

Source of the Ryoke granites

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The Ryoke granites are mainly of I-type and ilmenite-series. As they comprise garnet- and muscovite-bearing granites, it has been conceived that they have S-type-like nature in part. However, they are, including those S-type-like-rocks, assumed to be derived from mafic rocks that prevailed the lower crust of the arc at that time. It is supported by 1) a positive correlation of A.S.I. and SiO₂ content, 2) trace elements of arc magma affinity and 3) initial Sr isotopic ratios distinctly lower than the Ryoke metamorphic rocks and their unmetamorphosed equivalents representing the upper crust at that time.

Sporadic mafic rocks associated with the Ryoke granites will give us a clue to the lower crustal mafic source rocks, if they were formed during the same magmatism as the Ryoke granites and, if they have magmatic compositions. The Ryoke mafic rocks are composed of coarse-grained gabbros and fine-grained dikes and pillow-shaped bodies in silicic-mafic-magma mingling occurrences. The magma-mingling texture of the granitic and mafic rocks and reliable age data support the contemporaneousness and close relationships of the Ryoke mafic and granitic rocks. We have to exclude gabbros in the discussion of magma chemistry because they are cumulates and do not have a composition of any magmas. Carefully selected geochemical data suggest that these mafic rocks are designated as calc-alkali rock series and have continental arc affinities.

The major element chemistry and Sr isotopes of the Ryoke mafic rocks suggest that they are hybrid magma made of slightly fractionated mantle-derived primitive basaltic magma and upper crust-derived sedimentary components. A mixing model calculation gives the maximum percentage of the upper crustal component to be 30%. As the Ryoke mafic rocks have similar Sr isotopic initial ratios to the associated granites, the Ryoke granites can be generated by the fractionation or partial melting of that hybrid source magma. Thus, it is concluded that the Ryoke granites are mainly made from mantle-derived component.

Some isotopic variations in the Ryoke granites are ascribed to the interaction of the granitic magma with upper crustal materials during or shortly after they traveled to the upper crust. It may be the reason why the Ryoke granites do not give a beautiful whole rock isochron.