Sm-Nd ISOTOPIC SIGNATURE AND U-Pb SHRIMP ZIRCON DATING OF THE CACHEUTA SUB-BASIN, CUYO BASIN, NW-ARGENTINA

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INTRODUCTION

The Cuyo Basin rift is located in the northwestern Mendoza Province (NW-Argentina), as part of the Argentine Precordillera. It is a Triassic basin which has a very dynamic evolution controlled by climatic and tectonic events during the geological time. Such events influenced directly the basin inception, geometry and depositional evolution, leading to correlation between strata in different regions to be a very difficult task.

The Cacheuta sub-basin consists in one of the most important depocenters of the Cuyo Basin, especially due to its economic potential in hydrocarbon exploration (Chebli et al., 2001). The Cuyo Basin displays a general NW-SE trend, mostly controlled by pre-existing structures (Ramos, 1992) (Fig. 1). The eastern limit of this basin coincides with an important suture generated in the Silurian through the amalgamation of the Cuyania Terrane to the southwestern margin of Gondwana. On the other hand, the western border is a structure that represents the Devonian accretion zone of the Chilenia and Cuyania terranes (Ramos & Kay, 1991) (Fig. 1).

According to Mpodozis & Kay (1990) the extensional tectonic setting of the southwestern Gondwana at the Permian/Triassic boundary is related to processes of crustal thinning, which occurred after the end of the Paleozoic collisional phenomena, as already mentioned. This extensional event was accompanied by an extensive acidic-intermediate volcanism, characterized by andesites, rhyolites, and breccias (Choiyoi Group of Rolleri & Criado Roqué, 1968). The inception of the Cuyo basin, whose sediments were unconformably deposited upon Choiyoi volcanics and Paleozoic sediments, is also result of this generalized extensional setting (Ramos & Kay, 1991).

The aim of this study is to characterize the depositional history of the sedimentary and volcaniclastic deposits related to the active faulted margin of the Cacheuta sub-basin, Cuyo Basin, located near the town of Potrerillos. This work deals with (i) the sequence stratigraphic arrangement of the depositional systems; (ii) the geochronology of the volcaniclastic rocks that occur interlayered with the sedimentary deposits; and (iii) investigation of sediment provenance using Sm-Nd isotopes.

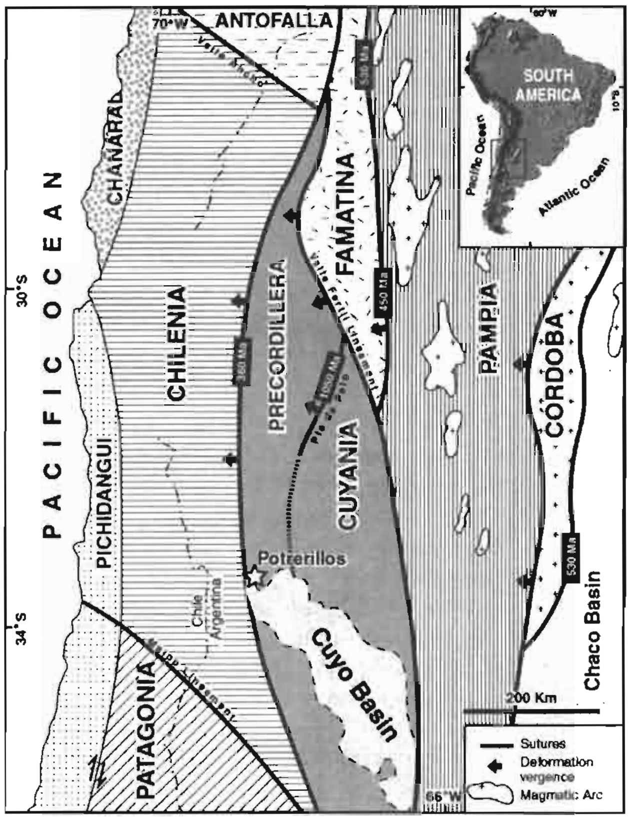

Figure 1. Main exotic terranes and sutures of NW Argentina and location of the subsurface portion of Cuyo Basin. The numbers indicate the approximate ages of the sutures (Ramos, 1995). Star designates the study area.

DEPOSITIONAL SEQUENCES

The composite stratigraphic profile was performed in the Potrerillos section, which comprises the coarse-grained deposits related to the active faulted margin of the Cacheuta sub-basin. The depositional stages correspond to the lowstand, trangressive, and highstand systems tracts of a second-order depositional sequence (the whole record of the Cuyo Basin).

During the initial stages (lowstand systems tract – LST), the active margin of the Cacheuta sub-basin was controlled by tectonic processes that influenced directly in the subsidence rate and quantity and type of material from source areas. The LST encompasses thick conglomerate succession associated with coarse-grained alluvial fans (sheetflood and debris-flow deposits) and pyroclastic flow deposits unconformably deposited upon pyroclastic rocks of the Choiyoi Group. Reddish-brown colored, poorly sorted, crudely stratified or massive, clast- and matrix-supported conglomerates, and interlayered conglomeratic sandstones comprise this basal section, which corresponds in the lithostratigraphy to the Rio Mendoza Formation as described by Borrello (1962). The conglomerate clasts are dominantly of volcanic origin (andesites, rhyolites, pyroclastic rocks), and reach up to 30 cm in diameter (mean diameter around 5 cm). The matrix is coarse sand-sized, and composed also of volcanic fragments. Interlayered with these deposits are rhyolitic, pumice-rich pyroclastic rocks. Expressive action of sheetflood- and debris-flow-dominated alluvial fans was responsible for the initial phase of the deposition in the Cacheuta sub-basin. Tectonics, basin-related volcanism, climate, and source area material were the primary controls on the active faulted margin sedimentation.

The transgressive surface is clearly delineated upon the lowstand deposits. The transgressive systems tract (TST) is composed of at least four parasequence sets which display an overall retrogradational trend. Clast-supported, massive and cross-bedded conglomerates and conglomeratic sandstones dominate the base of the package, while fine-grained sandstones and siltstones with horizontal and climbing ripple laminations are more common towards the top. The volcaniclastic contribution in the TST is very expressive, in the matrix and framework of the conglomerates and sandstones. Shards and pumice are present also in the finer-grained rocks. The TST corresponds, in the lithostratigraphy, to the Cerro de Las Cabras (Frenguelli, 1944) and Potrerillos (Truempy & Lhez, 1937) formations.

The maximum flooding surface was traced on lacustrine black shales of the Cacheuta Formation (Truempy & Lhez, 1937). These rocks have high content of organic matter and constitute the principal source rock for the hydrocarbon accumulations in this basin (Chebli et al., 2001).

The transition from black (Cacheuta Formation) to reddish (Rio Blanco Formation, Fossa-Mancini, 1937) siltstones and shales marked the onset of a progradational trend that characterizes the highstand systems tract. This prograding section begun with the establishment of oxidizing conditions, and continued with the progressively increased sedimentary influx to the basin depocenters by means of lacustrine deltas, which deposited sigmoidal- and cross-bedded sandstones associated with finer-grained rocks. The trend culminated with the deposition of a high-sinuosity, sandy, fluvial facies association, when the sedimentary influx overcame the creation of accommodation space. This phase is associated with thermal subsidence, corresponding to a "sag" basin (Kokogian et al., 1993), and the volcanic contribution in this portion of the succession is subordinated.

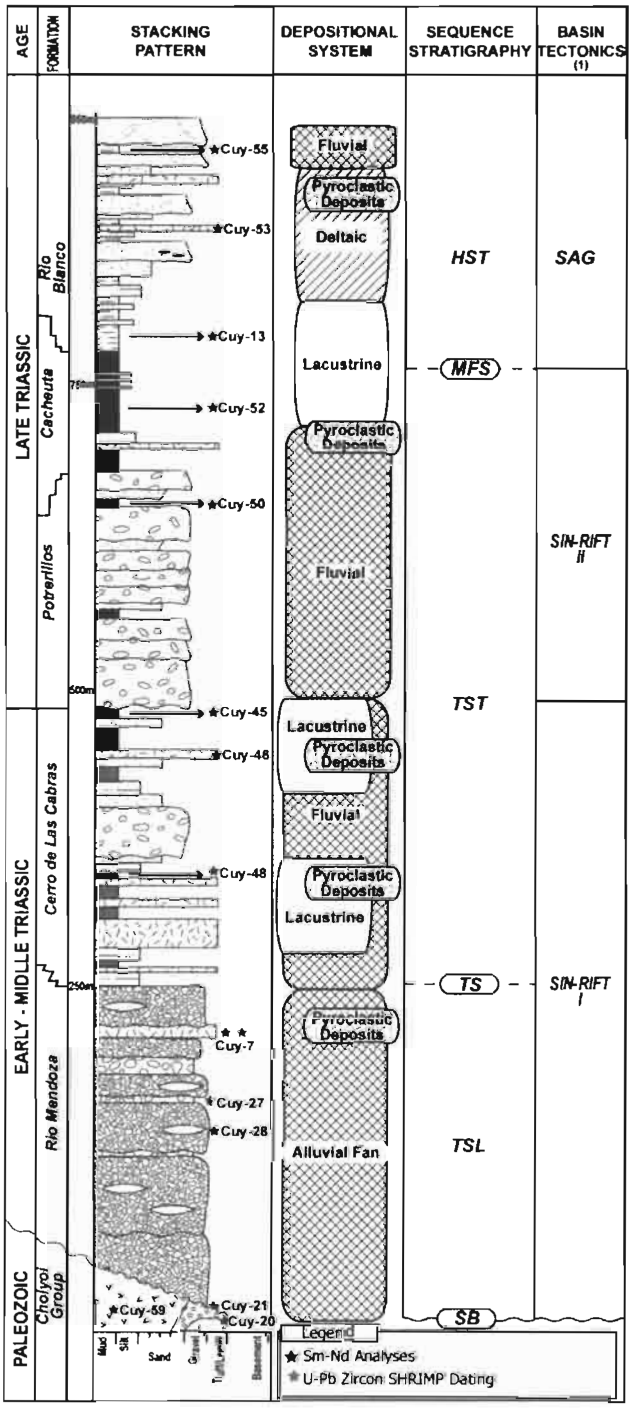

Figure 2. Sequence stratigraphic division chart of the Cacheuta sub-basin faulted margin, showing the stacking pattern, depositional characteristics and the sample location. (1) Kokogian et al., 1993.

U-Pb SHRIMP ZIRCON DATING

The selected sample for the application of U-Pb SHRIMP (Sensitive High-resolution Ion Microprobe) zircon dating is a pumice-rich, lithoclast-free, acidic ignimbrite (pyroclastic flow deposit) interlayered with the basal alluvial fan facies association (lowstand systems tract). The sample was crushed, milled, sieved, and the zircon crystals were separated by conventional magnetic and heavy liquid methods. Zircons were mounted in an epoxy disk with SL-3 and FC-1 standards and studied using petrographic microscopy, BSE and CL images. The U-Pb SHRIMP Zircon analyses were carried out at the Research School of Earth Sciences, Australian National University.

The analyzed zircons are euhedral and inclusion-free crystals, and they are interpreted as having a juvenile magmatic origin. Seven spot analyses in six zircon crystals yielded a 243 ± 4.7 Ma age (Fig. 3), positioning the lowstand deposits of the Cacheuta sub-basin (the Rio Mendoza Formation) in the Early to Middle Triassic.

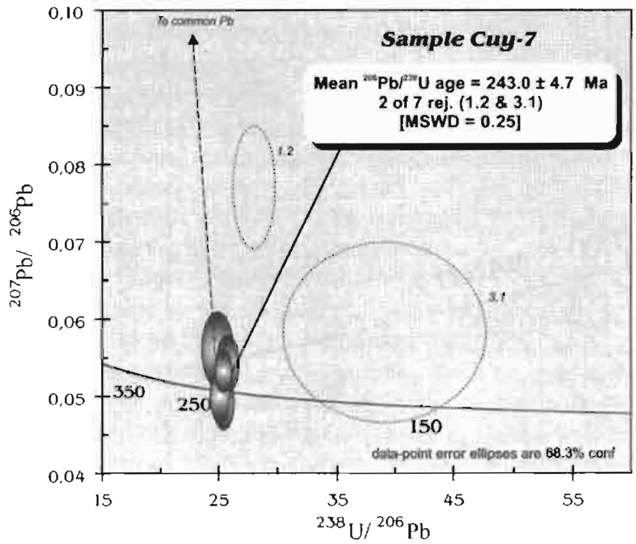

Figure 3. U-Pb SHRIMP zircon Concordia diagram for ignimbrite interlayered with the basal alluvial fan facies association of the Cacheuta sub-basin.

Sm-Nd ISOTOPES

Samples selected for the application of the whole-rock Sm-Nd isotopic analyses comprise: three basement rocks of the Cacheuta sub-basin (Silurian and Permian) and eleven samples of volcano-sedimentary rocks distributed through the sedimentary package (Fig. 2).

Rock powders for Sm-Nd analysis were spiked with mixed ^{149}Sm-^{150}Nd spike and dissolved using an HF-HNO_3 mixture and 6N HCL in teflon vials, warmed in hot plate until complete dissolution. The REE were extracted using a standard AG-50W cation resin; Sm and Nd were extracted using HDEHP-coated Teflon powder. Isotopic compositions were measured with a VG Sector multicollector mass spectrometer at the Laboratório de Geologia Isotópica of Universidade Federal do Rio Grande do Sul. Sm was loaded on Ta filament and Nd on external Ta triple filament (Ta-Re-Ta) with 0.25N H_3PO_4. All analyses are adjusted for variations instrumental bias due to periodic adjustment of collector positions as monitored by measurements of our internal standard; on this basis our analyses of La Jolla Nd average 0.511859 ± 0.000010. During the course of the analyses Nd and Sm blanks were lesser than 750 and 150 pg, respectively.

Sm-Nd data are illustrated in figure 4. Three basement samples of different ages were analyzed. A Sm-Nd model age (T_{DM}) of 1159 Ma and $\varepsilon_{Nd(t)}$ value of -2.1 were obtained for a granodiorite of Silurian age (t = 417 Ma, Cingolani, pers. comm.), exposed in the SE of Potrerillos town. A volcanic breccia of the Choiyoi Group (t = 260 Ma), exposed in the NW of Potrerillos town yielded a Sm-Nd model age of 990 Ma and $\varepsilon_{Nd\ (t)}$ value of -3.1. A model age (T_{DM}) of 867 Ma and an $\varepsilon_{Nd\ (t)}$ of -1.27 were obtained for a Permian syenogranite intrusive in the Silurian granodiorite.

The volcano-sedimentary samples of the Cacheuta sub-basin, black shales, sandstones and tuffs, yield Sm-Nd model ages ranging from 0.90 to 1.34 Ga and ε_{Ndt} values from -5.03 to -0.61.

CONCLUDING REMARKS

U-Pb SHRIMP zircon dating of a lithoclast-free ignimbrite interlayered with basal alluvial fan facies of Cuyo Basin yielded a magmatic age of 243 ± 4.7 Ma, and positioned these lowstand deposits in the Eotriassic to Mesotriassic boundary.

Sm-Nd model ages (T_{DM}) of 0.87 to 1.16 Ga and negative $\varepsilon_{Nd\ (t)}$ values (-3.1 to -1.27) obtained from samples of basement rocks indicate that they are derived from reworked Mesoproterozoic crust (Grenvillian rocks). The volcano-sedimentary samples of the Cacheuta sub-basin show T_{DM} model ages ranging from 0.90 to 1.34 Ga and $\varepsilon_{Nd\ (t)}$ values from -5.03 to -0.61, which are similar to the basement samples and, consequently, indicates that the sediment source areas for the Cacheuta sub-basin were located on igneous rocks from reworking of the Cuyania Terrane.

ACKNOWLEDGMENTS

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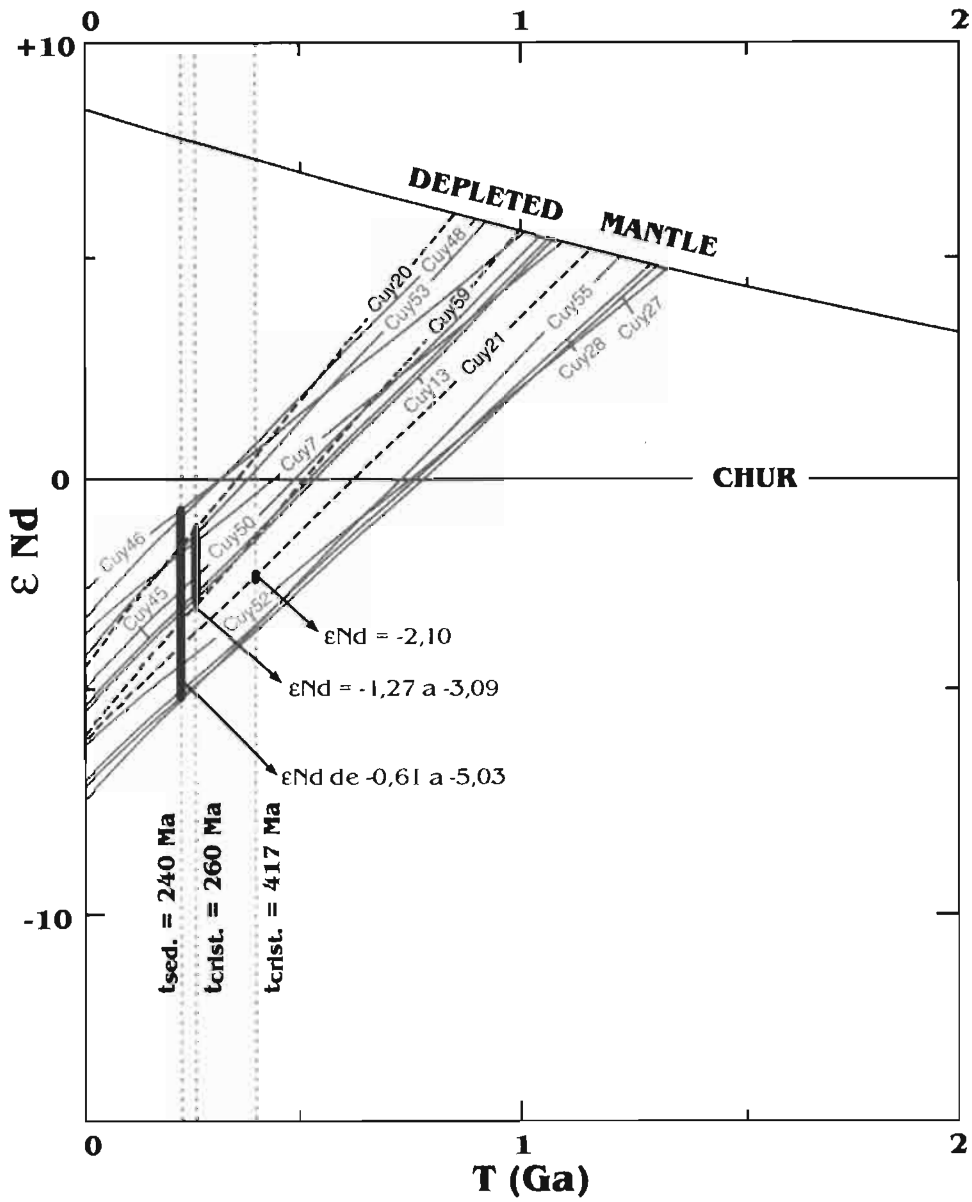

Figure 4. Plot showing εNd for igneous and sedimentary rocks of Argentine Southern Precordillera. Continuous lines correspond to Triassic volcano-sedimentary rocks of the Cuyo Basin, and dashed lines represent igneous basement rocks.