Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

SMP46-03 Room:304 Time:May 25 09:30-09:45

High-T metamorphic rocks and exhumation process of the Tseel terrane, SW Mongolia

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Tseel area, Tseel metamorphic terrane, SW Mongolia is mainly composed of metapelitic gneisses, amphibolites (sillimanite zone) and intruded by ring structure of the granitoids (sillimanite zone) and covered by sediments. Three mineral zones in the pelitic gneisses determined based on the petrographic study and mineral assemblages of each zones as follows: (1) Biotite zone (Bt + Pl + Qtz + Ms + Chl + Cal) (2) Garnet zone (Grt + Bt + Pl + Qtz +/- Chl +/- Ru +Il + Cal) (3) Sillimanite zone (Grt + Bt + Pl + Qtz + Sil + Ms + Chl +/- Crd +/- St + Ru + Il+ Cal +/- Fe-Mg Amp). Biotite zone observed in most area of southern and northern parts of Tseel area. Garnet zone is determined between biotite and sillimanite zones. The sillimanite zone is observed in the central parts of Tseel area. All mineral zones observed along the foliation from E to W trends at Tseel area.

We showed the characteristic features of chemical compositions of garnet, biotite and plagioclase in the pelitic gneisses and determine the P-T paths deduced from the garnet chemical zoning using thermodynamic equilibria in Tseel area as follows: Garnet in the pelitic gneisses shows almandine-rich compositions and some samples show clear compositional zoning. Based on the Ca (grossular) composition of garnet, the sillimanite zone is subdivided into sillimanite A and B zones. Garnet in the garnet zone shows relatively homogeneous compositions in the range of (530-600 ^{o}C and 6.0-10.0 kbar). The garnet chemical compositions in the sillimanite B zone show a homogeneous composition in a range of (620-750 ^{o}C and 1.8-6.0 kbar), and sometimes contain the retrograde rim produced by post-growth diffusion. The garnet chemical zoning in the sillimanite A zone typically is divided into three zones from core to rim: zone 1 (high Ca with homogeneous), zone 2 (decrease in Ca), and zone 3 (low Ca). The compositions of zones 1 and 2 correspond to those of garnet in the garnet and sillimanite B zones, respectively, and zone 3 indicate the effect of the post-growth diffusion. The P-T conditions during garnet growth were calculated by garnet-biotite geothermometry and garnet-biotite-plagioclase-quartz geobarometry. In application of geothermobarometry to garnet zonings, we calculated P-T conditions for four cases with highest and lowest XMg, Bt and XAn, Pl, that provide the possible P-T ranges for a given garnet composition and constrain roughly the shape of P-T path. The shapes of the P-T paths obtained for individual garnets are similar among the four cases, and the differences in pressure and temperature among the four cases are within 15 ^{o}C and 2.5 kbar, respectively. The P-T conditions estimated from the garnet zone are in a range of 530-600 ^{o}C and 6.0-10 kbar, that are located at the kyanite stability field. The P-T conditions estimated from the sillimanite B zone are in a range of (570-690 ^{o}C and 1.8-8.0 kbar). The longest P-T path is obtained from the samples in the sillimanite A zone, such as sample 3001, which shows a decompression from zone 1 (530-570 ^{o}C and 6.0-9.6 kbar) to zone 3 (570-620 ^{o}C and 2.0-4.0 kbar), corresponding with a change from the kyanite stability field to the sillimanite stability field. Zone 2 shows an increase in temperature by ˜40 ^{o}C and a decrease in pressure by 4-6 kbar.

The intrusions of the granitoids occurred during the exhumation of the Tseel terrane, and produced the regional anticline structures and mineral zones. The high temperatures and homogeneous garnet zoning of the sillimanite B zone were resulted from the thermal effects from the granitoids. The sillimanite A and B zones experienced the P-T conditions of the kyanite stability field, that was similar to the garnet zone. The high temperature of the garnet zone cannot be explained solely by the contact metamorphism by granitoids, but the regional high geothermal gradient is expected in the subduction zones.

Keywords: Tseel terrane, garnet, P-T paths, exhumation process