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アリゾナ州ガーネットリッジに産するガーネットの多様な化学組成及び包有物/離溶相—コロラド高原下部におけるマントル交代作用
Chemistry & inclusion/lamella mineralogy of garnet from the Garnet Ridge; Information of multi-stage mantle metasomatism

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Wide chemical variations and characteristic inclusion mineralogy are recognized in garnet xenocrysts and garnets in xenoliths from the kimberlite diatreme (ca. 30 Ma) at the Garnet Ridge in the Navajo volcanic field, Colorado Plateau. These garnets show the lithologies at a wide range of depths from crustal depths to deep mantle and imply the multi-stage metasomatism underneath the Colorado Plateau.

On the basis of major element chemistry, the garnets from the Garnet Ridge have been classified into the following 10 groups: A) Cr and pyrope-rich garnet, B) pyrope-rich reddish brown garnet, C) garnet aggregate, D) garnet megacryst, E) garnet in eclogite, F) garnet in metasomatized eclogite, G) quartz lamellae-bearing garnet, H) garnet in metasomatic rock I, I) garnet in metasomatic rock II, J) almandine-rich garnet. These garnets belong to the mantle origins (groups A, B, C and D), subducted oceanic crust origins (groups E, F and G) and crustal origins (groups H, I and J).

Groups A and B generally have Mg-rich and Cr-bearing compositions with inclusions of Ol, Cpx and Opx. This indicates mantle peridotite origins. Group A, a typical garnet in the Garnet Ridge, called ”Navajo Ruby”, has relatively high Cr_2O_3 (1.0-5.9 wt.%) with a limited range of CaO (4.2-5.8 wt.%), and includes Mgs and Dol. These features suggest carbonated garnet lherzolite origins.

Group B has a wide continuous chemical range in Mg-Fe components (Prp 49-76, Alm 12-43 mol%), suggesting the mantle metasomatism. The inclusion/lamella mineralogy can subdivide this group into four subgroups with unique chemical ranges: B_1) with lamellae of Amp and Ca-enriched composition (Grs 12-26 mol%), B_2) with lamellae of Ilm and fluid inclusion, B_3) with dense lamellae of titanates and inclusions of Mgs and Dol, B_4) with lamellae of Cpx and Amp, and Ca-poor composition (Grs 8-11 mol%). The variations in the chemical ranges of these subgroups were caused by the metasomatism of group A garnet.

Groups C and D have the compositions with wide variations located in the center area of a Ca-Fe-Mg diagram, and contain Ap lamellae. Group D is an euhedral to subhedral megacryst (max. 8 cm across). Group C is the aggregate of fragmented megacrysts. Both group C and D are products of mantle metasomatisms which are different from formation of group B.

Groups E and F (in eclogite xenoliths) are Fe-rich and show chemical zonation (core: Alm 52-56, Prp 6-7 mol%; rim: Alm 59-61, Prp 15-21 mol%). Group E includes aggregate of Zo and Ab, probably from precursor lawsonite inclusion. The host rock of group F is composed of eclogite part (Grt + Cpx) and jadeite-bearing omphacitite part (Cpx only), and lacks lawsonite (including relicts) in both parts.

Group G is rich in Fe and Mg (Alm 41-52, Prp 27-40 mol%) and characterized by its occurrence (xenocrysts) and lamellae (Rt, Ap and Qtz), although the chemical composition is similar to groups C, D, E and F. The Fe and Mg-rich chemistry and the inclusion/lamella mineralogy (occurrence of Cpx, Qtz and Zrn) are similar to groups E and F.

Groups H, I (in two types of xenoliths) and J contain minerals at crustal depths such as Qtz, Ab, An and Zo. Rutile lamellae in Qtz inclusions in group I and J, and Opx inclusion in group J suggest high temperature. Group H has Ca-rich composition (Grs 57-63 mol%) and includes Ca-rich silicates (An, Zo and Ttn) and K-rich amphibole. Ca-rich silicate inclusions and matrix assemblages of group H suggest origins of a calc-silicate rock like skarn.

As described above, the garnets from the Garnet Ridge show diverse features in color, morphology, chemistry and inclusion/lamella mineralogy. Such complexities were created by the chemical reactions in mantle peridotites, subducted oceanic crusts and continental crusts at a wide range of the depths. Decoding such information preserved in garnets leads to clarify the multi-stage metasomatisms underneath the Colorado Plateau, including the effect of the flat subduction of the Farallon Plate.
Keywords: the Colorado Plateau, pyrope garnet, lawsonite eclogite, kimberlite xenolith and xenocryst, mantle metasomatism