

**PROVENANCE ANALYSIS OF PALEOZOIC SEDIMENTARY SUCCESSIONS  
AT SALAR DE RINCÓN (NW ARGENTINA) - EVIDENCE OF CRUSTAL RECYCLING  
AT THE SW GONDWANA MARGIN \***

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## INTRODUCTION

At the Salar de Rincón (Fig. 1) in the NW of Argentina a sedimentary package from the Lower Ordovician to recent volcanic rocks are exposed (Donato and Vergani, 1985). The geological record of the Paleozoic rocks is of particular interest, as an insight in the crustal evolution is possible using provenance techniques. The oldest rocks are defined by trilobites as Lowermost Tremadoc (Las Vicuñas Formation; Moya et al., 1993) and are strongly folded. Above an angular unconformity follows the Salar de Rincón Formation (uppermost Ordovician to Lowermost Silurian; Isaacson et al., 1976). This unconformity is the only proof of the Oclóyic Orogeny being of Pre-Silurian age in NW Argentina, as in Bolivia the contact between the Ordovician and Silurian is concordant. The Upper Carboniferous red beds of the Cerro Oscuro Formation are overlying discordantly the Silurian deposits, and are in turn overlain by the Permian Arizaro Formation, which includes thick successions of carbonates. We carried out detailed petrographic, geochemical and stable isotope analyses on the entire volcano-sedimentary package to evaluate changes in source composition and the paleotectonic setting.

## RESULTS

The Las Vicuñas Formation (Tremadoc) is composed of coarse volcano-sedimentary rocks, which consist of volcanic debris of felsic derivation, and fine-grained shales. Intercalated volcanic rocks are of rhyolitic composition. The

Salar del Rincón Formation (Early Silurian) displays mature matrix-poor quartz-rich arenites, and Fe-ox rich layers, glacial beds are not preserved. The Cerro Oscuro Formation (Upper Carboniferous) comprises texturally mature but compositionally immature red coarse-grained sandstones and wackes. There are no relicts of volcanic debris. The Arizaro Formation is heterolithic and dominated by volcano-sedimentary facies at the top overlying thick limestones and dolomites. The bottom of the succession comprises mainly fine-grained mature arenites, with quartz and feldspar as dominant phases. Coarser grained beds display lithoclasts from different sources, metamorphic, sedimentary (including Fe-rich grains from the underlying Silurian beds), rarely volcanic. The matrix is < 5% and carbonatic cement as well as calcite grains occur. The carbonates are composed mainly of massive packstones, some of which contain foraminifera (Donato and Vergani, 1985). The dolomites are sparitic and fossil-free. The limestones are grading into red coarse-grained volcanoclastites intercalated with lapilli deposits. The volcanoclastites are dominated by debris from felsic to intermediate extrusives in a carbonate-rich matrix. However, meta- and sedimentary lithoclasts and dolomite fragments are abundant. Reworked volcanic fragments of the Ordovician volcanic rocks can be identified.

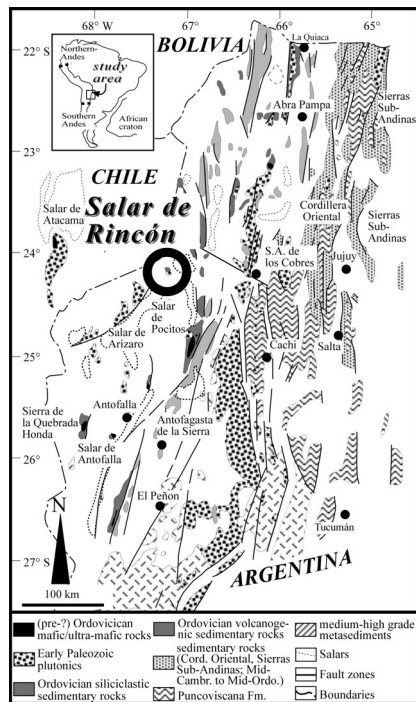


Fig. 1. Outcrop location of the Salar de Rincón in northwest Argentina in the context of the regional geology (from Zimmermann and Bahlburg, 2003).

The geochemistry points to a mainly upper crustal composition (UCC) of the detrital mix in all formations, an exotic component could not be observed. Fig. 2 shows the relation between Th/Sc and Zr/Sc to characterize provenance trends. Starting during the Lower Tremadoc the influence of two different clastic sources, volcanic arc and reworked UCC

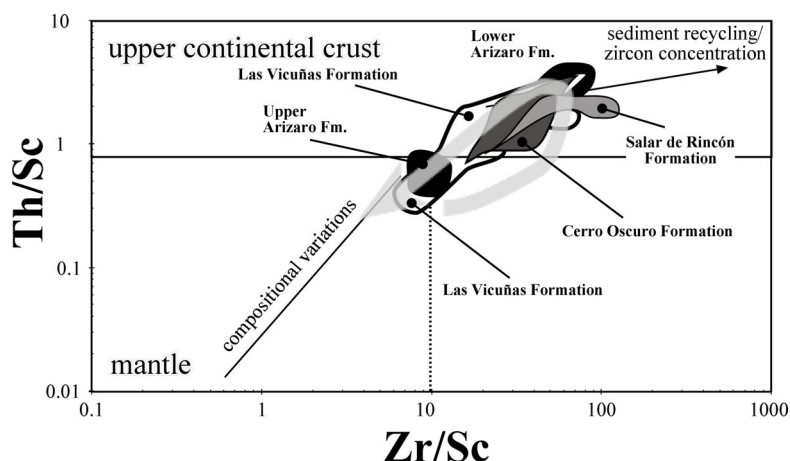


Fig. 2. Th/Sc versus Zr/Sc (after McLennan et al., 1990) ratios demonstrate the evolution during the Palaeozoic in NW Argentina. The grey arrow shows the trend from a volcanic arc setting to a non-volcanic during the Silurian and a probable more continental influenced basin in the Carboniferous and Lower Permian, and finally again a strong volcanic arc influenced environment during the Upper Permian.

material from underlying siliciclastic successions, can be observed. This marks the earliest manifestation of extrusive activity regarding the Puna-Famatina continental arc, which reached its climax during the Arenig (Zimmermann and Bahlburg, 2003). During the deposition of the Salar de Rincón Formation in the Early Silurian this volcanic component disappeared, and only recycled quartz-rich debris is deposited, derived from siliciclastic to volcanoclastic Upper Arenigian and Llanvirnian material from the Puna and Cordillera Oriental. The Cerro Oscuro Formation shows a well-mixed and recycled composition of UCC derivation, an arc component is not visible. The clastic rocks at the base of the Permian succession still reflect the “Carboniferous-signature” (Fig. 2), while the overlying clastic intercalations in the carbonates have a strongly developed continental arc component. In the detritus, fragments derived from the Early Ordovician arc can be recognized. However, these two components cannot be differentiated by geochemical and isotope-geochemical methods (Bock et al., 2000). Stable isotope analyses of carbonates point to  $\delta^{13}\text{C}$  values from -0.7 to +3.6‰ in a range typical for Upper Permian (see Heydari et al., 2000, p. 93), and  $\delta^{18}\text{O}$  values from -2.6 to -9.0‰<sub>V-PDB</sub>.

## CONCLUSIONS

Petrographical and (isotope-)geochemical provenance data indicate that the sedimentary succession at Salar del Rincón, which ranges from the lower Tremadoc into the Permian, records a succession of different paleotectonic settings. These evolved from an active continental margin in the Ordovician to a non-volcanic setting in the Silurian. During the Upper Permian, syn-sedimentary volcanic arc material reappears and is mixed with debris of the older, Ordovician arc. The entire succession is characterized by reworking of UCC-type material from cratonic and continental arc sources, which indicates that crustal recycling played a dominant role also in the evolution of the arc volcanic rocks.

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