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Growth of Kyanite and Staurolite Porphyroblasts in the Jingok Unit, Imjingang belts, South Korea

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Quantitative P–T–deformation path determination for metamorphic rocks can be revealed based on intersecting of X_{Fe}, X_{Mn}, X_{Ca} isopleths of zoned garnet and foliation intersection/inflexion axes (FIAs) preserved within the garnet porphyroblast. The method presented here is applied to metapelites in the Jingok Unit of the Imjingang belt, South Korea. Garnet and staurolite FIA trends are E–W to WNW–ESE (90–120°) and NE–SW (50–80°), respectively. The FIA data indicate that garnet porphyroblasts have grown under N–S to NNE–SSW bulk shortening. P–T paths for garnet growth in Grt, St and Ky zone in the Jingok Unit, calculated from geothermobarometers and the intersection of isopleths on P–T and T–X_{H2O} pseudosections in the MnO–Na_2O–CaO–K_2O–FeO–MgO–Al_2O_3–SiO_2–H_2O (MnNCKFMASH) system constructed using program THERMOCALC, are compressional heating from 545°C at 5.3 kbar to 630°C at 7.5–9.5 kbar.

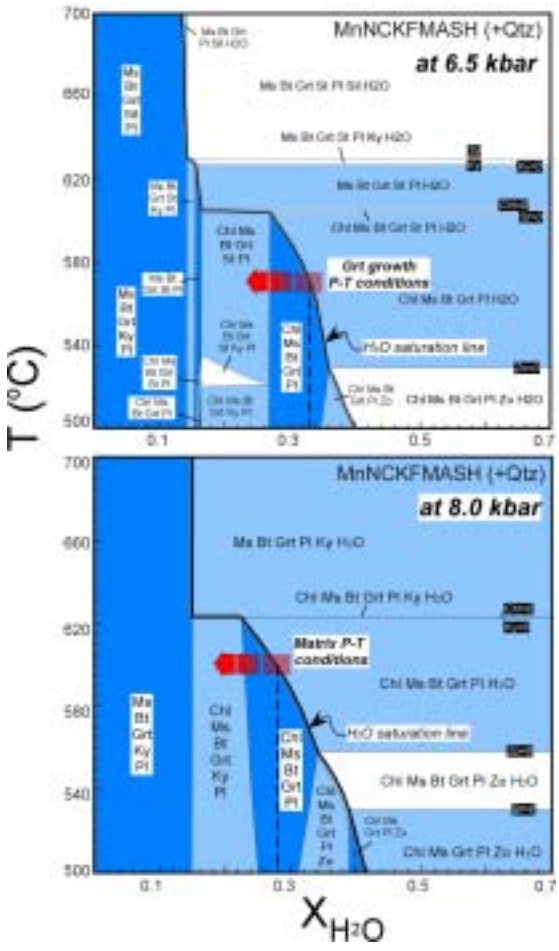

Fig. 1. T–X_{H2O}pseudosection of sample YC043 at 6.5 kbar and 8.0 kbar for MnNCKFMASH with quartz in excess.

Changes of X_{H2O} during the metamorphism can play an important role to extend Grt– and St–stability fields to lower temperature as shown in Figure 1. T–X_{H2O} psudosections at 6.5 kbar and 8.0 kbar for sample YC043 (Ky zone) suggest that staurolite and kyanite could form without pressure and temperature change (Fig. 1). If sample YC043 has metamorphosed in the presence of H_2O–rich fluids (at a X_{H2O}>0.33) at 580 °C and 6.5 kbar (Grt growth P–T), it would contain the staurolite-absent mineral assemblage. Whereas it has metamorphosed at the same P-T conditions in the presence of H_2O–poor fluids (at a X_{H2O}<0.27), it would contain the Grt+St– and Grt+Ky–bearing mineral assemblages (Fig. 1). The

similar variation of mineral phase occurred at the matrix P–T conditions (610 °C and 8.0 kbar). Therefore, Grt+Ky–bearing mineral assemblages could have generated from decreasing X_{H2O} from 0.28 to 0.24 (Fig. 1). However, the main metamorphic event for staurolite growth may have resulted from decompression after the peak metamorphic conditions (e.g., Kim, 2002; Cho et al., 2007). The early formed staurolite may have destroyed at the peak metamorphic conditions.

Consequently, kyanite–bearing mineral assemblages in the Jingok Unit probably have derived from decreasing X_{H2O} during and/or after garnet growth rather than change of bulk rock compositions. All compositional and microtextural data and thermodynamic modeling indicate that garnet porphyroblasts have formed during compressional heating under N–S crustal shortening, whereas staurolite porphyroblasts have mainly formed during decompression with overgrowing NE FIA. The metapelites in the Jingok Unit have experienced clockwise P–T path derived from Barrovian–type metamorphism belong in amphibolites facies.