SECTION NEWS

GEOMAGNETISM & PALEOMAGNETISM

Gathering Recognizes Contributions of Former Section President

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To celebrate the sixtieth birthday of Rob Van der Voo, AGU's President and President-elect of its Geomagnetism and Paleomagnetism Section, 1988–1992, a workshop was recently held in an intimate conference setting in Ann Arbor, Michigan. The purpose was to celebrate Rob's many contributions to the fields of paleomagnetism and tectonics as he reached this milestone. Some 30 people attended and were treated to 18 presentations, many of which have recently been published or are currently in review for a special issue in his honor. While great emphasis was placed on paleomagnetism as the only quantitative tool for generating paleogeographic reconstructions for pre-Mesozoic time, a recurring theme within the meeting was the integration of paleomagnetic results with those from other disciplines—a hallmark of Rob's research efforts at the University of Michigan. The meeting also provided an opportunity for students and colleagues of Rob's to indulge in more "speculative" ideas, and the presentations were accompanied by wide-ranging and "spirited" discussions during both the "formal" sessions and the highly enjoyable evening social activities.

The paleogeography of the late-Neoproterozoic and early Paleozoic formed the basis of one session. Paul Hoffman presented some of the evidence for a "Snowball Earth," including the evidence from stable isotope analyses and the occurrence of cap carbonates and the temporal distribution of banded iron formations; and postulated that such an extreme climatic scenario was almost inevitable, given the predominantly equatorial distribution of the major Neoproterozoic continents.

There are important uncertainties in the paleogeographic reconstructions, emphasised in the presentations by Trond Torsvik and Chris Scotese, which bear on the claimed equatorial paleolatitudes of the glacial deposits. At present, only one Neoproterozoic glacial deposit has yielded convincing evidence for low-latitude deposition, but, perhaps equally significant, no convincing polar glacial deposits have been documented. One of the major limitations to a better understanding of Neoproterozoic paleogeography, and a possible Snowball Earth, is the scarcity of reliable paleomagnetic data from several of the major continental blocks. Most reconstructions incorporate, to varying degrees, assumptions about the fits between various continental blocks, or use proxy paleomagnetic poles transferred from other continental blocks on the basis of an assumed fit.

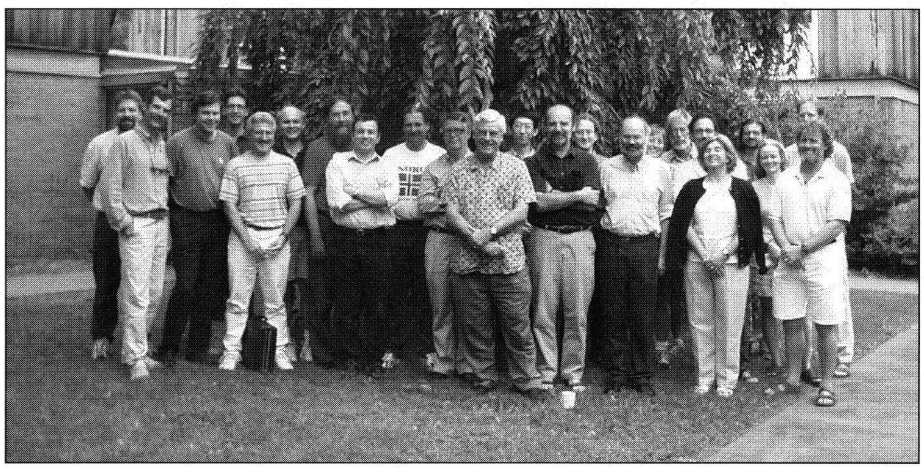
As an example, while the assembly of Gondwana in the latest Precambrian is generally viewed as a collision between east and west Gondwana, Joe Meert presented an analysis of the paleomagnetic and geochronologic constraints on the assembly, which suggests that eastern Gondwana was not an entity prior to overall Gondwana assembly. Any use of paleomagnetic data from one eastern Gondwana block to constrain the position of another is therefore invalid for times predating Gondwana assembly.

The application of Paleomagnetism to regional tectonics was exemplified by a number of presentations on a topic that is close to Rob's heart: the paleogeography and evolution of the Paleozoic Iapetus Ocean. Conall Mac Niocaill presented a synthesis, much of which was based on original data collected by Rob and co-workers, of terrane accretion histories in the Northern Appalachians, which indicates that the Iapetus Ocean contained several geographically distinct but contemporaneous volcanic arc terranes.

The evolving picture of Paleozoic paleogeography is reaching a level of refinement at which the location of individual terranes is more often the subject of dispute than the position of the major continents. The emerging picture of Iapetan paleogeography resembles, in many ways, the complex tectonics of the SW Pacific. The post-collisional history of these terranes was discussed by Mark Smethurst. Mark's new data from the Silurian of Newfoundland resolve a long-standing dispute about possible inclination errors contributing to erroneous paleogeographic models, where some units have yielded paleolatitudes that implied oceanic separation between the terranes persisting into the mid-late Silurian. These new data confirm that the various Paleozoic terranes that make up Newfoundland were assembled in the Silurian, but later underwent oroclinal bending by vertical axis rotations.

Vertical axis rotations also featured in other presentations, notably that of John Geissman, who presented paleomagnetic data from Permian and Triassic rocks along the eastern margin of the Colorado Plateau. These data indicate that small degrees of rotation are consistent with the regional pattern of deformation along the margins of the plateau since the mid-Cretaceous. John Stamatakos also presented new paleomagnetic evidence for vertical axis rotations associated with normal faulting in the Crater Flat basin, in southwest Nevada. This latter study is of particular significance, as they indicate geologically recent deformation within the region, which has been proposed as the site of the U.S. high-level nuclear waste repository.

For Mesozoic and younger times tests of paleomagnetic reconstructions become easier, but no less contentious, given that marine magnetic anomalies and hot-spot tracks become available for comparison. Dennis Kent summarized the results of paleomagnetic and magnetostratigraphic investigations of Triassic red-bed sequences, related to the early stages of extension in the Atlantic, along the eastern seaboard of North America, and demonstrated that the paleolatitudes obtained from the paleomagnetic studies agree with paleoclimate gradients obtained from lithofacies. Thus, the climate zonation of the



Many of the people who attended the workshop; from left: John Stamatakos, John Geissman, Trond Torsvik, Ben van der Pluijm, Ray Russo, Doug Elmore, Chris Scotese, Conall Mac Niocaill, Joe Meert, Mark Smethurst, Rob Van der Voo, Daming Wang, Dennis Kent, Jurgen Matzka, Mark Dekkers, Elizabeth Eide, Paul Hoffman, Arlo Weil, Donna Jurdy, Chad McCabe, Kate Hagstrum, Dave Rowley, and Jon Hagstrum.

early Mesozoic was not that different from the modern-day zonal variation and climatic indicators present a valuable test of plate reconstructions.

There has been much recent debate as to the fixity of hot-spots, and John Tarduno presented a comparison of paleomagnetic data from Cretaceous seamounts in the Pacific with the Mesozoic hot-spot framework. The results indicate a significant degree of motion of the hot-spots with respect to the paleomagnetic framework, and indicate that a substantial component of hot-spot migration took place in the Late Cretaceous, in contrast to models that argue for an enhanced component of True Polar wander at this time. Interestingly, Dave Rowley noted there is no evidence for any concomitant changes in the history of ridge production. Inversion of area-age relationships yields ridge production rates of the order of 3.4 km^2 per year, and there is no evidence for major changes in this rate over the past 180 Ma.

A final theme of the meeting was the application of rock magnetism in helping decipher the complex paleomagnetic signal carried by rocks. Doug Elmore provided an overview of a number of possible models for remagnetization of rocks, with particular emphasis on the remagnetization of cratonic strata. Despite more than 20 years of research on the phenomenon, a single underlying mechanism that can explain all of the observations has not been recognized, although there appears to be a temporal correlations between secondary magnetizations and orogenic events, even if the rocks themselves have not been directly involved in deformation.

A better understanding of remagnetizations most likely lies in the identification and genesis of secondary minerals, and Mark Dekkers illustrated a new method of analysing isothermal remanence acquisition curves using cumulative log Gaussian analysis. A cautionary tale of self-reversal in ocean floor basalts was presented by Jurgen Matzka, which indicates that great care must be taken in interpreting the paleointensity and directional magnetic records of these rocks, and again illuminated the role that careful rock magnetic work can play in plate reconstructions.

Authors

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BOOK REVIEWS

El Niño and the Southern Oscillation. Multiscale Variability and Global and Regional Impacts

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H. F. Diaz and V. Markgraf (Editors)

Cambridge University Press, New York, 496+ xv pp., ISBN 0-521-62138-0, 2000, $90.

The series of books edited by H. F. Diaz and V. Markgraf are standouts in the still-bullish ENSO market. *El Niño and the Southern Oscillation. Multiscale Variability and Global and Regional Impacts* is their second book; the first, *El Niño: Historical and Paleoclimatic Aspects of the Southern Oscillation*, was published in 1992. The contents of the latest volume are eclectic: four chapters cover modern ENSO variability, three treat miscellaneous impacts, four are about paleoclimate, one investigates historical records, and one presents a theoretical model. Only true ENSO junkies will be interested in all of these topics. Fortunately for the publisher, there is no shortage of us.

The lead article by R. Allan is a valuable summary of ENSO's temporal history in the 150 years of instrumental records. It is marred by treating auspicious conjunctions of frequency components as the cause of irregular ENSO variations. M. Hoerling and A. Kumar follow with a fine summary of the present understanding of extra-tropical teleconnections that draws heavily on their own excellent work. They conclude, somewhat pessimistically, that extra-tropical prediction is limited more by sensitivity to initial conditions than by misspecification of the sea surface temperature (SST) forcing. The next chapter covers non-ENSO modes of SST variability and their impact on climate. It is exceptional on the Atlantic, and quite adequate elsewhere. It is followed by a review of what is not known about the mechanisms responsible for the decadal variability of ENSO. This level-headed summary ends with a useful discussion of global warming models and concludes that none should be trusted with the future of ENSO variations.

The three first-rate impacts chapters address stream flow in the Americas, tropical cyclones, and vector-borne diseases in Colombia. Oddly, there is no review of ENSO's impacts on agriculture, which have been well studied. The low-frequency variations in patterns of stream flow appear to be related to the ENSO variations described by Allen, though the exact relationship is not spelled out. The review on tropical cyclones is motivated by the goal of prediction but explains much of the underlying physics. The most original chapter in the book links climate inputs to an entomological model for prediction of malaria and dengue fever in Colombia. The model captures the trends over the past three decades and does a decent job on the inter-annual variations.

The longest article in the book, by L. Ortlieb, is a close scrutiny—for Peru only—of the seminal historical reconstruction of El Niño events by the sainted Bill Quinn. A more complete and correct record results. Truth has its price: L. Ortlieb puts to rest the romantic notion that an El Niño smoothed Pizarro's path to conquest from 1531 to 1532.

Paleoclimate chapters cover tree rings, ice cores, and multi-proxy reconstructions. L. Thompson et al. demonstrate that the Huascaran ENSO signal is twice removed from the Pacific, being closely tied to ENSO-influenced trade wind fluctuations over the Atlantic, which is the moisture source for Huascaran. The most valuable climate information is obtained from the multiple records used by E. Cook and colleagues and M. Mann and colleagues, who show that ENSO teleconnections have not been stationary in the past, an important fact for prediction efforts. The multi-proxy record of M. Mann et al. also shows that the persistent warm state from 1990 to 1995 is not unusual in the long-term record; this issue cannot be firmly settled from the 150-year instrumental record.

The final chapter, V. Markgraf and H. Diaz's synthesis of the ENSO record for the past 20,000 years, is now an indispensable starting point for anyone's venture into paleo-ENSO. Still, it makes one marvel at the rapid progress of paleo-ENSO research in the very few years since it was written. How different their chapter would have been had the very recent S. Tudhope et al. report on fossil corals published in *Science* this year been available. New results have also overtaken the interesting theoretical model of D.-Z. Sun. Sun suggests that ENSO stopped in the early Holocene as a consequence of decreased stratification in the ocean, but both S. Tudhope et al. and D. Rodbell et al., which appeared in *Science* in 1999, show that ENSO merely weakened at this time. A number of model studies have shown the weakening to be a consequence of the difference in the Earth's orbit.

A number of themes run throughout the book, without a distinction between the modern and paleoclimate. Most prominent are ENSO variability on decadal and longer time scales and the changes in teleconnections over time. We have become reasonably aware of significance issues for time series, but we usually ignore the possibility that two spatial patterns—for example, inter-annual and decadal variability in Pacific SSTs—may not be significantly different. The modern instrumental record is too short to allow any confident statements about low-frequency variability, so paleo-proxy records are essential. But they are proxies, which leaves some doubt as to