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PROTEROZOIC ACCRETIONARY BELTS IN THE AMAZONIAN CRATON

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Classical models of orogens involve either Andean-type belts or Wilson cycle episodes of ocean opening and closing. In both cases, a pre-existent basement is involved in the petrogenetic processes related to the production of granitoid rocks, whose isotopic signature usually indicate a mixing of juvenile mantle-derived and reworked crustal components in the parental magmas.

A somewhat different model of accretionary orogens is originated when intra-oceanic magmatic arcs are formed within large oceanic domains, in areas of long-lived plate convergence and B-subduction, when both convergent plates consist of oceanic lithosphere. They exhibit typical juvenile isotopic signature, indicating essentially mantle derived parental magmas. In such processes of "soft collision and accretion", large areas can be formed by stacking and lateral accretion of successive magmatic arcs (see for instance Kröner et al.,1987, and Johnson, 2001, for the case of the Arabian-Nubian Shield).

In the Amazonian Craton, continental crust of Archean age is restricted to the relatively large granite-greenstone terrain of the Carajás province. Important Archean fragments are also found within the Maroni-Itacaiunas belt, that consists of meta-volcanic-sedimentary sequences associated with granitoid rocks with U-Pb zircon ages between 2.0 and 2.3 Ga, and positive Sm-Nd $\varepsilon_{Nd(T)}$ values. This belt also includes high-grade metamorphic rocks, indicating Paleoproterozoic collisional episodes (Tassinari et.al, 2000, and references therein).

In this work we will examine the large regions of accretionary belts made up by magmatic arcs of Proterozoic age that were formed from about 1900 to about 1300 Ma, adding mantle-derived material in the SW part of the Amazonian Craton,. The tectonic significance of these large domains will be considered, as well as their bearing for the reconstruction of the Proterozoic supercontinents.

A very large area in which such soft-collision/accretion processes are found is included within the Ventuari-Tapajós and Rio Negro-Juruena provinces (Tassinari et al., 2000). They are formed essentially by granitoid rocks with ages between 1900 and 1500 Ma, and typical juvenile isotopic signatures. Their Sm-Nd T_{DM} model ages are only slightly older than their U-Pb or Rb-Sr radiometric ages. Moreover, in such terranes there is no evidence of basement inliers with Archean ages, and regions with high-grade metamorphics are restricted. In our view, this area could be regarded as formed by the successive amalgamation of intra-oceanic arcs, of which the roots are now exhumed. Many associated volcanic-sedimentary basins are found all over the area, possibly formed by subsequent extensional tectonism, generally following the stacking of each individual arc.

In the southwesternmost part of the Amazonian Craton, the San Ignacio-Rondonian province occurs, in which a Paleoproterozoic basement area was identified in the Bolivian territory (Litherland et al., 1989). However, the largest part of this province is made up by juvenile granitoids with ages between 1500 and 1300 Ma (the Pensamiento granites of Darbyshire, 2000, and the Santa Helena batholith of Geraldes et al., 2001), whose tectonic settings are similar to those already described for the Rio Negro-Juruena province. At the southwestern end of the San-Ignacio-Rondonian province, the Sunsas orogenic belt occurs, with volcanic-sedimentary rocks and associated granitoid plutons. The deformation and magmatism of this belt are bracketed between 1250 and about 1000 Ma, and it may have had a role in the agglutination of Rodinia.

A large area of soft collision/accretion is also described as the Goiás magmatic arc (Pimentel et al., 2000 and references therein). It is marginal to the Amazonian Craton, and it comprises granitoids with ages between 940 and about 540 Ma. At least the older of these are clearly juvenile, as witnesses of a large oceanic basin that existed between the rifted margins of the Amazonian and the São Francisco-Congo Cratons, in the Neoproterozoic (Cordani et al, 2003; Kröner and Cordani, 2003).

Supercontinents are formed by the agglutination of pre-existing continental masses, with the concomitant disappearing of the intervening oceans. Reconstructions are based on the available paleomagnetic data that are normally affected by large uncertainties. If it would be possible to estimate the size of the oceans that separated the existing continental masses at a given time, the task of producing a reconstruction will be facilitated. Following the ideas put forward by Cordani et al. (2003), we will consider that intra-oceanic granitoid magmatic arcs, with juvenile isotopic signatures, would indicate the existence of significantly large oceanic basins. In contrast, when granitoid material yields isotopic signatures of crustal reworking, consumption of small oceanic floors would be more likely, indicating a relative proximity of the convergent continental masses.

Considering the possible relative positions of all ancient cratonic fragments now within South America, it is not difficult to envisage West Gondwana, still attached to Laurentia, at about 600 Ma. All of the orogenic belts of this age exhibit geochemical signatures indicating some degree of crustal reworking, and therefore the closing of small oceanic basins.

However, at about 800 to 1000 Ma, a large ocean (the Goiás Ocean) must have been in existence, separating the Amazonian Craton from the São Francisco-Congo Craton. As pointed out by Cordani et al. (2003), this makes a problem for the proposed reconstructions of Rodinia (for example, Hoffman, 1991).

Prior to Rodinia, at about 1400-1500 Ma, a large ocean, revealed by the juvenile granitoids of Pensamiento-Santa Helena, separated the northern part of the Amazonian Craton from a continental mass that probably existed toward south. Finally, between about 1900 and 1500 Ma, the series of intraoceanic magmatic arcs found in the Ventuari-Tapajós and Rio Negro-Juruena tectonic provinces testify the existence of a very large ocean. This means that Amazonia in Paleo and Mesoproterozoic times was much smaller, and this shall be taken into account in the reconstructions envisaged for those times.

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3-6

COMBINED EFFECTS OF SEA LEVEL AND MANTLE PROCESSES IN CONTROLLING THE DISTRIBUTION OF MESO-PROTEROZOIC DEPOSITIONAL SYSTEMS

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Preserved Mesoproterozoic (1.6-1.0 Ga) sedimentary successions typically are comprised of a combination of fluvial-marine sandstones and peritidal to shallow marine carbonate rocks, as well as a variety of evaporitic facies including the oldest extensive bedded gypsum deposits. Typically, these strata have been interpreted to have been deposited in either epicratonic (as platforms and rift successions) or proximal pericratonic depositional environments that were episodically cut off from open marine environments. The generally shallow-water character and high continentality of Mesoproterozoic sedimentary successions has resulted in a broad general description of these units as Mesoproterozoic highstand events, referring to their deposition during global highstands in sea level. Unfortunately, the paucity of radiometrically datable material in many of these basins has inhibited the reconstruction of a detailed sea-level history.

In the last decade, reconstruction of marine C-isotope compositions for the Mesoproterozoic (Buick et al. 1995; Xiao et al. 1997; Kah et al. 1999; Lindsay and Brasier 2000; Bartley et al. 2001; Frank et al. 2003) has revealed a distinct pattern of secular change in which the Mesoproterozoic can be divided into two distinct intervals based on the variation and magnitude of $\delta^{13}C$ values in the marine carbonate record. Whereas early Mesoproterozoic marine carbonates (from 1.6 Ga until after 1.3 Ga) exhibit uniform carbon isotope compositions ($\delta^{13}C = 0.0 \pm 1.0‰$), carbonate strata younger than 1.2 Ga are characterized by higher $\delta^{13}C$ values ($\delta^{13}C = +3.5 \pm 1.0‰$) and a number of sharp negative excursions (to $\delta^{13}C = -2‰$). Between 1.3 and 1.2 Ga, strata record a pattern of increasingly positive values interrupted by small-scale negative excursions, and not until the Neoproterozoic do marine C-isotope values rise above ~4.5‰. Construction of a geochronometrically well-constrained C-isotope curve for this time interval has allowed Mesoproterozoic basins to be viewed, for the first time, in a chronological framework.

When observed within this chronological context, an interesting pattern appears. Mesoproterozoic sedimentary successions in present-day northern and western Laurentia (e.g. Parry Bay and Dismal Lakes Group, Wernecke Supergroup, Carswell Formation, lower and middle Belt Supergroup) record deposition prior to ~1.3 Ga, are capped by a significant unconformity (duration exceeding 200 Ma), and are overlain by Neoproterozoic and younger successions (e.g. Shaler Supergroup and correlatives). In contrast, Mesoproterozoic successions in present-day eastern and southern Laurentia (e.g. Bylot Supergroup, Thule Group, Aston and Hunting formations, Central Metasedimentary Belt, Seal Lake Group, Midcontinent Rift, Allamoore and Castner formations, Crystal Springs and Apache Group strata) record deposition between ~1.25 Ga and 1.0 Ga – the interval during which northern and western Laurentia experienced non-deposition or erosion. In Rodinia reconstructions that place the Siberian craton along the present-day northern margin of Laurentia (north of and adjacent to the Thelon zone, cf. Hoffman 2989, 1991), this pattern can be consistently followed to Mesoproterozoic strata of the Uchur-Maya region, and the Anabar, Olenek, and Turukhansk uplifts.

Although broadly similar to reconstructions of Young (1981), revised geochronology of successions results in a strong WNW-ESE division of sedimentary basin formation. The distribution pattern for these Mesoproterozoic sedimentary successions is best explained by a combination of deposition during global highstand conditions and mantle driven changes in topography *via* regional extensional and compressional events. In this scenario, regional extension and initiation of rifting in northern and western Laurentia resulted in deposition of thick stratal packages during the early Mesoproterozoic. This region then maintained a high topographic profile (perhaps reflecting regional compression or mantle uplift) during the latter half of the Mesoproterozoic while eastern and southern Laurentia underwent subsidence related to regional extension inboard of the developing Grenville orogenic belt. Although direct causes of topographic change remain undetermined and may be strongly affected by local basin dynamics, the regional distribution of sedimentary successions may provide valuable clues linking broad-scale behavior of cratons to global plate tectonics activity.

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