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Revealing provenance of quartz-rich sandstones using detrital quartz and zircon as source rock indicators: an example from the Cambrian of NW Argentina

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The most common light and heavy minerals in quartz-rich sandstones are quartz and zircon, respectively. Many studies aiming to trace the source areas of sedimentary rocks concentrate solely on U-Pb dating of zircon. We will demonstrate the provenance-discriminatory potential of combining cathodoluminescence (CL) colour wavelength spectra of detrital quartz with the morphology and in situ U-Pb ages of detrital zircon grains. The shallow-marine Cambrian Mesón Group in NW Argentina is particularly well-suited for a test of the combined quartz and zircon methodology, because it is dominated by non-metamorphosed sandstones having > 90 % quartz. Among the heavy minerals, zircon prevails. Whole-rock element chemical compositions indicate main input from felsic source rocks (Th/Sc > 1.0). Hence, transport of sedimentary material dominantly occurred from rocks containing quartz and zircon. Therefore, the use of these minerals as provenance indicators will reveal characteristics of the major sources. Quartz CL wavelength spectra typical for red, violet and bright blue luminescent quartz grains, as well as zircon grains having mainly oscillatory zoning, point to a dominance of magmatic source rocks. Brown-luminescent grains of metamorphic origin are rare. In the stratigraphically oldest unit of the Mesón Group (Lizoite Formation), volcanic quartz grains are common (> 30 %). Most zircon grains are euhedral and yield ages between 510 and 600 Ma, correlating with zircon ages from exposed magmatic rocks proximal to the depositional basin. Input from local and regional igneous complexes and the Sierras Pampeanas in the south suggests direct detrital transportation paths of ca. 100-1000 km. The geographical position of the source areas suggests that most of the transport took place via marine currents within the Mesón Group basin itself. Together with the low degree of abrasion and a dominance of zircons formed during one single growth stage, this suggests that the arenites may represent first-cycle sand. In the stratigraphically upper parts (Campanario and Chalhualmayoc formations), the majority of quartz grains are of plutonic origin, whereas few are volcanic. Here, zircons of 550-700 Ma age are dominant. These zircons can partly be traced to igneous rocks of the Sierras Pampeanas. Presently unexposed or eroded rocks around the Mesón Group basin may have contributed further detritus. Alternatively, the Goiás Massif of the Brasília belt in central Brazil may have been an important source area. In that case, the far-travelled zircon grains probably were transported over the Río de la Plata Craton considering the presence of Transamazonian-aged grains (ca. 2 Ga). A higher degree of roundness and multiple growth zones in grains with inherited Transamazonian age suggest that these quartz-rich arenites represent multi-cycle sand. Our study shows that quartz-rich sandstones with a similar petrographic and whole-rock chemical composition throughout a studied sedimentary sequence may contain vital information about detrital transportation path changes.