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SCIENTIFIC CONTRIBUTIONS

SUPPLEMENT

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NEW INSIGHTS ON THE PALEOPROTEROZOIC BASEMENT OF TANDILIA BELT, RÍO DE LA PLATA CRATON, ARGENTINA: FIRST HF ISOTOPE STUDIES ON ZIRCON CRYSTALS 1-04

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Introduction

Following the fragmentation of the Rodinia supercontinent, Archean to Mesoproterozoic cratonic blocks were amalgamated to form the Gondwana continent during Neoproterozoic-Cambrian times. One of these continental blocks place at the core of western Gondwana, is the Río de la Plata craton (Almeida et al., 1973). The southernmost outcrops of this cratonic region are located in the Tandilia belt (also know as Sierras Septentrionales de Buenos Aires) in eastern Argentina (Fig. 1). It is exposed as a 350 km long and maximum 60 km wide northwest trending orographic belt, located in the central part of the Buenos Aires province. The Tandilia belt outcrops are in between the Salado (Mesozoic) and the Claromecó (Neoproterozoic-Paleozoic) basins. Some reviews on different aspects of Tandilia basement rocks were published by Dalla Salda et al. (1988), Cingolani and Dalla Salda (2000), Hartmann et al. (2002a), Pankhurst et al. (2003), Rapela et al. (2007) and Bossi and Cingolani (2010 and references therein). The main purpose of this contribution is to give new Hf isotopic insight on zircon crystals from the Tandilia Paleo- proterozoic igneous-metamorphic rocks in order to analyze their magmatic evolution and tectonic interpretation.

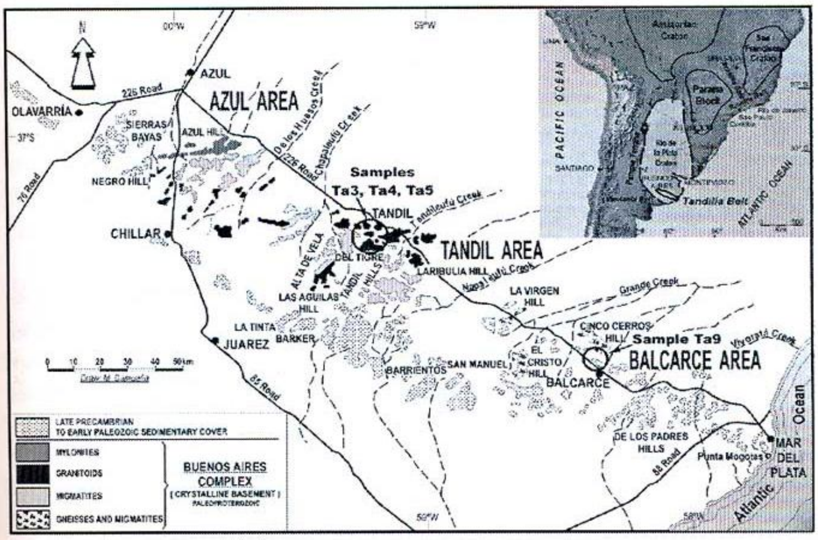

Fig. 1 - Geological sketch map of Tandilia belt from Iñiguez *et al.* (1989) and Dalla Salda *et al.* (1988) with the studied sample locations. A relative location of the Tandilia belt in the Río de la Plata cratonic area is shown in the inset.

Geological setting

The geological evolution of Tandilia comprises mainly a juvenile igneous-metamorphic Paleoproterozoic basement rocks which are covered by thin Neoproterozoic to Early Paleozoic sedimentary units. The Paleoproterozoic basement called 'Buenos Aires Complex' (Fig. 1) consists mainly of granitic-tonalitic gneisses; migmatites; amphibolites, some ultramafic rocks and granitoid plutons (Dalla Salda et al., 1988). Subordinate rock types include schists, marbles, and dykes of felsic and mafic composition. Tandilia was recognized as an important shear belt district with mylonitic rocks derived mainly from granitoids. The available geochemical data show that the igneous basement rocks have a calc-alkaline signature. Crust-derived Sm–Nd model ages (Cingolani et al., 2002; Hartmann et al., 2002a; Pankhurst et al., 2003) are in between 2.69-2.4 Ga implying that although the principal rock-forming events were Paleoproterozoic, the Neoarchean derivation could be possible. After U-Pb zircon crystals SHRIMP dating (Hartmann et al., 2002a; Cingolani et al., 2005) the tectonic scenario seems related to juvenile accretion (2.25-2.12 Ga) along an active continental margin, followed by continental collision (2.1-2.08 Ga). A lack of recrystallization or new zircon growth in the Neoproterozoic, suggests that the Tandilia Paleoproterozoic basement was preserved from younger orogenies such as those of the Brasiliano cycle. This geological evolution can be correlated with the Piedra Alta terrane (Uruguay), where Rb-Sr, Sm-Nd and U-Pb data show a similar signature (Cingolani et al., 1997; Hartmann et al., 2002b and references therein) during Paleoproterozoic times. After a long weathering process there is a record of Neoproterozoic sedimentary units and the final marine transgression at the Early Paleozoic.

Sampling and analytical techniques

Samples were taken from tonalitic-monzonitic granitoid and gneissic rocks from the Tandil region (Ta3; Ta4 and Ta5), and Opx-gneisses from the Balcarce region (Ta9, El Triunfo Hill) during the field work for U-Pb SHRIMP research (Hartmann et al., 2002a). The same zircon crystals and spots dated by U-Pb were analyzed for Hf isotope studies (Fig. 2). Samples Ta3 and Ta4 are foliated tonalitic gneiss and monzogranite (37º22'33"S-59º12'33"W) respectively sampled on the road cut about 10 km away from the Tandil town, both from the same outcrop. The Ta5 sample, is a granitoid from Montecristo quarry (37º22'15"S-59º10'42"W) homogeneous medium-grained grey rock. Sample Ta9 from El Triunfo Hill near Balcarce city (37º49'26"S-58º12'15"W) is a mafic to intermediate orthopyroxene-bearing gneiss.

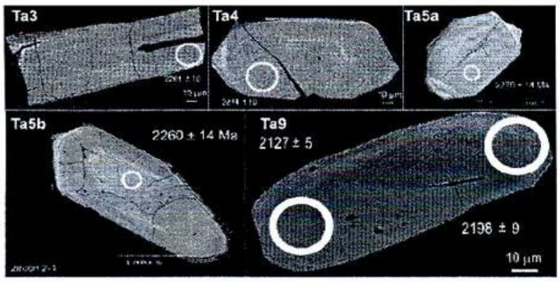

Fig. 2 - Backscattered electron images of zircons analyzed by Hartmann et al. (2002a) and Cingolani et al. (2005) by U-Pb SHRIMP. Same zircon crystals and spots were analyzed for Hf isotopes by ICP-MS-LA.

Hf-isotope analyses were carried out using a New Wave/ Merchantek UP213 laser-ablation microprobe, attached to a Nu Plasma multi-collector ICP-MS at MacQuarie University, Sydney. Mud Tank (MT) zircon was used as reference material which has an average ^{176}Lu/ ^{177}Hf ratio of 0.282522±42 (2SE) (Griffin et al., 2000). Initial ^{176}Hf/^{177}Hf ratios are calculated using measured ^{176}Lu/^{177}Hf ratios, with a typical 2 standard error uncertainty on a single analysis of ^{176}Lu/^{177}Hf ±1–2%. Such error reflects both analytical uncertainties and intragrain variation of Lu/Hf typically observed in zircon. Chondritic values (Blichert-Toft and Albarède, 1997) of 1.93?10$^{?11}$ have been used for the calculation of ÂHf values. Whilst a model of (^{176}Hf/^{177}Hf)i=0.279718 at 4.56 Ga and ^{176}Lu/^{177}Hf=0.0384 has been used to calculate model ages (T_{DM}) based on a depleted mantle source, producing a present-day value of ^{176}Hf/^{177}Hf (0.28325). T_{DM} ages, which are calculated using measured ^{176}Hf/^{177}Hf of the zircon, give only the minimum age for the source material from which the original magmas were derived. We have therefore also calculated a "crustal" model age (T_{DM} C) for each zircon which assumes that the parental magma was produced from an average continental crust (^{176}Lu/^{177}Hf=0.015) that was originally derived from depleted mantle.

Hf isotopes data and discussion:

As it is shown in Fig. 3 the coherent results on zircon crystals from all studied samples suggest that the depleted mantle model age (crustal) is Neoarchean 2.65 Ga, older (±350 Ma) than the crystallization age. Positive ÂHf obtained data show also derivation from juvenile material. An alternative interpretation could be a mixing with juvenile (2.27 Ga?) and crustal (more than 2.65 Ga) magmatic components. T_{DM} ages, which are calculated using measured 176Hf/177Hf of the zircon, give only the minimum age for the source material from which the original magmas were derived. The average of 28 Hf model-ages (2646 Ma) is almost coincident with the age of the only one inherited zircon of sample Ta3 (A.14-1, 2657 ± 8 Ma). This is strong evidence supporting the derivation from a Neoarchean crust (Fig. 3).

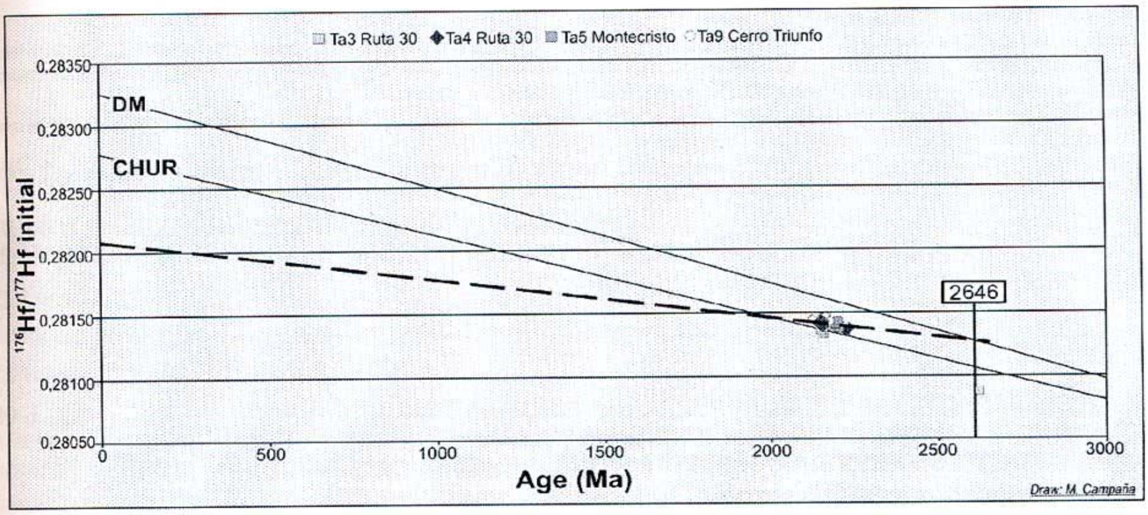

Fig. 3 - Plot of $^{176}Hf/^{177}Hf$ ratios versus ages on dated zircon crystals of samples Ta3, Ta4, Ta 5 (Tandil region) and Ta9 (Balcarce region). The slope of the dashed line uses the ratio of 0.015 for the $^{176}Lu/^{177}Hf$ ratio.

The present Hf isotope study confirm the Sm-Nd data published by Hartmann et al. (2002a) and Pankhurst et al. (2003) showing that the constituting material of the source region from the mantle was Neoarchean (*c.*2.6 Ga). These results are in agreement with precise U–Pb dating of the craton in western Uruguay and southernmost Brazil, which also indicate a relatively short-lived Paleoproterozoic orogeny.

Acknowledgements

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