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Geochronological constraints for the evolution of the metamorphic complex near the Tebicuary River, Southern Precambrian Region of Paraguay. In: III SSAGI, 2001, Pucon - Chile. III Simposio Sudamericano de Geologia Isotopica, 2001.

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INTRODUCTION

The crystalline basement in Paraguay is exposed in the eastern part of the country, along the so called “Asunción arch”, and includes a great portion of the catch basin of the Tebicuary river. The area, comprising not more than about 3000 sq. km., has been considered as a small cratonic fragment, and the age and evolution of its rocks has been subject of speculation and controversy.

The available radiometric dates, obtained essentially by the K-Ar and Ar-Ar methods (Comte and Hasui, 1971; Bitschene and Lippolt, 1986; Lohse, 1990; Engler, 1991), are related mainly to the Neoproterozoic and early Paleozoic. There are about 60 K-Ar or Ar-Ar apparent ages obtained in separated minerals (biotite, muscovite, hornblende, pyroxene, K-feldspar, plagioclase) from the different rocks in the region, and the great majority fell into the 470 – 590 Ma. age interval. However, a few isolated ages presented older values, and a Paleoproterozoic U-Pb zircon age (mentioned by Lohse, 1990) was obtained from an amphibolite of the southern part of the area.

Given the relevance of the area for the geotectonic interpretation of the central region of South America, a geochronological research was carried out by the U-Pb SHRIMP method on zircons, at the ANU (see Williams, 1998, for methodological informations). Rb-Sr and Sm-Nd measurements, carried out at the USP, complemented this research.

GEOLOGICAL SETTING

Figure 1 brings a geological sketch map based on the Villa Florida quadrangle (Cubas et al., 1997) for

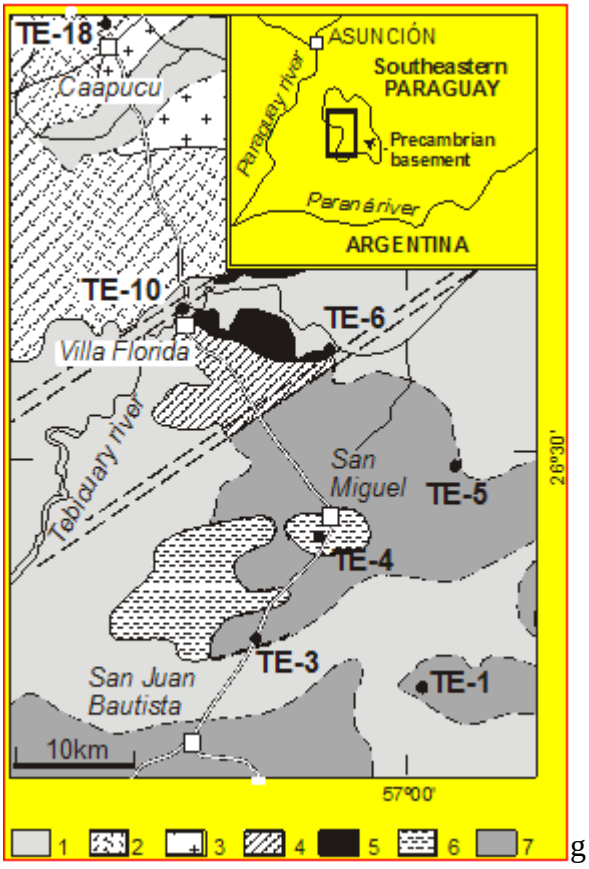

Figure 1 – Geological units of the area. 1 - Quaternary. 2– Caapucu magmatic suite. 3 – Barrerito granite. 4 – Metamorphic rocks and migmatites near Villa Florida. 5 – Centu Cué granodiorite. 6 – Quartzites. 7 – Retrogressed high grade metamorphic rocks.

the northern part of the area, and on the reconnaissance work by Kanzler (1987) for the southern part. Sample locations are indicated in the figure. Outcrop conditions are quite good north of Villa Florida,

but to the south outcrops are scanty, rocks are deeply weathered, and swamps and Quaternary sediments cover large areas.

The Caapucu magmatic suite of the northern part of the region includes acid volcanic rocks, mainly rhyolites, in association with shallow intrusives such as the Barrerito type granites, large bodies of which occur near the city of Caapucu. Outcrop Te-18 is a quarry where rhyolites and sub-volcanic granitoid rocks were collected.

Near Villa Florida there is a large NE trending megafracture zone (Kanzler, 1987), 10 km wide, where medium grade metamorphic rocks occur, intruded by the Centu Cué granodiorite (Cubas et al., 1997). Outcrop Te-10, at the bridge on the Tebicuary river, is a migmatitic rock in which the paleosome is formed by banded calc-silicate rocks, with quartz, diopside, Ca-garnet, amphibole, epidote, Ca-plagioclase, wollastonite, and sphene. At least three generations of granitoid neosome are observed, the last one in the form of dikes of fine-grained granite. Outcrop Te-6 corresponds to the Centu Cué biotite-hornblende granodiorite, intrusive into these metamorphic rocks.

In the southern part of the region, the predominant rocks are fine-grained gneisses, medium to high grade, in which quartz and feldpars largely predominate. Samples Te-1 and Te-5 are examples of retrogressed leucocratic orthogneisses, containing mesoperthitic feldspar, interstitial microcline, Na-plagioclase and biotite. At the outcrop Te-3 banded granulites occur, including felsic bands as well as intermediate and basic types, the latter formed by plagioclase, hornblende, and two pyroxenes. Amphibolitic and BIF lenses are also described in the southern region, and a few large outcrops of quartzite are indicated near the town of San Miguel, where the Te-4 sample was collected, a greenish quartzite with fuchsite and phengite.

The main tectonic discontinuity of the region is the megafracture zone occurring near Villa Florida, separating areas of very different geological character. In the northern part the volcanic and sub-volcanic rocks are virtually undeformed, while in the southern part the main metamorphic structures exhibit NE-SW to ENE-WSW and E-W trends, with predominantly northern to northwestern dips.

RESULTS AND DISCUSSION

On the acid magmatites of the Caapucu Suite, a Rb-Sr isochron was attempted on three samples of the Te-18 quarry nears Caapucu. All them exhibited very high $^{87}Rb/^{86}Sr$ ratios; the points were not well aligned, experimental error (2 sigma) is high, and the age result was 560±35 Ma, with initial $^{87}Sr/^{86}Sr$ ratio of about 0.708 and MSWD = 7.6. The age is in agreement, within experimental error, with the more precise dates obtained by Bitschene and Lippolt (1985) by the Ar-Ar method (544 ±11 Ma.) and by Cubas et al.(1997) by the Rb-Sr method (531±5 Ma).

Figure 2 is a Rb-Sr isochron diagram in which the analytical points of samples from outcrops Te-1, 5 and 10 were plotted. The points are not well aligned, and the best-fit lines do not correspond to true isochrones. However, a tendency can be observed for the best fit lines, suggesting an event at about 610 Ma. affecting the high-grade gneisses Te-1 and Te-5, as well as the neosome associated with calc-silicate rocks for sample Te-10. However, the younger neosome at the same outcrop indicates a younger age close to 500 Ma.

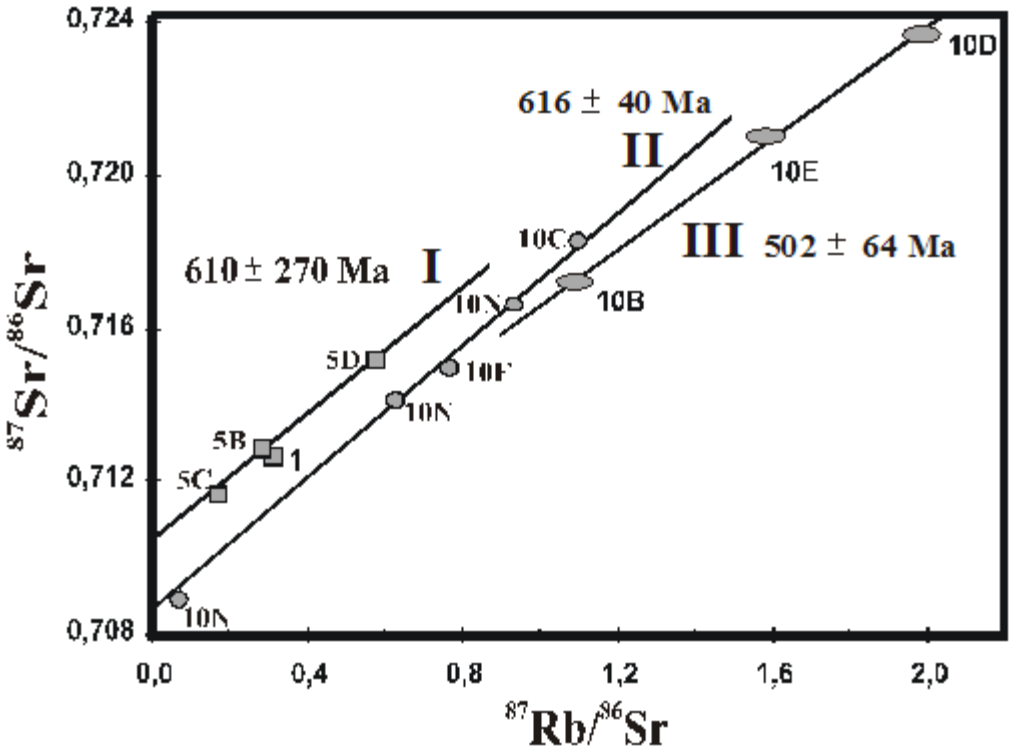

Figure 2 – Rb-Sr isochron diagram.
I – High-grade gneisses Te-1 and Te-5. – 610±270 Ma. (RI = 0.710 and MSWD =34)
II – Older neosome of migmatite Te-10 - 614±40 Ma. (RI = 0.708 and MSWD = 6.7)
III – Younger neosome of migmatite Te-10 – 502 ±64 (RI= 0.709 and MSWD = 0.26)

The Neoproterozoic metamorphic event of about 610 Ma. is confirmed by a two-points Sm-Nd isochron (garnet-total rock) made for sample Te-10, a calc-silicate rock that yielded an age of 589±13 Ma, with initial 143Nd/144Nd ratio of 0.51161. From the same Te-10 outcrop a few Sm-Nd TDM model ages were obtained, with values between 1.2 and 1.8 Ga. **Only one of the samples, from a granitoid leucosome, indicated na Archean age of 2,7 Ga.**

It is apparent that all geochronological tools reported above (K-Ar, Ar-Ar, Rb-Sr and Sm-Nd) point to a strong influence of the Brasiliano orogenic cycle in the Southern Precambrian of Paraguay. In order to verify the possibility of the existence of older events, some U-Pb SHRIMP measurements were attempted. Zircons were extracted from samples Te-3, 4, 6 and 10, and a few points from each sample were analysed at the ANU in a reconnaissance survey.

Six analyses were undertaken on clean oscillatory-zoned magmatic zircon from the Centu Cué granodiorite sample Te-6. All analyses yielded concordant ages (fig. 3), and the weighted mean 206Pb/238U date is 622±15 Ma. (2 sigma). This age is interpreted as the crystallization event of the granodiorite, and is similar to the Rb-Sr metamorphic age of the migmatitic rocks at the Tebicuary river bridge at Villa Florida.

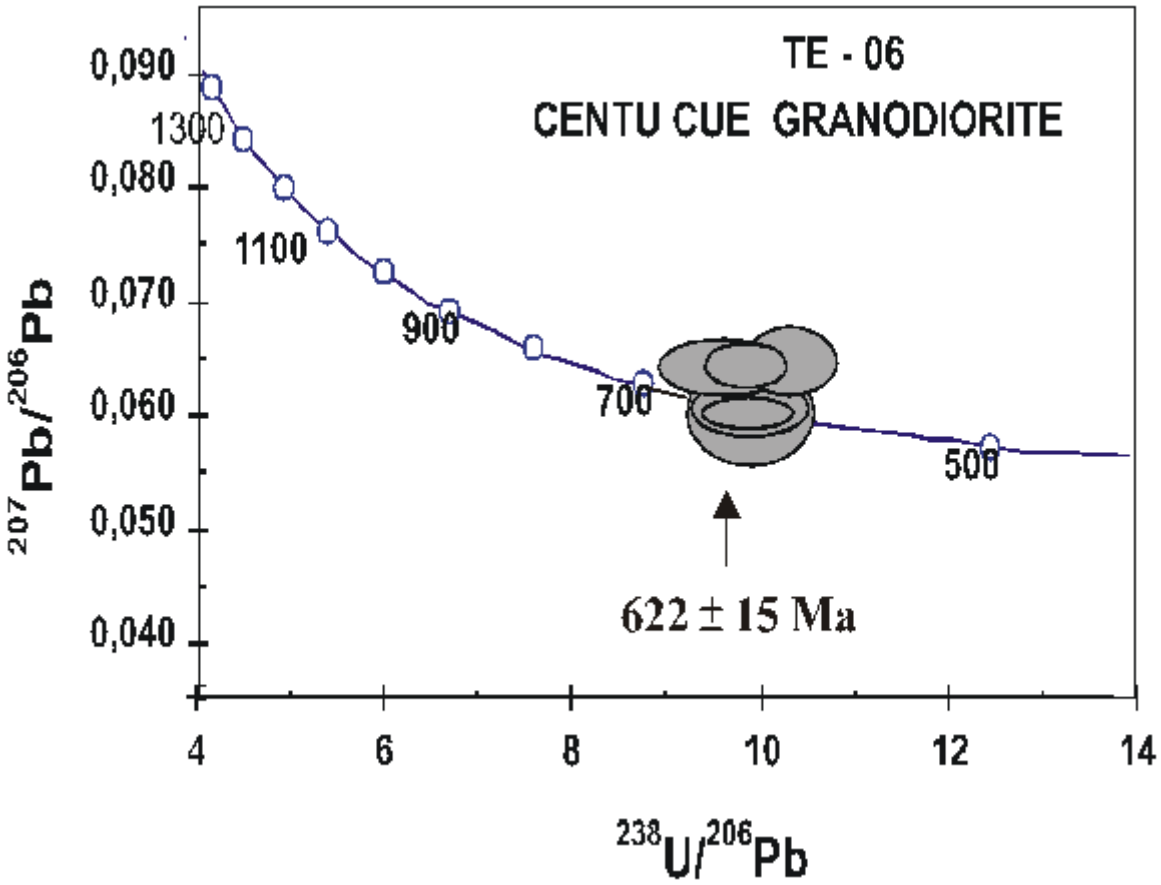

Figure 3 – Tera-Wasserburg diagram for the SHRIMP measurements on sample Te-6

Figure 4 is a Tera-Wasserburg diagram that includes the analytical points of eleven zircon crystals extracted from the Te-10 migmatite. Zircons in this sample are stubby prismatic to equant, and many of them exhibit areas of recrystallisation and homogenization. Seven points which yielded the most

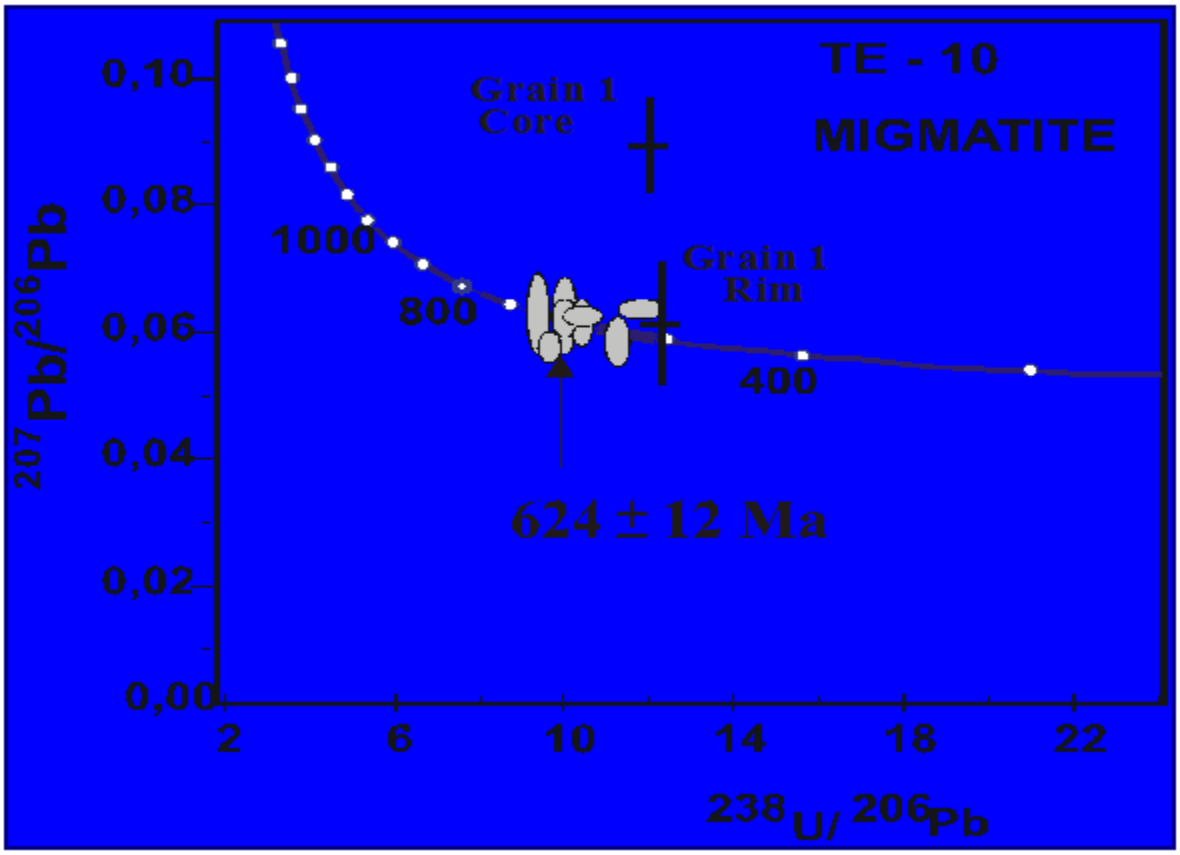

Fig. 4 – Tera-Wasserburg diagram for the SHRIMP measuremants on sample Te-10

concordant dates produced a weighted mean 207Pb/ 206Pb date of 624±12 Ma., which is in line with the Rb-Sr and Sm-Nd results obtained for the same outcrop. The other points are related to a somewhat younger population, possibly related to the formation of the younger granitoid veins observed in the rock.

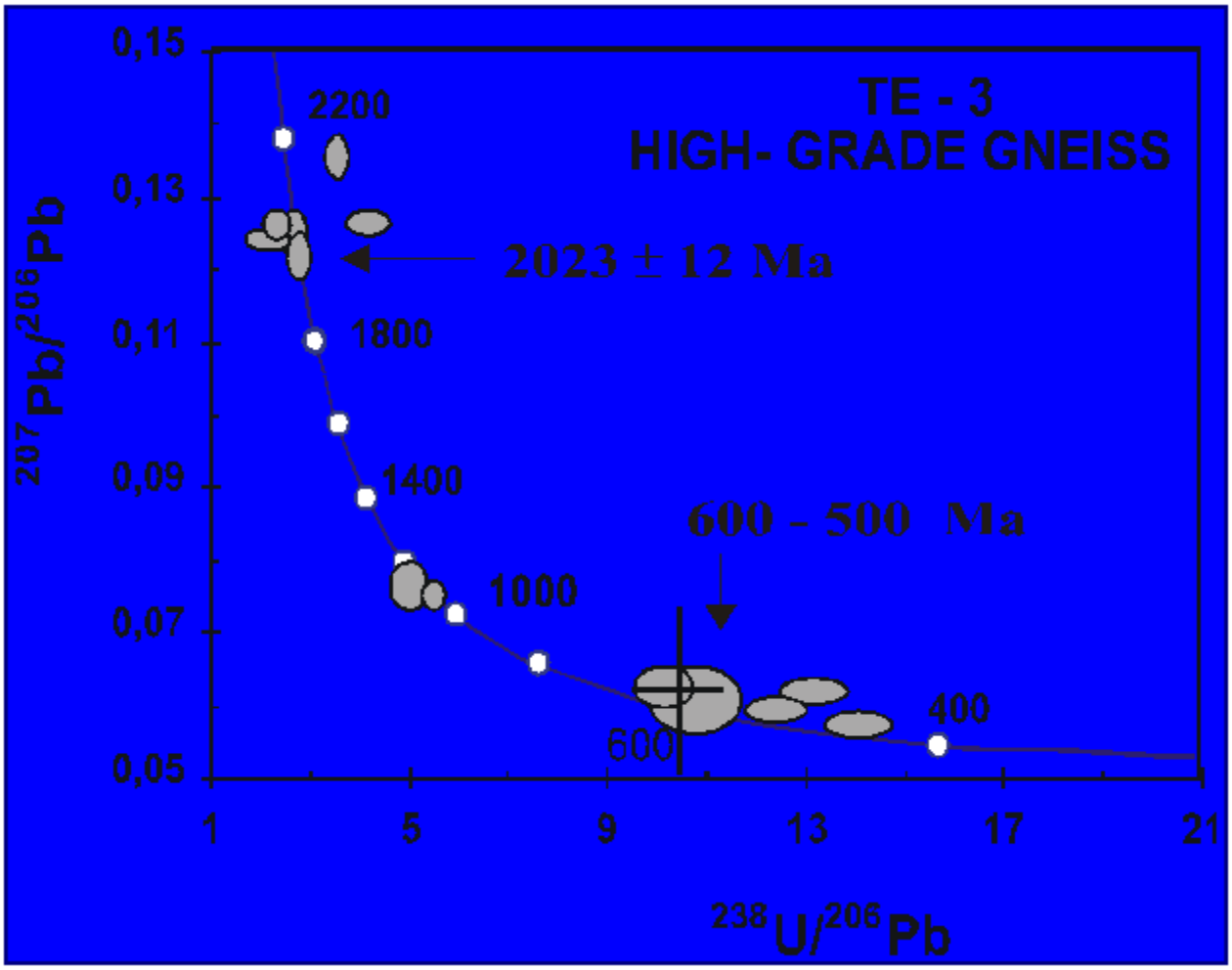

Figure 5 – Tera-Wasserburg diagram for the SHRIMP measurements on sample Te-3.

Sample Te-3 is a leucocratic band included in the retrogressed high-grade gneisses of the southern part of the area. In the CL image the grains formed a morphological diverse population, with a few zircon typologies, and complex internal structures. Cores and overgrowths were observed, and at least three different zircon generations were detected by the SHIMP measurements. Fifteen analyses were undertaken on eleven grains, and the analytical points are plotted in the Tera-Wasserburg diagram of figure 5. Several sites, within stubby prismatic to equant crystals, **yielded nearly concordant $^{207}Pb/^{206}Pb$ dates with a weighted mean of 2023±12 Ma.** An elongated prism with complex internal structure yielded an age of about 1100 Ma., while a few others indicated Neoproterozoic dates. In one of the crystals exhibiting a complex internal structure; the site within a central oscillatory-zoned domain yielded a ca. 600 Ma. age, and the other within the clear overgrowth indicated a younger age close to 500 Ma.

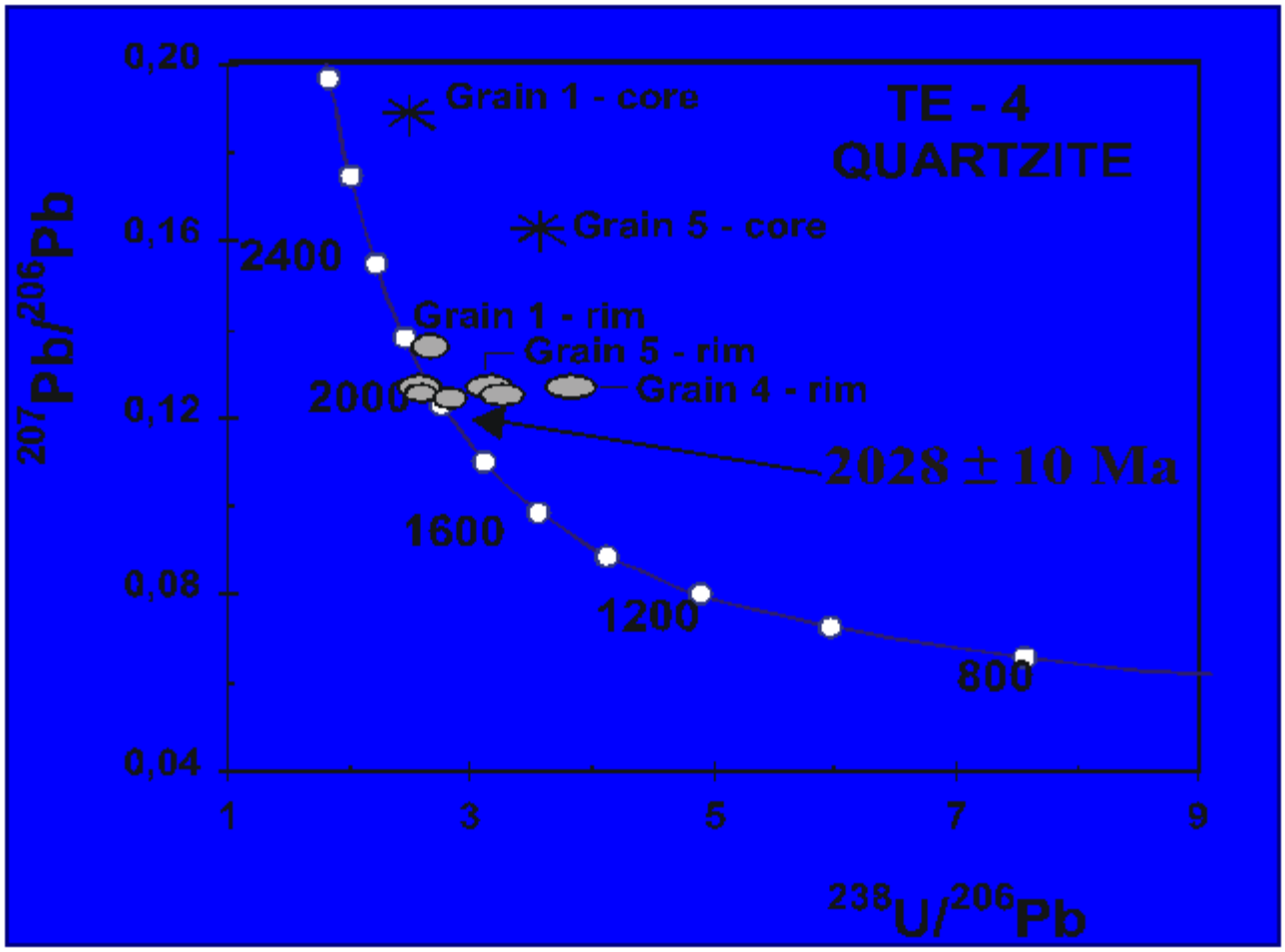

Figure 6 – Tera-Wasserburg diagram for the SHRIMP measurements on sample Te-4

Quartzite sample Te-4 yielded detrital zircons, mostly stubby prismatic, some of them with evident cores and overgrowths. Nine analyses were performed on seven grains, and the analytical points were plotted in figure 6. Five sites yielded nearly concordant dates, with a weighted mean 207 Pb/206Pb age of 2028±10 Ma., similar to the zircon age obtained for the high grade gneiss Te-3. Two others, obtained on cores, indicated inherited material from sources with possible Archean age.

CONCLUSIONS

The geochronological systematics obtained for the Southern Precambrian of Paraguay indicates a geotectonic evolution in which a high-grade Paleoproterozoic continental fragment was intensely reworked during the Neoproterozoic Brasiliano orogenic Cycle.

The northern part of the region corresponds to a post-orogenic supracrustal sequence of the Brasiliano Cycle, in which acid volcanics associated to shallow granitic intrusions predominate. The central part may correspond to a mesozonal supracrustal sequence, affected by syntectonic magmatism. Finally, a portion of rejuvenated basement of Paleoproterozoic age, in which some hints of older material are observed, makes up the southern part of the region. Moreover, the Neoproterozoic evolution of the geotectonic unit apparently includes two distinct tectonothermal events, an older one at about 610-620 Ma., and a younger one between 500 and 550 Ma.

Looking for continental correlations across the area of the Paraná sedimentary basin (see Cordani et al., 1984), the geochronological pattern of the Tebicuary region is quite similar to the one observed for the Ribeira belt of southeastern Brazil. Moreover, the very important northeast trending megafault zone near Villa Florida may correspond to the Jacutinga megafault zone, which marks the limit of the Ribeira belt against the Guaxupé massif.

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