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^{40}Ar-^{39}Ar Age Studies for Tectonics of the Gondwana Land

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^{40}Ar-^{39}Ar age studies have been performed for samples from Antarctica and India which were parts of the Gondwana land at Mesozoic and Paleozoic time in order to investigate their thermal history and tectonic movement. From the both areas, ages of about 500 Ma which have been considered to be the age of Pan-African Orogeny were obtained, which represents that this thermal event spread widely over the Gondwana land.

KEYWORDS: ^{40}Ar-^{39}Ar age, Gondwana, Antarctica, India

1. Introduction

Gondwana paleo-land has been considered to have existed at Mesozoic and Paleozoic time and constructed from Antarctica, Australia, South America, South Africa, India and others. In order to investigate the tectonic and thermal history of the Gondwana land, the age information is very important for geologic and paleomagnetic studies. ^{40}Ar-^{39}Ar dating study is one of the age determination methods and suitable to check the thermal history and to study the tectonic movement after the break of the Gondwana land.

Then, we studied ^{40}Ar-^{39}Ar datings for many rock and mineral samples from Antarctica and India, mainly concerned with the Gondwana land.

2. Experiments

Collected rock samples were crushed and separated in to the same size of such as 30-150 mesh, usually. For metamorphic samples, minerals such as biotite, muscovite, K-feldspar and hornblende were separated by hand picking and with the use of a magnetic separator. These samples were sealed in quartz tubes under vacuum condition below 10^{-1} Pa with age standards.

The quartz tubes were wrapped with Cd foil in order to decrease the effect of thermal neutrons. They were irradiated with fast neutrons for 24 hours in Japan Material Testing Reactor receiving about 10^{18} total neutrons.

After irradiation, Ar gas was extracted from samples using an induction heater and Ar isotopic ratios were analyzed with a mass spectrometer at Radioisotope Center, University of Tokyo. Ages were calculated from Ar isotopic ratios after some corrections.

3.Results and Discussions

From the difference of age and area, results are presented separately in four parts.

3.1. East Antarctica

13 samples of granite, syenite, gneiss, basalt and dolerite from Sør Rondane Mts., Ongul Island, Lambert Glacier areas in the East Antarctica (Fig. 1) were used for ^{40}Ar-^{39}Ar dating studies[1),2)]. These samples were collected by Dr. M. Funaki, National Institute of Polar Research, for paleomagnetic studies[3)].

Ages of 440-550 Ma were obtained from samples all over the East Antarctica (Fig.2). These ages indicate that the evidence of the large metamorphic event, Pan African Orogeny, in the Gondwana at about 500Ma, which were consistent with ages obtained in previous studies. The younger age of about 440Ma might represent that the igneous activity had continued to that younger age.

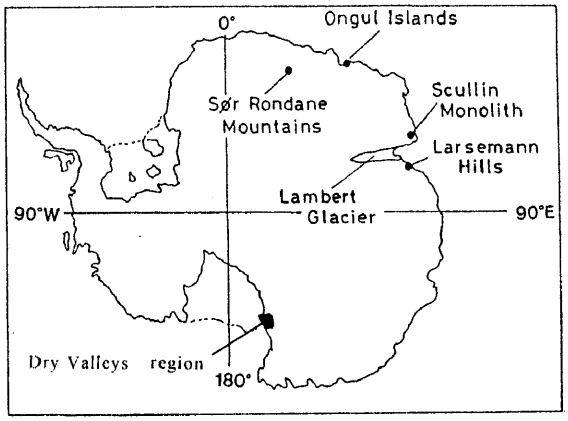

Fig. 1. Localities of the Sør Rondane Mountains, Ongul Islands, Lambert Glacier and Dry Valleys region in Antarctica.

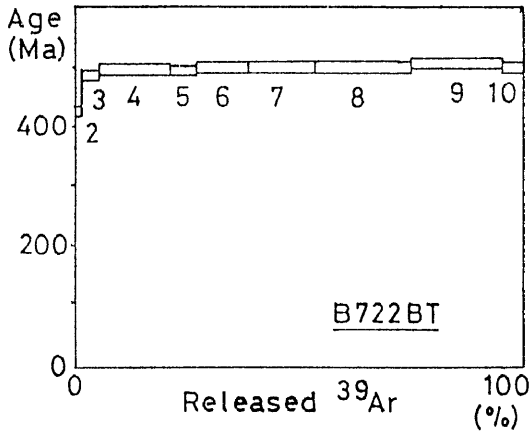

Fig. 2. ^{40}Ar-^{39}Ar age of biotite sample from Sør Rondane Mountains.

3.2. West Antarctica

^{40}Ar-^{39}Ar datings were performed to biotite rich fractions of two granitic rocks from the Dry Valleys region of South Victoria Land, West Antarctica (Fig. 1)[4)]. These samples were collected by New Zealand geologists, Dr. S. Cox and Mr. S. Ellery.

Though these samples were dated in order to clarify the tectonic age when the foliation occurred, the age of about 490 Ma was obtained from both samples, which are considered to represent the time of regional uplift/exhumation (Fig. 3). This age is the same as seen in East Antarctica mentioned in the previous section.

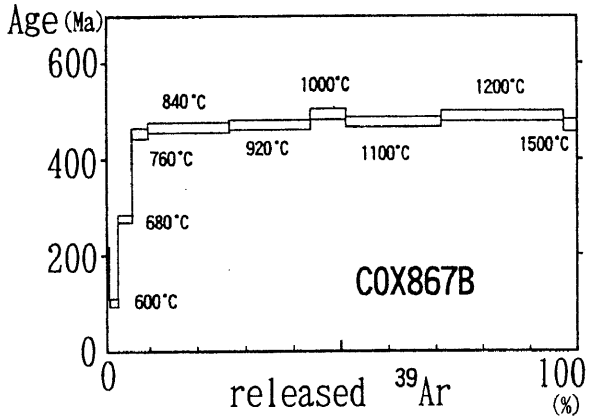

Fig. 3. ^{40}Ar-^{39}Ar age of biotite rich sample from Dry Valleys region.

3.3 Eastern Ghats in India

Many rock samples were collected from Mahanadi and Godavari Grabens, Eastern Ghats

in India, which were considered to have been connected to those in Antarctica up to early Cretaceous, for the paleomagnetic studies by Dr. H. Sakai (Toyama University), Dr. M. Funaki (NIPR) and others.

From these samples, 10 ^{40}Ar-^{39}Ar ages were obtained for biotite, gneiss, charnockite and dolerite (Fig. 4)[5]. ^{40}Ar-^{39}Ar plateau ages of about 500-580Ma were obtained which were consistent with those of samples in East Antarctica. One biotite sample from Mahanadi Graben showed 677Ma, which had not been reported in East Antarctica by the ^{40}Ar-^{39}Ar and K-Ar methods. This age may represent that the Pan African Orogeny had not affected a part of the Mahanadi Graben.

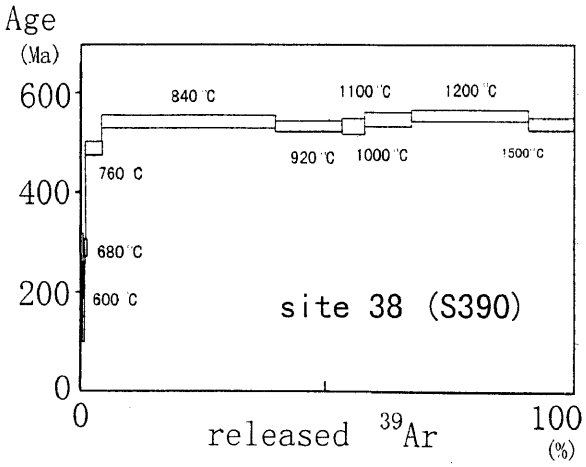

Fig. 4. ^{40}Ar-^{39}Ar age of muscovite sample from Mahanadi Graben.

3.4. Rajmahal Trap in India

To the northeastern part of Calcutta, India, there is a large early Cretaceous volcanism, Rajmahal trap. Dr. H. Sakai (Toyama University) and others collected samples for the paleomagnetic study and obtained good data of Virtual Geomagnetic Pole position[6].

^{40}Ar-^{39}Ar age results were obtained for 3 samples from different basalt flows of Rajmahal trap (Fig. 5). Although good plateau ages were not obtained owing to low potassium contents, insufficient correction of interfering Ar isotopes derived from calcium and the problem of excess Ar which had existed in the sample primarily, an age information of about 125 Ma was seen from each result of three samples. As this age is very close to the age that India was broken from Gondwana at about 130 Ma, the Rajmahal Trap may have erupted related to this break up.

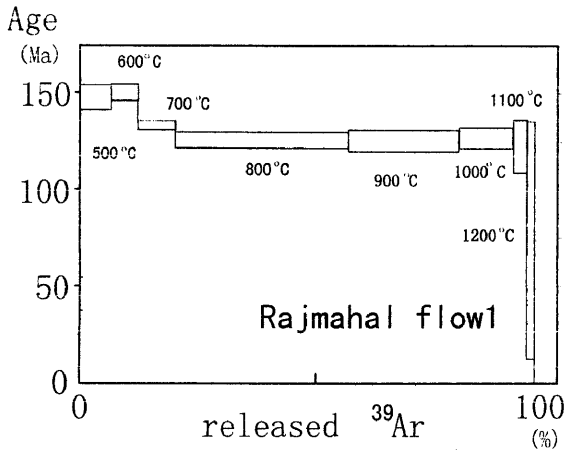

Fig. 5. ^{40}Ar-^{39}Ar age of basalt sample from Rajmahal Trap.

4. Summary

For studies of the thermal history of metamorphism and the geological tectonic movement of the Gondwana land, ^{40}Ar-^{39}Ar dating will become to be more necessary. We intend to continue to study ^{40}Ar-^{39}Ar datings of samples from the Gondwana land to elucidate the history of the Earth.

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1) Y. Takigami and M. Funaki, Proc. NIPR Symp. Antarct. Geosci. **5**, (1991) 122.

2) Y. Takigami, M. Funaki and K. Tokieda, Recent Progress in Antarctic Earth Science, eds. Y. Yoshida et al. (TERRAPUB, Tokyo, 1992) P.61.

3) M. Funaki and K. Tokieda, Proc. NIPR Symp. Anrarct. Geosci. **4**, (1990) 67.

4) Y. Takigami and T. Watanabe, Proc. NIPR Symp. Antarct. Geosci. **8**, (1995) 160.

5) Y. Takigami, H. Sakai, K. Venkata Rao, H. Sakai, M. Funaki and K. Hirooka, Proc. NIPR Symp. Antarct. Geosci. **8**, (1995) 277.

6) H. Sakai, M. Funaki, T. Sato, Y. Takigami, H. Sakai and K. Hirooka, J. Geol. Soc. Japan (in press). (in Japanese)