G025-003 Room: 101A Time: May 26 9:30-9:45

Prograde P-T-t path deduced from compositionally zoned garnet in a whiteschist from the Kokchetav massif, northern Kazakhstan

Hideki Masago[1], Soichi Omori[2], Shigenori Maruyama[3]

[1] Earth and Planetary Sci.,Grad. Sch. T.I.Tech., [2] Dept. of Earth and Planet., TIT., [3] Earth and Planetary Sci., Tokyo Institute of Technology

It has long been a centre of interest of metamorphic petrology to estimate pressure-temperature-time (P-T-t) paths for individual rocks. Garnet is a common mineral in metapelites over a wide P-T range. Garnet in metapelite generally has a distinctive compositional zonation, and many metamorphic petrologists have drawn P-T path using zoned garnet. In this paper, P-T-t path was estimated for whiteschists from the Kokchetav massif using compositional zoning and mineral inclusions in garnet.

Kokchetav high-P-ultrahigh-P (HP-UHP) massif in northern Kazakhstan is the deepest subducted metamorphic belt of the world. The studied whiteschist samples were collected from the Kulet region, the middle part of the Kokchetav massif. Whiteschist is often associated with eclogite blocks on their periphery and in embayment. The whiteschist consists of coarse-grained matrix of quartz, phengite and talc with porphyroblastic garnet and kyanite and minor amount of rutile.

The garnet porphyroblast is generally coarse-grained (up to 3 mm) and contains abundant mineral inclusions. The garnet is generally almandine-rich, and has a distinctive compositional zoning. Almandine and pyrope components increase towards rim. Grossular component shows the most distinctive zoning pattern. It shows a slight rim-ward increase in the core domain, which is followed by large decreases in the mantle and the rim domains. The zoning pattern of spessartine component is more irregular especially in the core domain, but generally decreases towards rim, which characterizes a prograde zoning. These zoning patterns are commonly observed in every analysed garnet.

Mineral inclusions in the garnet are abundant in the core domain, and relatively rare in the mantle and rim domains. The dominant inclusion mineral is SiO2 polymorph. It displays a clear zonal distribution in garnet porphyroblast. In the core domain, all SiO2 phase is monomineralic quartz, which occupies the most population of inclusions in the core domain, whereas coesite and its pseudomorph are found in the outermost mantle domain. Next to quartz, Ti-phase inclusions are abundant throughout the core and mantle domains. They also display a zonal distribution. Ilmenite occurs relatively inner part of core domain, and most of which makes a composite inclusion with rutile, whereas monomineralic rutile occurs relatively outer part of core to mantle domains. In the rim region, both of ilmenite and rutile are present, although their population is low. Zircon, apatite, monazite are commonly observed throughout the porphyroblast, and minor kyanite and phengite are observed in the outer-core to mantle domains.

Inclusion thermometry was carried out using ilmenite-garnet thermometer of Pownceby et al. (1991). The results range from 500 to 750 C, and show a systematic increase from core to rim in each porphyroblast. In the kyanite-bearing domain, the following P-sensitive reaction can be used for barometry: 3Fe-Ilm (in Ilm) + Ky + 2Qtz = 3Rt + Alm (in Grt). This barometry yielded P of 12-13 kbar for outer-core inclusions at given T.

A petrogenetic grid drawn in KCFMASH model system using a 'UniEQ' computer program of Omori & Ogasawara (1998) enables forward modeling of the compositional zonation in garnet. The change of grossular component along the model P-T path expected from the forward modeling is close to the observed grossular profile of outer-core to rim domains. No P-T constraint is available from thermobarometry in inner-core domain, however, the forward modeling of garnet zoning makes up for the early stage P-T path of garnet growth.

The estimated prograde P-T path is counter-clockwise which bents steeply at around 700 C, 12-15 kbar. This is similar to the metamorphic P-T gradient of the Kokchetav massif deduced from the metabasites. This result is highly different from the traditionally drawn clockwise P-T path in many metamorphic terranes.