

SESSION 21, Tectonics I: Southern Hemisphere and Precambrian Tectonics

relative rotations of up to 60 degrees. Previously reported paleomagnetic results from younger units typically yield rotations no greater than 20 degrees. The rotations recorded by younger units can be reasonably explained by a nearly symmetric oroclinal bending. The greater rotations of the older units indicates a more complex structural development in the oroclinal axis than that predicted by a simple oroclinal model. The data suggest at least one major fault cutting obliquely through the Eastern Cordillera. This structure may accommodate, in part, the lengthening of the orogen during the development of the Bolivian oroclinal. The greater and more variable vertical-axis rotations of the older units suggest that the Eastern Cordillera in the axis of the oroclinal was actively deformed during late Oligocene and possibly Eocene orogeny.

9:15 AM Kolata, Dennis R.

LOWER AND MIDDLE ORDOVICIAN K-BENTONITES IN THE PRECORDILLERA OF ARGENTINA: NEW DISCOVERIES AND SIGNIFICANCE

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K-bentonite beds (altered volcanic ash) are present in Lower and Middle Ordovician rocks in the Precordillera of western Argentina. First discovered two years ago in the upper part of the San Juan Limestone and overlying shales of the Gualcamayo and Los Azules Formations near Jachal, San Juan Province, this K-bentonite complex has now been identified in 10 areas between Guadacol, La Rioja Province and San Juan, San Juan Province, a distance of about 200 km. At two localities, over 30 beds are present, ranging in thickness from 1 to 60 cm. All known occurrences are in the central and eastern thrust belts of the Precordillera. The K-bentonites are mid-Arenigian to mid-Llanvirnian in age based on biostratigraphically diagnostic graptolite and conodont faunas, and they offer excellent potential for high-resolution correlation.

Deposition of the volcanic ash occurred prior to and shortly following the tectonic collapse of the Precordilleran carbonate platform beginning during the Arenigian. The volcanism appears to be related to the early Middle Ordovician collision and docking of the Precordilleran terrane with Gondwana. The geochemistry of the K-bentonites indicates a rhyolitic to trachyandesitic parental magma that originated in a volcanic arc-continental margin setting. The distribution and thickness of the K-bentonite beds suggest that the source volcanoes were situated to the east of the Precordillera, probably near the margin of the Argentine craton. K-bentonites occur in a comparable stratigraphic position in the southern part of the United States, but it is unclear what their relationship is, if any, to those in the Precordillera.

9:30 AM Haileab, Bereket

GEOLOGY OF NORTHERN ERITREA, EAST AFRICA.

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The geology of Eritrea is dominated by Precambrian crystalline basement overlain by Tertiary to Quaternary volcanic and sedimentary rocks. The Proterozoic rocks consist dominantly of volcano-sedimentary assemblages; gneisses, amphibolite, hornblende schist, quartz-mica-schist, garnet schist, staurolite schist, marble and basaltic flows. Intrusive rocks of varying size from stocks to batholiths are very common; they include granites to diorites and mafic to ultramafic bodies. Some of these seem to be emplaced during deformation and some post deformation. There are also several circular post-tectonic intrusive bodies that show little or no evidence of deformation. Petrographic analyses of the metamorphic rocks shows mineral associations including chloritoid, garnet, andalusite and staurolite. Mineral assemblages indicate the metamorphic history of the rocks ranges from greenschist facies to amphibolite facies. Most structures of northern Eritrea have strong linear features trending NNW-SSE. Several types of ductile folding, shear zones and normal faults structures can be seen from the outcrops as well as from satellite images. Tertiary flood basalts rest conformably on the Precambrian basement rocks. These basalts reach a thickness of more than 500 meters. Lateritic paleosols mark the contact between the Tertiary and basement complex in many parts of the outcrops. Quaternary geology of Eritrea indicates that the region is seismically active as can be seen from recent fault scarps, changes in drainage patterns and recent earthquakes.

9:45 AM Kozuch, M.

A 1 GA MAGMATIC ARC IN THE BORBOREMA PROVINCE, NE BRAZIL: A RODINIAN-AGE ANDEAN-TYPE CONTINENTAL MARGIN?

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Within the states of Pernambuco and Paraíba in the Borborema Province, NE Brazil, there are excellent exposures of plutonic, metavolcanic, metasedimentary, and gneissic rocks in this 0.6 Ga Brasiliano/Pan African orogen. Most undeformed granitoid plutons are Brasiliano in age. Growing evidence, however, indicates that extensive magmatism also occurred ~1.0±0.1 Ga (Cariris Velhos orogen); various workers have proposed a rift environment or arc environment for this activity, but the petrogenetic setting remained equivocal, primarily since these ~1.0 Ga rocks have been relatively little-studied.

New U-Pb data confirm earlier Rb-Sr work that ~1.0 Ga rocks represent a large proportion of exposures. The Ambó gneiss (north-central Pernambuco) yields a preliminary U-Pb age of ~1.0 Ga, assuming Brasiliano Pb-loss. About 40 km south, gneiss near Palmeira contains zircons that are 0.96 Ga, also assuming Brasiliano reactivation. The Palmeira granite, a Brasiliano pluton that intrudes the regional gneiss, contains inherited ~2.0 Ga zircons with an unforced lower intercept of ~0.5 Ga. Therefore, the Palmeira granite was probably not derived from the surrounding gneiss. Sm-Nd data for the Palmeira granite (TDM = 2.15 Ga; εNd[0.6 Ga] of -14.1) show derivation from an older, evolved source. TDM for the 1 Ga gneisses are 1.78 to 1.65 Ga, while εNd[0.6 Ga] are -3.8 to -5.8, suggesting that more than one source was involved to form the protolith of these gneisses, i.e. a younger and/or more depleted source plus an older and/or more enriched source.

Trace element and REE chemistry of 1 Ga gneisses show arc signatures (negative Nb-Ta anomalies), negative Eu and Sr anomalies (plagioclase restite), and shallow melting. Trace element and REE patterns of the Palmeira granite display depletions in HREE (deep melt source) and positive Sr and Eu anomalies (plagioclase in melt). Complementary geochemistry between the gneiss and intrusive Palmeira granite, coupled with age and isotopic data, suggests that a ~2.0 Ga reservoir (older crust) was reactivated ~1.0 Ga during Andean-type subduction, producing arc rocks with hybrid Nd signatures. The Brasiliano orogeny remelted the restite ~2.0 Ga reservoir, which existed at a deep crustal level at ~0.6 Ga, resulting in granitoids with old Nd signatures and old inherited zircons. The inferred arc may denote tectonic activity complementary to the assembly of Rodinia ca. 1 Ga.

10:00 AM Dalziel, I. W. D.

THE AMERICAN CONTINENTS AS MORPHOLOGIC "TWIN" BORN 400 M.Y. APART: BREAK-UP OF PANNOTIA AND PANGAEA

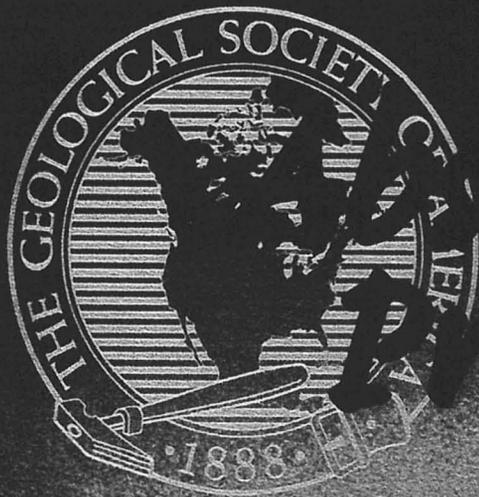
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There is widespread acceptance (Dalziel et al., *GSA Today*, 1996) that the Cambrian-Lower Ordovician carbonate platform constituting the Precordillera of northwestern Argentina (APC) was part of Laurentia until mid- to Late Ordovician times, and that it originated in the Ouachita embayment, as originally suggested by Dalla Salda et al., *Geology*, 1992). This means that the APC is indeed a critical clue in Paleozoic paleogeography. Astini et al. (*GSA Bulletin*, 1995) followed Thomas (*GSA Bulletin*, 1991) in suggesting that it was detached from Laurentia in the Late Cambrian, docking in South America as a microcontinent rather than as a result of the continent-continent collision hypothesized by Dalla Salda et al. However, comparison with the extensional regime associated with the Mesozoic separation of the Falkland/Malvinas Plateau from Africa during the opening of the South Atlantic Ocean basin at 128 Ma suggests that the Birmingham graben, South Oklahoma aulacogen, and Ouachita trough are analogous to the Rawson basins, San Julian basin, and Malvinas basin respectively. Moreover, positioning of the Greenland-Scotland-Labrador promontory of Laurentia within the Arica embayment of South America prior to the opening of the Iapetus ocean basin at ca. 545 Ma, as suggested by Dalziel (*GSA Today*, 1992), places the Ouachita embayment adjacent to the Falkland/Malvinas Plateau and opposite the latest Precambrian to Early Cambrian rifted margins of southern Africa and the Ellsworth Mountains block of the East Antarctic craton. Hence, the Grenvillian basement of the Precordilleran platform may have originated along the present-day southern margin of the Falkland/Malvinas Plateau, and the American continents may have been born ca. 400 m.y. apart as morphologic "twins" — southward tapering cratons with 1000-1500 km long promontories at their southeastern extremities. Opening of the western Iapetus (Laurentia-South America) and South Atlantic ocean basins coincided with the initiation of the first-order Paleozoic and Mesozoic rises in sea level respectively, presumably as a result of displacement of ocean water by new mid-ocean ridge systems at least 6000 km long in each case.

10:15 AM Hoffman, Paul F.

NO SWEAT: PAN-AFRICAN DAMARA OROGEN (NAMIBIA) AS AN UNSTABLE TRIPLE POINT, WITH IMPLICATIONS FOR RODINIA

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The tectonic assembly of Gondwanaland involved closure of the Mozambique and Brasilide (aka Adamastor) oceans, concurrent with breakup of the 1.05-0.75-Ga supercontinent



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Great Sand Dunes
National Monument.
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GSA Abstracts with Programs, vol. 28, no. 7; ISSN 0016-7592—Codon: GAAPBC is published by the Geological Society of America, Inc., with offices at 3300 Penrose Place, Boulder, Colorado 80301-9140 USA. Mailed at first-class before the respective meetings and fourth-class after. Seven issues published in 1996: February (3), March, April (2), and October. Copyright © 1996, the Geological Society of America, Inc. (GSA). All rights reserved. Copyright not claimed on content prepared wholly by U.S. Government employees within the scope of their employment. Individual scientists are hereby granted permission, without royalties or further requests, to make unlimited photocopies of abstracts and other items in this publication for noncommercial purposes advancing science or education, including classroom use, and to make up to five copies for distribution to associates in the furtherance of science. Permission is granted to individuals to make photocopies of those items for other noncommercial, nonprofit purposes advancing science or education upon payment of the appropriate fee (\$0.25 per page) directly to the Copyright Clearance Center, 27 Congress Street, Salem, Massachusetts 01970, phone (508) 744-3350 (include title and ISSN when paying). Written permission is required from GSA for all other forms of capture, reproduction, and/or distribution by any means. GSA provides this and other forums for the presentation of diverse opinions and positions by scientists worldwide, regardless of their race, citizenship, gender, religion, or political viewpoint. Opinions presented in this publication do not reflect official positions of the Society.

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