284-2 Invited Moores, Eldridge

PRECAMBRIAN OPHIOLITES AND THEIR TECTONIC SIGNIFICANCE

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Keywords: ophiolite; Precambrian; tectonics

A global survey of Precambrian ophiolites indicates that Neoproterozoic and Phanerozoic ophiolites are similar, but pre 1-Ga complexes are substantially different. Phanerozoic-Neoproterozoic complexes are of two principal types: a full (Penrose-type) sequence of tectonite peridotite, mafic-ultramafic cumulates, sheeted dikes, extrusives, and pelagic/volcanigenic sediments characterize magma-rich (generally fast-spreading) complexes, whereas an incomplete (Hess-type) sequence of serpentinized tectonite peridotite unconformably overlain by extrusives and pelagic/volcanigenic sediments characterize magma-poor (slow-spreading) environments. These ophiolites have been emplaced by mantle-rooted thrusts (incipient to mature subduction zones) over continental margins (Tethyan-type) or island arcs and/or accretionary prisms (Cordilleran type). In most orogens, ophiolite emplacement was a first-order tectonic event of magnitude, and predated continent-continent collision. Ophiolites typically represent the tectonically highest thrust sheet in an orogen (e.g. Himalaya); they are quickly eroded with only discontinuous fragments preserved. Pre 1 Ga ophiolites generally lack tectonite mantle beneath cumulate rocks. Mesoproterozoic-Paleoproterozoic complexes may include a "Penrose-type" ophiolite together with thick overlying sediments/volcanic deposits, and high-level intrusive complexes and plutons. Inferred Pre-1 Ga ophiolites include supra-subduction (SSZ), mid ocean ridge (MORB), and ocean island (OIB) compositions, and more komatiite in >1.6 Ga complexes, Mantle history affects tectonic interpretation of geochemical data, however. Archean greenstone belts may represent "flakes" of oceanic crust in "accretionary prisms". Oceanic crust probably has progressively thinned through time, with a possible abrupt change at 1 Ga. The prime tectonic importance of ophiolite emplacement also affects Precambrian orogens where deeper level of exposure make recognition of ophiolites difficult. Possible indicators include: part or all of an intact sequence, faulted fragments, possibly parts of a complete sequence, sheeted dikes, serpentinite unconformably overlain by hypabyssal/extrusive rocks, shear zones with metamorphosed ophiolitic fragments, metamorphic mafic/ultramafic rocks of possible ophiolitic parentage; geophysical indications of high-density or high-magnetic rocks within continental orogens.

284-3 Oral Kaufman, Alan Jay

TECTONICS, PRIMARY PRODUCTIVITY, AND GLACIATION AT BOTH ENDS OF THE PROTEROZOIC EON

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Keywords: Proterozoic; glaciation; greenhouse; cap carbonate; productivity

Earth history at both ends of the Proterozoic Eon was punctuated by a series of potentially long-lived and globe-encompassing ice ages where continental glaciers and sea ice apparently extended to sea level at low latitudes. A comparative analysis of the two glaciogenic intervals reveals striking similarities; in particular both are related to supercontinent rifting and are associated with extreme perturbations in carbon cycling, and differences, most notably the unusual presence of carbonate and iron-formation in the younger, but their general absence in the older where they are more expected. Discrete Neoproterozoic glacial diamictites (~570-750 Ma) deposited during rifting the supercontinent Rodinia, are often associated with iron-formations, and are commonly overlain by texturally and isotopically anomalous cap carbonates, which are characteristically depleted in 13C and enriched in 34S. Co-existing organic matter is 13C enriched resulting in significantly reduced biological fractionation. Paleoproterozoic ice ages (≤2.45 - >2.22 Ga) are also associated with rifting and breakup of the low latitude Kenorland supercontinent. Although three episodes of glaciation are known there are no classic iron-formations in this interval and very few significant carbonate accumulations. Chemostratigraphic studies worldwide reveal oscillation of carbon isotope abundances across some of these glacial events, which are similar to those of the Neoproterozoic Era; furthermore, preserved cap carbonates also have negative carbon isotope compositions and reduced fractionation. Geological and geochemical indicators suggest a stepwise increase in the atmospheric oxygen content across both the Paleoproterozoic and Neoproterozoic glacial epochs. The tempo and mode of atmospheric oxygen rise has important consequences for the abundance of the important greenhouse gases CH4 and CO2. As methane is a significantly stronger infra-red attenuator, modulations in the relative abundances of these atmospheric gases might have resulted in many of the Proterozoic ice ages. Ultimately, however, the rise of O2 must be tied to primary productivity, which also sequesters CO2 from the atmosphere into organic matter buried in sediments. Thus, the tectonic delivery of reduced elements and nutrients to oceans during rifting likely had a profound effect on primary productivity in largely anoxic oceans, and hence climate change, throughout the Proterozoic Eon.

284-4 Invited Cordani, Umberto Giuseppe

THE TECTONIC SIGNIFICANCE OF JUVENILE INTRA-OCEANIC MAGMATIC ARCS: THE CASE OF SOUTH AMERICA

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Keywords: Isotope geochemistry; South America; Crustal evolution; Accretionary belts; Magmatic arcs

Classical models of orogens involve either Andean-type accretionary belts, where subduction beneath the front of a continental block give rise to voluminous calc-alkaline magmatism, or a Wilson cycle of ocean opening and closing, where the final event is a continent-continent collision. In both cases, a pre-existent basement is involved in the petrogenetic processes related to the production of granitoid rocks, whose isotopic signatures indicate reworked crustal components in the parental magmas. A somewhat different model of accretionary orogens is related to intra-oceanic magmatic arcs, formed within large oceanic domains, in areas of long-lived plate convergence and B-subduction, when both convergent plates consist of oceanic lithosphere. They comprise calc-alkaline igneous rocks, with typical juvenile isotopic signature, indicating mantle derived parental magmas. Juvenile rocks produced in such processes of "soft accretion" are formed by lateral accretion of successive magmatic arcs, and are widespread over very large areas. Typical examples are the Eoproterozoic Svecofennian belt in the Scandinavian Shield, and the Arabian-Nubian Shield in northeastern Africa.Granitoid rocks are essentially juvenile in the Archean, when continental masses were much smaller, whereas in the Phanerozoic reworked material is largely more common. In the Proterozoic, a clear distinction of juvenile vs. reworked material can be made, and we suggest: (1) - large oceans existed where major juvenile magmatic arcs are reported and (2) - small ocean basins or continental margins were present where reworked material is predominant. In South America, the largest region with juvenile granitoid rocks comprises the Ventuari-Tapajós and Rio Negro-Juruena tectonic provinces of the Amazonian Craton. The rocks are Mesoproterozoic, indicating the existence of a very large ocean before the formation of Rodinia. Another very important tectonic province is the Neoproterozoic Goiás Magmatic Arc, revealing a large oceanic domain separating the Amazonian and São Francisco cratons before the agglutination of West Gondwana. In contrast, within the Neoproterozoic belts of the Borborema, Mantiqueira and Pampean provinces only reworked material is indicated for their granitoid belts, suggesting the presence of restricted oceanic basins. Similar mixed isotopic signature is noted for the Andean granitoid belts formed during the Phanerozoic at the long-lived Pacific continental margin of the continent.

284-5 Oral Cruden, Alexander

NEOARCHEAN ACCRETIONARY GROWTH OF CRUST IN THE WESTERN SUPERIOR PROVINCE, CANADA, FROM ISOTOPIC ANALYSIS OF ZIRCON

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Keywords: geochronology; zircon; Archean; Superior province

U-Pb geochronology combined with structural and sedimentological analysis reveals a detailed history of crustal growth in the Superior province by collision of a reworked Paleoarchean terrane (Winnipeg River - WRT) and juvenile arc sequences (western Wabigoon terrane - WWT) with a reworked Mesoarchean terrane to the north (North Caribou - NCT). Hf isotopic analysis of zircon serves as a fingerprint of rocks in different terranes and to identify provenance of detrital zircon. Collision caused progressive north to south uplift and deposition of orogenic sediments into foreland basins, which in some cases were overridden by thrust sheets. The earliest evidence of accretion and initial subduction of WRT crust is isoclinal folding of 2.9 Ga old WRT gneisses, dated at 2716 ± 2 Ma. This was coeval with shutdown of arc magmatism in the region and the earliest deposition of orogenic sediments. Large scale melting, vertical flattening and lateral flow occurred in deep WRT crust at 2710 ± 2 Ma, coeval with an early stage of upright folding at mid to high crustal levels in the adjacent WWT greenstones. Regional scale open upright folding occurred in WRT at 2700-2690 Ma, coeval with a second phase of deformation in WWT that formed regional shears and alluvial basins. Both areas were intruded by numerous sanukitoid plutons, possibly derived from melting of previously metasomatized mantle following slab breakoff and crustal extension. Rapid uplift and unroofing of WRT crust is evidenced at this time by the appearance of 3.0-3.5 Ga old detrital zircons with Paleoarchean Hf isotopic signatures in the WWT and Quetico subprovince to the south. In some cases 2.70 Ga old metasedimentary units were overthrust by older volcanic arc sequences only a few m.y. after deposition. Sediment accumulated in the Quetico basin over the period 2700-2690 Ma and in the Pontiac basin further south and west at 2690-2683 Ma. The style of Neoarchean accretionary tectonics in Superior province seems marked by southwardly advancing uplift, sedimentation and deformation that involved interleaving of volcanic sequences with orogenic sandstones on scales from several to hundreds of kilometers accompanied by crustal melting at depth. The present subprovince structure of Superior province may be more representative of late differential erosion and exposure of this interlayered crust than docking of discrete terranes.

284-6 Invited Da Silva, Luiz Carlos

THE NEOPROTEROZOIC MANTIQUEIRA PROVINCE AND ITS AFRICAN CONNECTIONS: A ZIRCON-BASED U-PB GEOCHRONOLOGICAL SUBDIVISION FOR THE BRASILIANO/PAN-AFRICAN SYSTEMS OF OROGENS

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Keywords: Brasiliano/Pan-African orogens; Mantiqueira Province; U-Pb ages

The Mantiqueira Province (MPV) is a large and complex structural province deformed by the Neoproterozoic/Early Paleozoic Brasiliano orogenic event in South America. Its evolution is herein detailed on the basis of the geological and geometric characterisation, structural and thermal overlapping of the distinct phases of the orogenic collage. In addition to the tectono-structural analysis, some 50 new zircon U-Pb SHRIMP data from a large number of selected units provided a powerful tool for understanding the granitic chronostratigraphy and the orogenic evolution. We also integrated existing U-Pb analyses, totalling some 250 determinations, which also furnished important constraints to delineate the precise tectono-magmatic succession (orogenic episodes). The study delineated an intricate evolution comprising three successive systems of orogens: Brasiliano I, II and III. New crustal growth including juvenile intraoceanic volcano-plutonic arcs characterises the earlier Brasiliano I orogenic system, which presents collisional climaxes at ca. 790 Ma (Embu Domain) and 730-700 Ma (São Gabriel Orogen). On the other hand, recycling of pre-existing crustal sources are the dominant processes operating within the systems Brasiliano II and III. The collisional climaxes within the Brasiliano II are recorded at 640-620 Ma (Dom Feliciano Orogen) and 600 Ma (Paranapiacaba and Rio Piên orogens), whereas the Brasiliano III climaxes is also well-constrained at 590-560 Ma (Araçuaí Orogen) and 530-500 Ma (Búzios Orogen). The available geochronological data from the Pan-African literature suggests temporally similar orogenic succession. The protracted, dominantly accretionary, Pan-African I system lasts from 850-700 Ma, whereas the Pan-African II (collisional peak at 650-600 Ma) and the Pan-African III (collisional peak at 590-540 Ma) are characterised dominantly by crustal recycling processes. The data reinforced previous attempts to correlate the northernmost Araçuaí Orogen and the West Congo orogen (AWCO), both belonging to the system Brasiliano/Pan-African III. On the other hand, the available data did not confirm previous configurations for the western Gondwana Supercontinent amalgamation, based on a direct linkage between the south-eastern orogens from Ribeira and Dom Feliciano belts (Brasiliano II) and the south-western African orogens, i.e. Kaoko, Damara, Gariep, and Saldania (Pan-African III).

284-7 Invited Pedrosa-Soares, Antônio Carlos

CONFINED OROGEN: THE CONCEPT, A PRECAMBRIAN EXAMPLE AND TECTONIC IMPLICATIONS

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