$^{40}AR/^{39}AR$ METAMORPHIC RECORD OF A COLLISION RELATED TO THE WESTERN GONDWANA COLLAGE: THE (541-531 MA) PARAGUAY BELT IN THE NOVA XAVANTINA (MT) REGION:

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INTRODUCTION

This work presents $^{40}Ar/^{39}Ar$ data determined on the Paraguay belt metamorphic rocks related to the Brasilian-Panafrican event, in the region of Nova Xavantina, Mato Grosso State, Brazil, with the purpose of better constrain the timing of metamorphic event and discuss the tectonic implications. The origin of this fold belt is correlated to the Neoproterozoic collision of the Amazonian craton, the Paranapanema cratonic fragment and the Rio Apa block and the Neoproterozoic geological evolution of the Paraguay belt may be included among the orogenies correlated to the Gondwana assembly. These orogenies were diachronic, many of which were coeval with taphrogenic processes elsewhere, and the plurarity of processes converged to the closure of many oceans and to the collage of the continental fragments (terranes or micro-continents).

GEOLOGICAL SETTING

The Paraguay belt and its corresponding cratonic cover were formed on the southern margin of the Amazonian Craton (Figure 1) and subsequently metamorphosed in greenchist facies conditions. The sedimentary sequences comprise limestones, laminated siltstones and sandstones (Cuiabá Group), carbonates (Corumbá Group), and siliciclastic rocks (Boquira and Alto Paraguay Groups). A Rb-Sr isochron at 568 ± 20 Ma as reported in the literatura for shalles from the top of the Alto Paraguay sequence, interpreted as diagenetic age. However, the stratigraphic position of the metavolcanic rocks observed in the studied area is still debatable, being considered, on the other hand, is representative of the Cuiabá Group basement.

The metamorphosed volcano-sedimentary rocks in the studied area outcrop in a structural window which limits are: sediments of Alto Paraguay Group (north); Ponta Grossa Formation (Devonian of Paraná Basin) (west). The eastern limit of the fold belt with the Goiano Complex of the Brasilia Belt is hampered by Quartenary/Tertiary sedimentary cover. Detailed petrographic studies allowed to conclude that the protoliths of the metamorphic units observed in the studied area are chemical sedimentary rocks as phyllites, graphitic phyllites, cherts and banded iron formations; siliciclastic sedimentary rocks such as quartz-phyllites, quartzites and conglomerates; and volcanic units comprised of ultramafic, mafic and intermediate rocks. The primary structures (such as parallel banding) of the volcanosedimentary rocks are mainly observed in the BIF's, quartzites and phyllites. Subparallel to the sedimentary bedding occurs the penetrative foliation, which is roughly W-E/33S. This foliation is interpreted as result of a shear zone (Araés shear zone) activity during the regional metamorphism. The main foliation and the sedimentary bedding (both locally W-E) are deformed by open folds with NW-trending.

RESULTS AND DISCUSSION

The $^{40}Ar/^{39}Ar$ step-heating dating here presented indicated that the complex crustal evolution of the Paraguay belt rocks requires high analytical precision and improved spatial resolution. The biotite grains were irradiated at the IPEN/CNEN IEA-R1 nuclear reactor. The analysis were done using the Mass Analyser Products (UK) MAP-215-50 mass spectrometer at USP $^{40}Ar/^{39}Ar$ laboratory. Blanks were measured between each step of the step-heating procedures. The aparent age (Ma) *versus* cumulative % ^{39}Ar released diagrams show complex patterns and their interpretations need accurate analysis.

The sample AR-105 had two grains analysed and yielded two different cumulative % ^{39}Ar released *versus* aparent age (Ma) spectrum. The first grain yielded a $^{40}Ar/^{39}Ar$ plateau age of 531 ± 0.6 Ma and an integrated age of 539.3 ± 0.5 Ma (Figure 2). The plateau age may be interpreted as the metamorphic peak age of the analysed rock. The second grain of sample AR-105, by the other hand, yielded a disturbed Argon step-heating spectrum marked bya a "sadle" shape (see Figure 2), in which anomaously high ages are obtained at both low and high temperatutes of the gas released. This excess Argon may ocurr during crystallization and subsequent cooling of the mineral or during some later thermal/metamorphic event, due the presence of an external high partial-pressure of Argon. Since such excess Argon was not observed in the isotopic ratios obtained during the experiment (no $^{39}Ar/^{40}Ar > 295.5$) each step-heating gas fraction is likely to have sampled a distinct Ar reservoir in the amphibole grain. Consequently for the sample AR-105 (second grain), the calculated integrated age is anomalously high and geologically meaningless.

From the second sample (97-107), the two grains analysed by $^{40}Ar/^{39}Ar$ step-heating technique produced two different spectra. In the first grain, 10 steps were performed, yielding a forced plateau age of 531 ± 0.6 Ga and an integrated age of 539.3 ± 0.5 Ga (Figure 2). The spectrum shows higher ages in the first 5 steps where ages reach 700 Ma, indicating partial argon-loss in the biotite grain. The obtained spectrum, in the studied case, may be interpreted as mixing of two Ar reservoirs: one older, which isotope composition indicates the pre-metamorphic crystalization of the biotite grains; and the second probably presents the Ar isotopic composition of the last thermal event. Consequently the step-heating fraction with young ages may be interpreted as the closer age to the metamorphic peak.

The second grain from the second sample (97-107) had only two steps analysed, yielding an integrated $^{40}Ar/^{39}Ar$ age of 684 ± 12 Ma (Figure 3). The spectrum obtained is equivalent to $^{40}Ar/^{39}Ar$ total-fusion or K-Ar dating technique. As discussed above about the first grain from sample AR-107, this sample probably presents two ^{40}Ar reservoirs: one has $^{40}Ar/^{39}Ar$ age of ca. 541 Ma and the second has age about 700 Ma or older. Consequently $^{40}Ar/^{39}Ar$ total-fusion age is meaningless in the studied case, since it is the mixture of two Ar reservoirs.

The $^{40}Ar/^{39}Ar$ spectra here obtained suggest completely or partially-overprinted biotite grains. The Ar loss closure temperatue for biotite is ca. 350°C. Therefore, the greenschist facies grade rearched in the Paraguay belt metamorphic event was not enough to reset completely the Argon in biotite minerals. Such hyphothesis, however, is based on the assumption that the opening temperature during reheating is the same as the closure temperature during cooling, and this may not be true. Furthermore, biotite grains here analysed were obtained from metabasic rocks which probably went through deformation and fluid interaction rather than simple heating. In this environment the argon-loss closure-temperature concepts has no validity.

Consequently, the disturbed spectrum showed in sample AR-107 grain 2 and sample AR-105 grain 2 provide useful geochronological data from diffusive-loss profiles and suggest a coherent thermal history of both metabasic samples. Altogether, the four $^{39}Ar/^{40}Ar$ step-heating data suggest metamorphic ages in the range from 541 ± 0.7 Ma to 531 ± 0.5 Ma reflect the time of a late thermal event, probably linked to the regional thermal event related to Amazonian craton and Paranapanema block collision.

As tectonic implications upon the isotopic data here presented, we may suggets that the collision of the southern region of the Amazonian craton probably occurred not only with the Paranapanema cratonic fragment. At that moment (541-531 Ma) important terranes and microplates had already assembled. Probably the São Francisco craton had joined to Rio de La Plata cratonic fragments. In this way the Amazonia craton collided at 541-531 Ma with this continuous continental mass (São Francisco-Rio de la Plata-Luis Alves). In addition, the Rio Apa block collided to the Paranapanema craton and originated the southernmost branch of the Paraguay belt; and the collison between the Rio Apa block and Amazonian craton originated the western branch of the Paraguay belt denominated as Tucavaca. Pratically simultaneously to these collisions, there occurred the collision of the last accretion of Ribeira belt in SE Brazil (Buzios orogeny), corresponding to the collision of the Congo craton and the São Francisco craton. And probably at the end of this two last orogenies, the Gondwana supercontinent was formed.

CONCLUSIONS

The $^{40}Ar/^{39}Ar$ data here reported may suggest important constraints in the geological evolution of the Paraguay belt as well as tectonic implications. Based upon these $^{40}Ar/^{39}Ar$ results and the discussion above we may sugest the following conclusions:

1) The age of the metamorphic peak of the Paraguay belt may be constrained between 541 Ma and 531 Ma.

2) This metamorphic event probably is result of the collisional processes between the Amazonian craton and the Paranapanema cratonic block (Rio de la Plata craton), and comprises late collision of the western Gondwana collage.

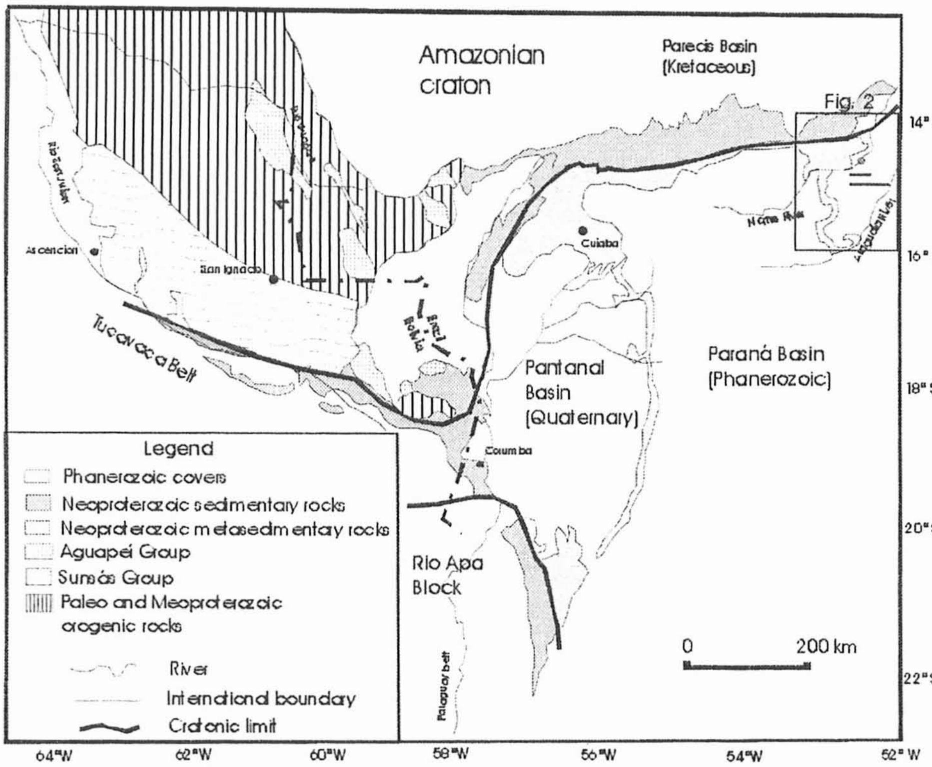

Figure 1. General overview of the Paraguay belt. The rocks of the Paraguay belt may be divided in undeformed sedimentary rocks (cratonic cover) and deformed sedimentary rocks, corresponding to the orogenic external and internal zones, respectivelly.

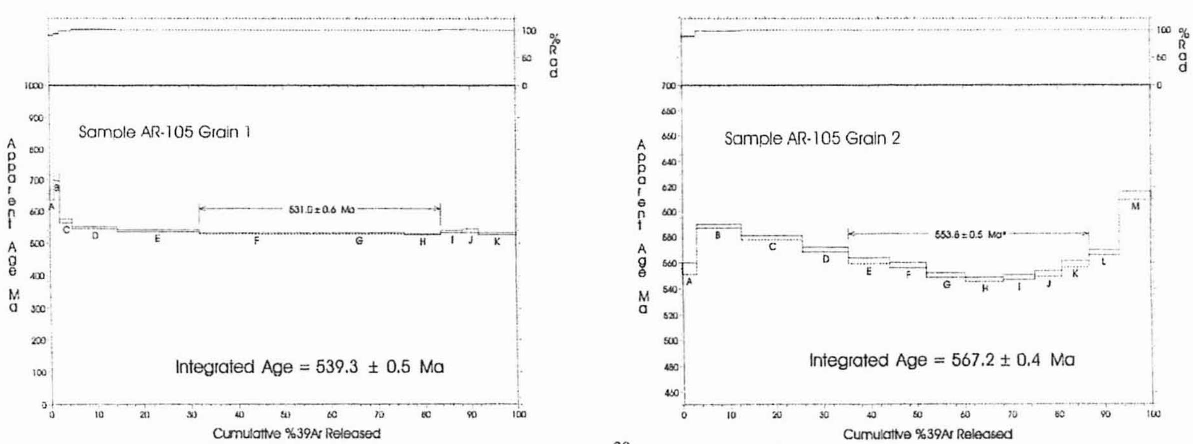

Figure 2. Apparent age *versus* cumulative $\%^{39}Ar$ released diagram for sample AR-105.

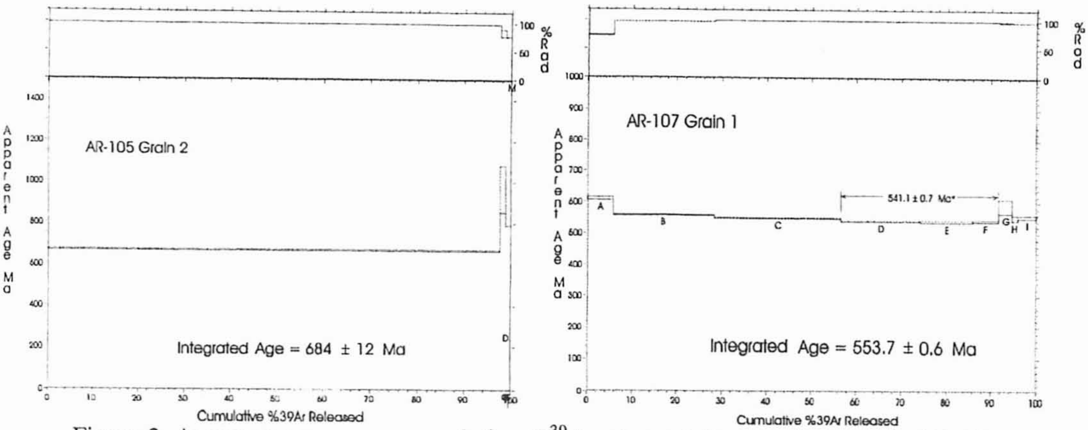

Figure 3. Apparent age *versus* cumulative $\%^{39}Ar$ released diagram for sample AR-107.