

Itapicuru River Greenstone Belt: An Archaean or a Palaeoproterozoic Terrane?

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Summary

New geochronological data are available for the Itapicuru River Greenstone Belt, Bahia, Brazil. This is the first time U-Pb single zircon SHRIMP ages have been performed for the Itapicuru sedimentary unit. Although the new ages do not reveal any pattern of interaction between the Mesoarchaeon basement and Paleoproterozoic (Transamazonian) tectonic and plutonic activity to the origin of these sediments and the major question of whether the Rio Itapicuru Greenstone Belt is Archaean or Paleoproterozoic remains without a conclusive resolution, these results show the importance of more work to be done at these terranes.

Introduction and Geological Context

The Sao Francisco Craton (SFC), the largest preserved remnant of Archaean and Paleoproterozoic terrains of the Brazilian Shield, is well exposed in Bahia State and extends to the southwest into Minas Gerais State. It is considered to have been stable during the Brasiliano (Neoproterozoic) Orogeny and contains a large number of greenstone belts (Cordani et al. 2000), which have been affected by greenschist to lower amphibolite metamorphism. Many of these granitoid-greenstone formation along all the Trans-amazonian cycle belts of South America were metamorphosed at ~2077 Ma, a period characterized by intrusion of post-tectonic potassic granitoid and regional high-temperature metamorphism (Rios et al. 2009) related to the Rhyacian Trans-Amazonian pulse.

The Itapicuru River greenstone belt (IRGB) is situated within the Serrinha Nucleus Terrane, Eastern SFC, and is an approximately 80 km long x 40 km wide greenstone surrounded by granitic gneisses and various granitic rocks, been the most important gold producer of the Bahia State (Silva et al. 2001). IRGB was probably formed in a back-arc basin and include from base to top: (i) mafic-ultramafic lavas, E-MORB sea floor, consisting of tholeiitic basalts and mafic tuffs, with associated banded iron formations, cherts, and graphitic phyllites; (ii) a bimodal sequence (silica gap between 55-60% SiO₂) of intermediate and felsic lavas in the upper units, similar to those of modern active continental margins, with compositions ranging from andesite to dacite. Both sequences are cut by Archaean tonalite-trondhjemite suites, like Ambrosio Batholith (Rios et al. 2009). Intrusive sub-volcanic bodies are represented by rhyodacites, quartz diorites, gabbros and subordinately alkali-feldspar syenites and lamprophyres dykes (formerly mapped as sheared diorites), which occur locally along the shear zones, some spatially related to mineralized ore bodies (Xavier and Foster 1999). The Itapicuru belt supracrustal pile is estimated to be 9.5 km thick and also presents an upper thick unit of

metasedimentary rocks, composed of conglomerates, sandstones, siltites and shales, as well as carbonate, marbles, and BIFs, which represent a minor component.

Regional fieldwork supported by geochronological data show that the Serrinha Nucleus area has undergone a long-lived, complex deformation history, spanning at least 1.5 billion years (Rios et al. 2009). This includes, from oldest to youngest: (1) an early stage of folding probably associated with thrust faulting, ~3.15 Ga; (2) N-S-trending, major transpressional shearing, ~2.15 Ga, interpreted to have taken place during the Paleoproterozoic Trans-Amazonian Orogeny; followed by (3) brittle faulting, and fault reactivation, ~2.07-2.05 Ga. Strong overprinting and reworking with coaxial geometry gives the belt an apparent simplistic structural style that in places appears to be dominated by a single N-S foliation.

Rb–Sr isochron ages of 2080 ± 90 Ma and 2000 ± 200 Ma were obtained by Brito Neves et al. (1980) for the felsic intermediate unit of Itapicuru greenstone, and a 2089 ± 85 Ma (Mello et al. 2006) for the metasedimentary unit, which has been interpreted as the crystallization age. Metasediments in the Itapicuru greenstone have previously been suggested to have been metamorphosed in the Paleoproterozoic (Silva et al. 2001) and hence to have had Paleoproterozoic sedimentary protholits. However, up to now, there are no detrital provenance data from metasediments in Itapicuru greenstone, and a quartzite from Caldeirao belt, north area of Serrinha Nucleus, yielded a U-Pb sedimentation age of 2687 ± 16 Ma (Mello et al. 2006). Because the Rb–Sr system in felsic volcanics is commonly reset and the age defined is in the same range or younger than the late granites (Rios et al. 2009.), it may have been modified during Transamazonian events, as was observed, for example, for the Contendas–Mirante and Mundo Novo felsic metavolcanics. Here we will present and discuss some U-Pb zircon SHRIMP data for the metasedimentary unit of the Itapicuru greenstone belt.

Geochronological Data

U-Pb SHRIMP analyses were performed at the J.C. Roddick Ion Microprobe Laboratory, of the Geological Survey of Canada (GSC), Ottawa, Canada, using a Sensitive Resolution Ion Microprobe (SHRIMP II). The analytical methods of zircon U-Pb-Th age determinations using the SHRIMP of GSC are reported in Stern (1997). All age calculations and statistical assessments of the data have been done utilizing the geochronological software package ISOPLOT/EX of Ludwig (2001).

Zircon dating was performed on two samples (NS3167 and NS3168) of metasedimentary biotite-schists collected near Ambrosio Village. Rocks present garnet aggregates and titanite porphyries sized ca. 0.6 to 0.3 cm, with corrosion textures, fractures and inclusions. Garnet crystals cut the foliation, showing they are posterior to metamorphism. The quartz-feldspatic (quartz, plagioclase, microcline) ground mass is fine grained and slightly foliated, alternating with bands of mica minerals.

Only few grains were recovered on sample NS 3168. At sample NS 3167 two distinct populations have been identified: (i) few big pink fragments, clear, without inclusions, that seems to be of metamorphic origin. (ii) At the predominant population, most crystals are smaller, and occur as subhedral to anhedral, brown, short-prismatic shaped zircon grains. Occasionally they are fractured and show suggestive textures of corrosion inside the grains. Some of these grains seem to have diagenetic overgrowths, maybe of xenotime.

The data from the 12 analyzed grains are subconcordant in the Concordia diagram (Fig. 1) and define an average $^{207}\text{Pb}/^{206}\text{Pb}$ age of $2145 \pm$ Ma, which is concordant with the ages of calc-alkaline palaeoproterozoic granites, as Nordeste pluton (Rios et al. 2009). This first set of data provides $^{207}\text{Pb}/^{206}\text{Pb}$ ages ranging from 2117 to 2166 Ma. This result suggests a Palaeoproterozoic age for the zircons, but the range of ages observed (50 Ma) suggests distinct

origins and/or some further lead loss. It is also similar to the Nd model ages obtained for the volcanic rocks of IRGB (Mello et al. 2001) and suggests that felsic volcanism is related to a palaeoproterozoic stage of accretion of juvenile continental crust.

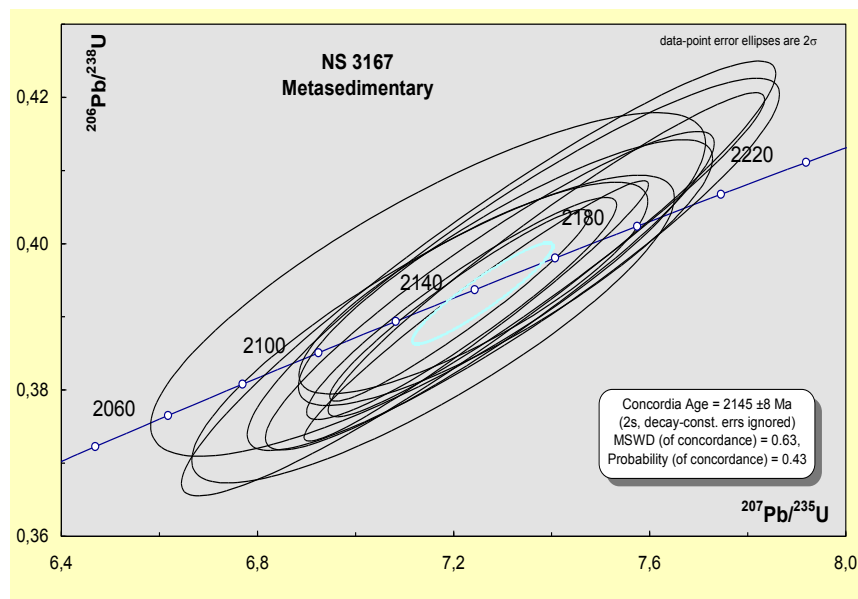


Figure 1. U-Pb Concordia diagram for the metasedimentary IRGB unit.

Another set of zircon data, found at NS3168 sample yields ages of ca. 720 Ma. Only two grains have been analysed although similar neoproterozoic ages have also been reported for the kimberlitic pipes of IRGB (Pisani et al. 2001, Pereira and Fuck 2005).

Conclusions

The age of greenstone rock types is often difficult to constrain using traditional geochronological methodologies and the best way to date such volcano sedimentary complexes more precisely is to use felsic metavolcanic rocks, which are often associated with mafic rocks and generally contain magmatic zircons. Pronounced recrystallisation and fluid flow also mask structural complexity. The various structures seen at IRGB are not developed uniformly across all lithological units within and outside the belt. Although, structural analysis and an increasing understanding of the lithological relationships between the various units are allowing better distinctions to be made between successive tectonic events. This has provided key criteria towards understanding the depositional timing and character of the units, and understanding and relating formation of structural elements such as mineral lineations and dominant foliations to specific events in time and space.

On a regional scale, the IRGB greenstone belt shares some structural similarities with the nearby Salvador-Curaçá Mobile Belt, which marks the western margin of the Serrinha Nucleus. This, and relationships in the greenstone belt, shows that the Paleoproterozoic Transamazonian Orogeny has affected a greater portion of the Serrinha Nucleus than previously thought. Unravelling these complex structural relationships is a fundamental step towards understanding granite-greenstone formation, and the early evolution of one of the probable Earth's oldest

crustal fragments (Rios et al. 2008). The neoproterozoic ages testify something else hit this nucleus, as it was not expected neoproterozoic ages to be report on this area.

These new presented data do not reveal any pattern of interaction between the Mesoarchaeon basement and Paleoproterozoic (Transamazonian) tectonic and plutonic activity to the origin of these sediments. However, the major question of whether the Rio Itapicuru Greenstone Belt is Archaean or Paleoproterozoic remains without a conclusive resolution, owing to a previous lack of zircon-bearing volcanic rocks.

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