Haze and pollution sources over the Grand Canyon and Canyonlands National Parks

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Daily samples of total suspended particulates (TSP), particles ≤ 2.5 μm ($PM_{2.5}$), trace gases, and organic compounds were collected in the Grand Canyon (AZ) and Canyonlands (UT) National Parks in the summers (July and August) of 2001 and 2002 and in the winter (December-January) of 2001-2002. Factor analysis based on the trace elements in the TSP and $PM_{2.5}$ samples reveals a persistent regional signal from a mixture of crustal materials, coal flyash, and aged pollution. In addition, a signal from power plant emissions is present in each area. The regional signals at both parks account for one-third of the source variation. For the Grand Canyon, a number of anthropogenic signals, including a source for rare-earth elements and a source for Cu, Mo, Ag, and Cd, are present in the summer. In winter, a local pollution source, loaded with almost all the pollution elements, is dominant; this contributes ~40% to the total variation. In contrast to the Grand Canyon, Canyonlands has less distinctive pollution sources in summer. The atmosphere there carries signatures of smelters that are enriched in pollution elements such as Cr, Ni, and rare-earth elements. During the winter at Canyonlands, however, many individual pollution sources (primarily smelters) were evident. The chemical data clearly show that the main long-range transport pathway for pollution in summer is via southwesterly winds at both parks. During that season southeastern California, central northwestern Arizona, and southern Arizona are the major source regions of pollution. In winter, pollution comes from the Salt Lake City area (UT) due to northerly or northwesterly transport patterns. Seasonal forest fire signals also were present in the summer.

Use of Zr/Rb ratios in Chinese loess sequences to trace paleo-winter monsoon winds strength

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The long-term dust accumulation sequences on the Chinese Loess Plateau (CLP) provide a valuable opportunity to study the evolution of East Asian winter monsoon strength. Grain size of bulk samples (MSGB) of loess deposits, though widely used, is a modified measure of the strength of winter monsoon wind due to modification by post-depositional weathering and pedogensis. Here, an elemental tracer is introduced to provide new insight into the original information of aeolian deposits.

Zr is associated with the coarse-grained fractions of loess deposits while Rb is enriched in fine-grained fractions; enrichments of Zr and Rb occur in paleosols resulting from postdepositional weathering of soluble species (e.g. carbonates) but the Zr/Rb ratio remains unchanged. Therefore, the Zr/Rb ratio can reflect the grain size variations of paleodusts without pedogenic effects.

Zr/Rb ratios in six loess-paleosol sections on the CLP encompassing the last 130ka display a generally similar pattern to that of MGSB record, i.e. higher in loess samples and lower in paleosols. Though a positive correlation exists between the Zr/Rb ratio and MGSB, the correlation coefficient obviously decreases in southern and eastern sections where intense pedogenesis occurred in relatively warm and humid climates. The long-term Zr/Rb variation in the Lingtai section exhibits similar amplitude and frequency to those in the MGSB and mean grain size of quartz particles (MGSQ, a more reliable proxy than MGSB) in the upper loess-paleosol sequence over the past 2.6 Ma. However, for the underlying red clay formation over the past 7~ 2.6 Ma interval, MGSB record is relatively stable, whereas both the Zr/Rb ratio and MGSQ show distinct variability, and display similar amplitudes to those observed in the overlying loess-paleosol sequence. These results demonstrate that the Zr/Rb ratio reflects original eolian grain size and may be served as a reliable index for indicating the strength of East Asian winter monsoon winds.

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