CHAPTER 4

JOBAN SEAMOUNT CHAIN & UYEDA RIDGE

4-1 Introduction

Samples from the top of the Mizunagidori Seamount were dredged during KH92-3 cruise of the R.V. *Hakuho-Maru* by Ocean Research Institute, University of Tokyo, at the 37°07' N to 37°09' N, 145°20' E to 145°17' E, and approximately 2800 to 2300 meters depth. Among the samples; KH92-3 D3-008a and 008d we used in this study. Samples from the western tip of the Uyeda were dredged Ridge during KH87-3 cruise of R.V. *Hakuho-Maru* by Ocean Research Institute, University of Tokyo, at the 27°08' N to 27°10' N, 143°27' E, and 6129 to 5869 meters depth, and samples; KH87-2 5-003 and 006 were used in this study.

Joban Seamount Chain

The Joban Seamout Chain is a good collinear chain of the azimuth of SW to NE and composed of main 10 seamounts which are concentric (see chapter 2-3) (Figure 2.4).

Masalu *et al.* (1997) conducted a systematic geophysical survey of the Joban Seamount Chain and nearby the Daigo-Kashima Seamount, and examined the paleomagnetic directions of the Joban Seamount Chain and implied the tectonics of the Pacific Plate. They suggest that the Hitachi and Iwaki Seamounts have the Early Cretaceous poles whereas the other poles are the Late Cretaceous and that the Joban Seamounts formed near the equator, similar to other seamounts in the WPSP. These interpretations are consistent with the bathymetric characters that only the Hitach and Iwaki Seamounts in the 10 Joban Seamounts are guyots and may be older edifices (Figure 2.5), whereas the others are not.

Uyeda Ridge

The Uyeda Ridge is part of the Uyeda-Round Ridge, trending east and west around 28-27°N just east of the Izu-Bonin Trench. The site of the Uyeda Ridge lies between 27° to 36°N and 141 to 147°E in the western tip of the Marcus Seamount Chain (see chapter 2-4) (Figure 2.5). The Uyeda Ridge is named after Dr. Seiya Uyeda, Earthquake Research Institute, Tokyo University, in recognition of his outstanding contributions to geophysical investigations in this region (Smoot and Heffner, 1986).

The peculiar bathymetry of the Uyeda Ridge can let us conceive being expected the different formation processes with the normal concentric seamounts of hotspot origin. Smoot and Heffner (1986) and Kobayashi (1990) suggested that the Uyeda Ridge may be part of an extinct remnant spreading center or may be the result of magma leakage through a transform fault, because the topography of the Uyeda Ridge are straight and parallel to a magnetic lineation of chron M19 (approximately 140 Ma)

(Figure 2.6).

If the formation age is the Early Cretaceous, the Uyeda Ridge would be an extinct mid-oceanic ridge remained by ridge jump. On the other hand, it might be possible to be due to magma leakage if it is of the younger age than that of the oceanic crust underneath.

Early Cretaceous Spreading Center?

Smoot and Heffner (1989) suggested that the Uyeda-Round Ridge and the Ryofu-Kashima Ridge were both fossil spreading ridges of the same age, and the Heffner's Fault (generally called the "Kashima Fracture Zone" (Nakanishi *et al.*, 1989)) offsets these ridges. Their "Kashima-Ryofu Ridge" corresponds to just the Joban Seamount Chain in this thesis. Although the trend of the linear Uyeda Ridge is approximately 70°NE (Smoot and Heffner, 1989), perpendicular to the Kashima Fracture Zone, the Joban Seamount Chain is not but 50°NE (Figure 4.1).

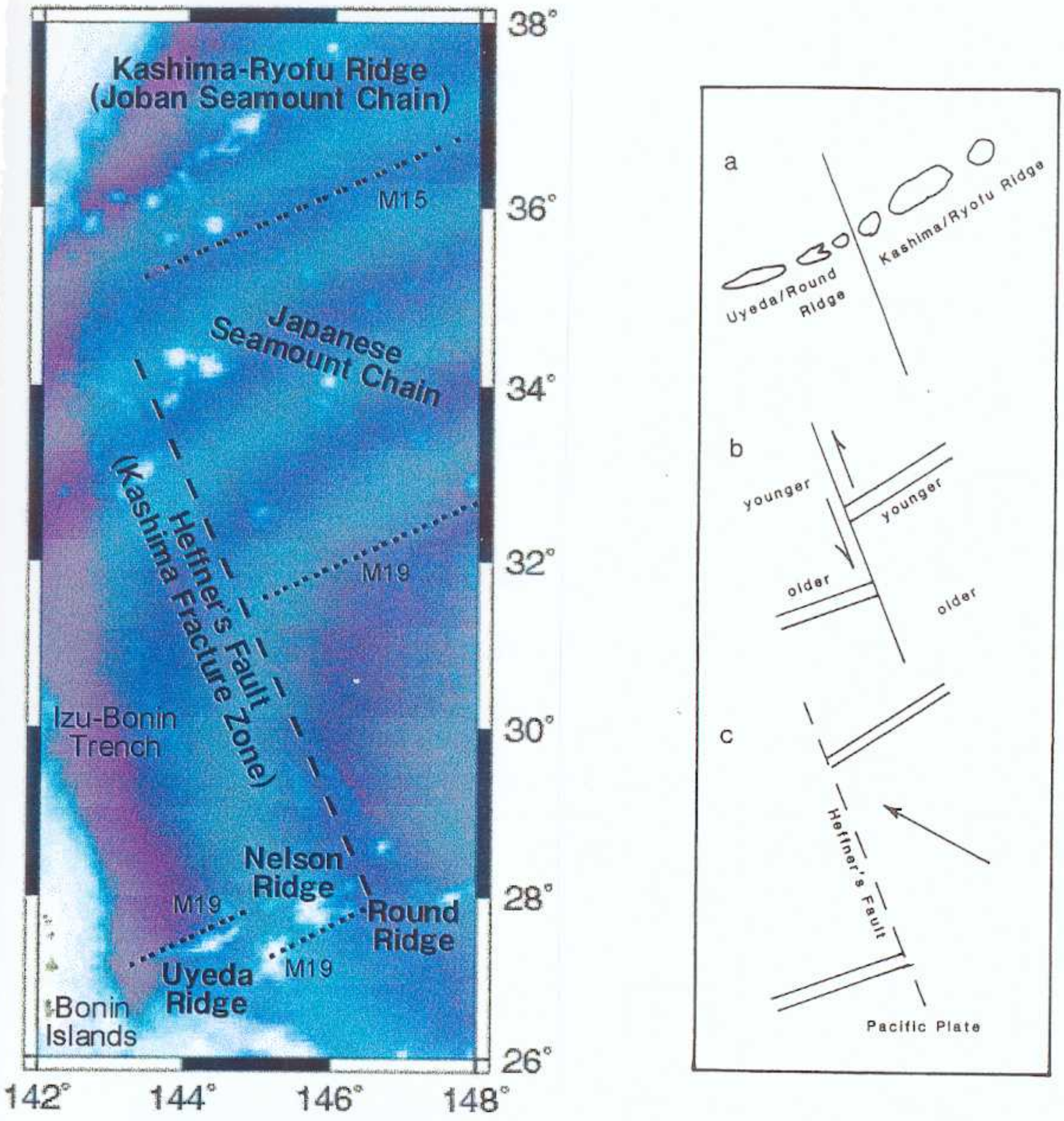


Figure 4.1 Bathymetric map around the Uyeda Ridge to Joban Seamount Chain. Right figure is a possible tectonic evolution model of Uyeda-Round and Kashima-Ryofu Ridge connected by the Heffner's Fault. Adopted from Smoot and Heffner (1989).

4-2 Results

Petrography

Samples of KH92-3 D3-008a and D3-008d from the Mizunagidori Seamount are very vesicular, and show the remarkable flow structure of plagioclase. Phenocrysts are scarce, and groudmass is composed of plagioclase, ilmenite, altered clinopyroxene and rare potassium-feldspar.

On the other hand, samples of KH87-3 5-003 and 5-006 from the Uyeda Ridge are composed of altered ironic relic phenocrysts including many chromian spinels, which were probably olivine, and groundmass is composed of plagioclase, potassium feldspar, chromian spinel and altered clinopyroxene.

Bulk Geochemistry

Although all the samples from the Mizunagidori Seamount and Uyeda Ridge are identified hawaiite (Figure 4.2), the bulk chemistry of two samples from the Uyeda Ridge is characterized by lower TiO_2 (less than 2 wt%), higher Al_2O_3 (over 18 wt%) and lower incompatible trace elements contents than of normal oceanic island alkali-basalts (Table 4.1).

Table 4.1 Results of XRF analysis of bulk chemistry of basalt samples from the Uyeda Ridge and Mizunagidori Seamount.

	Uyeda Ridge		*Mizunagidori Seamount*	
sample	KH87-3 5-003	KH87-3 5-006	KH92-3 D3-008a	KH92-3 D3-008d
(wt%)				
SiO_2	**51.22**	**50.54**	**45.99**	**46.06**
TiO_2	**1.71**	**1.37**	**2.85**	**2.83**
Al_2O_3	**18.18**	**18.58**	**17.07**	**17.38**
Fe_2O_3	**13.88**	**10.39**	**5.67**	**6.03**
MnO	**0.06**	**0.10**	**0.13**	**0.14**
MgO	**1.55**	**1.50**	**1.14**	**1.21**
CaO	**6.42**	**9.01**	**14.55**	**14.59**
Na_2O	**2.71**	**2.40**	**3.22**	**3.14**
K_2O	**3.53**	**3.74**	**2.30**	**1.95**
P_2O_5	**1.10**	**2.17**	**6.49**	**6.30**
Total	**100.38**	**99.79**	**99.40**	**99.63**
(ppm)				
Ba	**4.1**	**60.0**	**307.4**	**288.0**
Co	**51.0**	**122.0**	**77.0**	**53.0**
Cr	**665.0**	**389.0**	**37.0**	**—**
Nb	**4.8**	**7.0**	**48.9**	**52.0**
Ni	**100.1**	**68.2**	**28.9**	**31.5**
Pb	**0.1**	**3.6**	**8.9**	**6.4**
Rb	**43.9**	**49.5**	**31.8**	**24.2**
Sr	**223.9**	**275.4**	**646.1**	**635.8**
Th	**1.2**	**0.7**	**5.3**	**4.6**
Y	**29.0**	**63.0**	**164.5**	**125.4**
Zr	**84.8**	**77.0**	**224.0**	**235.2**

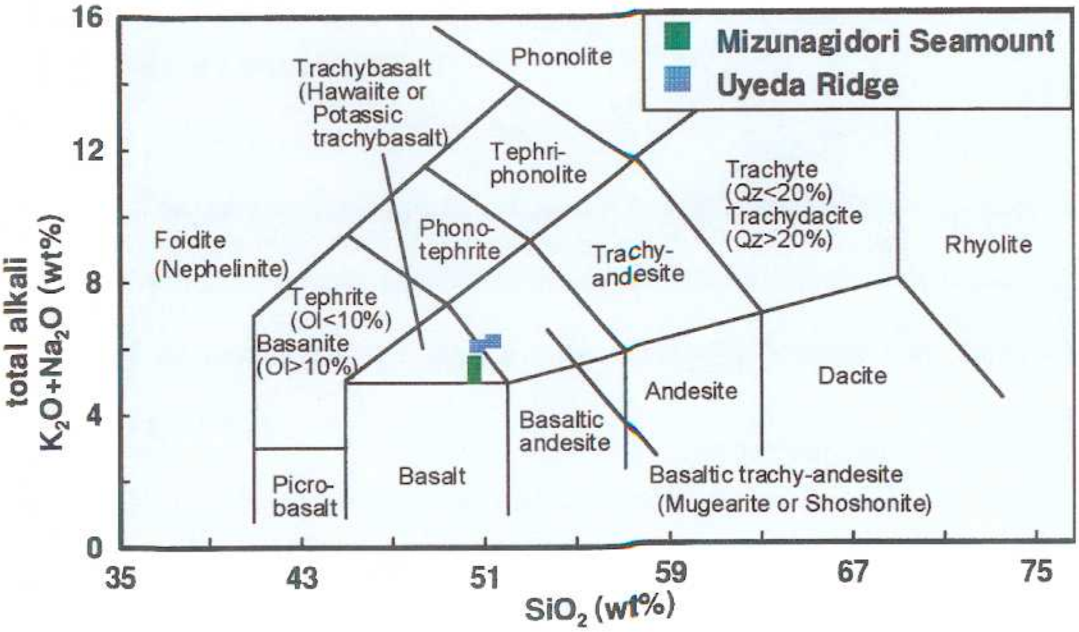


Figure 4.2 SiO_2-total alkali diagrams of KH92-3 D3-008a, D3-008d, KH87-3 5-003 and 5-006 from Mizunagidori Seamount and Uyeda Ridge.

The microprobe analysis of KH87-3 5-003 and 5-006 was done for the cromian-spinels (Appendix C). Compositions of cromian-spinels have higher TiO_2 than in island arc basalts and the slightly lower Cr/(Cr+Al) cations ratio than in abyssal basalts (Figure 4.3).

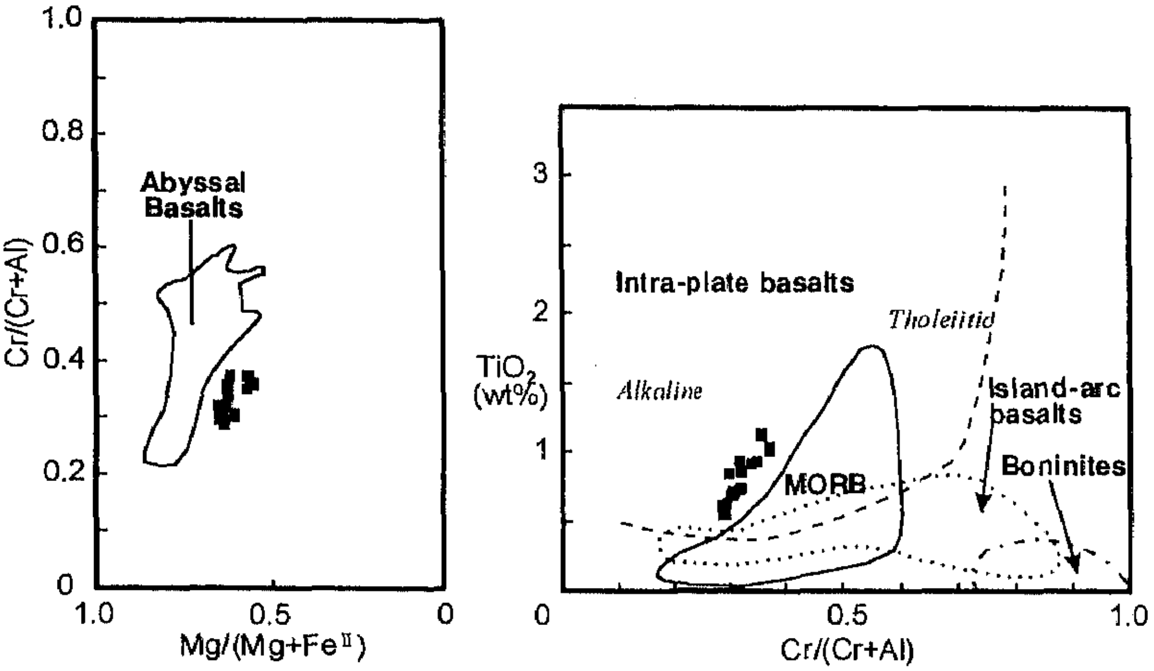


Figure 4.3 Compositions of chromian spinels in the KH87-3 5-003 and 5-006 samples. Some areas of each tectonic settings adopted from Arai (1992).

Ar-Ar Age

Pieces of whole rockof the samples, a few mm in size, of KH87-3 5-003 and 5-006, were analyzed by the ^{40}Ar-^{39}Ar method. The data and results are shown in Appendix D. In the both samples, we can obtain well-defined isochron ages. In KH87-3 5-003 sample, we omit the two lowest temperature fractions (600 and 800 °C) from the calculation, because the isotope compositions in these fractions seem to be disturbed by alteration. The age spectrum of KH87-3 5-003 do not show a plateau age, but 5-006 from the same place shows a plateau age, 55.5±2.7 Ma, in accordance with the three high temperature fractions in 95 % confidence level (Figure 4.4). As both of the two samples have the excess Ar, trap ^{40}Ar/^{36}Ar ratios of 400-450, we should discuss the geochronology using not the age spectrums but the ^{36}Ar/^{40}Ar-^{39}Ar/^{40}Ar isochron diagrams. Then the geological reliable age of the Uyeda Ridge by the isochron age in KH87-3 5-006 is resulted in 51.8±3.8 Ma.

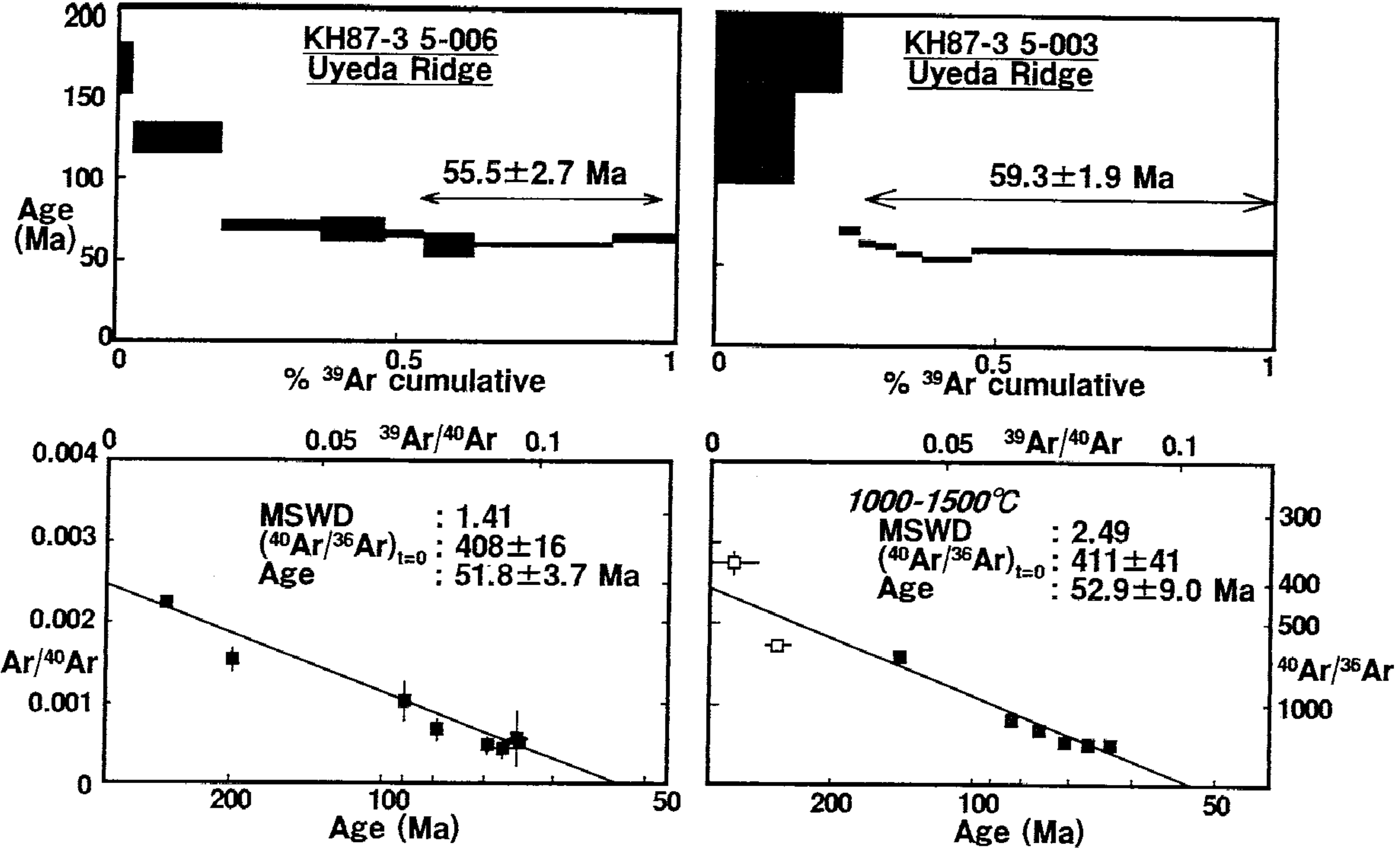
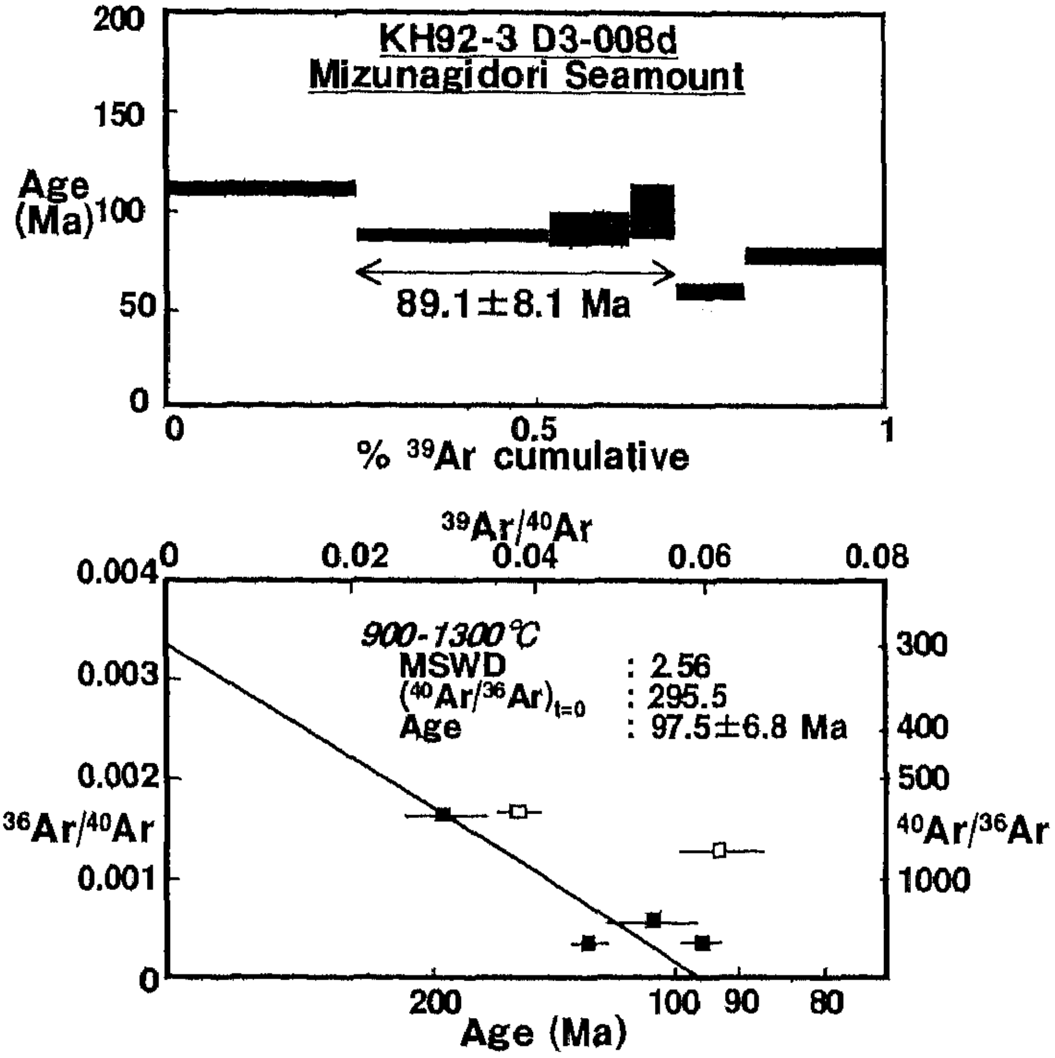


Figure 4.4 Ar-Ar age results of KH87-3 5-003 and 5-006 from Uyda Ridge. Age spectra and isochron diagrams for $^{40}Ar/^{39}Ar$ incremental heating experiments on both samples. Each J value of sample 5-003 and 5-006 is J=(3.046±0.058)×10^{-3} and (3.48±0.11)×10^{-3}, respectively, which defines a dimensionless parameter determined for each irradiation from standard samples whose ages are known from conventional potassium-argon measurements (Mitchell, 1968). Standard samples are three "HD-B1 biotite (24.0±0.4 Ma)". The correction factors for the interfering isotopes during the irradiation of samples were determined experimentally as follows; $(^{36}Ar/^{37}Ar)_{Ca}=(3.76\pm0.10)\times10^{-4}$, $(^{39}Ar/^{37}Ar)_{Ca}=(11.18\pm0.41)\times10^{-4}$. The mean squared weighted deviations, MSWD=SUMS/[n-2] (York, 1969), indicates how well data fit the least-squares calculated straight line in the three isotope diagram.

In the case of the sample of KH92-8 D3-008d from the Mizunagidori Seamount, we did not obtain the good isochron age but ages of middle temperature, 800-1100 °C, which corresponds to the age spectrum. The plateau age is judged as 89.1 ±8.1 Ma (Figure 4.5; Appendix D).



Fuigure 4.5 Ar-Ar age result of KH92-3 D3-008d from Mizunagidori Seamount, Joban Seamount Chain. J value, J=(3.232±0.066)×10^{-3}, are obtained from standard samples, which are three "HD-B1 biotite (24.0±0.4 Ma)". The correction factors; $(^{36}Ar/^{37}Ar)_{Ca}=(0.77 \pm 0.17)\times 10^{-4}$, $(^{39}Ar/^{37}Ar)_{Ca}=(1.57\pm 0.11)\times 10^{-2}$.

4-3 Discussion

Discordant Ages in Joban Seamount Chain

In this paper, a hawaiite from the Mizunagidori Seamount shows a 89.1±8.1 Ma plateau age that is thought to be a volcanic product of the main-shield stage (see chapter 1-4). On the other hand, the trachyandesite from the Daiichi-Kashima Seamount, whose Ar-Ar age is shown as 120 Ma by Takigami *et al.* (1989), is a differentiated rock, thus the main volcanic edifice is considered of the late stage shield volcanism before 120 Ma.

The Joban Seamount Chain could be identified as the well-straight seamount chain of the direction NE to SW. However, above data in this thesis suggest that the Joban Seamount Chain is not a simple hotspot origin because of discordant age progression of the Daiichi-Kashima and Mizunagidori Seamounts. This result is consistent with the paleomagnetic data in Masalu et al. (1997) (see chapter 2-3). However, the origin of the Joban Seamount Chain is not clear, because there is no direct evidence to prove this.

The absolute Pacific Plate motions deduced from the age data of the Mizunagidori and Daiichi-Kashima Seamounts are shown in Figure 4.6. The bathymetric trail of the Joban Seamount Chain have obviously nothing to do with hotspot traces of each age (Figure 4.6). The Joban Seamount Chain can not be a hotspot trail but an accidentally assembled seamount chain of the Early and Late Cretaceous.

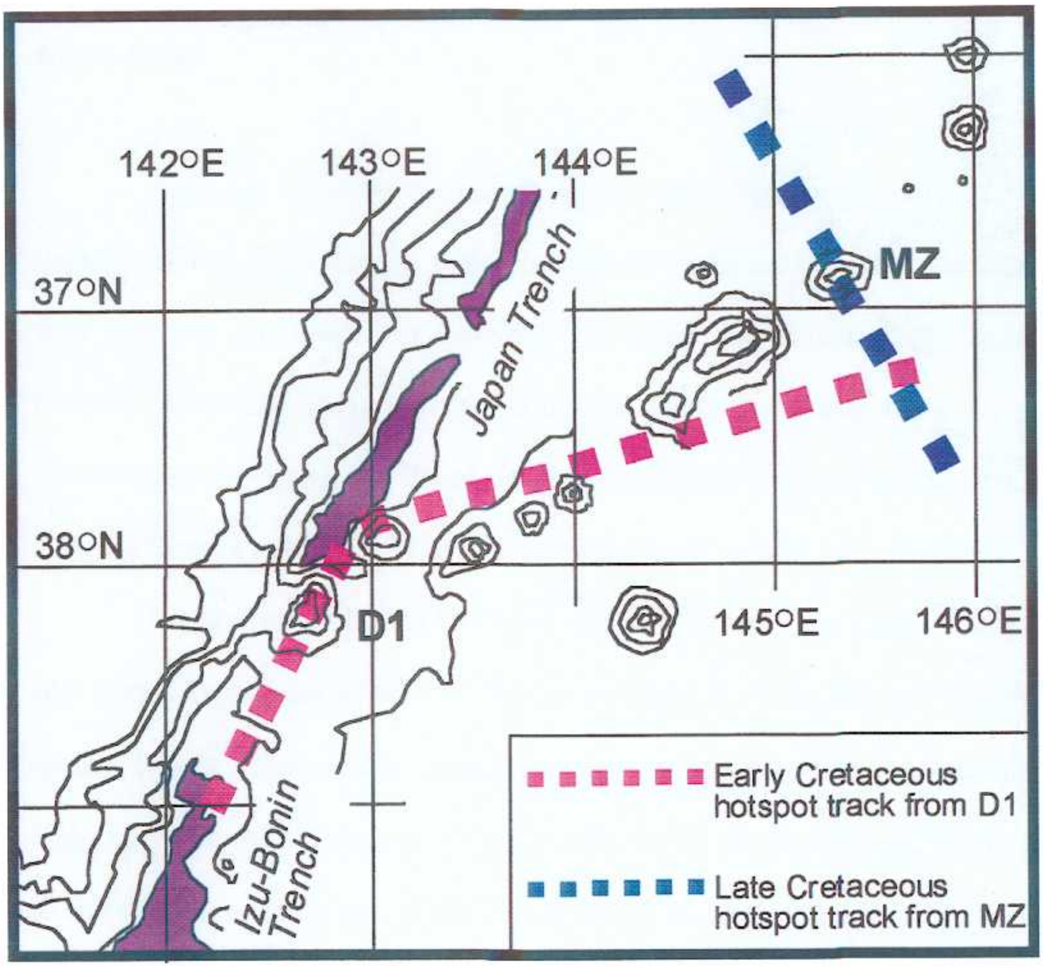


Figure 4.6 Temporary hotspot trails following the age data of the Mizunagidori and Daiich-Kashima Seamounts by this thesis and Takigami *et al.* (1992). These dot lines are not on the topography of the Joban Seamount Chain.

Uyeda Ridge

Although volcanic rock from the Uyeda Ridge is hawaiite of typical OIA (oceanic island alkali-basalt), concentrations of incompatible trace element are lower than that and are similar to E-MORB (enriched mid-oceanic ridge basalt) or OIT (oceanic island tholeiite). Microprobe data of chromian spinels show the origin from OIA magmas in Figure 4.3. Based on the geochemical and microprobe data, the Uyeda Ridge is thought to be a series of volcanic edifices of oceanic island type.

An age result of KH87-3 5-006 shows a well-defined isochron age, 51.8±3.8 Ma. Some Ar-Ar ages of 80-100 Ma, are reported from the Marcus Seamount Chain, eastern Uyeda Ridge, and a mid-Cretaceous fossil age is from the southern neighbor Yabe Guyot in the Ogasawara Plateau (Shiba, 1979; Winterer *et al.*, 1993). Comparing to there previous ages, age of the Uyeda Ridge known in this thesis is very young as early Eocene.

Based on the Ar-Ar age, more depleted trace element compositions, chromian spinel compositions and curious bathymetry, the Uyeda Ridge is considered to a volcanic edifice made by magma leakage along some ruptures of oceanic crust. In addition, this paper is negative to the idea of separated ridges between the Uyeda Ridge and Joban Seamount Chain presented by Smoot and Heffner (1986).