

H-O isotopes and water content in nominally anhydrous minerals from UHP eclogite in the Dabie orogen

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Fluid activity during subduction-zone metamorphism is an important issue with respect to chemical geodynamics of continental collision. In particular, it has been intriguing where retrograde fluid comes from during exhumation of deeply subducted continental crust. Mineral water concentration and stable isotope analyses are a powerful means to decipher the origin and nature of aqueous fluid in UHP metamorphic minerals. Using a stepwise heating procedure, a number of FTIR analyses demonstrate that only molecule H₂O is removed from garnet from eclogite, without significant loss of structural OH. A TC/EA-MS online method, together with the stepwise heating procedure, is used to determine both H isotope ratios and concentrations of total water and structural hydroxyl in nominally anhydrous minerals from UHP eclogite at Bixiling in the Dabie orogen, China. The results show total H₂O concentrations of 1791 to 2997 ppm in omphacite and 522 to 981 ppm in garnet, and hydroxyl concentrations of 1242 to 2808 ppm H₂O in omphacite and 279 to 747 ppm in garnet. Except for quartz which has a higher concentration of molecule H₂O (189 ppm) than structural hydroxyl (117 ppm), all of the other minerals have much higher concentrations of structural hydroxyl than molecule H₂O. The eclogite has total water δD values of -112 to -92‰ for omphacite and -98 to -94‰ for garnet; structural hydroxyl δD values of -91 to -85‰ for omphacite and -87 to -72‰ for garnet. It appears that the total H₂O is depleted in D relative the structural OH in the nominally anhydrous minerals. The nominally anhydrous minerals have similar δD values to each other, but are lower than δD values of -59 to -58‰ for muscovite. On the other hand, hydroxyl δD values for the nominally anhydrous minerals are close to hydroxyl δD values for hydrous minerals. Laser fluorination analysis obtained that the eclogite has an $\delta^{18}O$ value of 2.5‰ for zircon, 2.7 to 3.7‰ for garnet and 3.3 to 4.5‰ for omphacite. They are lower than normal mantle zircon $\delta^{18}O$ values. Both O and H isotope equilibrium and disequilibrium occur between coexisting omphacite and garnet, but retrograde metamorphism occurred with internal buffering of stable isotope compositions. Thus both O and H isotope signatures of minerals from the eclogite indicate incorporation of meteoric water into eclogite protolith by high-T hydrothermal alteration and subsequent magmatism. The meteoric signature was preserved in the UHP minerals during the subduction of continental slab, with only limited activity of fluid within the slab. Nevertheless, fluid became available during exhumation due to a decrease in water solubility with pressure decrease. Therefore, exsolution of structural hydroxyl and molecular water from the minerals is the most plausible source for the retrograde fluid.

A fractal concentration-mass method for geochemical anomaly separation in Shizhuyuan tungsten deposit area

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Anomaly separation plays an important role in mineral exploration. A fractal concentration-mass (C-M) method was presented for separating geochemical anomalies from background. The method is derived from Mandelbrot's coastline length-ruler model by replacing the length with mass and ruler with concentration. In log-log plot, the concentration-mass pattern follows the fractal distribution with uni-scale or multi-scale, which was used to discriminate geochemical processes and to separate geochemical anomaly from background.

The C-M method was tested on stream sediment geochemical data in Shizhuyuan tungsten deposit area, Hunan province in China. The stream sediments were sampled using grid method by 31 multiply 31 kilometers with one sample per square kilometer (n=961). Six elements, W, Sn, Pb, Ag, Ni and Ba, were selected to test the C-M method in this area, in which W, Sn, Pb, Ag with mineralization and Ni, Ba without. The results indicated that multi-scale fractal or mixing-dominant geochemical processes was occurred in this area and the anomaly can be separated from background efficiently. Compared with the typical method (anomaly determined by average plus double standard deviation), the anomaly area of W, Sn, Pb, Ag determined by C-M method is evidently smaller (with larger anomaly value) and more coincident with known deposit sites, and the anomaly area of Ni, Ba is distinctly larger (with smaller anomaly value) and more consistent with the Devonian and pre-Cambrian strata area respectively. Therefore, the C-M fractal method is efficiently in separating geochemical anomaly from background with good qualities in aiming at deposit target promptly or in avoiding losing weak anomaly information.