

Geochemistry and petrology of nephritites from Hetian, China

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A combined study of petrology, mineralogy and stable geochemistry was carried out for nephritites from the Hetian nephrite deposit located in the northern part of the Kunlun Mountains, south of the Tarim Basin, Xinjiang, China. Nephritites from the deposit consist mainly of tremolite, with minor diopside and calcite, and display three main textures: coarse-grained porphyroblast, deformed slender, and fiber crystals of recrystallization. Petrographic observations and backscattered electron imaging revealed two replacements: tremolite replaces dolomite marble (Dol→Tr), or diopside replaces dolomite marble, then tremolite substitutes diopside (Dol→Di; Di→Tr). The nephritites are enriched in light rare earth elements (LREE), but depleted in heavy rare earth elements (HREE) (ΣREE , $1.74 \times 10^{-6} \sim 6.82 \times 10^{-5}$; $\Sigma\text{REE}+\text{Y}$, $2.03 \times 10^{-6} \sim 7.71 \times 10^{-5}$), having apparent Eu negative anomaly ($\text{Eu}/\text{Eu}^* = 0.15-0.97$) without apparent Ce anomaly ($\text{Ce}/\text{Ce}^* = 0.79-1.04$). Their Cr and Ni enrichments (1.91 ppm to 307.4 ppm and 2.68 ppm to 352.1 ppm, respectively) are much less than serpentinite-related nephritites. Some high field strength elements and large ion lithophile elements are moderately enriched. Their $\delta^{18}\text{O}$ values range from 2.38 to 11.27 ‰, and $\delta\text{D} = -55.66$ to -102.75 ‰, corresponding to fluid isotope compositions of $\delta^{18}\text{O} = 12.15$ to 22.42 ‰, and $\delta\text{D} = -34.94$ to -81.82 ‰, suggesting that the fluids are within, or just adjacent to, the metamorphic water field. Based on these geochemical characteristics and occurrence, it is inferred that igneous rock fluids and sedimentary rocks provide the main ore material for the Hetian nephrite deposit.

Re-thinking of the isotope mass-independent fractionation (MIF) definition

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Otake *et al.* [1] questioned the coefficient of mass-dependent fractionation of sulfur isotopes used in the definition of mass-independent fractionation (MIF) phenomena. That coefficient was deduced approximately at high temperature limit from the Bigeleisen-Mayer equation and is obviously not constant for different temperatures or compounds. The theoretical base of MIF research has hence been challenged.

Here, we deduce out a formula to calculate such coefficients without any approximations. Then, we calculate the coefficients of O and S isotope systems approximately at a theoretical level beyond the Urey model. Several very interesting things have been found: 1) Our results generally agree with the results of Otake *et al.* [1], the coefficients are varied at different temperatures or compounds. 2) If we use a logarithm-type expression for the small delta as recently advocated by many researchers, the coefficients in the MIF definition are no longer dramatically varied. They are almost constant for the whole temperature range and for different compounds. In another word, the way of using a sole coefficient in such MIF definition could be justified. 3) For O isotope systems, our results suggests the slope of the 'exact' mass-dependent equilibrium fractionation line (MDFL) is different from that of terrestrial fractionation line (TFL) which is established by experimental results. The slope of MDFL calculated by us is about 0.528-0.529 at 0-300°C for gaseous molecules, larger than the 0.524 used by many researchers. This finding let us speculate the causes lead to this difference.

[1] Otake *et al.* (2008) *Chem. Geol.* **217**, 315-329.