Source tracing of heavy metal elements in the upper reaches of the Pearl River: a comprehensive study from multi-isotopic systems

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Heavy metal pollution in southwestern China is an important social and environmental issue. According to the data from the China Geological Survey, more than 80% of the heavy metals in the southwestern karst area are caused by the high geologic background. Carbonate rocks are dominant in the upper reaches of the Pearl River, and these bedrocks have lower levels of heavy metals (especially iron-family elements). However, studies have shown that when the carbonate rocks are weathered into soil, heavy metal elements produce significant secondary enrichment, which may be the key cause of heavy metal pollution in karst areas of southwestern China. In addition, black rock series in southwestern China are widely distributed. The formed soil contains a variety of toxic heavy metal elements, which is a potential "natural source" of heavy metal pollution in the soil and has received extensive attention. A small amount of Permian Emeishan basalt is also distributed in the Pearl River source area. Isotope source tracing of heavy metal elements was previously used to distinguish between anthropogenic activities and natural sources, while commonly ignoring the influence of weathering from different lithological end members.

In order to identify the contribution of different lithologic natural weathering to heavy metals in the Pearl River catchment, we systematically sampled river water, riverbed sediments, soils and bedrocks in small mono-lithological watersheds flowing through carbonate rocks, basalts and black rock series. These small watersheds are rarely affected by industrial activities, and heavy metals are mainly derived from the natural weathering of bedrock. Moreover, in order to avoid the limitations of single isotope in source analysis, we performed a comprehensive analysis of the Sr, Nd, Pb, and Zn isotopes (and Cd isotope to be analyzed). The initial results show that the $^{87}Sr/^{86}Sr$ vs. ε_{Nd}, $^{208}Pb/^{207}Pb$ vs. $^{206}Pb/^{207}Pb$ plots can distinguish carbonate rocks, basalts and black rock series well. In the Zn concentration vs. $^{66}Zn/^{64}Zn$ plot, the distinction between carbonate rock and black rock series is relatively poor, but can be easily distinguished from basalts. Therefore, by coupling these isotopes and using mass balance equations, it is expected obtain more reliable results in source identification of heavy metals in the Pearl River catchment.