



Carbonated Ophiolitic Peridotites (Listvenite) from Iran: isotopic evidence and element mobility

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In Iran, listvenites (fully quartz-carbonate altered peridotites) are commonly associated with Late Cretaceous ophiolites. Despite the abundance of carbonate alteration in these ophiolites, there have been few studies of these rocks, including isotopic investigations into the source of fluids [1, 2] and element mobility due to this alteration [3]. Here, we provide constraints on the sources of altering fluid by using the stable (C, O) and radiogenic (Sr) isotopes and report on element mobility associated with listvenitization of ophiolitic peridotite in the Hangaran area of Birjand, Iran.

In the Sistan Suture Zone (SSZ) of eastern Iran, this alteration focused along faults and shear zones. The Birjand ophiolites occur within the SSZ and represent obducted parts of Neotethys oceanic crust. Carbonate alteration replaces silicates such as olivine and pyroxene and led to complete carbonation of peridotite. The assemblage of quartz + magnesite (\pm dolomite) + relict Cr-spinel \pm sulfide is characteristic of listvenite here, and we distinguish silica-listvenite from silica-carbonate listvenite on this basis.

Carbon, O and Sr isotopic compositions of partially serpentinized peridotites, variably carbonate-altered serpentinites and listvenites are used to constrain the origin of the fluid involved. The $\delta^{13}C_{VPDB}$ and $\delta^{18}O_{VSMOW}$ isotope compositions of peridotites and serpentinites range from -8.46 to -1.77‰ and 12.74 to 24.11‰ respectively, whereas the age-corrected $^{87}Sr/^{86}Sr$ ratios range from 0.7065 to 0.7071. The $\delta^{13}C_{VPDB}$, $\delta^{18}O_{VSMOW}$ and $^{87}Sr/^{86}Sr$ values in listvenites and associated dolomite veins range from -8.74 to -0.87‰ 15.17 to 23.83‰ and 0.7061 - 0.7079, respectively. A pelagic limestone sample in the vicinity of the study area has the heaviest $\delta^{13}C_{VPDB}$ and $\delta^{18}O_{VSMOW}$ compositions of 1.96‰ and 25.42‰ and $^{87}Sr/^{86}Sr$ ratio of 0.7078. The stable isotopic composition of the altered ultramafics, listvenites and veins are comparable with Oman listvenites [4] but the $^{87}Sr/^{86}Sr$ ratios are lower and comparable to those of pelagic limestone and global Late Cretaceous seawater values. This indicates that the listvenitising fluids in the Hangaran area were dominated by seawater and further suggests that this alteration occurred on the seafloor and/or during obduction in Late Cretaceous time.

Major element patterns show significant changes from peridotite to listvenite especially for LOI, Mg and Si. The transition from serpentinite to listvenite is evidenced by concentration of Mg and LOI in magnesite and Si in quartz, leading to two types of silica and silica-carbonate listvenites. Trace element patterns show enrichment of fluid-mobile elements such as Li, Rb, Cs, Sb, Mo, Sn, As and S in silica-listvenite and Ba, U, Sr and Pb enrichment in silica-carbonate listvenite if compared to serpentinite and peridotite protoliths. Major and trace element patterns suggest mass-transfer due to interaction of hydrothermal CO₂-bearing fluid possibly derived from seawater and/or surficial fluids with peridotite protolith.

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