Paper Number: 4327

Source to sink – or sink to sink? Sedimentary recycling and its effects on detrital zircon-based provenance analysis

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Sedimentary provenance analysis based on detrital zircon U-Pb age data and Lu-Hf isotope data is based on the assumption that there is a predictable relationship between the original source of a zircon (the *protosource*) and the sedimentary basin in which it was finally buried. However, many sedimentary basins have been filled with material eroded off older sedimentary rocks rather than from the protosource in crystalline bedrock. Although such sedimentary recycling is commonly recognized in priniciple, its real consequences for provenance analysis are rarely taken into account in attempts to deduce source-to-sink sedimentary pathways [1]. The consequences of recycling may be particularly detrimental in a supercontinental setting, where material from basement blocks that now form part of different continents may have been mixed and deposited in intracontinental basins [2].

Permian to Triassic sandstones in the northeastern part of the Main Karoo Basin of South Africa were deposited along the northern margin of an intracontinental basin of the Gondwana supercontinent. A large amount of observational data indicate that material in this part of the basin originated from present-day north, i.e. from the Archaean Kaapvaal Craton and the Mesoproterozoic Namaqua-Natal Belt [3,4,5]. However, detrital zircon U-Pb and Lu-Hf data show a dominance of late Mesoproterozoic and Neoproterozoic protosources, which cannot be distinguished from sandstones in stratigraphically higher parts of the Karoo Supergroup (upper Beaufort and Stormberg Groups), which are generally thought to be sourced in the Gondwanide orogen to the present-day south [3,4]. Archaean zircon (potentially from the Kaapvaal Craton) is very scarce throughout the sequence. Hf isotope signatures of the Mesoproterozoic zircons do not match with potential protosource rocks in the Namaqua-Natal Belt, but correspond closely to detrital zircon populations in some of the Neoproterozoic sedimentary rocks of the region (e.g. in the Saldania and Damara Belts). The most likely origin of the detrital zircon stored in the sandstones of the Karoo Supergroup is recycling of earlier sedimentary rocks in southern Africa, in particular from sequences deposited during formation of the Gondwana Supercontinent. The absence of Archaean material in sedimentary rocks sourced in the north may be explained by the previous existence of a Meso- to Neoproterozoic sedimentary cover that was removed by recycling into the Cape-Karoo intercontinental basins. A similar scenario can be invoked for Cenozoic sediments deposited in eastern South Africa, which are also virtually free of Archaean material, but show detrital zircon distributions similar to that of the Karoo Supergroup, suggesting that recycling has dominated over primary basement sources.

In a setting where recycling processes are important, material from many different protosources may have contributed, and no data from recycled detrital zircons can give a realistic indication of sediment routing from older sinks that act as sources to the younger sedimentary sink.

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