19. $^{40}Ar/^{39}Ar$ GEOCHRONOLOGICAL STUDIES OF BASALTS FROM HOLE 462A, NAURU BASIN, DEEP SEA DRILLING PROJECT LEG 89[1]

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ABSTRACT

$^{40}Ar/^{39}Ar$ geochronological studies were performed on basalts taken from the bottom of Hole 462A. An age of 129.7 ±4.6 Ma was obtained for two temperature fractions (800 and 1000°C) of Sample 462A-109-1, 106–108 cm. That age is between the age of the oceanic basement, as deduced from the magnetic anomaly data, and the age of interlayered sediment, as deduced from the sparse fossil content.

INTRODUCTION

At the bottom of Hole 462A below the Cretaceous (Aptian) sediments, basalt layers were found that may be either the oceanic basement of the Nauru Basin or part of a thick sill or additional flows overlying basement. Basement age is estimated to be about 155 Ma, based on magnetic anomaly data (Larson and Schlanger, 1981). Ozima et al. (1981) obtained a $^{40}Ar/^{39}Ar$ age of 110 ±3 Ma for a basalt sill (Sample 462A-32-1, 65–69 cm; Leg 61) that intruded into the Cretaceous sediments. The age gap between 155 Ma and 110 Ma suggested that there may have been volcanic activity after the formation of the oceanic basement.

Hence, it is very important to determine the precise age of basalt layers recovered from Hole 462A in order to gain insight into their origin as sills or flows above basement or as basement rock in the Nauru Basin.

SAMPLES

$^{40}Ar/^{39}Ar$ dating was carried out on four basalt samples from Hole 462A, Cores 94 to 109. According to the petrographic data (Site 462 report, this volume), Sample 462A-94-1, 122–124 cm is a sparsely plagioclase phyric basalt. There is no direct petrologic description of the other three samples. However, there are petrologic descriptions of neighboring samples that lie above or below these samples. The samples are similar petrologically, especially among samples at similar core portions. Assuming that a sample from an intermediate position has the same petrologic composition as that of the samples lying above and below it, the petrologic characteristics of the three samples are assigned tentatively as follows: Sample 462A-102-4, 3–5 cm—sparsely clinopyroxene–plagioclase phyric basalt; Sample 462A-106-1, 23–25 cm—aphyric glassy basalt; Sample 462A-109-1, 106–108 cm—clinopyroxene–plagioclase phyric glassy basalt.

These samples were chosen because they are relatively fresh, contain a minimum amount of clay minerals, and represent the different basalt units.

EXPERIMENTAL PROCEDURES

Chunks of four samples (about 1.0 g each) were sealed in two quartz tubes (9 mm dia. × 7 cm) together with CaF_2, K_2SO_4, and four standard samples. Among them, two biotite standards ($K_2O = 7.64$ wt.%, age = 90.8 Ma) were prepared from the original rocks of JG-1, which were used to make a standard by the Geological Survey of Japan. The other two standards (LP-6 biotites; $K_2O = 8.33$ wt.%, age = 128.9 Ma) (Engels and Ingamells, 1971, 1972; Ingamells and Engels, 1976) were irradiated together to monitor the values of JG-1 biotites. The quartz tubes were then subjected to a total neutron flux of about 10^{18} neutrons/cm^2 in the Japan Material Testing Reactor at Tohoku University. The gradient in the neutron flux was estimated to be about 1.6%/cm along the length of the quartz tube based on the results for the standard samples. The irradiated samples were cooled for about three months. For extraction of Ar gas, each sample was heated for 45 min. successively in eight or nine temperature fractions with a high-frequency induction heater. The temperature was controlled by adjusting the output power of the induction heater with the aid of an optical pyrometer. The extracted Ar gas was purified by conventional procedures and stored in a glass tube.

Ar was analyzed on a Quadrupole Mass Spectrometer (QMS) (Takigami, 1983). To correct for interfering neutron-induced Ar isotopes, correction factors were determined by analyzing irradiated K_2SO_4 and CaF_2; we obtained the following values: $(^{40}Ar/^{39}Ar)_K = 0.06$, $(^{39}Ar/^{37}Ar)_{Ca} = 0.0013$, and $(^{36}Ar/^{37}Ar)_{Ca} = 0.0005$. Data reduction was made following conventional procedures (e.g., Dalrymple and Lanphere, 1971). When the ages of LP-6 are calculated following the values of sample JG-1, we get values of 127.8 ±1.3 Ma and 126.3 ±1.4 Ma. These are consistent with the reported values of 128.9 ±1.4 Ma and 127.9 ±0.7 Ma (Ingamells and Engels, 1976; Odin et al., 1982). Hence, the assigned age of JG-1 would also be supported.

RESULTS

The results of the $^{40}Ar/^{39}Ar$ datings are summarized in Table 1.

K contents are estimated from the comparison of the total amount of ^{39}Ar between a sample and a standard sample. The samples analyzed have very low K contents ranging from 0.034 to 0.044 wt.%.

Samples 462A-94-1, 122–124 cm, 462A-102-4, 3–5 cm, and 462A-106-1, 23–25 cm give very ragged age spectra

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Table 1. Summary of $^{40}Ar/^{39}Ar$ dating of basalts at Hole 462A.

Sample (Core-section, interval in cm)	K[a] (wt.%)	^{40}Ar[b] (10^{-7} ccSTP/g)	$^{40}Ar/^{39}Ar$ age (Ma)	
			Total	Plateau
94-1, 122–124	0.042	6.9	53.8	No
102-4, 3–5	0.044	35.2	24.0	No
106-1, 23–25	0.039	11.9	52.7	No
109-1, 106–108	0.034	4.4	82.9	(129.7 ± 4.6)[c]

[a] K contents were estimated based on the ^{39}Ar output power of the QMS compared with that of JG-1 biotite (K_2O = 7.64 wt.%). About 10% uncertainty is included judging from the reproducibility of JG-1 biotite.

[b] ^{40}Ar: (total ^{40}Ar = radiogenic ^{40}Ar + nonradiogenic ^{40}Ar).

[c] This value is estimated from 800°C and 1000°C fractions, which constitute 46.6% of the total released ^{39}Ar.

showing no plateau age. Hence, no meaningful age information can be obtained for these samples. Total fusion ages are also given in Table 1.

Sample 462A-109-1, 106–108 cm shows a plateaulike age of 129.7 ±4.6 Ma for two fractions (800 and 1000°C), which constitute 46.6% of the total released ^{39}Ar (Fig. 1). However, the ages in higher temperature fractions decrease again, which may be due to insufficient corrections for interfering Ar isotopes together with blanks.

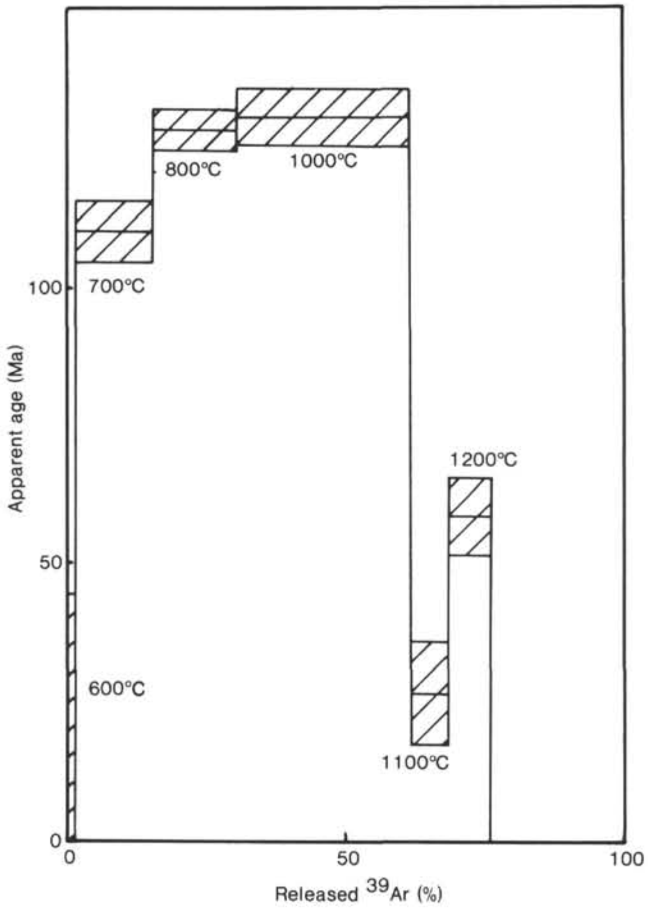

Figure 1. The $^{40}Ar/^{39}Ar$ age spectrum for Sample 462A-109-1, 106–108 cm. Vertical and horizontal axes indicate the apparent age and the released fraction of ^{39}Ar, respectively. All values were corrected for interfering Ar isotopes induced from Ca and K by the neutron irradiation. Hachured area represents the uncertainty of ±1σ in the $^{40}Ar/^{39}Ar$ age.

DISCUSSION

We have obtained an interesting result: Sample 462A-109-1, 106–108 cm indicates an age of 129.7 ±4.6 Ma for two temperature fractions (800 and 1000°C). This age is older than the fossil age (Aptian) (Site 462 report, this volume) and the $^{40}Ar/^{39}Ar$ age (110 ±3 Ma) (Ozima et al., 1981) of the higher samples. The age is younger, however, than that which has been estimated from the magnetic anomaly data (~155 Ma). Thus an interpretation of the analysis is that the flow at the bottom of the hole was erupted about 129.7 Ma.

Nevertheless, there are two possible reasons why 129.7 Ma may not represent the true age of the sample. One reason is that because these ages are observed in intermediate temperature fractions, we cannot deny the possibility that these ages might represent the time when secondary clay minerals were formed. At present, it is difficult to discern whether this age represents a formation of the basalt or of clay minerals.

Another reason is that the $^{40}Ar/^{39}Ar$ age determination of these basalts has relatively large uncertainties. There are two reasons for the uncertainties: One is that K contents of these basalts are extremely low (on the order of 0.04–0.06 wt.%). Accordingly, the amount of radiogenic ^{40}Ar is very small even if a sample is as old as about 150 Ma. Hence, the air contamination rate becomes large, causing difficulties in obtaining a precise age. The other reason is that the background at mass 36 in the QMS corresponds roughly to about 10% of the total ^{36}Ar for each sample. Therefore the uncertainty in the background correction for ^{36}Ar might not be well evaluated for some fractions. This may be another reason for the scattered results in this age study.

However, it is worth mentioning that this age is the oldest one so far obtained for Hole 462A samples. Further refined techniques are required to get more reliable ages for these basalts.

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