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Quantifying the provenance of dune sediments in the Taklimakan desert using multidimensional scaling and sediment source fingerprinting

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Study of windborne sediments in the Taklimakan Desert is of great significance in the context of global change. Much effort has gone into characterizing the Taklimakan dune sediments, but quantitative understanding of the source contributions from the surrounding mountains is lacking. Accordingly, using elemental data, we applied multidimensional scaling (MDS) and sediment source fingerprinting (SSF) to examine homogenization of the dune sediments in the desert, and to quantify the contributions of key sources. The results underscored the heterogeneity of geochemistry in dune sediments in the Taklimakan Desert. On the basis of dominant wind directions and the drainage network in the Tarim Basin, as well as lithologic features in the surrounding mountains, potential sources of sand dune sediments comprised three groups: “Tianshan”, “Pamirs-Kunlun”, and “Kunlun-Altun”. Using the FingerPro and MixSIAR fingerprinting models our results suggested that the contributions of the three sources to the target dune sediments were: “Kunlun-Altun” > “Pamirs-Kunlun” > “Tianshan”. However, substantial variations in the respective contributions were observed for different target dune samples. Although both the frequentist and Bayesian models performed well in the calculations of the relative source proportions based on goodness of fit (GOF) (0.97 on average for the two models respectively), virtual mixtures (VM) tests indicated that the frequentist model returned more accurate predictions. Consequently, using the frequentist results, we propose that the “Kunlun-Altun”-derived sediment (an average of 56%) is mainly delivered to the Taklimakan Desert via fluvial transport; sediment supply from the “Pamirs-Kunlun” source (33%) depends on fluvial and wind transport and that aeolian processes are mainly responsible for distribution of the “Tianshan”-derived sediment (11%) in the desert by transporting the fine fraction. Our findings thereby highlight the interaction between fluvial and aeolian transport within the Tarim Basin.