

MANTLE ISOTOPIC CHARACTERISTICS BELOW THE SW AMAZONIAN CRATON: U-PB, $^{40}\text{Ar}/^{39}\text{Ar}$ AND ND-SR EVIDENCE FROM MESOPROTEROZOIC MAFIC-FELSIC PLUTONIC ROCKS

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INTRODUCTION

The Amazonian Craton encompasses the Central Amazonian (Archean inner core) and Maroni-Itacaiunas (Paleoproterozoic) provinces which achieved tectonic stability after the Transamazonian orogeny (2.25 – 2.10 Ga) - Tassinari et al., 2000. This Paleoproterozoic scenario resulted from amalgamation of independent fragments of the Amazonian and West African protocratons, as suggested by paleomagnetic and geochronologic evidences. Younger Proterozoic magmatic arcs accreted along this foreland margin gave rise to four, adjacent provinces, namely: the Ventuari-Tapajós (VT; 2.00 - 1.83 Ga), Rio Negro-Juruena (RNJ; 1.80 - 1.55 Ga), Rondonian-San Ignácio (RSI; 1.55 - 1.30 Ga) and Sunsás-Aguapeí (SA; 1.25 - 0.97 Ga). From the geodynamic point of view, this giant Amazon segment reflects orogenic collage from 2.0 to 1.0 Ga during which juxtaposition of distinct rock assemblages took place, combined with polyphase deformation and metamorphism, extensional/transpressional tectonics, as well as multiple episodes of igneous complex emplacement throughout in time and space (e.g., Cordani and Teixeira, 2005). Whereas recurrent mafic-felsic magmatism is widespread within this polycyclic domain, genetically linked with outboard development of the progressively younger Mesoproterozoic accretionary belts; the inboard occurrences of undeformed volcanic-sedimentary covers, dikes and rift-basins of different ages are indirect evidence of the previously stabilized lithosphere.

In such a polyphase tectonic scenario, precise radiometric ages from key magmatic rocks combined with their Nd-Sr primary signatures, constitute powerful tools not only for dating the stepwise evolution and establishing regional stratigraphic correlations, but also for addressing the pulses of mantle-derived material accreted to the crust throughout time.

From the above tectonic perspective, this paper reports new $^{40}\text{Ar}/^{39}\text{Ar}$ and U/Pb age data and Nd-Sr analyses obtained from mafic and felsic rocks of three distinct Mesoproterozoic geologic units outcropping in

the RNJ, RSI and SA provinces, in the SW fringe of the Amazonian Craton: *i*) The Serra da Providência Intrusive Suite; *ii*) The Colorado Metamorphic Suite and; *iii*) The Nova Brasilândia Group.

RESULTS AND DISCUSSION

The mafic-felsic rocks of this Serra da Providência Suite (Bettencourt et al., 1999) make up a bimodal magmatism that is anorogenic in relation to the gneisses and granulites (1.76 - 1.73 Ga) of the RNJ orogeny, but were triggered by outboard development of a calc alkaline plutonic arc developed farther southeast of the investigated area (e.g., Geraldés et al., 2004). The mafic rocks of the this suite give $^{40}\text{Ar}/^{39}\text{Ar}$ cooling ages of 1556 Ma, in agreement with the radiometric ages of other coeval rocks (1.53 - 1.60 Ga; Payolla et al., 2002), whereas their $\epsilon_{\text{Nd}(T)}$ (+2.5/+2.8 and -0.9/+0.4) and $\epsilon_{\text{Sr}(T)}$ (-12.0; -3.3/+11.7) evidences are consistent with DMM- to CHUR-like magma sources.

The Colorado Metamorphic Suite (1.36-1.30 Ga; Rizzotto et al., 2002) comprises a major tectonic-magmatic event in SW Amazonian Craton which is related with the RSI orogeny. The mafic rocks of this suite give $^{40}\text{Ar}/^{39}\text{Ar}$ cooling ages between 1327-1315 Ma. A metagabbro from this suite yields U/Pb crystallization age of 1352±4/-3 Ma. The influence of the DMM end-member reservoir in the magma genesis is outstanding in the mafic rocks, as evidenced by their $\epsilon_{\text{Nd}(T)}$ (0.0/+5.2) and $\epsilon_{\text{Sr}(T)}$ (-5.0/-30.7) signatures whereas the cogenetic gneisses show $\epsilon_{\text{Nd}(T)}$ signature of +1.4. All together these signatures confirm the important role of a juvenile differentiation/accretion event. This conclusion is also supported by time of regional geologic overprint in Rondônia and by reported ages in country rocks (1.30 - 1.35 Ga). As such, the new $^{40}\text{Ar}/^{39}\text{Ar}$ ages (see above) reflect the regional cooling of this major event.

The Nova Brasilândia Group (Rizzotto et al., 2001) in southern Rondônia overlies in places the Colorado unit, and makes up a high grade metamorphic belt. It is composed of metasediments and coeval metaplutonic and

plutonic felsic-mafic rocks, characteristic of intracontinental rifts evolved from passive margin settings. Whereas SHRIMP analysis of detrital zircons from the Nova Brasilândia pelitic rocks yield 1.21 Ga (the youngest group of zircons) interpreted as the maximum sedimentation age for the suite (Santos, 2003). The reported U-Pb (titanite, monazite) and $^{40}\text{Ar}/^{39}\text{Ar}$ (amphibole, biotite) ages throughout the metasedimentary belt range from 1.09/1.06 Ga to 0.97/0.91 Ga. This reveals a long history of metamorphism, tectonic exhumation and cooling.

The Nova Brasilândia mafic-felsic intrusions yield $^{40}\text{Ar}/^{39}\text{Ar}$ ages between 1025-982/970 Ma, in rough agreement with the onset of the SA collision. The mafic rocks of this suite show $\epsilon_{\text{Nd(T)}}(+0.1/+1.6)$ and $\epsilon_{\text{Sr(T)}}(-2.4/+34.2)$ values, but published data (+3.1/+5.0) from coeval rocks are consistent with ocean floor-like magmas.

CONCLUDING REMARKS

The Nd-Sr isotopic data of the investigated rock associations display contrasting signatures among them, and permit two conclusions. The first one concerns the heterogeneity of the mantle source during Mesoproterozoic times in the protocraton, as indicated by the high degree of isotopic variation particularly for the Colorado and Serra da Providência mafic samples. The second one refers to the nature of the mantle components. The influence of the DMM end-member is variable, but can be discerned in all of the investigated units. Similarly Rizzotto et al. (2001) reported strong positive $\epsilon_{\text{Nd(T)}}(+3.1/+5.0)$ signatures for the Nova Brasilândia gabbros, whereas the coeval (1.10 Ga) monzogranites have $\epsilon_{\text{Nd(T)}}$ of $-0.4/+0.5$. The signatures reported for these gabbros are characteristic of ocean floor-like magmas and demonstrate the significant role of accreted juvenile materials in the Nova Brasilândia tectonic setting. On the other hand, the Serra da Providência field plots near the “Bulk Earth” value, suggesting some influence of the EMI reservoir in the magma genesis. The absence of samples with $\epsilon_{\text{Sr(T)}}$ values higher than 40, or trending towards EMII, indicate that this component probably did not play an important role in the mantle composition through Mesoproterozoic time. Consequently, this suggests a minor influence of continental sediments on the isotopic signature of the mantle source below the SW fringe of the Amazonian Craton.

Finally, the radiometric results, when integrated to the previous geologic and geochronologic information, provide insights on the geotectonic model of the Craton. In this way, a scenario of long-lived plate convergence with accretionary arc activities during Mesoproterozoic times is envisaged. In addition, the juvenile $\epsilon_{\text{Nd(T)}}$ and $\epsilon_{\text{Sr(T)}}$ signatures of distinct mafic-felsic rocks indicate not only Mesoproterozoic crustal growth under an

intermittent mantle-accretion regime, but also that the accretion was roughly coeval with episodic (inboard) emplacement of the bimodal magmatism within the more stable foreland. In other words, this interpretation is consistent with steady westward crustal growth by the action of extensional events associated with long-lived plate convergence and development of intra-oceanic magmatic arcs. Eventually this process led to progressive amalgamation of the accretionary belts to the evolving continental margin and reworking of the pre-existent, stabilized crust.

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RESUMO

Idades U-Pb e $^{40}\text{Ar}/^{39}\text{Ar}$ em conjunto com dados isotópicos Sr-Nd são apresentados para três unidades magmáticas bimodais mesoproterozóicas do setor SW do Craton Amazônico, a saber:

Suíte Intrusiva Serra da Providência (1.53-1.60 Ga): as rochas máficas desta suíte anorogênica fornecem idades aparentes $^{40}\text{Ar}/^{39}\text{Ar}$ da ordem de 1556 Ma, ao passo que os dados $\epsilon_{\text{Nd}(\text{T})}$ (+2.5/+2.8 and -0.9/+0.4) e $\epsilon_{\text{Sr}(\text{T})}$ (-12.0; -3.3/+11.7) são compatíveis com fontes magmáticas assemelhadas ao DMM com tendência ao CHUR.

Suíte Metamórfica Colorado; representa um cinturão metamórfico formado entre 1.36 e 1.30 Ga: um metagabro indica idade de cristalização U/Pb em zircão de 1352+4/-3Ma. Determinações $^{40}\text{Ar}/^{39}\text{Ar}$ em rochas máficas coevas indicam idades aparentes (resfriamento) entre 1327-1315 Ma, ao passo que as assinaturas $\epsilon_{\text{Nd}(\text{T})}$ (0.0/+5.2) e $\epsilon_{\text{Sr}(\text{T})}$ (-5.0/-30.7) são consistentes com fonte magmática influenciada por componente DMM.

Grupo Nova Brasilândia (1.12-0.98 Ga): rochas intrusivas máficas e félsicas desta unidade formada em ambiente rift indicam idades $^{40}\text{Ar}/^{39}\text{Ar}$ entre 1025-982 e 970 Ma. As assinaturas isotópicas obtidas para essas rochas: $\epsilon_{\text{Nd}(\text{T})}$ (+0.1/+1.6) and $\epsilon_{\text{Sr}(\text{T})}$ (-2.4/+34.2); em conjunto com dados publicados $\epsilon_{\text{Nd}(\text{T})}$ (+3.1/+5.0) em rochas máficas coevas são consistentes com derivação a partir de magmas de assoalho oceânico.

Os dados obtidos, em conjunto com o acervo geocronológico e isotópico disponível, são coerentes com um cenário tectônico acrescionário com desenvolvimento de arcos intra-oceânicos mesoproterozóico na parte SW do Craton Amazônico, no qual as assinaturas juvenis ($\epsilon_{\text{Nd}(\text{T})}$ e $\epsilon_{\text{Sr}(\text{T})}$) de diferentes rochas máficas e félsicas são coerentes com um regime intermitente de geração partir de diferentes componentes mantélicos.