JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 100, NO. B8, PAGES 14,965–14,998, AUGUST 10, 1995

Late Triassic-earliest Jurassic geomagnetic polarity sequence and paleolatitudes from drill cores in the Newark rift basin, eastern North America

D. V. Kent, P. E. Olsen, and W. K. Witte[1]

Lamont-Doherty Earth Observatory, Columbia University, Palisades, New York

Abstract. Paleomagnetic study of about 2400 samples from nearly 7 km of core recovered at seven drill sites in the Newark continental rift basin of eastern North America provides a detailed history of geomagnetic reversals and paleolatitudinal motion for about 30 m.y. of the Late Triassic and earliest Jurassic (Carnian to Hettangian). Northward drift of only about 7° is recorded in the continental sediments and minor interbedded basaltic lavas in the basin, from 2.5° to 6.5° north paleolatitude in the Carnian and from 6.5° to 9.5° north paleolatitude over the Norian-"Rhaetian" and the early Hettangian. A total of 59 polarity intervals, ranging from about 4 m to over 300 m in thickness, have been delineated in a composite stratigraphic section of 4660 m. The lateral continuity and consistent relationship of lithological lake level cycles and magnetozones in the stratigraphically overlapping sections of the drill cores demonstrate their validity as time markers. A geomagnetic polarity timescale was constructed by scaling the composite section assuming that lithostratigraphic members in the predominant lacustrine facies represent the 413-kyr orbital periodicity of Milankovitch climate change and by extrapolating a sedimentation rate for the fluvial facies in the lower part of the section; a 202 Ma age for the palynological Triassic/Jurassic boundary was used to anchor the chronology based on published concordant radiometric dates linked to the earliest Jurassic igneous extrusive zone. Geomagnetic polarity intervals range from about 0.03 to 2 m.y., have a mean duration of about 0.5 m.y., and show no significant polarity bias. The cyclostratigraphically calibrated record provides a reference section for the history of Late Triassic-earliest Jurassic geomagnetic reversals. Correlations are attempted with available magnetostratigraphies from nonmarine sediments from the Chinle Group of the southwestern United States and marine limestones from Turkey.

Introduction

The global nature of geomagnetic polarity reversals has made magnetostratigraphy an essential tool for precise correlation between widely distributed sections of rocks of different lithological and biotic facies. The best documented history of geomagnetic polarity reversals is for the Jurassic to Recent and is based on the analysis of marine magnetic anomaly profiles from the global ocean [e.g., *Cande and Kent,* 1992; *Gradstein et al.*, 1994]. The relative spacing of polarity intervals is established from the anomaly patterns and is calibrated in time by correlation to magnetostratigraphic sections with biostratigraphy, radiometric dates, and now by cyclostratigraphy [e.g., *Shackleton et al.*, 1990; *Hilgen,* 1991]. Because of the absence of seafloor and hence marine magnetic anomalies, a geomagnetic polarity reference scale for pre-Jurassic time is much less well developed and requires long, continuous magnetostratigraphic sections with good chronostratigraphic control from the continents.

A very thick sequence of lacustrine and fluvial sediments is represented in the Newark Basin, one of the largest of a chain of Mesozoic rift basins that developed along the margin of eastern North America in the early stages of formation of the Atlantic Ocean [*Manspeizer*, 1988]. Deposition in the basin is now known to span much of the the Late Triassic to earliest Jurassic [*Cornet and Olsen*, 1985] and was punctuated only by a brief igneous intrusive and extrusive episode just after the Triassic/Jurassic boundary [*Olsen and Sues*, 1986; *Fowell et al.*, 1994] and dated at 201-202 Ma [*Sutter*, 1988; *Dunning and Hodych*, 1990]. The lacustrine sediments that constitute much of the Newark Basin section record climatically induced lake level variations reflecting Milankovitch orbital forcing [*Van Houten*, 1964; *Olsen*, 1986]. These climatic cycles constitute a basis for detailed lithostratigraphic correlation as well as chronological scaling.

Early paleomagnetic work on Newark Supergroup rocks focused on the igneous units and found mostly normal polarity magnetizations [e.g., *DuBois et al.*, 1957; *Opdyke*, 1961; *Smith and Noltmier*, 1979]. This contributed to the concept of a quiet or long normal polarity interval in the Late Triassic and Early Jurassic [*McElhinny and Burek*, 1971; *Perchesky and Khramov,* 1973; *Irving and Pullaiah*, 1976; *Haq et al.*, 1988]. More extensive sampling of the Newark Basin sedimentary section has revealed the presence of numerous polarity reversals [*McIntosh et al.*, 1985; *Witte and Kent*, 1989, 1990; *Witte et al.*, 1991]. The Newark Basin section thus provides an opportunity to obtain a cyclostratigraphically scaled, high-resolution timescale of

[1]Now at Geophysical Institute, University of Alaska, Fairbanks.

Paper number 95JB01054.
0148-0227/95/95JB-01054$05.00

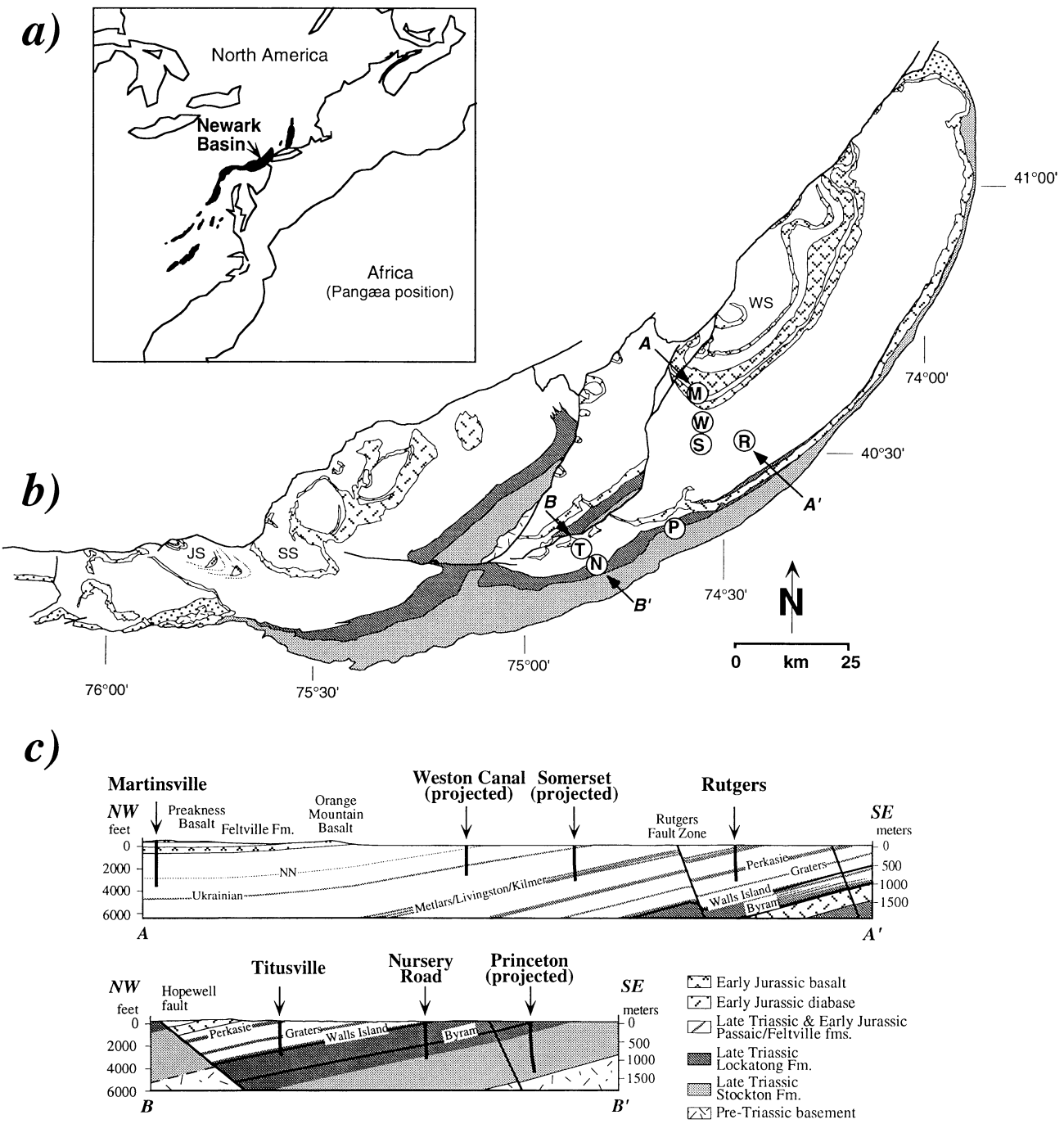

Figure 1. (a) Location of the Newark Basin among other early Mesozoic rift basins (dark shading) in eastern North America which is shown in a predrift (Pangea) continental configuration with respect to Africa. (b) Geological sketch map of the Newark Basin with the location of Newark Basin Coring Project drill sites indicated by the circled first letter of the site name. Other localities referred to in the text are WS, Watchung syncline; SS, Sassamansville syncline; JS, Jacksonwald syncline. (c) Cross sections showing positions of NBCP drill sites projected onto A-A' and B-B' of Figure 1b.

Late Triassic and earliest Jurassic geomagnetic polarity reversals. Outcrop exposure is, however, typically poor and discontinuous due to the low relief and urbanized setting of the basin. This difficulty was addressed by the National Science Foundation-sponsored Newark Basin Coring Project (NBCP) which resulted in the recovery of a virtually complete stratigraphic section through the thick continental rift basin sequence of central New Jersey from seven stratigraphically overlapping drill cores. The lithostratigraphy and cyclostratigraphy of the NBCP cores are described by *Olsen et al.* [1995] and *Olsen and Kent* [1995]. The paleomagnetism of the NBCP cores is reported here.