American Mineralogist, Volume 98, pages 522–523, 2013

Book Review

FORMATION AND EVOLUTION OF AFRICA: A SYNOPSIS OF 3.8 GA OF EARTH HISTORY edited by D.J.J. van Hinsbergen, S.J.H Buiter, T.H. Torsvik, G. Gaina, and S.J. Webb (2011) Geological Society London Special Publication number 357. 378 pp. ISBN: 1-86239-335-4. £120.00 List price.

The African continent is the largest on the planet (~30×10^6 km^2, some 21% of Earth's continental surface), about three times the size of the U.S.A. The U.S.A. just about "fits" into central Africa—the east-west coast-to-coast distance from NY to LA is about the same as that from Mombasa in Kenya to Douala in Cameroon. Describing the geology of such a chunk of real estate is a daunting task. When the Geological Society of America celebrated its centenary in 1988, it aimed at documenting the geological history of North America in 71 volumes. A monumental undertaking intended to provide a massive, systematic synthesis of geological knowledge of North America to serve as a benchmark for future research. A similar detailed history of the geology of Africa would require more than 200 volumes. Thus, this book provides but a tiny glimpse of what Africa has to offer the world of geosciences. While it is not a synopsis in the way the title suggests, its 100-odd authors do a good job in branding Africa as an attractor to its superlative natural heritage. Sadly, only about 27% of the authors are African, or reside in Africa; the rest are "scientific visitors", and unfortunately some remain socially and politically insensitive to Africans—one paper refers to "the Kaffir tribes of South Africa".

There are no rocks discovered, yet, in Africa that date back to 3.8 billion years (Ga); the oldest reported rocks in Africa are just shy of 3.7 Ga (from Swaziland), and none of the contributions in this book deal with these or any other Archean rocks or processes (>2.5 Ga). On several counts then the title of the book is misleading. Be that as it may, there are some interesting new snippets and a few good reviews in this book that was compiled for Professors Kevin Burke and Lewis Ashwal as a token of appreciation for their contributions to enhancing knowledge of Africa's geology, as abridged in the editors' Introduction.

The rest of the book is a potpourri of 18 papers focused on 13 small areas spread across the continent, and one paper each on Madagascar and the Seychelles. Two further papers deal with the continent as a whole: one is focused on Paleozoic paleogeography of proto-Africa, e.g., before its emergence as a continent out-of-Gondwana; and one deals broadly with the contemporary topography of Africa.

The furthest back into Africa's past this book delves is through discussion of the Rehoboth province that straddles the national boundaries of Namibia and South Africa. The origin of this province has long been subject to debate, not least because most of it is buried beneath a very thick cover of Kalahari sand. Along the margins of the province some of its meta-sedimentary Precambrian basement is exposed. New data are presented from several hundreds of detrital zircons: three zircon grains yield Archean dates (2.74, 2.75, and 2.98 Ga); the rest are "Eburnean" (2.2–1.9 Ga), "Kibaran" (1.3–1.1 Ga), and a large peak of zircons around 1.7 Ga. The authors interpret their data to represent at least three main episodes of crustal development, including Archean crust exposed in the province during the Paleoproterozoic. But 3 detrital zircons do not necessarily make an Archean terrane, and the formation and evolution of this province remains obscured.

The most coherent set of small-area papers (three) covers part of the Atlantic side of northwest Africa in Morocco: two Permo-Triassic studies from the Argana Basin, and the third from the Jurassic-Cretaceous Tarfaya Basin. The first two should be of interest to those aiming to better understanding the early history of conjugate continental margins and feedback between plumes and rifts; in this case between the CAMP (200 Ma) large igneous province (LIP) and early rift basins during the opening of the Central Atlantic. Data presented from the Argana Basin should stimulate those interested in matching the astronomically driven time control on the geomagnetic polarity timescale and the rich multi-pronged stratigraphy in this African "twin" of the Newark Basin.

There are five small-area papers dealing with aspects of the closure of Late Neoproterozoic oceans in widely disparate Pan-African regions, including: descriptions of sedimentary rocks and related thrusts from the Fungurume foreland basin to the Lufilian Arc in the DRCongo; the timing of deformation in southwest of the Damaran Belt of Namibia; the development of a major suture zone of the Arabian-Nubian Shield traversing northern Ethiopia; description of a significant gravity signature of a potential suture hidden beneath the sands of the central Sahara in Chad; and a multi-authored (19) overview of "Mozambiquean" orogenic features in central and northern Madagascar, including the enigmatic Betsimaraka suture, summarizing recent World Bank sponsored field and geochronology work there by scientists from the BGS (British Geological Survey), the USGS, and the Malagasy Mineral Resources Bureau. All these papers provide new Pan-African food for thought with which to track the accretion history of Gondwana.

Five small-area papers deal with volcanic rocks and magmatism related to the Ethiopian LIP and/or rift volcanics to the south (in Kenya) and north (in Egypt and Libya). The first is a focused study that confirms volcanism was spread over a large region for near 24 million years before being focused along the Main Ethiopian Rift at about 11 Ma. Bimodal Ethiopian flood basalts, which young southward from northern Ethiopia between 30 Ma to 20 Ma, are interlayered with rhyolite sequences. The two suites are shown to be related through fractional crystalli-

0003-004X/13/0203–522$05.00/DOI: http://dx.doi.org/10.2138/am.2013.604

zation and, increasingly with time, also through contamination with lower-crust materials due to thermal softening of the crust. Some 2000 km to the north, basalt lavas also extruded around Cairo at 24 Ma, overlapping with the opening of the Red Sea. Their geochemistry is described in detail in another paper; and petrogenetic analysis suggests an Afar-like magma source mixed with local crust. However, the nature of subsurface links, if any, among these disparate regional lava fields of NE Africa remain unresolved, but this set of papers will surely be of benefit to those exploring large-scale crust-mantle feedback processes. In this context, there is a thought-provoking paper dealing with far-field stress transfer from the subduction processes along the Africa-European plate in the central Mediterranean (Sicilian-Calabrian Arc) to deformation of the North African Tripolotania platform sediments flanking the Sirte Basin more than 1500 km away, inducing formation between 0.2–6 Ma (and with historic seismicity) of local rifts and several alkaline basalt fields in Libya.

Another interesting paper deals with Late Neogene climate changes in equatorial highlands using lava flows with interbedded paleosols and loess at the base of the Mount Kenya Volcanic series. New Ar-Ar dates (5.19–5.45 Ma) and paleomagnetic measurements place the sequence predominantly in the early Gilbert Reversed Chron (e.g., in the Messianian). The data reveal a clear trend from dry to sub-humid during the Late Miocene to Pleistocene transition and to humid conditions in the subsequent Pleistocene interglacials. This work shows that high-resolution climate information can be extracted from weathering profiles interlayered with episodic lava-flows.

There is also a clever study using simple physical parameters on a 300 km long, 13.5 Ma phonolitic lava flow along a paleo-river, to deduce that their eruption occurred on a pre-Cenozoic plateau of the Kenya Highlands with an elevation of at least 1400 m. Unfortunately, the authors do not explore uncertainties in their calculations, but the dye is set to use volcanology together with low-temperature thermochronology to home in, with improved confidence, on estimating paleo-elevation and topography.

Five small-area papers deal with palaeomagnetism, new apparent polar wandering (APW) paths, and/or magnetostratigraphy. New paleo-poles for Africa, or older fragments thereof, are provided for time slices in the Paleoproterozoic, the Neoproterozoic, the Paleozoic, and the Mesozoic. Not all are of the same quality and in some cases difficult to evaluate for lack of relevant data. A new, robust Paleoproterozoic pole is presented for the 2.06 Ga Palaborwa Complex that intrudes the Kaapvaal Craton of South Africa. Together with previous poles from the Bushveld Complex (2.05 Ga), the Vredefort Dome (2.02 Ga), and Waterberg dolerites (1.88 Ga), the paper demonstrated very slow motion of the craton in the late Paleoproterozoic. Whilst the paper initially sets out to test for the existence of large paleo-continents such as Columbia (1.8–2.1 Ga) and Vaalbara (3.4–2.1 Ga), it provides no further clues or discussion, leaving this intriguing aspect of the work hanging.

Excellent Permo-Triassic magneto-stratigraphy is presented from the Argana Basin; and a first robust Cretaceous (Turonian) paleopole for northwest Africa is provided from the Tarfaya Basin. New well-dated paleomagnetic poles are presented for rocks from the Seychelles intruded during magnetochron C28a, and from which a reconstruction of the Seychelles-India is derived before they separated around 65 Ma. How this separation may relate to the Deccan LIP and to the Reunion plume is also explored. No paleo-horizontal data are presented for the new paleomagnetic data, making it difficult to evaluate the results.

The longest paper of the book deals with the Paleozoic history of central Gondwana, of which Africa makes up the largest component. A new APW path from 550–250 Ma is presented, and discussed in conjunction with short national and regional geology and biostratigraphy reviews, accompanying 8 new paleogeographic maps. The most accurate reconstructions are those from the northern Margin of Africa and its related Euro-American connections; synopsis of southern and central Africa are less precise and contain many editorial mistakes and several gross scientific misrepresentations (e.g., claims that there are no Paleozoic rocks in Madagascar; that glaciogenic sedimention in Namibia started at 302 Ma; no recognition of the classical glaciogenic sediments in the Democratic Republic of Congo and Tanzania, and so forth). Beyond a better understanding of the circum-tectonics of Gondwana's margins, it is difficult to value these paleogeographic maps especially against similar scientific compilations but with more artistic flair, for example, by the Scotese school (http://www.scotese.com/) whose renditions evoke greater stimulation and curiosity.

The final paper of the book offers a good overview of the state of play in understanding Africa's complex and unique manifold topography, and how passive-source seismic studies are helping to differentiate what topography is dynamic and mantle induced, and what is inherited from the African lithosphere. There is much uncertainty and speculation about this, most of it related to a lack of continent-wide data, which in turn reflects the low level of investment by the global community in fundamental geo-observatories for Africa. The few external centers dedicated to this cause, such as at Penn State University in the U.S.A., are but a drop in the ocean. This paper exemplifies what may legitimately be asked then: when is Africa going to see some real geo-outreach investment in return for continuous exploitation of its geo-heritages that feature so prominently in the research endeavors reported on with such enthusiasm in this "visitors" book?

This book was evidently compiled in a hurry. As an example, the opening overview figure of the book is full of spelling mistakes and faulty scientific labeling; and there are significant editorial shortcomings in a fair number of the papers and diagrams. Some of the blame for the poor editing may perhaps be placed at the feet of the Publisher. To meet a "bottom line", the ever-increasing publication pressure affects not just scientists, but also publication centers including the Geological Society of London. Its "old guards" might argue that editorial quality of their society's publications "is not what it used to be". They may have a point: the editorial boards of the proud series of which this book is one, are now expected to meet unsustainable book targets—unsustainable that is in terms of its past history of excellence. Perhaps it is a warning-bell for scientists not to be lured by profit margins like their banking peers.

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