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Middle Pleistocene Luminescence Ages on Coastal Sediments from North Evoikos Gulf: Overcoming Quartz Saturation by Elevated-temperature Infrared Stimulated Luminescence (IRSL) from Feldspars

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The employment of luminescence dating techniques on coastal sediments from North Evoikos Gulf (Central Greece) revealed that Optically Stimulated Luminescence (OSL) and Isothermal Thermoluminescence (ITL) natural signals of quartz grains are close to saturation (Figure 1a,1b) and also yielding broadly scattered equivalent dose (De) values, thus perplexing the calculation of reliable luminescence ages. To overcome this problem, Infrared Stimulated Luminescence (IRSL) dating of feldspar was attempted, which was proven more suitable for such sediments, as it showed higher saturation levels. Natural luminescence signal from feldspar grains (Figure 2) produced accurate De values, the reliability of which was confirmed by the properly corrected sensitivity changes that take place during measurements, as well as a number of validation tests (namely, dose recovery and preheat plateau tests). The post-IRSL SAR protocol after Thiel et al. (2011) was employed which use an elevated temperature both during preheating and stimulating of the feldspar samples. Our luminescence dating results on the coastal samples provided ages that go back to the Middle Pleistocene (Figure 3). The reliability of the post-IRSL ages are further confirmed by a number of previous palaeontological studies in the area (Kumadakis, 1969; Keraudren, 1975; Phillip, 1974; Lemeille, 1977; Rondoyanni-Tsiambaou, 1984; Genre 1999; Mauridis et al., 2006), as they provided ages which are in fair agreement with the dating results of this study. Based on the derived absolute ages, the mean sedimentation rate in the study area was also determined, which could be considered as being relatively low, ranging from 0.15 to 0.7 cm/yr, similar to the sedimentation rate estimated by previous studies in the area (Kamperi and Sakellariou, 2006). In addition, a mean uplift rate of 0.11 to 0.15 mm/y was calculated for the southern part of North Evoikos Gulf since the Middle Pleistocene.

During the Middle Pleistocene, North Evoikos Gulf was periodically becoming a lake, when the sea level was low enough, not exceeding the maximum depth of Lichades Strait, while a change to a lagoon environment was taking place when seawater from the Aegean Sea entered the Gulf. Probably, the first entry of seawater into the North Evoikos Gulf took place at the beginning of the Middle Pleistocene, as indicated by the presence of brackish deposits, sitting on layers of successive lacustrine and terrestrial deposits of an older age. This is also confirmed by the presence of mollusk fauna, which is also present on the Caspian and Black Sea, thus signifying a connection between Evoikos Gulf and the Black Sea and the Caspian Sea, through the Marmara Sea and the Dardanelles Strait respectively.

This study revealed that post-IRSL dating was a reliable technique for establishing the chronological framework of North Evoikos Gulf and an alternative trustworthy dating technique when OSL on quartz suffers from saturation. Furthermore, the produced post-IRSL ages are the first Middle Pleistocene ages reported for Greek clastic sediments using the luminescence dating techniques.

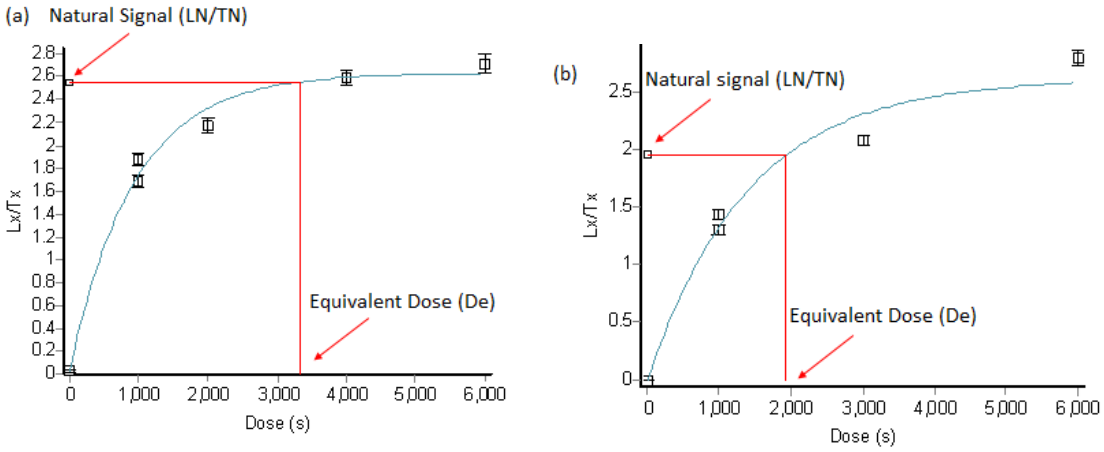

Figure 1. Growth curves of a quartz aliquot close to saturation using (a) the OSL and (b) the ITL dating techniques.

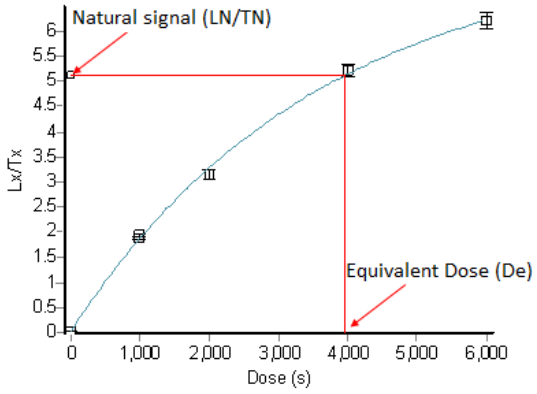

Figure 2. Growth curve of an aliquot containing feldspar grains using the post-IRSL protocol.

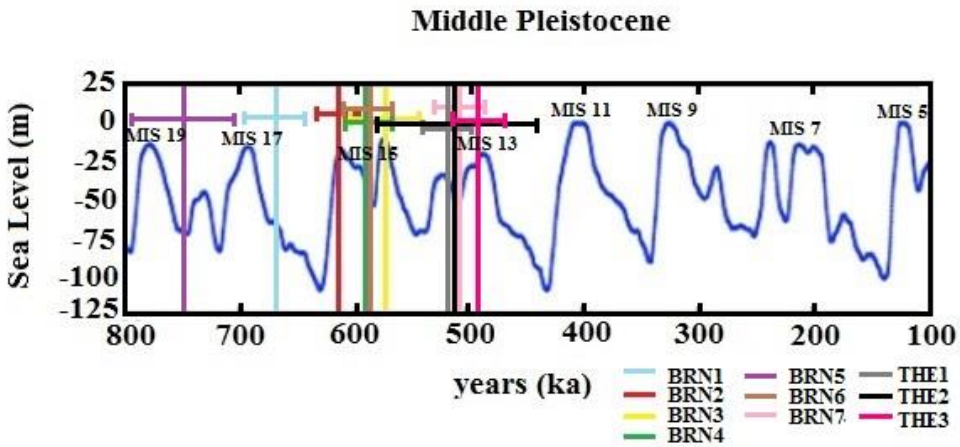

Figure 3. post-IRSL Middle Pleistocene ages of North Evoikos Gulf, plotted on an eustatic curve (modified after Bintanja et al., 2005).

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