'Zircon effect' alone insufficient to generate seawater Nd-Hf isotope

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Many studies have suggested that continental contributions must be required to balance the oceanic dissolved Hf budget, the question whether the offset of oceanic Nd-Hf isotopes from the terrestrial array could be fully generated by 'zircon effect' during continental incongruent weathering is still not well constrained. Previous mass balance calculation suggested that the seawater Hf-Nd isotopic array can be generated by weathering of up continental crust (UCC) with 65–70% of Hf retained in zircons (namely the 'zircon effect'). However, such model bears a premise that zircons in the UCC were formed when the continental rocks were extracted from the mantle. Obviously this requirement could hardly accord with the actual history of UCC growth and evolution. In most cases, zircon crystallization ages seldom equal the bulk rock Hf or Nd isotopic model ages which roughly represent the extraction time of crusts from the mantle.

The combination of crystallization ages and Hf-isotopes of detrital zircons from modern rivers, provide a new perspective to assess the above question in a quantitative and more reliable way. In this study, we calculated model values of Nd-Hf isotopic compositions for the zircon free part of the upper continental rocks based on published data of modern global riverine sand detrital zircons. The results strongly suggest that the elevated Hf isotopic compositions in seawater cannot be fully explained by 'zircon effect' alone. Further studies on other processes, such as submarine hydrothermal activity and/or incongruent weathering of other minerals besides zircon, are needed to explain the offset of oceanic Nd-Hf isotopes from the terrestrial array.

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Diagnostic fluid inclusions of different hydrothermal systems

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This paper attempts to setup a scientific linkage between ore geology and fluid inclusions, considering that in previous works, observations and measurements of the fluid inclusions were not well interpreted. Geological data did not agree with the results obtained from fluid inclusion studies. In this paper, we classify hydrothermal deposits into three types: 1) intrusion-related hypothermal systems, such as porphyry-systems, breccia-pipes, IOCG and skarns; 2) orogenic- or metamorphic hydrothermal type; and 3) epizonogenic hydrothermal ores including epithermal, sedimentary hosted low-temperature deposits such as Carlin-type gold, and submarine hydrothermal venting system such as VMS and SEDEX. In this work we select diagnostic geological and fluid-inclusion characteristics of these ore-systems, and clarify their key differences that can be used as genetic markers. Ore-fluids are classified into three end-members, namely epizonogenic, metamorphic and magmatic fluids. Many ore-systems are known to form as a result of multiple fluids during multi-stage events; and their late-stage of mineralization always being caused by fluids with a high-proportion of epizonogenism of the original ore systems or by renewed fluid flow. Therefore, the features of late-stage fluids, alteration and mineralization cannot be used to identify the origin and genetic type of an ore-system. Instead, we suggest that only the early-stage signatures can be employed to determine the origin and type of an ore-system. Epizonogenic fluids are characterized by low-temperature (<300°C), low-salinity and low-content of CO_2; metamorphic fluids by moderate-temperature, low-salinity and high-content of CO_2; and magmatic fluids by high-temperature, high-salinity and variable content of CO_2. Magmatic hydrothermal ore-systems contain daughter mineral-bearing fluid inclusions; metamorphic ore-systems contain low-salinity CO_2-rich fluid inclusions; and the epizonogenic hydrothermal ore-systems contain neither daughter mineral-bearing nor CO_2-rich/bearing fluid inclusions, but are populated by aqueous inclusions.