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# Provenance study of the Jurassic clastic rocks in the Sizugawa area, South Kitakami Terrane

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The previous result of the provenance studies from conglomerate, sandstone and heavy minerals in the Jurassic sedimentary rocks in the South Kitakami Terrane revealed that the most of detritus was derived from granitic rocks and continental basement. However, sparse work has focused the provenance change during Jurassic time. Moreover, little work has addressed whole-rock chemical composition with trace elements related to provenance analysis.

The Jurassic sediments distributed in the Shizugawa area, South Kitakami Terrane, are divided into two groups; the Lower Jurassic Shizugawa Group and Middle-Upper Jurassic Hashiura Group. The purpose of this study is to examine the provenance change from the Lower to Upper Jurassic sediments in the Shizugawa area, on the basis of its major and trace elements compositions including rare earth elements (REE) by XRF and ICP-MS.

Major elements: Sandstones show $SiO_2$ contents between 61-76 wt% (average 69 wt%). Average of $Al_2O_3$ and $K_2O/Na_2O$ ratios are 15 wt% and 0.7 respectively. Siltstones show $SiO_2$ contents between 59-70 wt% (average 65 wt%). Average of $Al_2O_3$ and $K_2O/Na_2O$ ratios are 17 wt% and 1.3 respectively. Chemical composition of sandstones and siltstones closes to felsic igneous rocks, however $Al_2O_3$ is relatively enriched. Moreover, there is no significant trend become enriched in $SiO_2$ content in the Late Jurassic sediments that was suggested from the sandstones in the Soma and the Oshika areas, South Kitakami Terrene.

CIA index and A-CN-K diagram: The Chemical Index of Alteration (CIA : $CIA=Al_2O_3/(Al_2O_3+CaO*+Na_2O+K_2O)$) is established as a method of quantifying the degree of source rocks weathering (Nesbitt and Young, 1982, 1984). The Jurassic sediments in the Shizugawa area show CIA index from 51 to 70. The plots in A-CN-K diagram, which consists of $Al_2O_3$-CaO+$Na_2O$ and $K_2O$ as end-members, suggest the protolith of the Jurassic sediments is correlated to felsic igneous rocks. Furthermore, it is also suggested that the Middle-Late Jurassic sediments were supplied from more felsic source rocks than the Early Jurassic.

REE pattern: REE patterns show enriched LREE and significant negative Eu anomalies, which is similar to the one of PAAS (post-Archean Australian shale: Taylor and McLennan,1985). Those patterns suggest that the provenance of the Jurassic sediments was mainly granite and continental basement. Middle Jurassic sandstones show significant trend enriched LREE. Because no siltstones show this trend, it is possible that the sandstones had different provenance from siltstones.

Trace elements: It is known that Th/Sc ratios reflect magmatic differentiation (Taylor and McLennan,1985; McLennan and Taylor,1991). The Middle and Upper Jurassic sediments have relatively high Th/Sc ratios ($>1$).

Geochemistry of the Jurassic sediments indicates the source rocks was granite and continental basement. The plots in A-CN-K diagram and trace elements imply the derivation from more felsic source during Middle to Late Jurassic time.

The obvious compositional change during Jurassic period has been reported from chemical composition and modal analysis of the sandstones in Japanese islands. The derivation from more felsic source rocks is recognized in the Middle and Late Jurassic time also in the Shizugawa area, which suggests the large provenance change in the eastern margin of the Asian continent.

Keywords: Jurassic, clastic rocks, provenance, chemical composition, rare earth element, trace element