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白亜紀前弧海盆堆積物におけるテフラの対比とテフロクロノロジー
Tephrochronology in the Cretaceous forearc basin, northern Japan

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1. Introduction

Tephrochronology is useful method for basin analysis because tephra provide isochronous horizons across the different facies. Although numerous studies of tephra correlations have long been conducted on the Quaternary strata, there are much fewer attempts to correlate pre-Quaternary tephra because most of the pre-Quaternary tephra are not appropriate for applying conventional tephrochronological methods on account of alteration of glass. On the other hand, several studies based on the heavy mineral chemistry of tephra have been successful in identifying and correlating highly altered tephra (e.g., Sell and Samson, 2011a, b). Detailed tephra correlations by these studies solved various controversies on the Euro-American Ordovician biostratigraphy, biogeography and sequence stratigraphy. Consequently, prevailing tephrochronologic study of the pre-Quaternary strata appears to bring significant progress in the various field of earth sciences because it can provide a much higher precision of chronostratigraphic correlation than that of the radiometric dating in both local and regional scale.

The Yezo Group, exposed in Hokkaido, Japan, is represented by the mid-Cretaceous – Paleocene marine sequences which were deposited in a fore-arc basin along east of the active Asian continental margin. This group contains abundant macro- and microfossils as well as felsic tuffs. However, it has been very difficult to correlate between shallow and deep sea facies in detail because of difference in fossil fauna and sedimentary facies. In order to establish detailed depositional model in such old basin, we establish the Cretaceous tephrochronology in the Yezo Group based on the heavy mineral chemistry of phenocrysts within the tuffs.

2. Method

We collected 30 tuff samples from the whole horizons of the Yezo Group in Tomamae, Oyubari and Urakawa areas. The samples were separated into light and heavy fractions using sodium polytungstate. The separated heavy fraction was collected and handpicked under a binocular microscope to collect the apatite and biotite grains. 20 biotite phenocrysts per sample were analyzed major elements at the Department of Earth Science, Tohoku University using a JEOL 7330. 20 apatite phenocrysts per sample were analyzed major and minor elements at the Institute for Material Research, Tohoku University using a JEOL 8530F. Apatite analyses followed the method described in Gross et al. (2013).

3. Result and discussion

Apatite is one of the most common accessory mineral in the volcanic rocks, and is highly resistant to weathering, diagenetic alteration and diffusion processes. Furthermore, apatite shows a wide variety of trace-element compositions because the structure of apatite is highly tolerant of structural distortion and chemical substitutions. Therefore, chemical fingerprinting of apatite is ideal method to discriminate the altered tephra. Each tuff exhibits unique trend in Cl, Mg, Fe, and Mn concentrations in apatite, which demonstrates that apatite chemistry is useful for discriminating tuffs in the Yezo Group. Although biotite is one of major phenocrysts in the tuffs of the Yezo Group, it is less useful than apatite because of its weakness against diagenesis and weathering. However, Mg number and TiO_2 content of biotite are most effective discriminator of the tuffs in the Yezo Group, and each tuffs are distinguishable on the bivariate plot of the Mg number and TiO_2 contents.

Based on the above result, we correlated tuffs of the Yezo Group among the Tomamae area and the other areas in Hokkaido. As a result, we confirmed that at least 3 tuffs (tuffs at Lower Cenomanian, Turonian/Coniacian boundary and Santonian/Campanian boundary) can be traced widely (more than 100 km distance) throughout Hokkaido and across the different sedimentary facies.

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