U-Pb (ID-TIMS) zircon ages on pyroclastic events from Balcarce Formation, Tandilia System, Argentina: unreworked or reworked origin?

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INTRODUCTION

In eastern Argentina the southernmost outcrops of the Río de la Plata cratonic region are exposed in the Tandilia System in the central part of the Buenos Aires province (Fig. 1). The evolution of Tandilia comprises mainly a juvenile igneous-metamorphic Paleoproterozoic (2.2 to 2.1 Ga) basement named Buenos Aires Complex. After a long paleoweathering process the Sierras Bayas Group (c. 185 m thick) is a record of the first Neoproterozoic sedimentary unit (siliciclastic, dolostones, shales, limestones), covered by the Cerro Negro Formation (c.150-400 m thick, siliciclastics) and assigned to the Upper Neoproterozoic (both were firstly called "La Tinta Group"). The final sedimentary transgression at the Early Paleozoic is the Balcarce Formation (c. 90-450 m thick) (Iñiguez *et al.,* 1989) reflecting an independent marine basin evolution in a passive margin setting.

It is important to mention that pyroclastic levels were recognized in Tandilia System by Cuomo *et al*. (1983) from boreholes (Olavarría region) and Dristas and Frisicale (1987, 2003) in outcrops for the Cerro del Corral, Sierras de la Tigra and Los Barrientos areas. Also there are several evidence (kaolinite clay deposits, quartz crystals, alunite and iron-rich levels) originated by subsequent hydrothermal activity (Dristas and Frisicale, 2003; Dristas and Martínez, 2003). These authors described an alteration of original fall out pyroclastic material related to mafic rocks at Cerro del Corral area in the sedimentary cover, showing a kaolinite and rutile-anatase assemblage from low-temperature process. Other deposits involving mainly reworked pyroclastic material were also recognized along the Tandilia System.

The main purpose of this work is to present U-Pb zircon ages by ID-TIMS methodology, on samples taken from pyroclastic levels outcropped in Cerro del Corral area and discuss the implications on two lines: the study zircons helps to constrain the age of the Balcarce Fm or represent reworking material?.

GEOLOGICAL SETTING

The geological sketch map of the Cerro del Corral also called San Ramón kaolin deposits (Fig. 1) shows that are exposed (not in contact) the basement rocks (Buenos Aires Complex) and the subhorizontal sedimentary clastic cover known as the Balcarce Fm (Cingolani *et al*., 1985). This unit crops out along the southern edge of Tandilia from the Olavarría area to Mar del Plata at the Atlantic coast and unconformably overlies all the Precambrian units of the Tandilia System. The unit is composed of quartzites, fine-grained quartzitic conglomerates and kaolinitic shales. Locally at the base of the sequence c. 2 m of kaolinitized pyroclastic levels were exposed. The Balcarce Fm developed in shallow marine open shelf contains abundant and diverse trace fossils of the "*Cruziana* ichnofacies" (Borrello, 1966; Cingolani, *et al*., 1985; Seilacher *et al*., 2002) broadly constrain the stratigraphic age between the Ordovician to Silurian.

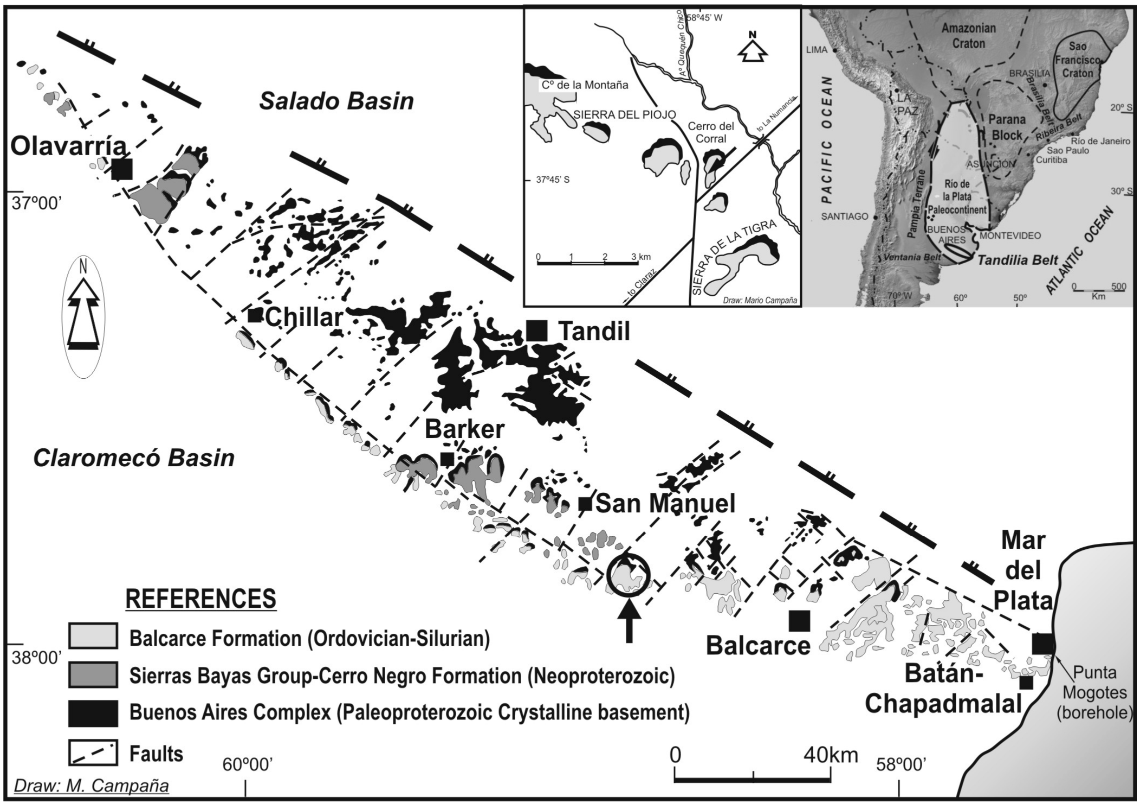
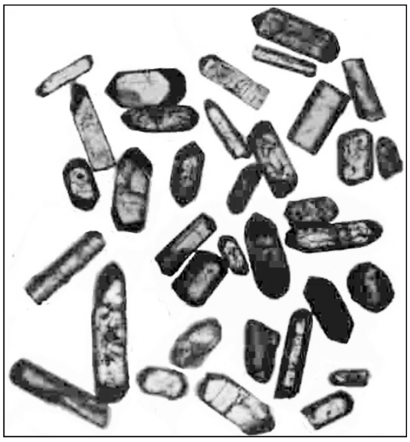


FIGURE 1: Geological sketch map of Tandilia System (after Iñiguez *et al*., 1989) in between the Claromecó and Salado basins (Buenos Aires Province), and location of the study area. On the right inset the regional location in southern South America of the Río de la Plata paleocontinent. Left inset the detailed location of the Cerro del Corral area.

Rapela *et al.* (2007) reported U-Pb detrital zircon ages from Los Pinos quarry near Balcarce city. The zircon populations are dominated by Neoproterozoic ("Brasiliano"), Mesoproterozoic and Late Palaeoproterozoic grains. A zircon peak as young as 480 Ma gives an estimate for the maximum depositional age of the Balcarce Fm. After Zimmermann and Spalletti (2009) the Balcarce Fm comprises mainly detrital material derived from old upper crustal material, with high concentrations of tourmaline and Ti-rich heavy minerals, including zircon and nearly euhedral chromite, are common. These authors mentioned that trace element geochemistry of recycled pyroclastic material, associated with the quartz arenites, also suggests volcanic arc sources for the Balcarce Fm. Detailed mineralogical studies on the pyroclastic levels were done by Dristas and Frisicale (1987; 2003 and references). On the other hand, the preliminary contribution by Krekeler *et al.* (1995) suggests that the unaltered primary phenocryst minerals of the pyroclastic level consist dominantly of quartz and some amphiboles. Beta-quartz grains contain pristine inclusions of glass, primary biotite, and also contain fluid inclusions.

SAMPLING AND METHODOLOGICAL PROCESSES

Samples for isotopic studies were taken from the c. 2 m pyroclastic level interbedded in a quartz-rich bearing ichnofossils strata, at the western side of the Cerro del Corral (37º 45' 47" S/ 59º 09' 29" W, 263 m, Fig. 1). The 3-4 kg for each sample were crushed and sieved to less



than 100µm to obtain zircon crystals. By hydraulic processes the heaviest fraction was separated, and treated with heavy liquids to obtain a fraction enriched in zircons, followed by an electromagnetic separation with a Frantz (CIG, UNLP). The final selection of crystal populations was done by handpicking under a binocular microscope (Fig. 2). The non-abraded zircon crystals were analyzed by isotopic dilution and thermal ionization mass spectrometry (ID-TIMS) at the CPGeo U-Pb Laboratory, University of Sao Paulo, Brazil. Passarelli *et al*. (2009) present the current methodology used at the laboratory on ID-TIMS method.

Figure 2: Composed microphotograph (220X scale) of some studied zircon crystals that shown euhedral to subhedral forms with igneous characteristics.

RESULTS AND DISCUSSION

The zircon crystals obtained from Cerro del Corral pyroclastic levels, show mainly idiomorphic bi-pyramidal type characteristics suggesting acidic igneous origin and reveal few transport from the source (Fig. 2). Despite the efforts trying to work only with very well preserved grains, all analyzed zircons indicated much older ages than the Ordovician-Silurian age of Balcarce sedimentation. Most of $^{207}Pb/^{206}Pb$ ages are close to 2.1 Ga (Fig. 3 a, b) suggesting a main Paleoproterozoic source area for these crystals, representing the typical age of the Tandilia basement. Other source areas could be at about 1.1 and 1.4 Ga. Considering that the Balcarce Formation was not affected by any late tectono-thermal episode, the dispersion and the high discordance degree of the analytical fractions in the Concordia diagram cannot be explained by Ordovician-Silurian metamorphism. Among the 18 analyzed zircon fractions, extracted from volcaniclastic layers, no evidence of an Ordovician-Silurian volcanic episode was obtained, suggesting that these crystals represent a re-working product of previous Paleoproterozoic volcanic rocks.

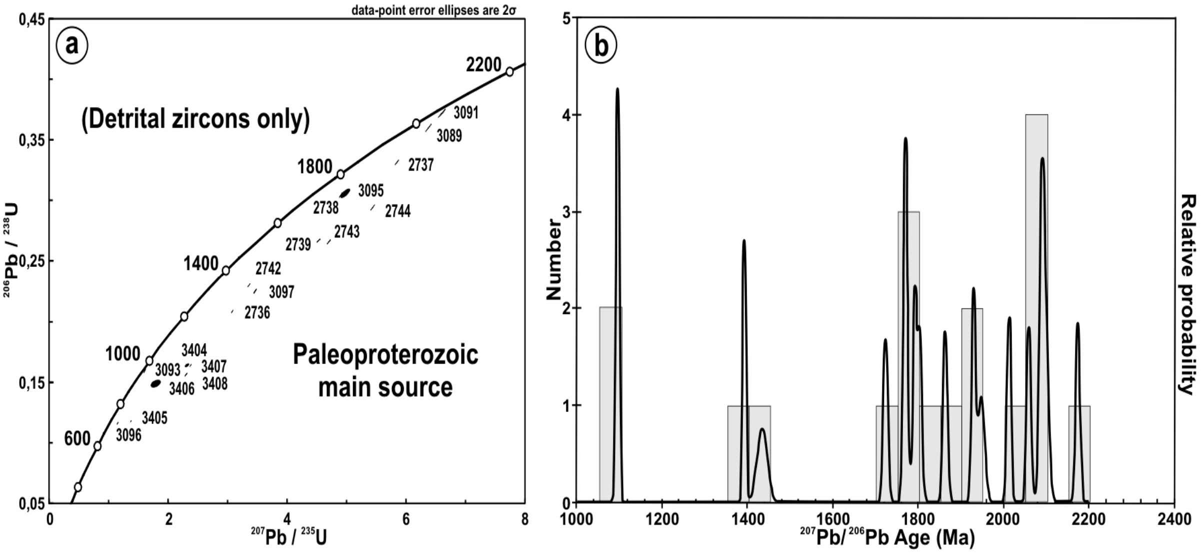


Figure 3: **a.** Concordia-Discordia U-Pb diagram with 18 study zircon fractions. **b.** Relative probability ages in a frequency diagram.

Surprisingly the zircon crystal ages do not represent stratigraphic value for constrains the sedimentation age of the Balcarce Fm. Subsequent hydrothermal processes occur (e.g. kaolinitization) but not affecting the age of zircons. Additional insights on the isotope geochemistry utilizing other methods (SHRIMP or ICP-LA-MS) on individual zircons less than 150μm are currently in progress. In this way the preliminary inferences presented here will be tested.

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