Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
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SMP10-P05 会場:コンベンションホール 時間:5 月 26 日 18:15-19:30

アリゾナ州ガーネットリッジからの含 Na, OH パイロープガーネットの新たな発見—コロラド高原下のマントル交代作用の証拠
Na and OH-bearing pyrope garnet - Evidence of mantle metasomatism by ancient oceanic crusts underneath Colorado Plateau

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Na-amphibole lamellae together with clinopyroxene, ilmenite, and rutile, were discovered in pyrope-rich garnet from the Garnet Ridge, northern Arizona, Colorado Plateau. Oriented amphibole lamella has a pargasitic composition and was identified as exsolved phase from precursor Na and OH-bearing pyrope. Chemical formula is as follows:

$Na_{1.10}(Ca_{1.90}Na_{0.10})2(Mg_{3.79}Ni_{0.06}Fe_{0.32}Al_{0.79})_{5.01}(Al_{1.95}Si_{6.05})_8O_{22}(OH_{1.97},Cl_{0.03})_2$.

Pargasite lamella in pyrope and its precursor hydro-sodic composition are the first report from the Navajo Volcanic Field. The garnets in the Garnet Ridge are xenocrysts delivered from wide range of the depths from the mantel to crustal level by kimberlite diatremes (ca. 30 Ma). We classified the diverse garnets of the Garnet Ride into 10 groups (Sato et al. 2014, 2015). There are two types of pyrope-rich garnets in this area: group A: Cr and pyrope-rich (Cr_2O_3: 1-6 wt.%, Prp: 67-71mol%), purple color (called *Navajo Ruby*), and group B: pyrope-rich reddish brown garnet (Prp:xx-71 mol%). The garnet in this paper belongs to group B (pyrope-rich reddish brown garnet). Group B garnet has a continuous compositional range (from pyrope to almandine-rich) in Ca-Mg-Fe compositional triangle from the compositions of group A, and this continuous compositional variation suggests that group B garnet is a metasomatic product of group A.

On the basis of exsolved phases, group B is subdivided into 4 subgroups, B_1: amphibole type, B_2: ilmenite type, B_3: black type, and B_4: clinopyroxene-amphibole type. B_1, B_3, and B_4 contain Na-amphibole lamella. B^1: amphibole type (Prp: 49-66; Alm: 18-28; Grs: 16-26 mol%) contains exsolved phases of amphibole, rutile, ilmenite, and clinopyroxene. A few chlorite inclusions which are trapped during crystallization also occurs. B_2: ilmenite type (Prp:49-68; Alm: 20-38; Grs: 12-19 mol%) contain fluid inclusions and exsolved ilmenit}e; the other exsolved phased are never identified. B_3: black type (Prp:54-72; Alm: 18-33; Grs: 12-15 mol%) looks like a opaque mineral because it has exsolved lamellae of rutile, amphibole, ilmenite, pyroxene, apatite, and srilankite densely. Sometimes, carbonate inclusions are recognized. B_4: clinopyroxene-amphibole type (Prp:61-76; Alm: 13-27; Grs: 8-11 mol%) have exsolved rutile, pyroxene, amphibole, and ilmenite.

Although Na is a trace component of garnet even at UHP condition, Na-bearing garnet is reported garnet peridotite in the North Qaidam UHPM terrene (Song et al., 2005). The rare occurrence of Na-bearing garnet reflects very low Na solubility in garnet and very low Na content in the mantle (<0.6 oxide wt.%).

In the mantle peridotite, garnet coexists with olivine, orthopyroxene, and clinopyroxene which have a relatively high Na solubility, and Na which is originally little, is preferentially partitioned to clinopyroxene, not to garnet; such features of Na partitioning indicate very rare occurrence of Na-bearing garnet; however, Na and OH-bearing garnet formed in the mantle underneath the Colorado Plateau and this suggests Na metasomatism by Na-bearing H_2O-fluid at great depths. A possible source of Na-rich metasomatic fluid could be subducted ancient oceanic crusts probably before Farallon Plate subduction. The fragments of ancient oceanic crusts being stagnated in the deep mantle for a long time were dehydrated to released Na-rich H_2O fluids, which were infiltrated into garnet peridotite and metasomatized to form Na- and OH-bearing garnet. The precursor compositions of Na and OH-bearing garnet from the Garnet Ridge could be a significant key to clarify the complex interactions between the mantle, ancient oceanic materials and fluid underneath the Colorado Plateau.

Keywords: hydrosodic garnet, pargasite exsolution, Garnet Ridge, Colorado Plateau, mantle metasomatism