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Provenance and recycling of Arabian desert sand

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This study seeks to determine the ultimate origin of aeolian sand in Arabian deserts by high-resolution petrographic and heavy-mineral techniques combined with zircon U-Pb geochronology. Point-counting is used here as the sole method by which unbiased volume percentages of heavy minerals can be obtained. A comprehensive analysis of river and wadi sands from the Red Sea to the Bitlis-Zagros orogen allowed us to characterize all potential sediment sources, and thus to quantitatively constrain provenance of Arabian dune fields. Two main types of aeolian sand can be distinguished. Quartzose sands with very poor heavy-mineral suites including zircon occupy most of the region comprising the Great Nafud and Rub' al-Khali Sand Seas, and are largely recycled from thick Lower Palaeozoic quartzarenites with very minor first-cycle contributions from Precambrian basement, Mesozoic carbonate rocks, or Neogene basalts. Instead, carbonaticlastic sands with richer lithic and heavy-mineral populations characterize coastal dunes bordering the Arabian Gulf from the Jafurah Sand Sea of Saudi Arabia to the United Arab Emirates. The similarity with detritus carried by the axial Tigris-Euphrates system and by transverse rivers draining carbonate rocks of the Zagros indicates that Arabian coastal dunes largely consist of far-travelled sand, deposited on the exposed floor of the Gulf during Pleistocene lowstands and blown inland by dominant Shamal northerly winds. A dataset of detrital zircon U-Pb ages measured on twelve dune samples and two Lower Palaeozoic sandstones yielded fourteen identical age spectra. The age distributions all show a major Neoproterozoic peak corresponding to the Pan-African magmatic and tectonic events by which the Arabian Shield was assembled, with minor late Palaeoproterozoic and Neoarchean peaks. A similar U-Pb signature characterizes also Jafurah dune sands, suggesting that zircons are dominantly derived from interior Arabia, possibly deflated from the Wadi al-Batin fossil alluvial fan or even from Mesozoic sandstones of the Arabian margin accreted to the Cenozoic Zagros orogen. Due to extensive recycling and the fact that zircon is so resistant to weathering and erosion, the U-Pb age signatures are much less powerful a tracer of sedimentary provenance than framework petrography and heavy minerals. Actualistic provenance studies of dune fields at subcontinental scale shed light on the generation and homogenization of aeolian sand, and allow us to trace complex pathways of multistep sediment transport, thus providing crucial independent information for accurate palaeogeographic and palaeoclimatic reconstructions.