K-Ar isochron ages using phengite and paragonite in UHP metamorphic rocks from the Tso Morari dome, western Himalaya

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Ultrahigh-pressure metamorphic (UHPM) rocks occur commonly in continent-continent collision type orogenic belts and their mineral assemblages indicate the formation at the depth of 100 km and more. Since Chopin (1984), the geology and petrology of the UHPM rocks have been studied well to estimate their P-T histories at ca. 20 localities in the world. However, the geochronological approaches to estimate time of events, especially exhumation, are still not well successful. In UHPM rocks and the associated high-pressure metamorphic (HPM) rocks of many metamorphic sequences, discordant K-Ar and Ar/Ar age relations have been reported, probabry caused by the excess 40Ar.

To reveal exhumation history of UHPM rocks, phengite and paragonite, separated from UHPM rocks from the Tso Morari dome (TMD), western Himalaya, India, are analyzed with K-Ar and Ar/Ar methods.

The authors collected eclogites, basic schists and pelitic schists, which are closely associated with each other, from an area (ca. 20 km x 15 km) in TMD whose sources are thought to be margin of Indian continent. Sachan et al. (2001) discovered coesite in an eclogite block in this area. Calcschists are also collected from the adjacent Indus suture zone (ISZ) which is the boundary between Eurasian and Indian continents.

Eclogite having Grt + Omp + Ca-amp + Czo + Phn + Rtl +/- Pg +/-Chl +/- Cc occurs only in the core of meter-scale mafic rock lenses, which were intercalated into the pelitic schists. This suggests that the coexisted mafic and pelitic rocks have suffered the UHPM and experienced the same P-T-t history. The smaller mafic lenses and pelitic rocks were retrograded to have the mineral assemblages of Ca-Amp + Czo + Bt + Chl + Ab + Cc + Tnt +/- Phn and Qtz + Phn + Ab + Tnt + Zrn +/- Pg +/- Chl +/- Grt +/- Bt +/-Czo +/- Kfs +/- Cc, respectively. Phengites have significantly different chemistry among rocks, being due to difference of bulk chemistry of rocks. Phengites in pelitic schists show variable Si/Al and Na/K ratios in a thin section and even in a single crystal, which indicate recrystalization during retrograde metamorphism. Biotites are homogeneous.

K-Ar analyses were carried out on phengite (50 to 87 Ma) from pelitic schists and biotite (96 and 134 Ma) from the basic schists in TMD, indicating variety of ages. Phengites from calcshists in ISZ were 40 and 43 Ma. Pelitic schist TM205 has paragonite and phengite, giving 84 Ma in the paragonite - phengite mixture (K = 4.9 wt. %) and 85 Ma in the phengite rich fraction (K = 7.8 wt. %). The isochron age using these two data sets is 91+/-13 Ma. Eclogite TM810 having phengite and paragonite were analyzed by laser Ar/Ar method. Ar/Ar step-heating analyses using single phengite crystal showed the age spectra having 130 to 170 Ma fractions with a plateau of 132 Ma defined by 80% of total gas released. Ar/Ar spot dating results using a thin section were 124 and 145 Ma from phengites, and 77 and 155 Ma from paragonites. The inverse isochron age using the four data sets is 105+/-37 Ma with an initial ratio of 592+/-15.

TMD has also been studied with other chronological methods ranging from 48 to 55 Ma (de Sigoyer, 2000; Leech et al., 2003). These ages are consistent with phengite K-Ar ages of the ISZ calcschists, and may not be the time of UHPM because they do not have any exact indicator of UHPM for the geochronological system. On the other hand, new closure temperature of at least 450 degrees for phengite K-Ar system makes it possible to interpret the Cretaceous isochron ages (91 and 105 Ma) obtained in this study as the time of early stage of UHPM rocks exhumation.