Available online at www.sciencedirect.com
SCIENCE DIRECT
Earth and Planetary Science Letters 247 (2006) 41–60
EPSL
www.elsevier.com/locate/epsl

Precessional forcing of lacustrine sedimentation in the late Cenozoic Chemeron Basin, Central Kenya Rift, and calibration of the Gauss/Matuyama boundary

Alan L. Deino [a,*], John D. Kingston [b], Jonathan M. Glen [a,c], Robert K. Edgar [d], Andrew Hill [e]

[a] *Berkeley Geochronology Center, 2455 Ridge Road, Berkeley, CA 94709, USA*
[b] *Department of Anthropology, Emory University, Atlanta, GA 30322, USA*
[c] *US Geological Survey, MS989, 345 Middlefield Road, Menlo Park, CA 94025, USA*
[d] *Farlow Herbarium of Cryptogamic Botany, Harvard University, Cambridge, MA 02138, USA*
[e] *Department of Anthropology, Yale University, New Haven, CT 06520, USA*

Received 15 November 2005; received in revised form 22 March 2006; accepted 6 April 2006

Editor: V. Courtillot

Abstract

The fluviolacustrine sedimentary sequence of the Chemeron Formation exposed in the Barsemoi River drainage, Tugen Hills, Kenya, contains a package of five successive diatomite/fluvial cycles that record the periodic development of freshwater lakes within the axial portion of the Central Kenya Rift. The overwhelming abundance in the diatomite of planktonic species of the genera *Aulacoseira* and *Stephanodiscus*, and the virtual absence of benthic littoral diatoms and detrital material indicate areally extensive, deep lake systems. A paleomagnetic reversal stratigraphy has been determined and chronostratigraphic tie points established by $^{40}Ar/^{39}Ar$ dating of intercalated tuffs. The sequence spans the interval 3.1–2.35 Ma and bears a detailed record of the Gauss/Matuyama paleomagnetic transition. The $^{40}Ar/^{39}Ar$ age for this boundary of 2.589±0.003 Ma can be adjusted to concordance with the Astronomical Polarity Time Scale (APTS) on the basis of an independent calibration to 2.610 Ma, 29 kyr older than the previous APTS age. The diatomites recur at an orbital precessional interval of 23 kyr and are centered on a 400-kyr eccentricity maximum. It is concluded that these diatomite/fluvial cycles reflect a narrow interval of orbitally forced wet/dry climatic conditions that may be expressed regionally across East Africa. The timing of the lacustrine pulses relative to predicted insolation models favors origination of moisture from the northern Africa monsoon, rather than local circulation driven by direct equatorial insolation. This moisture event at 2.7–2.55 Ma, and later East African episodes at 1.9–1.7 and 1.1–0.9 Ma, are approximately coincident with major global climatic and oceanographic events.

Keywords: radiometric dating; astronomical time scale; Gauss/Matuyama boundary; climate change; hominin evolution; East Africa

1. Introduction

Recently, Trauth et al. [1] reviewed the deep-water lake history of the East Africa rift system and identified three humid periods in the past 3 million years, at 2.7 to

* Corresponding author. Tel.: +1 510 644 1295; fax: +1 510 644 9201.
E-mail address: al@bgc.org (A.L. Deino).

0012-821X/$ - see front matter © 2006 Elsevier B.V. All rights reserved.
doi:10.1016/j.epsl.2006.04.009

2.5 Ma, 1.9 to 1.7 and 1.1 to 0.9 Ma, superimposed on a longer-term aridification trend [2]. Interestingly, these episodes of wetter climate correspond to increased aridity in northwest and northeast Africa [3,4], to major global climate transitions [5–10] and major steps in human evolution. However, none of these lacustrine episodes has yet been sufficiently documented to elucidate their precise timing and relationship to changes in the Earth's orbital parameters.

Direct $^{40}Ar/^{39}Ar$ age calibration of orbital climate proxy records in East Africa can address not only related issues in paleoclimatology, but also such diverse topics as time scale calibration and biotic evolution. Detailed paleomagnetic studies in continental sections, when combined with precise correlations to the Astronomical Polarity Time Scale (APTS), can yield estimates of the age and duration of paleomagnetic boundary events that are not subject to the delayed lock-in effects of marine diagenesis.

The present study is an analysis of a fluviolacustrine sequence exposed in the Barsemoi River drainage near Lake Baringo, Central Kenya Rift. This ~200-m-thick sediment package is part of the 5.3–1.6 Ma Chemeron Formation and is one of the examples cited in the compilation of East African lake records of Trauth et al. [1]. The lake history that is recorded at Baringo allows evaluation of events both on a precessional time scale and in the perspective of longer-term climate change. In the fields of paleoecology, paleontology and hominin evolutionary studies, such well-delineated paleoclimate records lay the foundation for testing relationships between climate change and potential responses in faunal communities, and may help elucidate driving forces in hominin evolution.

1.1. Geological setting

The late Cenozoic Chemeron Formation consists of a series of subaerial and lacustrine sediments and siliceous tuffs, discontinuously exposed in the foothills along the eastern flank of the Tugen Hills, a structural horst within the Central Kenyan Rift west of Lake Baringo (Fig. 1). Sedimentary and tuffaceous rocks of the Chemeron Beds, formally designated by McCall et al. [11], were

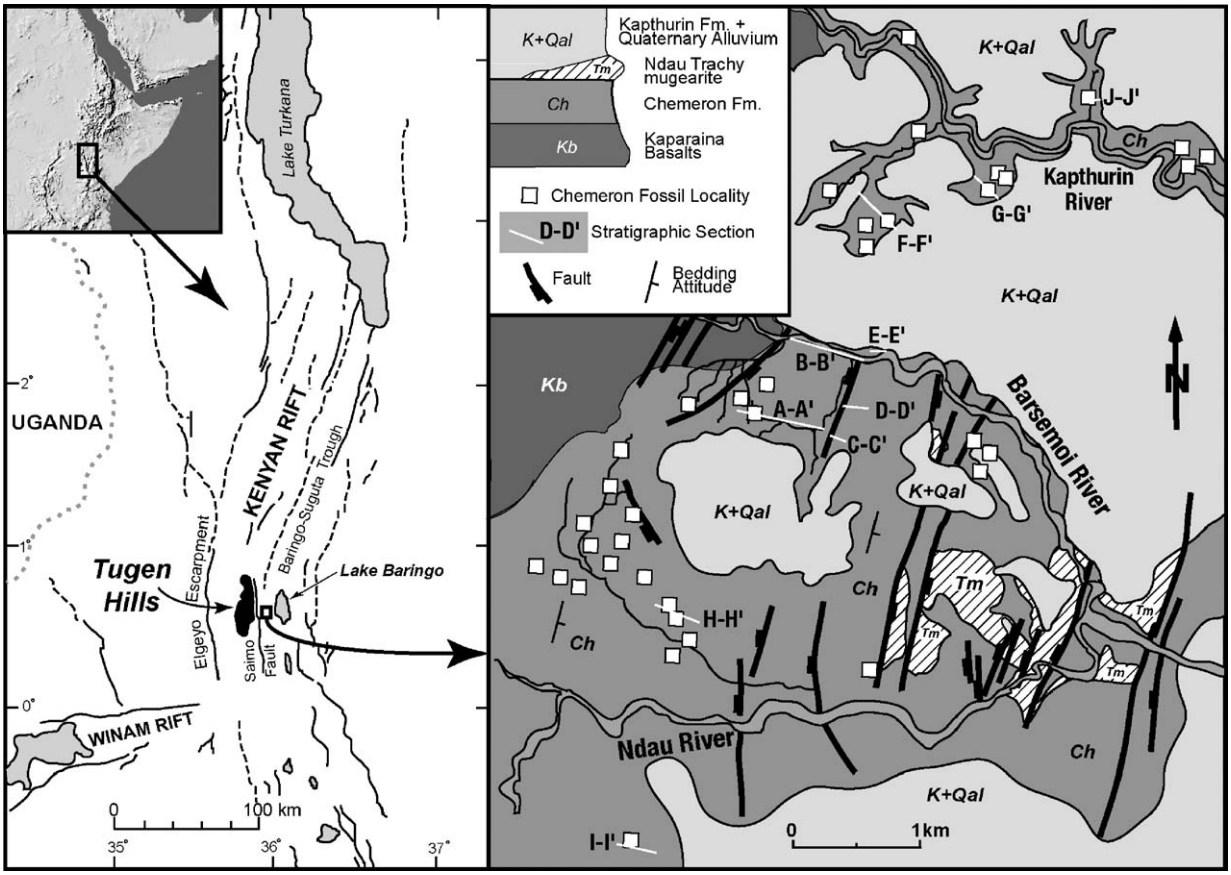

Fig. 1. Location map of the middle Chemeron Formation exposures in the Baringo Basin, central Kenyan Rift Valley.