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U-Pb MONAZITE AGES FROM PELITIC PARAGNEISSES IN NE RONDÔNIA, SW AMAZONIAN CRATON: EVIDENCE FOR 1.54 Ga METAMORPHISM

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INTRODUCTION

Although recognized as part of the metamorphic basement in the NE Rondônia (Scandolara et al., 1999), only recently the paragneisses has been unambiguously identified as a distinct lithologic unit (Payolla et al., 2002). Within the studied area, the paragneisses are exposed as a distinct NW belt across the Machadinho river basin, intruded by granitoids, mangerites, charnockites and mafic rocks of the Serra da Providência Intrusive Suite (1.60-1.53 Ga; Bettencourt et al., 1999) and granitoids of the Santa Clara Intrusive Suite (1.08-1.07 Ga; Bettencourt et al., 1999). Further west, they occur as minor thin layers and lenses in deformed granitoids and charnockites of the Serra da Providência Intrusive Suite and fine-grained granitic gneiss and charnockitic granulite (1.43-1.42 Ga; Payolla et al., 2002). U-Pb zircon and monazite, Sm-Nd whole-rock-garnet and hornblende $^{40}Ar/^{39}Ar$ ages demonstrate that at least two high-grade tectonometamorphic episodes affected this region at 1.33-1.30 Ga (Tassinari et al., 1999; Payolla et al., 2002; Santos et al., 2002) and 1.20-1.10 Ga (Tohver et al., 2001).

Conventional and SHRIMP-RG U-Pb zircon ages bracket the deposition of the paragneiss protolith between 1660 and 1590 Ma (Payolla et al., 2002, this symposium). As such, the paragneisses probably do not represent high-grade metamorphic equivalents of the 1740-1700 Ma volcano-sedimentary Beneficente and Roosevelt groups (Santos et al., 2000) exposed just to the southeast, but a younger sedimentary sequence deposited after the Juruena Orogeny (1750 Ma; Santos et al., 2001).

Monazite, which is a common mineral in anatectic metapelites, is a powerful tool for the precise dating of anatectic processes and high-grade metamorphism because it is often devoid of any inherited Pb and commonly shows concordant behavior in U-Pb systems (Foster et al., 2000). This study presents U-Pb monazite isotopic data from two high-grade migmatitic paragneisses separated by about 50 km, to place additional constraints on the high-grade metamorphism that affected these rocks. The 1.54 Ga monazite ages obtained for the paragneisses are interpreted as the time of monazite formation under peak metamorphic conditions, spatially and temporally related to the emplacement of plutons of the Serra da Providência Intrusive Suite.

ANALYTICAL TECHNIQUES AND RESULTS

Initial preparation of monazite minerals for isotopic analysis was done at the Universidade Estadual Paulista - Departamento de Petrologia e Metalogenia in Rio Claro, São Paulo. Single monazite crystals, spiked with a ^{205}Pb-^{235}U tracer solution, were dissolved using a solution of concentrated ultrapure H_2SO_4 (5 uL), 6M HCl (40 uL) and 7M HNO_3 (40 uL). Samples were then conditioned with 3.1 M HCl prior to microcolumn chromatography modified from Krogh (1973). Isotopic ratios were measured using the Finnigan MAT-262 multi-collector mass spectrometer at the Geochronology Laboratory of the University of Brasília. Both Pb and U isotopic compositions were analyzed on single Re filaments and corrected for average mass discrimination of 0.12 ± 0.05% per mass unit for multi-collector analyses (based on replicate analyses of common Pb standard SRM 981). Uranium fractionation was monitored by replicate analyses of SRM U-500. Uncertainties in U/Pb ratios due to uncertainties in fractionation and mass spectrometry were around ± 0.5%. Radiogenic Pb isotopes were calculated by correcting for modern blank Pb and for original nonradiogenic original Pb corresponding to Stacey & Kramers (1975) model Pb for the approximate age of the sample. Uncertainties in radiogenic Pb ratios are typically ± 0.1%. Decay constants and isotopic ratios used in the age calculations are those listed by Steiger & Jäger (1977). The U-Pb monazite data were regressed using the ISOPLOT/EX program of Ludwig (1999). For both samples, forced Model 1 regressions were performed as the analytical points were either concordant or nearly concordant with little spread in the data. Uncertainties in concordia intercept ages are given at the 2-sigma level.

Sample WB-152 (Fig. 1) is from a banded high-grade metapelitic migmatite which consists of black or gray 1- to 10 mm wide layers of variable amounts of sillimanite, garnet, biotite, cordierite, orthopyroxene, hercynite and Fe-Ti oxides aluminous melanosome and 5- to 50 mm wide layers and irregular patches of pink K-feldspar, plagioclase, quartz and garnet leucosome. Monazite occurs in both melanosome and neosome domains. Individual monazite grains are clear, pale yellow, subhedral to euhedral and unzoned. Grain sizes range from approximately 50 to 150 μm. Three monazite grain analyzed are high in U (4214 – 10,150 ppm) and plot in the concordia, suggesting little disturbance to the U-Pb isotopic system (Fig. 2). These data define an upper intercept of 1545 ± 4 Ma, and is considered to be the formation age of the monazites in the paragneiss.

Sample WB-140 (Fig. 1) is from a migmatitic metapelite that crops out up near the margin of a granitic pluton of the Santa Clara Intrusive Suite. The migmatite consists of gray mesosome layers of sillimanite, cordierite, garnet, biotite, plagioclase, quartz and K-feldspar and pink to gray irregular patches of plagioclase, quartz, K-feldspar and garnet neosome. Monazite occurs in the mesosome as subhedral, 20 to 100 μm grains. The U-Pb system of monazites from this sample is disturbed and the two grains analyzed are discordant (Fig. 3). The discordia regression intercepts concordia at 1542 ± 4 Ma.

DISCUSSION AND CONCLUSIONS

The monazite ages from both paragneiss samples are mutually indistinguishable and, as a result, records a well-defined monazite growth episode at 1545 Ma, under high-grade metamorphic conditions. In the sample WB-152, three generations of low-Th/U metamorphic overgrowths on the zircon give ages at 1590, 1545 and 1524 Ma (Payolla et al., this symposium). The monazite formation age is the same as the intermediate generation of zircon overgrowth. The zircon overgrowths and monazite ages of the paragneisses agree well with the interval of age emplacements of the intrusive within-plate granitoids, the charnockites and basic rocks of the Serra da Providência Intrusive Suite (1.60–1.53 Ga). This suggests a temporal and spatial relation between 1.60-1.53 Ga magmatism and high-temperature metamorphism and anatexis in NE Rondônia. The discordance shown by monazites from sample WB-140 may be associated with the subsequent 1140 Ma tectonometamorphic event, on the basis of a garnet-whole rock Sm-Nd isochron age for the same rock.

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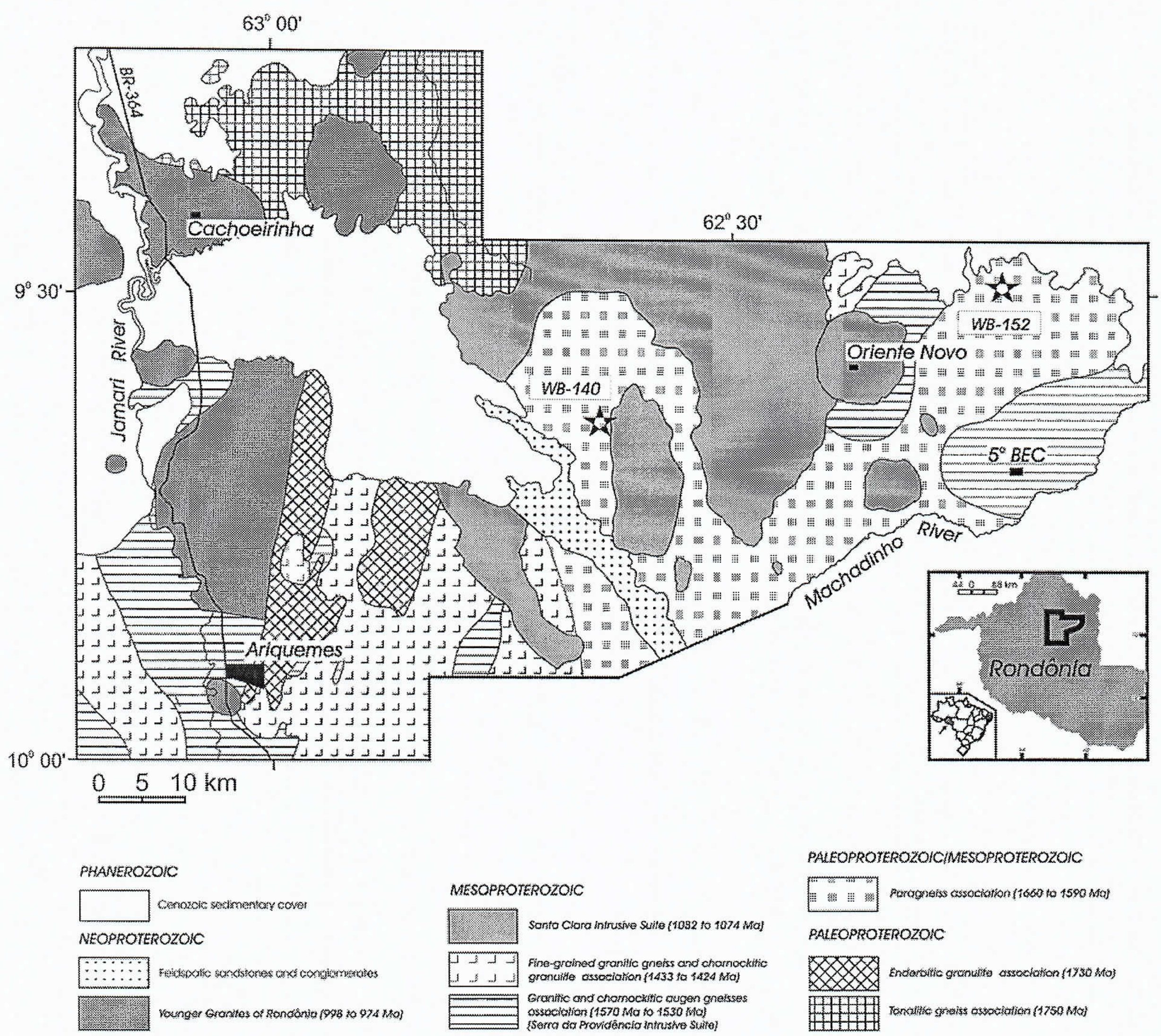

Figure 1. Map of the northeastern part of Rondônia State showing lithological associations and location of sampling sites (modified after Payolla et al., 2002).

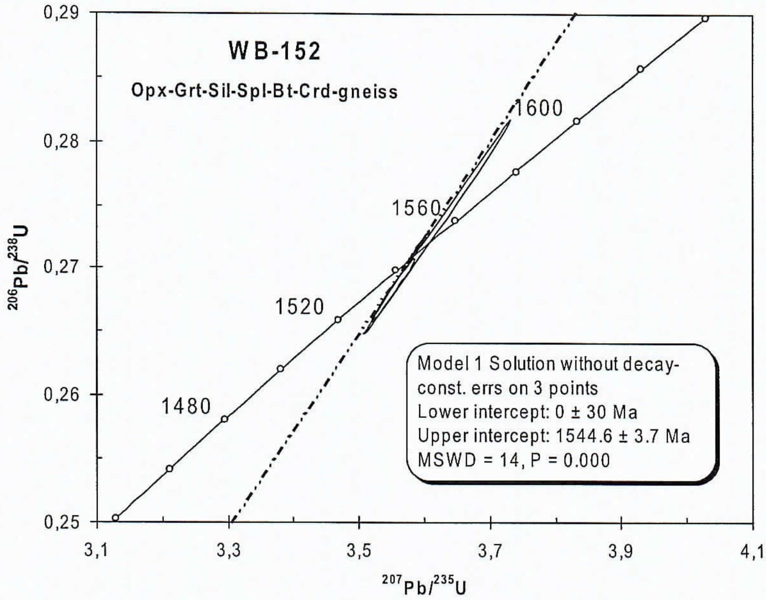

Figure 2. Concordia plot of monazite analyses from paragneiss WB-152. Analytical uncertainties are depicted as 2σ.

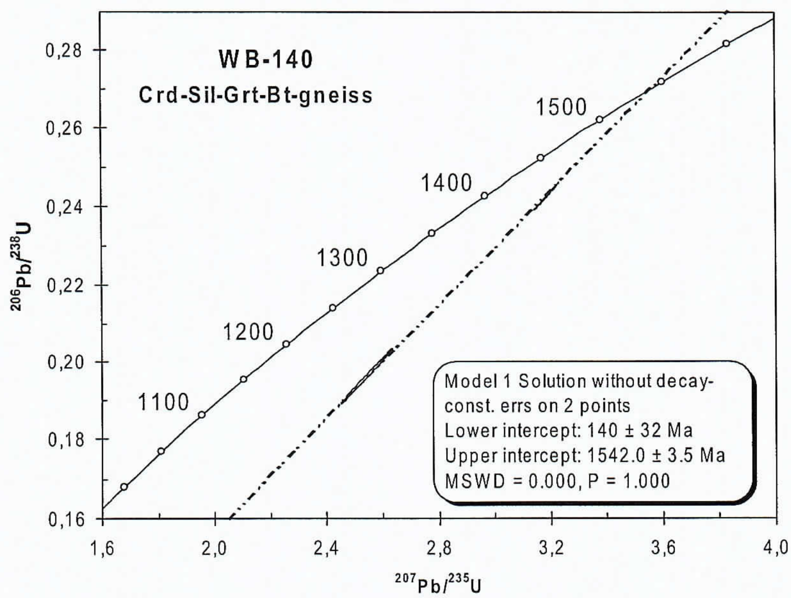

Figure 3. Concordia plot of monazite analyses from paragneiss WB-140.Analytical uncertainties are depicted as 2σ. Note the significative normal discordance.