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ESR dating of calcrete nodules from Bala, Ankara (Turkey): Preliminary results

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ABSTRACT

The age of two calcrete nodules (C1 and C2) from the Bala section in the region of Ankara, Turkey, is determined by the Electron Spin Resonance (ESR) method. Three radiation-induced ESR signals at $g=2.0056$ (A signal), $g=2.0006$ (C signal) and $g=2.0038$ (broad signal, BL) were observed. The broad signal (BL) intensity was used as a dating signal. The properties of this dating signal are described in this manuscript. The calcrete nodules were irradiated with a ^{60}Co gamma source and measured with an ESR spectrometer (X-band) to obtain the signal intensity vs. dose curve and fitted well with the single exponential saturation functions. Based on this model, accumulated dose (D_E) values for dating are obtained using the multiple-aliquot additive dose method. The D_E values of C1 and C2 calcretes are 1880 ± 207 and 671 ± 67 Gy, respectively. The ESR ages of the two calcrete samples are obtained by assessing the annual dose rate (D) from the content of ^{238}U, ^{232}Th and K_2O determined by wavelength dispersive X-ray fluorescence (XRF) spectrometry. The results are 761 ± 120 and 419 ± 64 ka, respectively, falling into the Middle Pleistocene Epoch in the geological time scale in agreement with the positions of the stratigraphical record.

1. Introduction

Calcretes, the diagenetic carbonate facies of subaerial exposures, are major carbonate deposits generally located in the Pleistocene–Early Holocene landscapes of the present semi-arid to arid and subtropical regions (Esteban and Klapa, 1983; Kapur et al., 2000). It is defined by Wright and Tucker (1991) as a near surface, terrestrial accumulation of predominantly calcium carbonate, which occurs in a variety of forms from powdery to nodular to highly indurated. Development of calcretes depends on the magnitude of the past and present carbonate sources together with climatic fluctuations (Kapur et al., 2000). Therefore calcretes are also called climate-dependent features that can be used for paleoclimatic interpretations.

Calcretes to the south of Turkey like other Mediterranean calcretes have long been recognized and studied (Eren et al., 2008; Kapur et al., 2000, 1990, 1987; Atalay, 1996) but those of the Ankara region (Central Anatolia) have received little attention. This region was chosen due to widespread occurrences of calcretes and the lack of any age data related with them. This study will be the first in literature to represent the age of the calcretes from the Bala district in the studied region (Fig. 1A). A continental climate is dominant in this region with very cold and snowy winters and very hot and dry summers. According to the relevant studies (James, 1972; Goudie, 1973, 1983; Wright and Tucker, 1991) these conditions are suitable for calcrete formation.

The age of the calcretes and their paleosols in Ankara have so far not been obtained by any geochronological age dating techniques. Based on field observations and stratigraphic relationships, the Pliocene–Pleistocene age is suggested by some investigators for widespread fluvio-lacustrine formations, including calcretes and associated paleosols (Koçyiğit and Türkmenoğlu, 1991; Erol, 1983; Calvi and Kleinsorge, 1940). On the contrary, Dönmez et al. (2008) assigned the Middle Miocene to Pliocene age to the formations that have calcretes and their host sedimentary rocks.

The Electron Spin Resonance (ESR) technique has lately been widely used to date Quaternary deposits (Engin et al., 1999, 2006, 2010; Liu et al., 2010; Candy and Black, 2009; Tissoux et al., 2008; Beerten and Stesmans, 2007; Gongming et al., 2007; Voinchet et al., 2007). However, there is not much work related to ESR dating of semi-arid to arid zone calcretes (Kailath et al., 2000; Chen et al., 1989, 1994; Özer et al., 1989). In this study, two calcrete samples collected from different horizons along a stratigraphic section that is measured at the Bala location are used for ESR dating. Its results are significant since they prove for the first time the Middle Pleistocene age of these calcrete formations based on an absolute dating technique. Therefore they will allow us to identify the periods of calcrete formation in the region and correlate the paleoclimate proxies for further studies. Obtaining an age of calcretes will improve the use of calcretes and their paleosols as paleoclimate indicators of the region. This contribution aims to

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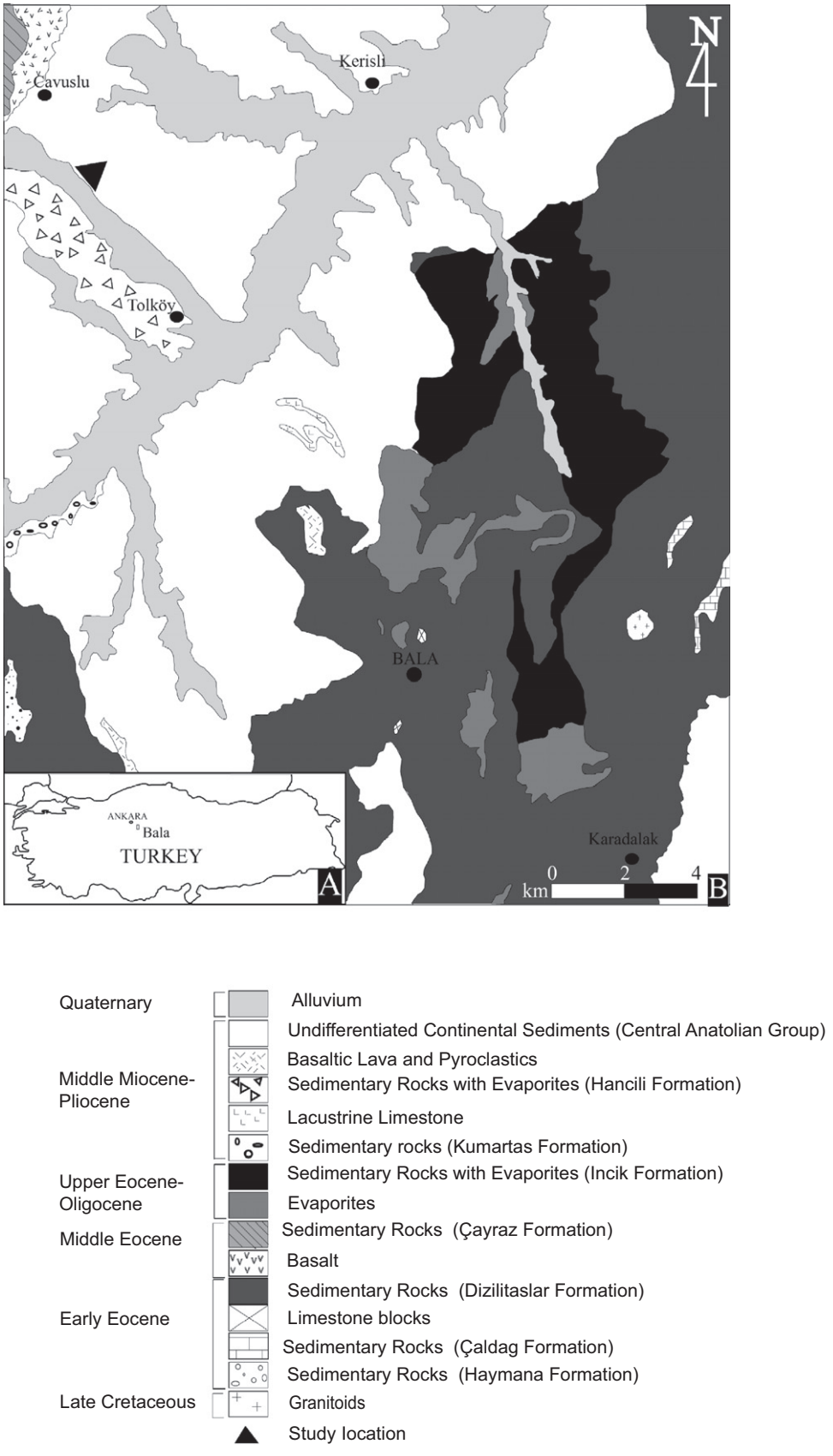

Fig. 1. (A) Map of Turkey showing the location of Ankara and Bala (not to scale). (B) Geological map of the study area representing the positions and ages of the lithologic units and the location of the Bala section (Dönmez et al., 2008).