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カナダアカスタ片麻岩体に存在する初期太古代角閃岩の岩石学的・地球化学的研究
Petrology and geochemistry of amphibolite blocks in the earliest Archean orthogneisses, the Acasta Gneiss Complex

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The Hadean from 4.567 to 4.03 Ga is the earliest period of the history of the earth, and defined by no preservation of rock records in the earth. Although it is suggested that the earth underwent the whole earth differentiation related to the magma ocean, core formation and early crustal formation in the period, the details are not revealed yet. Many Hadean, >4.0 Ga, zircons, including a 4.4 Ga detrital zircon from the Narryer Complex, Western Australia are found, and their geochemistry and mineral inclusions implies that the mantle had been already differentiated to make felsic continental crusts in the Hadean. But, the interpretation of the zircon geochemistry and inclusions is still controversial because the zircons occur as detrital or inherited in the middle to Early Archean sedimentary rocks and orthogneisses and the host rocks are still unknown. Therefore, it is quite significant to study the Early Archean rocks and geologic bodies to understand the early evolution of the earth.

Acasta Gneiss Complex (AGC), located along the Acasta River in the westernmost part of the Slave Province, northwestern Canadian Shield, is one of the Early Archean complexes, and contains the oldest rock in the world. Bowring et al. (1999) reported the oldest, 4.03 Ga, zircon from a granodioritic gneiss. The AGC is divided into two main domains by a northeast-trending fault. The Eastern area is dominated by ca. 3.6-4.0 Ga white gneiss suites whereas ca. 3.9-4.0 Ga layered gneiss suites are predominant in the Western area. Gray gneisses, defined by geological evidence for intrusive structures by the white and layered gneisses, exist in the both areas. Iizuka et al. (2006) found a 4.2 Ga inherited core within a 3.9 Ga magmatic zircon. Furthermore, Hf model ages of zircons from the ca. 3.7~3.9 Ga granitic gneisses indicate the source materials were formed at ca. 4.2-4.0 Ga. The line of evidence suggests that the gray gneiss suites are older than the white and layered gneisses, and possibly goes back to the Hadean age. This paper presents field occurrence, metamorphic petrology and geochemistry of the gray gneisses to reveal the origin of the gray gneiss and early evolution of the solid earth.

The gray gneisses consist of hornblende + plagioclase + quartz ± chlorite ± epidote ± biotite ± apatite ± sphene ± garnet ± clinopyroxene ± opaque. The mineral assemblages indicate that these rocks were suffered from amphibolite to upper amphibolite facies metamorphism. Based on the mineral paragenesis, we classified the gray gneisses into three groups: (1) a garnet-amphibolite, (2) a hornblendite with over 95 % modal abundance of hornblende, and (3) amphibolite, respectively. The hornblendites occur ubiquitously, whereas the garnet-amphibolites occur only in the northern part of the eastern area.

We analyzed whole rock major element compositions of two garnet-amphibolites, four hornblendites and twenty amphibolites with XRF at Tokyo Institute of Technology. The compositions are basaltic, and are correlated with their petrography. The garnet-amphibolites have relatively lower SiO2 (43 %) and higher FeO (18-19 %) contents, consistent with expansion of garnet stability field increasing FeO contents. The hornblendites have relatively lower Al2O3 (3-5 %) and higher MgO (14-19 %) contents.

Some compositional trends are distinguished with MgO versus major element variation diagrams: for example, increase, constant and decrease trends in SiO2 contents in increasing MgO contents, respectively. Secondary elemental movement accounts for the increase and decrease in SiO2 contents because SiO2 contents of magmas change a little compared with MgO, FeO and Al2O3 contents during fractional crystallization of basaltic magmas.

Except for the altered rocks with quite higher or lower SiO2 contents, the compositional variations are similar to those of modern abyssal basalts, consistent with geological evidence for supracrustal remnants within the earliest Archean orthogneisses.