Disturbance of the Hf-W systematics during alteration processes

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The ^{182}Hf-^{182}W chronometer is commonly used to investigate early processes in the solar system. Many meteorites experienced however mild to severe aqueous alteration and the consequences of this process on the Hf-W systematics have not been considered so far. Here we aim first at studying experimentally the relative mobility of hafnium and tungsten during alteration of meteorites, and second at exploring the consequences of the different Hf-W mobility in the fluid on the ^{182}Hf-^{182}W isochrons.

Two powdered rocks, taken as analogues of the meteoritic silicates (dunite and lherzolite), were reacted separately in water at 110°C in close and semi-open reactors in batch system, for 10 days and without shaking. The initial pH of the solution was either 4 or 8. Batch experiments confirmed that W is much more mobile than Hf, resulting in a strong Hf/W fractionation during alteration processes. Thanks to the chemical composition monitored in the solution and in the remaining solid throughout the experiment, the silicate dissolution rate could be related to the variation of the Hf/W ratio during lixiviation.

A model is proposed to take into account the Hf-W fractionation induced by alteration, when applying the ^{182}Hf-^{182}W short-lived radiochronometer to altered meteorites. Apparent ages may have been modified by several million years due to the disturbance of the Hf/W ratio. This observation leads to carefully consider calculated ^{182}Hf-^{182}W ages for highly weathered meteorites like CR2 chondrites. Alteration under basic conditions, especially if it occurred before Hf was extinct, leads to a more significant disturbance of the Hf-W isochrons than alteration in an acidic medium.