Role of Basaltic Magma in the Evolution of Continental Crust: Formation process of Nikanbetsu Gabbro Complex in the Hidaka Metamorphic Belt

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The net growth of continental crust and the development of layered structure occur owing to the addition of basaltic magma and heat from the mantle in arc environment. The purpose of this study is to clarify the role of basaltic rocks, now frozen as gabbroic bodies in an exposed section of arc crust as metamorphic belt, in the heat and mass transportation processes through the crust. We have chosen the Hidaka metamorphic belt, which is a high-temperature medium-pressure type and was uplifted by collision of two island arcs. It is believed that the metamorphic belt represent a cross section of the arc crust exposed continuously from the upper crust (eastern side), through the lower crust, to the upper mantle (western side) (Komatsu et al., 1986). We particularly focus on the southern area, where several peridotite bodies are associated with large gabbroic-tonalite bodies, one of which is the Nikanbetsu gabbro complex, our study target. The gabbro complex consists of various lithologies such as troctolite, olivine gabbro, gabbronorite, and quartz diorite, all of which shows diverse variation in grain sizes and complex contacting relationships in the field. There is a systematic lithological distribution; less fractionated rocks such as olivine gabbro are distributed in the peripheral (northeastern) part, the more fractionated quartz diorite in the central part of the complex, and moderately fractionated gabbronorites in betweem. The complex can be regarded as a zoned pluton, which is similar to the Opirarukaomappu gabbro/tonalite complex (Honma, 1997) located to the northeast of the Nikanbetsu gabbro complex.
The An # = Ca / (Ca + Na + K) of plagioclase, and Mg # = Mg / (Mg + Fe) of clinopyroxene and orthopyroxene, decrease continuously from olivine gabbro to quartz diorite. By investigating the whole rock chemical composition focusing on fine grained rocks, which better reflect the melt composition, it was found that the less fractionated magmas, such as olivine gabbro, are classified as the tholeiite series, whereas more fractionated ones, such as quartz diorite and some gabbronorites, are classified as calc-alkaline series. This contrast is also evident in their rare earth element (REE) concentration patterns.The former shows a REE pattern depleted in LREE, whereas the latter shows a pattern enriched in LREE. Any crystal fractionation models cannot reproduce the latter from the former as a parental magma. It is concluded that there were at least two contrasting parent magmas: one belonging to the tholeiite series and the other to the calc-alkaline series. It can be inferred from its trace element pattern that the parent magma of olivine gabbro formed by adiabatic decompressional melting of the Middle Ocean Ridge Basalt (MORB) source mantle. We propose a scenario that the heat released by the crystallization of this magma elevating the temperature of the lower part of the Hidaka crust to form the parent magma of quartz diorite belonging to the calc-alkaline series by partial melting. The Nikanbetsu gabbro complex gives us an excellent chance to scrutinize processes of heat and material transportation, which takes place deep in the crust and is usually not accessible.

