PROVENANCE OF ORDOVICIAN AND DEVONIAN SILICICLASTIC SANDSTONES FROM SOUTHERN PERU AND NORTHERN BOLIVIA

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We use provenance analysis as a tool for the paleogeographic reconstruction of the Western Gondwana margin of southern Peru and northern Bolivia during Ordovician and Devonian time. For the study of the siliciclastic sandstones of southern Peru and northern Bolivia different provenance-indicative methods were applied (light mineral, heavy mineral, whole-rock geochemical analysis and geochemistry of tourmalines) in order to get a comprehensive dataset.

The Ordovician sandstones of the Sandia (southern Peru) and equivalent Amutara Formations (northern Bolivia) were deposited in the Peru-Bolivia Through in a back-arc position. The Peru-Bolivia Trough had a NW-SE strike direction and was limited by the Arequipa Massif to the southwest and the Brazilian shield to the northeast. The Ordovician successions have a thickness of up to 7000 m and sediment structures such as current ripples and crossbedding imply a paleocurrent-direction towards the SW. The sandstones of the Sandia and Amutara Formations are mature and relatively quartz-rich but they have a high matrix content of usually well above 20%. To approach the original composition of framework minerals the normative composition was combined with the whole rock geochemistry of the sediments. After recalculation most of the sediments still show a well-recycled nature but indicate a significant larger content of labile components like feldspars and rock fragments. Some of the Sandia Formation sandstones result in having a normative framework composition typical of arc sediments. This arc signature is reinforced by considering the provenance-indicative ratios of immobile incompatible (e.g. La, Th) to compatible (e.g. Co, Sc, Ti) elements, gathered from whole-rock geochemical analysis. Approximately half of the 26 samples from the Sandia and Amutara Formations are felsic, with ratio values typical of sediments of a passive margin setting, whereas the other half is less felsic and preserve characteristics of an active continental margin source. The heavy-mineral spectrum in general and the chemical composition of tourmalines in particular indicate significant reworking of the sediments before deposition. The heavy mineral content is dominated by the stable minerals zircon, tourmaline and rutile (ZTR; mostly more than 90%). Considering the indicative elements Al, Fe, Mg and Ca in the tourmaline chemistry, 85% of the tourmalines from the Sandia and Amutara Formations have a chemical composition typical for metasedimentary protolithes and about 15% for tourmalines grown in granitoids.

The Lower Devonian Cabanillas Group was deposited in a presumably similar plate-tectonic setting to the Ordovician basin. This Group is divided into two sediment successions with different features and location. One succesion (WCo) crops out in the Western Cordillera (near Cabanillas) with a thickness of aproximately 1200m. The other succession (CCo) is preserved on the coastal block, unconformably covering the Arequipa Massif and has only a maximum thickness of 400 m. Paleocurrent direction is towards the East on the WCo site and towards the West on the CCo site. The sediments from the CCo site are significantly less mature than the sediments from the WCo site, as indicated by the normative light mineral content (after recalculation considering the whole rock geochemistry). The CCo sediments contain more rock fragments and feldspar and point to an arc source. This is reinforced by the minor and trace element composition. The average Zr/Sc ratios are 54 and 19 for the WCo and the CCo sites, respectively. This is characteristic for a high degree of recycling at the WCo site and a low degree of recycling at the CCo site, the latter with values close to the upper continental crust composition. From the heavy mineral and the tourmaline chemical analysis both succession show signatures typical for mature sediments. This is demonstrated by the high ZTR content (mostly over 90%) and the high content of tourmalines from metasedimentary sources (WCo: 61,5-67,4% CCo: 100%). The well-recycled nature of the Ordovician and Devonian sediments makes it probable that they originate from a stable inner craton or a reycled older orogen. The additional arc signature from the Sandia Formation could originate from the contemporaneous Ordovician arc or could be an older arc signature. The arc signature of the CCo sediments could be interpreted to support the assumption of a Devonian arc in the region of the Arequipa Massif. Alternatively it could represent an older unidentified arc system. We plan to apply LA-ICP-MS dating of detrital zircons to test the different hypothesis.