Workshop on "Geology of the SW Amazonian Craton: State-of-the-Art"
2003, São Paulo. Abstracts.

Lithosphere *versus* Asthenosphere source for the SW Amazonian craton A-types granites: the role of the Paleo and Mesoproterozoic accretionary belts for their coeval continental suites

M. C. Geraldes, W. Teixeira, and J. S. Bettencourt

Instituto de Geociências, Universidade de São Paulo-São Paulo (SP) Brasil

Introduction

The origin of Proterozoic rapakivi granites is controversial and unsolved. Most models for continental magmatism envision heat or magma transfer from the mantle asthenosphere to the base of the lithosphere leading to partial melting of the lower crust. Early models have been based on thermal doming or hot spot beneath a supercontinent. Lithospheric extension and thinning have been linked to the generation, ascent and emplacement of rapakivi magmas where an over-thickened crust underwent extensional collapse. The production of the rapakivi granite melts by fractional crystallization of I-type melts is not reliable (according to some authors) because rapakivi complexes are anhydrous and have contrasting chemical signaures (low Rb and fairly high Sr content).

The tectonic setting and source revealed by isotopic and geochemical integrated data (available in the literature) of the Paleo and Mesoproterozoic magmatic suites in the SW Amazonian craton allow a temporal correlation between the accretionary mobile belts and the continental magmatism (e.g. rapakivi complexes) within the foreland. In this regard the continental magmatism may represent a synorogenic response linked to the high heat flow in the asthenosphere resulted of the ocean crust subduction, which was contemporary with the development of the magmatic arcs.

The SW Amazonian Craton

The SW Amazonian Craton can be divided (Figure 1) into four geochronological provinces: the Ventuari-Tapajós (1.95-1.80 Ga), the Rio Negro-Juruena 1.79-1.52 Ga), the Rondonian-San Ignacio (1.51-1.34 Ga), and the youngest Sunsás-Aguapeí (1.24-1.00 Ga).

Up to now, two collisional belts were described within the Rio Negro/Juruena province: The Alto Jauru orogen (1.79-1.74 Ga) and the Cachoeirinha orogen (1.58-1.52 Ga). The oldest orogen consists of igneous and metamorphic rocks, including several volcano-sedimentary belts, felsic orthogneisses, and intrusive granitoids with U/Pb zircon ages from 1795 Ma to 1746 Ma. Sm-Nd data of Alto Jauru volcanic and plutonic rocks yielded T_{DM} from 2.01 Ga to 1.87 Ga and $\varepsilon_{Nd(t)}$ values from +2.8 to +2.4 indicate that these rocks were originated from mantle-derived magmas containing little contamination by older supracrustal host rocks. Chemical and petrological studies on plutonic rocks indicate a calc-alkaline affinity, interpreted as being generated in an arc related environment. The anorogenic magmatism coeval to the Alto Jauru orogen is represented by the Aripuanã bimodal volcanic-plutonic sequence, intruded into the Ventuari/Tapajós province (foreland). This unit is dominated by granitoid rocks intruded into a sequence of acid volcanic rocks with subordinated interlayed basalts. U/Pb (SHRIMP) yielded crystallization ages between 1762 Ma and 1755 Ma and chemical, isotopic and geological evidences indicate that this ensialic magmatic event represents the tectonic stability of the Ventuari-Tapajós cratonized Province.

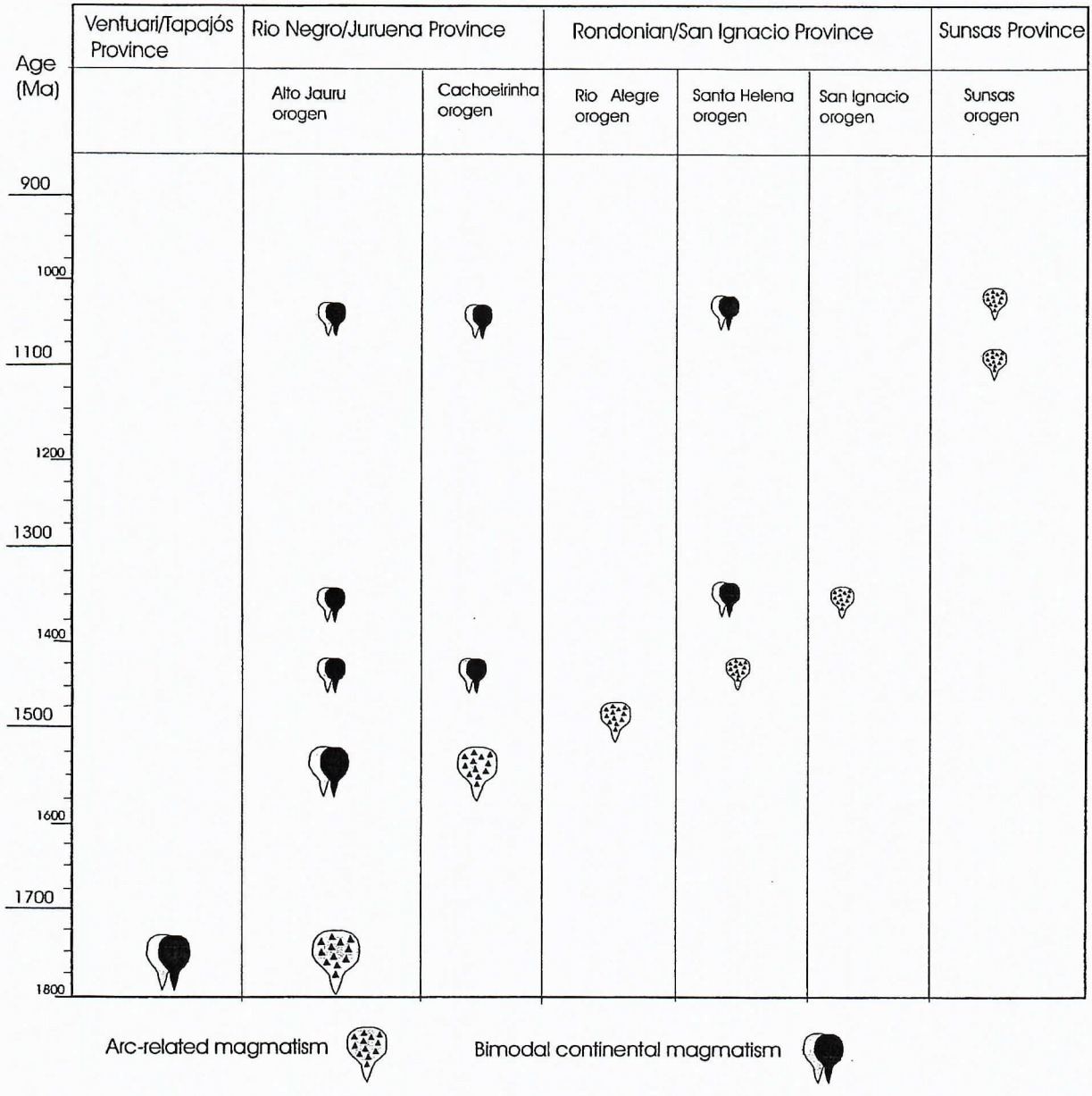

Figure 1. The accretionary events of SW Amazonian craton. The juvenile arc-related magmatisms have their coeval bimodal magmatism within the continent. See text for discussion.

The Cachoeirinha orogen comprises several tonalite to granite plutons, intruded into the Alto Jauru orogen rocks, which yielded U/Pb ages ranging from 1587 Ma to 1522 Ma with Sm/Nd model ages (T_{DM}) from 2.05 Ga to 1.75 Ga and ε_{Nd} values from –0.8 to +1.0. These data indicate that the granitoid magmas were mantle-derived with an important contribuition from the country rocks. Geochemical data are most consistent with a calc-alkaline magmatic suite, and the Cachoeirinha orogenic rocks probably represent continental margin magmatic arc activity. The rapakivi granites in SW Amazonian craton which exhibit ages between 1580 Ma to 1520 Ma are represented by the

Serra da Providência Intrusive Suite described in the southeastern part of the Rondônia Tin Province. The oldest intrusion of this granite yielded U/Pb zircon ages of 1606 Ma, while the porphyritic hornblende-biotite monzogranite has U/Pb age of 1573 Ma and a pyterlite yielded an U/Pb age of 1566 Ma. The associated Ouro Preto charnockite yielded a zircon U-Pb age of 1532 ± 24 Ma.

The Santa Helena orogen (1.45-1.42 Ga) (ascribed to the Rondonian/San Ignacio Province) is mainly represented by a 35 x 75 km batolith. The 11 U/Pb available results yielded ages varing from 1.45 Ga to 1.42 Ga, and the Sm/Nd results are also relatively uniform, with $\varepsilon_{Nd(t)}$ values ranging from +2.6 to +4.0 and T_{DM} ages from 1.48 Ga to 1.63 Ga. The strong positive $\varepsilon Nd(t)$ values indicate that the magmas for the Santa Helena batolith were derived largely from juvenile sources. Intrusive rocks probably related to this mesoproterozoic arc were recently also described in Rondonia, represented by 1.43 Ga fine-grained granitic and charnockitic association, which indicates the extension of the Santa Helena orogen toward NW.

The anorogenic magmatic activities related to development of the Santa Helena orogen comprise mafic and felsic rocks (1.47-1.42 Ga Rio Branco Suite) confined within the volcanic-plutonic rocks of the ca.1.79-1.74 Alto Jauru foreland. Sm-Nd mantle-depleted model ages vary from 1.73 to 1.80 Ga for the mafic rocks ($\varepsilon_{Nd(t)}$ values from +1.24 to +1.91) and from 1.81 to 1.89 Ga for felsic rocks ($\varepsilon_{Nd(t)}$ values from +0.16 to –0.96), which suggest that these rocks had an older continental lithosphere component in their magma. Similar model ages were recorded in the surrounding Alto Jauru basement.

The magmatic events ascribed to the Santa Helena orogen in northern Rondonia, particularly in the Rondonia Tin Province, comprise intermittent distinctly bimodal intraplate rapakivi suites, which intruded the ca. 1.75-1.53 Ga Rio Negro/Juruena crust. This magmatism is represented by the Santo Antonio and Teotônio Intrusive Suites (U/Pb ages of 1406 Ma and 1387 Ma, respectively).

The San Ignácio orogen comprises a significant syn to post-tectonic granitoid magmatism represented by a potassic calc-alkaline complex (Rb/Sr ages about 1.32 to 1.28 Ga) and by the El Tigre alkaline Complex (1286 ± 46 Ma). Recent U/Pb (SHRIMP) dating (ca 1.380 Ma) from monzonite formed by partial melting of tonalites is interpreted as age of the San Ignácio orogenesis. The San Ignácio arc accretion in Bolivia was followed in northern Rondônia by a prolonged period of voluminous anorogenic rapakivi plutonism. Three distinct intraplate rapakivi magmatism age groups which intruded Rio Negro/Juruena (1.75-1.53 Ga) crust and ca. 1.45 Ga Santa Helena arc rocks are documented by the following suites: Alto Candeias (1338-1346 Ma) and São Lourenço-Caripunas (1314 Ma and 1309 Ma, respectively).

The Sunsás orogen represents an important continental distension event, which involves alkaline plutonism and deposition of the Sunsás Group. The geochronological data, based mainly on Rb/Sr and K/Ar ages, allow the conclusion that metamorphism, deformation and plutonism of this belt extended from 1280 Ma to 950 Ma. The Sunsás mobile belt (ca. 1000 Ma) which occurs in the southern part of the San Ignácio orogenic rocks is represented by reactivated basement, syn- and post-tectonic granitoids, and sparse outcrops of metasedimentary rocks. The San Diablo granitoids, described in the southernmost part of the Sunsás Orogen, are interpreted as juvenile magmatic products formed during the S-SW dipping subduction zone responsible for Sunsás magmatic arc.

The effects of the Sunsás orogen in northern Rondônia region occurred between 1.07 Ga and 0.97 Ga. The Sunsás magmatism in Rondônia is composed of rapakivi granites and associated mafic rocks, including the Santa Clara Intrusive suite (1.07 Ga) and Younger Granites of Rondônia (1.0-0.97 Ga). The granites are mostly subalkaline, metaluminous to peraluminous, and show

geochemical features of A-type within-plate granites and they intruded into the older Rio Negro-Juruena and Rondonian-San Ignacio Provinces.

Discussion and Conclusions

The western part of the Amazonian Craton is a multi-orogenic region formed between 1.8 and 1.0 Ga, as supported by successive magmatism, metamorphism, and deformation events. Consequently, the southwestward growth of the continental crust during the Paleo and Mesoproterozoic, like Baltica and Laurentia shields, is given by juvenile accretionary events with progressive amalgamation to the older continental margin.

The intermittent intraplate bimodal magmatism recognized in the all known provinces of SW Amazonia could be regarded as distal inboard extensional manifestation related to the development of the evolving continental margin in SW Amazonian craton during Paleo- and Mesoproterozoic times. The origin of the rapakivi suites from lower lithospheric sources may be explained by decompressional melting, with ascent probably guided by features of the accretionary event, in agreement with the current petrogenetic models.

It is yet to be proven if there are any inboard correlatable coeval rapakivi complexes to the Rio Alegre and Nova Brasilândia accretionary events. The lack of coeval rapakivi complexes related to the 1.51-1.50 Ga Rio Alegre orogen may be explained probably postulating the origin of this magmatic event had taken place away from the continental margin of the Amazonian craton at that time, as speculated in Figure 1. The remaining doubt is whether the Nova Brasilândia 1150 Ma and 1098 Ma mafic-felsic magmatism might suggest emplacement inboard of a continental margin over a northward dipping subduction zone and subsequent back-arc rifting or simply an expression of an intracontinental rifting and a protho-ocean expansion.

The definition of distinct accretionary stages to the older crust and their temporal correlation with the rapakivi episodes suggest that the latter were related to processes occurring at the evolving continental margin. Therefore, the temporal link between orogenic belts and the peculiar continental magmatism in SW Amazonian Craton may be explained by reorganization of intracratonic lithosphere stresses when each episode of subduction stepped westward. The genetic link of accretionary events and rapakivi magmatism hypotheses takes into account (i) an overthickened lithosphere which attempted to regain isostatic equilibrium, resulting in extensional collapse, and (ii) the mantle conditions beneath the large and immature crustal terrane of the arc-accretionary SW sector of the Amazonian craton had constant conditions from 1.8 to 1.0 Ga.

The hypothesis here stressed also raises consequences for the paleogeographic reconstruction of a Mesoproterozoic (1.6-1.5 Ga) supercontinent. If the correlation between accretionary belts and continental magmatism is correct, and if there are temporal correlations between accretionary belts and rapakivi granites in Baltica, Laurentia and Amazonia, then paleogeographic configurations of these continental masses should be throughout a juxtaposition with a continuos evolving margin and continuos landmasses where the development of intracontinental magmatism has taken place.