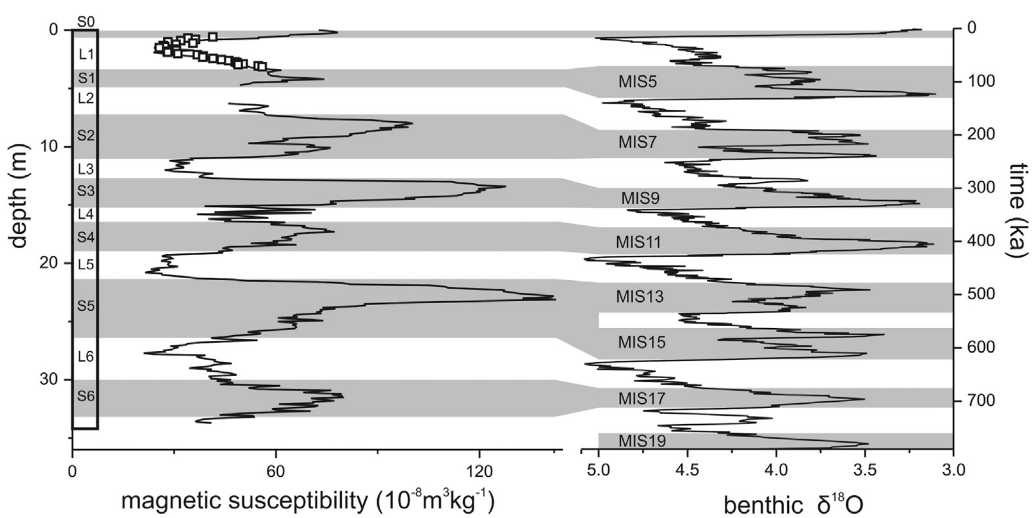

Fig. 2. Magnetic susceptibility record (solid line) and stratigraphy of Lunca section after Necula (2006). L1 to L6 designate the loess layers, S0 is the recent soil and S1 to S6 designate the paleosols. Open squares show the magnetic susceptibility of the collected OSL samples. Each paleosol (S1 to S6) correspond to an odd marine isotope stage (MIS5 to MIS17) according to Necula (2006). Benthic δ^{18}O curve and interglacials (odd MIS) boundaries after Lisiecki and Raymo (2005).