Perspectives on the petrochemical study of UHP-HP metamorphism

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Current state of knowledge of UHP-HP metamorphism are reviewed and several perspectives for the future petrochemical study on UHP-HP rocks are suggested. (1) What is the Barrovian-zone metamorphism? The UHP-HP rocks, typified by eclogitic and garnet peridotite blocks enclosed within quartzo-feldspathic terrane, have been extensively documented from many collisional orogens. The collision orogeny create the UHP-HP metamorphism with late-stage extensive hydration event that obliterates the preceding UHP-HP records. The so-called Barrovian-zone metamorphism once considered to be a characteristic for collision-type orogen must be re-evaluated. (2) Zircon is recognized as an excellent container to preserve the progressive UHP-HP metamorphism. In spite of extensive hydration during exhumation, zircon separates from both eclogite and quartzo-felsphatic unit preserve parageneses and compositions of minerals from (a) protolith and prograde, (b) peak, and (c) retrograde stages of recrystallization. For example, more than 18 minerals were identified in zircons in the Kokchetav massif (Katayama et al. 2000). (3) Combining SHRIMP micro-spot U-Pb dates of zoned zircons with mineral inclusions formed at different stages, the rate of exhumation can be obtained. For example, about 30 m.y. was necessary to exhume diamond-bearing gneissic rocks of the Kokchetav massif from 200 km depth to mid-crustal level where extensive hydration occurred (Katayama et al. 2001). (4) The metamorphic facies series of most HP-UHP terranes define a unique kink point of the prograde P-T path at 10 kb; a higher geotherm occurred at shallow depths and 5 times lower geotherm occurred at great depths. Such kinked P-T path is consistent with numerically simulated subduction zone geotherms. (5) Compositions of Kokchetav metabasites have been modified at different depths according to the stability fields of hydrous silicates. More than 95% of LIL elements were leached to the hanging wall before the slab reached to 90 depth whereas HFS elements were not mobile. This observation suggests that characteristic signatures of the arc basalts with enriched LREE in SW Japan may be related to the metasomatism during melting of subducting young oceanic slab. (6) Space-time distribution of HP-UHP belts exhibits secular cooling of subduction zones in the Earth’s history. The oldest UHP belt ca.630-620Ma occurs in the Pan-African belt of W. Africa and its southwestern extension in Brazil. Compilation of P-T geotherms of global metamorphic rocks suggests that the transition from late Proterozoic Snowball Earth to Phanerozoic Earth marks the initiation of return flow of seawater into mantle. (7) Peridotites enclosed in UHP-HP belt preserve the earliest records within clinopyroxene with exsolution lamellae. Their host assemblages may have recrystallized at great mantle depths below 300 km, and subsequently incorporated into UHP belt after mantle convection within the mantle wedge.