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Tectono-metamorphic evolution of the Chinese Altai, central Asia: new insights from microstructures

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The Altai Orogen, extending from Russia, through northeast Kazakhstan and northwest China, to western and southern Mongolia, occupies a pivotal position in understanding the accretionary process of the Central Asian Orogenic Belt and has drawn much attention in recent years. However, its orogenic evolution remains poorly constrained, because previous studies were mainly focused on the geochronological and geochemical signatures and much less work has been done on metamorphic and structural studies.

Metamorphic rocks widely occur in the southern Altai Range and have previously been separated into high-T/low-P and medium-P types. Recent studies demonstrated that these two kinds of rocks may have similar protoliths, i.e. early Paleozoic arc-related assemblages, but experienced different metamorphic histories. The development of biotite, garnet, staurolite and kyanite metamorphic zonal sequences in the low- to medium- grade rocks, demonstrate typical medium-pressure metamorphism that has been suggested as a major consequence of the orogenesis. The high-T/low-P metamorphism, represented by the growth of garnet+cordierite+sillimanite+k-feldspar and was accompanied by extensive anatexis, remains its tectonic significance poorly constrained.

Field structural investigation in the Chinese Altai reveals that the high-T/low-P metamorphic rocks have major S-L fabrics (defined by the strongly aligned biotite and sillimanite) exactly in the same orientations as those developed in the associated medium-P grade rocks. Geochronological studies constrain the major fabrics in both kinds of rocks developed during mid-Devonian, coeval with the strong magmatism in the region. Micro-structural investigation on both kinds of rocks show similar prograde metamorphic history featured by clockwise P-T path evolution. Phase equilibrium modeling in the MnNCKFMASH system indicates that the development of major fabrics in the medium-P metamorphic rocks mainly recorded the notable increase of pressure and that in the high-T rocks was featured by the significant increase of temperature. The pressure increase could attribute to the progressive crustal thickening that may be correlated to the accretionary regime of the southern Altai in the mid-Devonian and the high temperature conditions most likely imply a significant heat input from the deep depth, consistent with the syn-chronologically emplacement of juvenile magmas on a large scale. Our study indicates the development of high-T metamorphism was genetically linked with that of the medium-P metamorphism and suggests that the crustal thickening during the orogenic process of the Altai region was accompanied by large heat input.

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