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Report

Chemical compositions and ages of basalts from seamounts in the Northwest Pacific

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Abstract: As part of the exploration for cobalt-rich ferromanganese crusts in the Northwest Pacific, seamount basalts were collected for chemical composition analysis and K–Ar/Ar–Ar dating. Although the primary chemical compositions of the seamount basalts were not well preserved due to alteration and phosphatization, all 20 seamounts sampled showed typical characteristics of ocean island alkaline basalts. K–Ar dating did not provide reliable ages due to alteration, but Ar–Ar dating provided reliable plateau ages for several seamounts. Formation ages of 67–116 Ma were obtained from the Marcus-Wake Seamount Group, 87 Ma and 105 Ma from the Magellan Seamount Group, and 90 Ma from the Marshall Islands Seamount Group, which were generally consistent with those reported in previous studies.

Keywords: Northwest Pacific, hot spot volcanism, K–Ar/Ar–Ar dating, geochemistry

1. Introduction

The Japan Oil, Gas and Metals National Corporation (JOGMEC, formerly the Metal Mining Agency of Japan) has been conducting exploration for cobalt-rich ferromanganese crusts (referred to as cobalt-rich crusts) in the Northwest Pacific (JA area, Fig. 1) since 1987 commissioned by the Ministry of Economy, Trade and Industry (METI, formerly the Ministry of International Trade and Industry). Promising seamounts were selected based on the evaluation of the mineral resources in each seamount, and a 15-year exploration contract was signed with the International Seabed Authority (ISA) in January 2014 for a total of 3,000 km^2 of the flat tops of six seamounts (JA02, JA03, JA04, JA06, JA12, JA17) off the southeast of Minami-Torishima Island. The exploration contract requires that an environmental baseline survey be conducted in order to assess the environmental impact of future mining activities in addition to the resource estimation survey.

In this paper, we report on the chemical composition and age of the seamount basement rocks obtained in previous surveys. The formation history of the seamounts inferred from these data provides basic geological information and is useful for understanding the formation mechanism of cobalt-rich crusts. It is also important to understand the characteristics of the particles derived from the basement rock for the suspended plume generated during the mining activity.

2. Study area

The JA area is in the southwest of the North Pacific, extending from around Minami-Torishima Island (Marcus Island) in the north to the Caroline Islands in the south, and from Wake Island in the east to the Mariana Trench in the west. In the northern part of the JA area, the Marcus-Wake Seamounts (JA01-JA06, JA11, JA12, JA17, JA18, MT473) are linked in an east-west direction, and their eastern extension is continuous with the Central Pacific Seamounts. The Magellan Seamounts (JA09, JA13-JA15, JA19, JA22) are arranged in the NW-SE direction from the central to the southern part of the JA area. To the southeast of the JA area, the Marshall Islands Seamounts are aligned in the NNW-SSE direction, and some of the seamounts at their northwestern end are distributed in the southeast of this area (JA10, JA16) (Fig. 1).

Most JA seamounts are flat-topped (Guyots), and their tops are generally shallower than 1,400 m in depth. The basement rocks of the seamounts are mainly basalt, hyaloclastite, and conglomerate, which are covered by shallow-water limestones and pelagic sediments.

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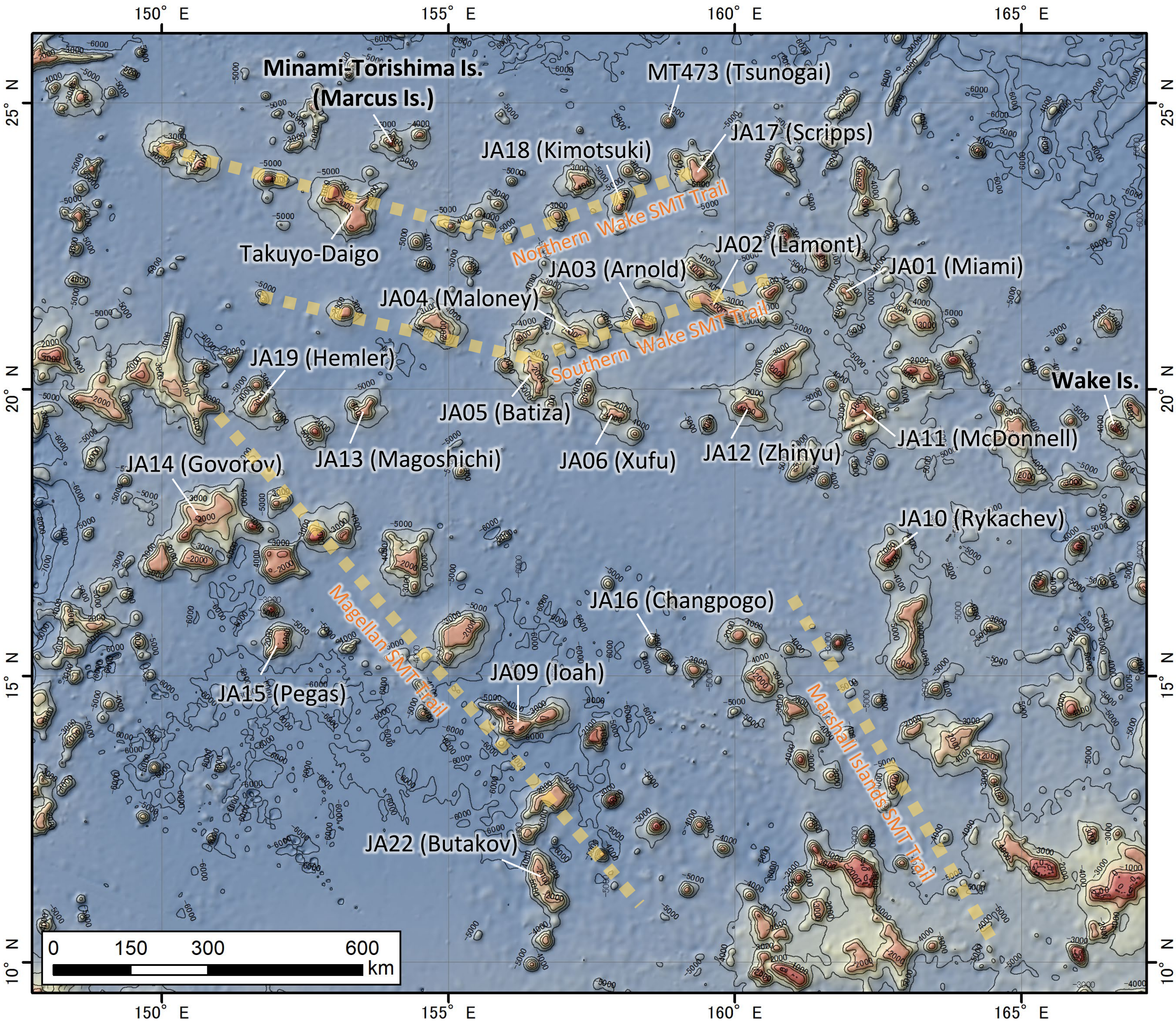

Fig. 1 JJA area in the Northwest Pacific with seamount names. The map was created using ArcGIS ver10.8.1 (ESRI Japan). The used topographic data is ETOPO1 published by NOAA National Centers for Environmental Information (NCEI). The coordinate system is the World Geodetic System (WGS 84).

The limestones contain fossils of corals and thick-toothed bivalves, suggesting that the volcanic islands or atolls gradually subsided and reached the present depth. Limestones are sometimes phosphatized to form phosphate rocks. The exposed basement rocks are covered with ferromanganese crusts of several to ten centimeters thick, and foraminiferal sand is deposited on the flat tops (Watkins *et al.*, 1995, Usui and Someya, 1997).

The depth of the basin is 5,500–6,000 m, and it is known to belong to the oldest zone in terms of geological age of anywhere on Earth, which corresponds to the Cretaceous-Jurassic period according to paleomagnetism (e.g., Larson *et al.*, 1985, Abrams *et al.*, 1993). Based on the $^{40}Ar/^{39}Ar$ age of basalts, it is considered that the Marcus-Wake Seamount Group was formed 100–120 Ma (Early Cretaceous), while the Magellan Seamount Group and the Marshall Islands Seamount Group were formed 70–100 Ma (Late Cretaceous) (Smith *et al.*, 1989, Staudigel *et al,* 1991, Koppers *et al.* 2003).

The chemical composition of these basalts is similar to that of basalts from hotspot volcanoes in French Polynesia in the South Pacific, suggesting that these seamounts were formed by volcanic activity in the French Polynesian region, and have been subducting since the Cretaceous, moving with plate movements to their present positions (Smith *et al.*, 1989, Staudigel *et al.*, 1991). Volcanic activity in French Polynesia is often characterized by unique isotopic features such as HIMU mantle endmember (Zindler and Hart, 1986), and is referred to as the South Pacific Isotope and Thermal Anomaly (SOPITA) (e.g., Staudigel *et al.*, 1991). However, Koppers *et al.* (2003) proposed that the seamount chain was formed by intermittent short-term hotspot activity with diverse isotopic compositions, rather than continuous hotspot activity over a long period of time, based on the diversity of isotopic ratios and the contrast between the two regions.

3. Materials and methods

In each seamount, rock samples were collected mainly by arm type dredge (AD) or chain-bag dredge (CB), and core samples were collected by deep-sea drill machine (BMS: Benthic Multi-Coring System) from 2001. The year and project name for which samples were collected and/or analyzed are shown in Table 1 and 2.

3. 1 Chemical analyses

Analytical methods for bulk chemical composition vary with each analysis year.

FY1989–1990: Detailed analysis methods are unknown.

FY1997: Major elements were measured by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES), FeO by titration, CO_2 by high-frequency combustion infrared absorption method, H_2O and loss on ignition (LOI) by gravimetric method, and rare earth elements by instrumental neutron activation analysis.

FY1998–2002: Major elements were measured by ICP-AES, FeO by titration, CO_2 and H_2O^+ by high-frequency combustion infrared absorption method, H_2O^- and LOI by gravimetric method, and trace elements by Inductively Coupled Plasma Mass Spectrometry (ICP-MS).

FY2005: Major elements were measured by X-ray Fluorescence Spectroscopy (XRF), FeO by titration, C by electrometric analysis, H_2O^+ by high-frequency combustion infrared absorption method, H_2O^- and LOI by gravimetric method, and trace elements by ICP-MS.

FY2018–2019: Analysis was performed at ALS Canada Ltd., Canada, including pretreatment. Major elements were measured by XRF or ICP-AES after mixed lithium tetraborate and lithium metaborate melt treatment. Trace elements were measured by ICP-AES or ICP-MS after mixed acid treatment or lithium metaborate melting treatment; H_2O^+ was measured by high-frequency combustion infrared absorption method; H_2O^- and LOI were measured by gravimetric method.

FY2020: Analysis was performed at GSJ/AIST. Rock samples were dissolved using mixed acid (HNO_3+HF), and then trace elements were measured by ICP-MS (Agilent 7700x) combined with the indium internal standard technique.

3. 2 K–Ar/Ar–Ar dating

Based on the observation under microscope, samples with minimal alteration were selected for dating. The K–Ar dating was conducted through 1998, and the Ar–Ar dating was conducted starting 1999.

In the K–Ar dating, potassium was determined using a flame photometer and argon isotope ratios were determined using a noble gas mass spectrometer. The decay constants used are based on Steiger and Jaeger (1977).

$\lambda e = 0.581 \times 10^{-10}$ /year

$\lambda\beta = 4.962 \times 10^{-10}$ /year

The ratio of ^{40}K in K was determined to be $^{40}K/K$ = 0.01167 atom%.

For the Ar–Ar dating, the analysis was carried out by the step heating method. When a constant Ar–Ar age is obtained from contiguous heating steps comprising >50 % of total ^{39}Ar, the age is called a plateau age. Plateau ages are considered to indicate the age of formation of the sample without secondary Ar loss. The isochron age can also be determined from the Ar isotope ratios obtained from each step.

For the measurements, the samples were crushed, dried at 105 °C for 3 h, and then finely ground to 180–250 µm. The sample (2 g) was washed twice with 20 % nitric acid and once with 5 % hydrofluoric acid to prevent the formation of gases from carbonate minerals and other secondary minerals that could interfere with Ar analysis. The acid-washed sample was washed thoroughly with pure water, methanol and acetone. A portion of this sample was packed in aluminum foil and set in the reactor. Detailed procedures were described in Ishizuka *et al.* (2006).

Neutron irradiation was carried out at McMaster University in Canada in FY1999, 2000, and 2001. The samples and the standard samples for J-value measurement were irradiated for 45 hours. The standard samples used were LP-6 (biotite, 127.8 Ma) and Fish Canyon sanidine (27.95 Ma). The samples were heated in 8 to 11 steps in the range of 800 to 1800 K. In 2002, neutron irradiation was performed at the research reactor of Oregon State University. The samples and the standard samples for J-value measurement were irradiated for 16 hours. The standard sample used was Taylor Creek Rhyolite Sanidine (27.92 Ma). The sample was heated in 11 to 15 steps for the range of 460–1100 K.

Ar isotope corrections for K, Ca, and Cl originating from atmospheric and neutron irradiation were performed to determine the $^{40}Ar/^{39}Ar$ ratio. The $^{40}Ar/^{39}Ar$ ratio of the measured sample was then calculated from the J-value of the standard sample. The criteria for determining the age of the plateau were: 1) three or more consecutive heating age values in the medium to high temperature range must agree with each other with 95 % confidence limits, 2) the plateau must contain more than 50 % of the total ^{39}Ar. The weighted average of all the age values comprising the plateau was used as the plateau age (Dalrymple *et al.*, 1980).

4. Chemical composition

The chemical compositions of the basement rocks from each seamount are summarized in Table 1 and 2, and the plots of H_2O_{total} (H_2O^+ + H_2O^-) and CO_2 against LOI are shown in Fig. 2. The ratios of major elements to SiO_2 are shown in Fig. 3. LOI is >5 % in most of the samples, suggesting that they have suffered strong alteration.

Table 1 Major elemental compositions of basement rocks from seamounts in the JA area

Year	Seamount	Sample ID	Rock type	(wt%) SiO_2	TiO_2	Al_2O_3	Fe_2O_3t	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	H_2O^+	H_2O^-	H_2O_{total}	CO_2	LOI	Total	FeO*	Mg#	FeO*/MgO	Project name
1999	JA01	99JA01AD12	Clinopyroxene olivine alkali basalt	39.8	3.4	12.2		8.9	2.3	0.3	7.1	11.8	2.0	1.4	1.8	4.0	4.2	8.1	0.3	8.8	99.9	10.3	0.41	1.45	DMRS 1999
1999	JA01	99JA01AD13	Olivine clinopyroxene basalt	42.8	3.2	15.2		8.7	3.9	0.2	5.1	10.2	2.1	1.2	0.5	3.0	3.7	6.7	0.1	7.5	100.5	11.7	0.30	2.31	DMRS 1999
1999	JA01	99JA01AD18	Clinopyroxene olivine alkali basalt	40.3	3.7	14.3		9.5	2.8	0.2	7.3	12.0	1.6	1.0	1.2	2.4	3.3	5.6	0.1	6.0	99.9	11.3	0.39	1.56	DMRS 1999
1999	JA01	99JA01AD23	Clinopyroxene olivine alkali basalt	48.6	2.4	18.4		6.1	2.5	0.2	3.8	7.0	5.0	3.1	0.4	1.5	1.5	3.0	>0.05	2.8	100.3	8.0	0.32	2.12	DMRS 1999
2001	JA02	01JA02BM02C	Olivine clinopyroxene basalt	40.1	3.3	12.5		8.3	4.7	0.2	8.0	13.0	2.8	1.2	1.2	2.7	1.2	3.9	0.2	4.7	99.9	12.1	0.40	1.51	DMRS 2001
2001	JA02	01JA02BM03A	Clinopyroxene olivine basalt	39.3	3.0	11.5		9.3	3.3	0.2	10.1	12.4	1.5	0.6	1.1	4.0	2.9	6.9	0.0	7.5	99.8	11.7	0.46	1.16	DMRS 2001
2001	JA02	01JA02BM05A	Olivine basalt	36.9	3.2	11.8		12.1	3.2	0.1	7.6	12.9	1.9	0.9	1.1	3.6	2.3	5.9	0.0	7.4	99.0	14.1	0.35	1.86	DMRS 2001
2002	JA02	02JA02BMS06B		39.4	2.4	13.1		5.3	6.3	0.2	9.7	12.4	1.6	0.5	0.6	3.5	2.2	5.7	1.8	7.8	99.2	11.1	0.47	1.14	DMRS 2002
2005	JA02	01JA02BMS05B																							SOPET 2005
2005	JA02	01JA02BMS02B																							SOPET 2005
2005	JA02	02JA02BMS06B																							SOPET 2005
2005	JA02	02JA02BMS07A																							SOPET 2005
2018	JA02	18JA02#016BMS01A	Basalt	45.8	1.8	14.4	12.1			0.2	7.5	9.3	2.9	1.0	0.7	3.2	4.1	7.3		6.2	101.8	10.9	0.41	1.46	SRAPT 2018
2018	JA02	18JA02#016BMS01C	Basalt	43.0	1.9	14.6	12.5			0.2	5.0	11.1	2.9	1.3	0.8	2.7	2.8	5.5		6.9	100.1	11.2	0.31	2.23	SRAPT 2018
2018	JA02	18JA02#018BMS01A	Basalt	39.0	2.7	14.4	12.4			1.2	6.3	6.6	1.8	2.2	1.8	5.1	6.6	11.8		10.3	98.6	11.2	0.36	1.79	SRAPT 2018
2018	JA02	18JA02#018BMS01C	Basalt	40.5	2.8	13.5	13.9			0.9	5.8	11.6	2.2	1.4	1.5	2.9	3.5	6.4		5.9	100.0	12.5	0.32	2.13	SRAPT 2018
2018	JA02	18JA02#019BMS01A	Basalt	42.4	1.3	13.8	12.3			0.2	8.9	8.9	2.4	1.4	0.5	3.7	5.0	8.7		9.7	101.6	11.0	0.45	1.24	SRAPT 2018
2018	JA02	18JA02#020BMS01A	Basalt	40.8	2.1	12.9	13.0			0.4	10.2	8.7	1.8	1.2	1.1	3.5	6.8	10.4		8.3	100.4	11.7	0.47	1.15	SRAPT 2018
2018	JA02	18JA02#020BMS01B	Basalt	41.0	2.4	14.4	14.9			1.2	5.9	4.3	2.4	1.8	0.8	6.2	8.7	14.8		11.3	100.2	13.4	0.31	2.28	SRAPT 2018
2018	JA02	18JA02#020BMS01C	Basalt	43.0	2.2	13.6	11.1			1.3	9.2	7.0	2.1	1.4	0.7	5.2	5.8	11.0		9.8	101.3	9.9	0.48	1.08	SRAPT 2018
2018	JA02	18JA02#021BMS01B	Basalt	39.8	2.8	12.5	12.0			0.2	9.5	12.1	1.7	0.8	1.1	2.8	4.1	6.9		6.3	98.6	10.8	0.47	1.14	SRAPT 2018
2018	JA02	18JA02#021BMS01C	Basalt	37.2	2.0	13.3	16.0			1.4	4.1	12.2	3.0	1.3	3.1	2.1	3.9	6.0		5.9	99.4	14.4	0.22	3.48	SRAPT 2018
2018	JA02	18JA02#033BMS01A	Basalt	38.1	1.8	14.9	12.7			1.7	2.2	10.6	2.8	1.7	4.5	4.8	4.9	9.7		9.4	100.2	11.4	0.16	5.20	SRAPT 2018
2018	JA02	18JA02#033BMS01B	Basalt	42.5	1.9	15.8	11.7			2.3	2.4	8.6	3.0	1.8	2.5	5.0	4.1	9.2		8.7	101.2	10.5	0.19	4.33	SRAPT 2018
2018	JA02	18JA02#034BMS01A	Basalt gravel	33.4	1.4	11.4	10.2			0.2	5.6	14.6	2.5	1.7	7.4	5.2	6.8	12.0		10.8	99.1	9.2	0.38	1.64	SRAPT 2018
2018	JA02	18JA02#034BMS01B	Basalt	31.4	1.5	11.9	8.8			0.3	4.7	18.1	2.4	1.0	1.3	4.0	3.7	7.7		17.1	98.5	7.9	0.37	1.70	SRAPT 2018
2018	JA02	18JA02#034BMS01C	Basalt gravel	38.0	1.8	14.2	10.7			0.3	3.9	12.4	2.9	1.6	5.8	4.3	5.2	9.4		8.5	100.1	9.6	0.29	2.45	SRAPT 2018
2018	JA02	18JA02#038BMS01A	Basalt	37.0	2.7	10.7	12.1			0.8	11.5	12.6	1.1	0.5	0.6	4.4	6.3	10.7		9.2	98.7	10.9	0.51	0.95	SRAPT 2018
1997	JA03	97JA03AD19		39.9	3.4	13.7		7.3	6.0	0.2	7.7	12.7	1.5	0.8	0.5		3.3	3.3	0.2	5.9	99.6	12.5	0.38	1.62	DMRS 1997
2002	JA03	02JA03BMS04B-1		54.5	0.6	20.2		3.6	0.8	0.1	1.6	2.3	4.7	4.9	0.1	2.9	2.0	4.8	<0.05	5.5	99.0	4.1	0.28	2.56	DMRS 2002
2005	JA03	02JA03BMS04B-2																							SOPET 2005
2019	JA03	19JA03#052BMS01C	Fresh basalt	43.1	2.5	14.1	13.1			1.5	8.6	10.9	3.6	1.4	1.0					1.8	101.5	11.7	0.42	1.37	SRAPT 2019
2019	JA03	19JA03#054BMS01C	Basalt gravel	41.8	3.7	14.3	11.4			1.6	5.8	12.8	2.7	0.9	2.3					4.2	101.6	10.3	0.36	1.76	SRAPT 2019
2019	JA03	19JA03#062BMS01A	Basalt	45.9	3.5	18.7	11.1			0.4	3.3	6.4	2.9	2.1	0.9					4.9	99.9	10.0	0.25	3.06	SRAPT 2019
2019	JA03	19JA03#064BMS01A	Basalt	38.9	3.3	12.1	13.3			1.1	7.1	13.2	1.6	0.7	3.2					5.1	99.6	12.0	0.37	1.68	SRAPT 2019
2019	JA03	19JA03#064BMS01C	Basalt	39.5	3.3	13.0	13.9			0.3	7.9	14.9	2.0	0.8	2.1					3.9	101.5	12.5	0.39	1.58	SRAPT 2019
2019	JA03	19JA03#072BMS01B	Basalt	46.1	2.5	16.4	11.7			0.7	4.7	10.5	2.8	1.8	1.5					2.5	101.1	10.5	0.31	2.22	SRAPT 2019
2019	JA03	19JA03#072BMS01D	Weathered basalt	39.6	3.1	15.4	12.8			2.1	4.0	9.6	2.0	2.4	4.1					6.0	101.1	11.5	0.26	2.91	SRAPT 2019
2002	JA05	02JA05BMS01B		42.3	3.0	15.0		6.8	4.3	0.3	2.8	10.2	4.1	3.4	0.9	3.8	1.2	5.0	<0.05	5.5	98.6	10.4	0.21	3.70	DMRS 2002
1997	JA06	97JA06AD20		39.9	3.2	16.2		8.1	2.4	0.4	2.9	11.6	3.1	2.1	4.3		2.4	2.4	0.5	4.4	98.6	9.7	0.23	3.39	DMRS 1997
2018	JA06	18JA06#085BMS01B	Basalt gravel	43.3	3.2	17.0	13.0			0.6	4.6	10.9	3.1	1.3	0.7	1.7	2.2	3.9		3.4	100.9	11.7	0.28	2.54	SRAPT 2018
2018	JA06	18JA06#086BMS02A	Basalt	44.5	2.5	14.2	12.3			0.2	6.1	11.5	2.5	1.2	0.5	2.2	2.5	4.7		4.2	99.6	11.1	0.36	1.81	SRAPT 2018
2018	JA06	18JA06#086BMS02B	Basalt	44.5	2.5	14.4	12.5			0.4	6.2	12.2	2.4	1.2	0.8	2.4	2.7	5.1		4.6	101.4	11.2	0.36	1.82	SRAPT 2018
2018	JA06	18JA06#089BMS01C	Basalt	39.4	2.2	11.4	16.5			0.8	7.3	12.9	2.2	0.7	0.7	1.8	3.0	4.7		4.4	98.4	14.8	0.33	2.05	SRAPT 2018
2018	JA06	18JA06#089BMS01D	Basalt	39.1	2.3	11.2	10.2			1.2	6.2	16.2	2.3	1.3	2.9	2.7	3.7	6.5		6.9	99.7	9.2	0.40	1.48	SRAPT 2018
2018	JA06	18JA06#093BMS01A	Basalt	41.3	2.9	13.6	11.8			0.4	6.5	13.0	2.1	1.0	1.6	2.7	3.0	5.7		5.1	99.1	10.6	0.38	1.63	SRAPT 2018
2018	JA06	18JA06#096BMS01A	Basalt	41.1	2.7	12.3	13.3			0.5	7.2	14.1	1.9	0.9	0.9	1.9	2.3	4.2		3.8	98.7	11.9	0.38	1.66	SRAPT 2018
2018	JA06	18JA06#096BMS01B	Basalt	36.1	2.3	12.1	13.6			1.3	5.9	15.2	1.6	1.3	4.5	3.4	3.9	7.3		7.4	101.1	12.2	0.32	2.08	SRAPT 2018
2018	JA06	18JA06#096BMS01C	Basalt	39.2	2.6	12.3	13.1			1.1	7.3	14.1	1.6	0.9	1.7	2.4	3.3	5.7		5.2	99.0	11.8	0.38	1.61	SRAPT 2018
2018	JA06	18JA06#100BMS01A	Basalt	40.2	3.2	12.2	14.5			1.0	7.8	14.6	1.4	0.7	0.8	2.6	4.0	6.6		4.9	101.2	13.0	0.38	1.66	SRAPT 2018
2018	JA06	18JA06#100BMS01B	Basalt	43.2	2.5	13.3	13.8			0.3	8.5	11.9	3.0	0.9	0.5	0.7	1.0	1.8		1.2	98.9	12.4	0.41	1.46	SRAPT 2018
2018	JA06	18JA06#100BMS01C	Basalt	41.9	2.4	14.2	13.3			1.1	7.0	10.2	3.7	1.4	0.7	1.7	2.7	4.4		3.4	99.1	11.9	0.37	1.70	SRAPT 2018
2018	JA06	18JA06#086BMS01A	Basalt	37.7	2.3	13.1	13.2			0.8	4.8	14.0	2.2	1.1	3.5	2.8	3.8	6.6		5.8	98.2	11.8	0.29	2.49	SRAPT 2018
2018	JA06	18JA06#087BMS01A	Basalt	39.5	3.0	14.5	14.6			1.0	4.9	12.6	3.1	1.2	1.8	1.2	2.0	3.2		3.3	99.4	13.1	0.27	2.66	SRAPT 2018
2018	JA06	18JA06#087BMS01B	Basalt	39.9	3.0	14.5	14.2			1.7	5.1	11.7	2.8	1.1	1.3	1.8	2.4	4.2		4.0	99.0	12.7	0.28	2.52	SRAPT 2018

Table 1 Continued.

Year	Seamount	Sample ID	Rock type	(wt%) SiO_2	TiO_2	Al_2O_3	Fe_2O_3t	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	H_2O^+	H_2O^-	H_2O_{total}	CO_2	LOI	Total	FeO*	Mg#	FeO*/MgO	Project name
2018	JA06	18JA06#087BMS01C	Basalt	42.8	3.1	15.3	14.1			0.6	5.7	11.4	3.2	1.1	0.6	1.1	1.5	2.5		2.1	100.0	12.7	0.31	2.23	SRAPT 2018
2018	JA06	18JA06#088BMS01C	Basalt	43.4	3.0	15.9	14.6			0.5	5.7	10.5	3.4	1.1	0.6	0.8	1.8	2.5		1.8	100.4	13.1	0.30	2.30	SRAPT 2018
2018	JA06	18JA06#091BMS01A	Basalt	43.7	2.6	13.2	13.2			1.3	7.1	10.9	2.9	1.0	0.8	1.9	2.6	4.5		3.6	100.1	11.9	0.37	1.68	SRAPT 2018
2018	JA06	18JA06#091BMS01B	Basalt	42.9	2.7	13.7	13.4			0.5	7.7	11.4	3.1	1.0	0.8	1.3	1.9	3.2		2.8	99.9	12.1	0.39	1.57	SRAPT 2018
2018	JA06	18JA06#091BMS01C	Basalt	44.1	2.7	14.2	12.8			0.4	6.0	12.5	2.8	1.2	0.7	2.0	1.9	3.8		4.5	101.8	11.5	0.34	1.94	SRAPT 2018
2018	JA06	18JA06#092BMS01C	Basalt	41.3	2.9	16.3	11.4			0.2	2.8	10.2	3.1	2.1	3.0	2.5	3.4	5.9		6.2	99.3	10.2	0.22	3.65	SRAPT 2018
1998	JA09	98JA09AD18	Fine-grained tuff	19.2	1.0	5.9		5.6	<0.01	3.1	1.6	29.5	1.3	1.5	19.5	3.3	3.4	6.7	2.4	10.8	98.9	5.0	0.24	3.09	DMRS 1998
1998	JA09	98JA09AD20-1		46.8	3.6	18.2		9.4	0.9	0.1	1.2	6.5	3.7	2.9	1.6	1.4	2.2	3.6	0.2	4.2	99.1	9.4	0.11	7.80	DMRS 1998
1998	JA09	98JA09AD20-2		46.3	3.0	18.3		10.6	1.5	0.1	1.1	5.9	3.6	3.0	1.1	1.4	2.7	4.1	0.1	4.8	99.1	11.0	0.09	10.11	DMRS 1998
1999	JA09	99JA09AD34-1		46.6	2.3	14.6		9.4	0.0	0.5	2.0	7.2	3.8	3.5	2.4	1.4	4.0	5.4	0.7	6.9	99.2	8.4	0.19	4.21	DMRS 1999
1999	JA09	99JA09AD34-2		44.3	2.7	17.2		10.5	0.4	0.1	1.2	7.3	3.4	2.8	2.8	2.1	3.4	5.5	0.4	7.1	99.8	9.8	0.11	8.48	DMRS 1999
1999	JA09	99JA09AD34-3		40.0	2.3	15.1		7.0	0.4	0.1	2.1	13.5	3.5	1.9	6.2	1.8	3.8	5.5	1.0	7.4	99.2	6.7	0.24	3.20	DMRS 1999
1999	JA09	99JA09AD35-1	Clinopyroxene olivine alkali dolerite	45.5	2.1	13.4		9.9	1.4	0.2	6.1	9.9	2.7	2.1	1.4	2.1	2.9	5.0	>0.05	5.9	100.6	10.3	0.37	1.68	DMRS 1999
1999	JA09	99JA09AD35-2	Clinopyroxene olivine alkali basalt	45.1	2.4	15.1		9.1	1.4	0.2	5.2	7.6	2.9	2.2	1.0	3.6	3.7	7.4	0.5	7.6	99.7	9.6	0.35	1.85	DMRS 1999
2000	JA09	00JA09AD54-1	Olivine basalt	47.1	2.3	18.3		10.1	1.6	0.3	2.8	8.4	3.5	1.2	0.4	3.7	1.6	5.3	<0.05	3.5	99.4	10.7	0.21	3.88	DMRS 2000
2000	JA09	00JA09AD54-2	Olivine basalt	39.7	3.0	17.3		12.2	0.3	0.8	1.1	11.6	3.0	1.3	3.5	4.9	1.7	6.7	0.4	5.4	99.0	11.2	0.09	10.10	DMRS 2000
2000	JA09	00JA09AD58	Clinopyroxene andesite	46.6	3.4	16.6		10.4	1.3	0.1	1.3	7.5	3.5	2.6	2.5	4.3	2.3	6.6	<0.05	4.8	100.5	10.7	0.11	8.47	DMRS 2000
2000	JA09	00JA09CB69	Aphyric basalt	46.4	1.5	17.8		10.0	1.0	0.1	2.1	8.8	3.5	1.4	0.3	4.4	2.2	6.6	0.8	5.5	98.4	10.0	0.18	4.70	DMRS 2000
1989	JA10	89JA10AD04-E	Amygdaloidal olivine basalt	35.9	3.2	14.9		9.7	3.7	0.2	4.8	11.2	1.4	1.2	1.3					12.1	99.5	12.4	0.28	2.59	DMRS 1989
1999	JA10	99JA10AD11	Clinopyroxene olivine alkali basalt	36.7	2.8	12.3		9.6	3.7	0.2	5.5	13.5	1.0	1.2	0.8	3.4	5.0	8.4	3.0	11.6	98.8	12.4	0.31	2.24	DMRS 1999
1999	JA10	99JA10AD17	Clinopyroxene olivine alkali basalt	36.6	4.5	12.4		8.4	5.3	0.2	8.0	14.6	3.4	2.3	0.8	1.0	1.0	2.0	0.9	2.6	99.1	12.9	0.38	1.61	DMRS 1999
2000	JA10	00JA10AD33	Olivine alkali basalt	28.1	3.6	10.6		8.5	3.1	0.2	5.4	22.3	1.0	0.8	1.4	5.4	1.5	6.9	8.5	14.0	98.9	10.7	0.33	1.99	DMRS 2000
2000	JA10	00JA10AD34	Olivine alkali basalt	40.3	4.4	12.9		10.6	2.2	0.2	4.3	8.6	2.1	2.6	1.3	8.2	3.8	12.0	0.6	9.5	99.0	11.7	0.27	2.72	DMRS 2000
2000	JA10	00JA10AD37	Olivine alkali basalt	41.6	3.3	16.6		9.5	2.6	0.2	4.7	11.0	1.7	2.1	0.6	4.6	1.4	6.0	0.9	5.9	99.8	11.2	0.29	2.41	DMRS 2000
2000	JA10	00JA10AD41	Olivine alkali basalt	44.0	2.6	14.5		8.3	4.4	0.2	6.6	11.2	3.2	1.3	0.4	2.2	0.6	2.8	<0.05	2.3	98.8	11.8	0.36	1.78	DMRS 2000
2002	JA10	02JA10BMS02B		45.2	4.3	15.1		7.6	1.9	0.1	5.4	8.6	3.7	1.5	0.8	2.7	1.7	4.4	0.3	4.8	99.0	8.8	0.38	1.61	DMRS 2002
2001	JA11	01JA11BM01A	Olivine basalt	40.3	4.9	14.7		14.0	1.6	0.3	4.8	6.8	2.7	2.2	1.6	2.8	2.4	5.2	<0.01	5.8	99.7	14.2	0.25	2.95	DMRS 2001
2001	JA11	01JA11BM02A	Clinopyroxene basalt	44.6	4.8	14.4		10.4	3.3	0.2	5.0	7.6	3.3	1.7	0.8	2.1	1.2	3.2	<0.01	3.5	99.5	12.7	0.28	2.53	DMRS 2001
2005	JA11	02JA11BMS06A																							SOPET 2005
1989	JA12	89JA12AD07-A	Olivine basalt	40.9	2.8	12.2		9.6	3.6	0.7	8.9	11.9	2.4	1.5	0.7					4.0	99.0	12.2	0.42	1.38	DMRS 1989
2002	JA12	02JA12BMS03A		37.9	3.6	13.2		8.9	4.9	0.2	7.1	14.0	3.2	1.3	0.8	2.1	1.0	3.2	0.4	3.7	98.9	13.0	0.36	1.82	DMRS 2002
2002	JA12	02JA12BMS04A		41.2	1.8	15.2		11.5	1.3	0.1	3.0	8.9	3.1	2.9	0.6	2.7	1.8	4.5	4.3	9.2	98.7	11.6	0.21	3.84	DMRS 2002
2019	JA12	19JA12#101BMS01A	Weathered dolerite	33.2	3.5	10.6	10.8			0.3	5.4	21.1	1.5	1.5	8.9					4.6	101.2	9.7	0.36	1.79	SRAPT 2019
2019	JA12	19JA12#101BMS01B	Weathered dolerite	39.7	4.4	13.1	7.8			0.5	4.7	16.0	1.5	2.0	6.7					4.8	101.0	7.0	0.40	1.50	SRAPT 2019
2019	JA12	19JA12#101BMS01C	Weathered dolerite	35.8	3.5	10.5	11.2			0.4	7.0	18.2	1.4	1.3	5.7					3.3	98.1	10.0	0.41	1.44	SRAPT 2019
2019	JA12	19JA12#103BMS01C	Hyaloclastite	37.8	2.6	12.4	12.8			0.5	2.5	12.5	1.8	1.7	8.0					7.9	100.3	11.5	0.18	4.66	SRAPT 2019
2019	JA12	19JA12#105BMS01A	Volcaniclastic tuff	16.4	1.4	5.7	6.8			0.3	5.1	33.9	1.0	0.5	11.7					16.4	99.2	6.1	0.45	1.20	SRAPT 2019
2019	JA12	19JA12#105BMS01C	Volcaniclastic tuff	22.1	1.8	7.1	8.2			0.3	6.9	27.0	1.0	0.6	2.8					22.4	100.1	7.4	0.48	1.07	SRAPT 2019
2002	JA13	02JA13BMS02B		42.0	2.9	16.1		7.5	4.1	0.2	3.9	9.5	3.5	1.7	0.8	3.3	1.8	5.1	1.1	6.5	98.6	10.9	0.27	2.78	DMRS 2002
1989	JA14	89JA14AD06-B	Olivine basalt	45.3	2.5	15.5		4.8	5.9	0.2	8.3	8.0	2.9	1.9	0.6					4.0	99.9	10.3	0.45	1.23	DMRS 1989
1998	JA15	98JA15AD10CA01	Basalt	40.4	1.6	13.5		10.8	0.2	0.3	4.2	10.9	3.0	1.8	4.7	2.4	3.2	5.6	0.8	7.3	98.5	9.8	0.30	2.34	DMRS 1998
1998	JA15	98JA15AD12CA01	Basalt	49.3	2.4	14.7		8.5	2.0	0.1	4.0	6.4	3.0	4.1	0.6	1.2	1.8	3.0	<0.01	3.7	98.8	9.7	0.29	2.42	DMRS 1998
1998	JA15	98JA15AD13CA01	Basalt	19.9	1.0	7.6		9.1	<0.01	0.5	1.7	27.7	1.2	2.3	17.5	3.1	3.0	6.1	2.6	10.1	98.6	8.2	0.17	4.86	DMRS 1998
1998	JA15	98JA15AD19CA01	Hyaloclastite	44.7	2.1	13.7		10.1	0.3	0.1	4.8	1.7	3.1	3.8	0.3	4.3	7.7	11.9	0.2	14.3	98.7	9.4	0.34	1.95	DMRS 1998
1989	JA16	89JA16AD01	Amygdaloidal pyroxene basalt	37.4	3.6	14.2		7.9	4.0	0.2	4.0	11.4	2.0	1.5	1.4					12.0	99.6	11.1	0.26	2.78	DMRS 1989
1990	JA17	90JA17AD01C	Augite aegirine olivine basalt	37.4	3.4	13.0		7.1	5.5	0.3	6.0	15.5	1.3	1.9	1.1					7.8	100.3	11.9	0.33	1.99	DMRS 1990
2005	JA17	05JA17AD05b1		40.0	3.6	12.9		7.9	5.8	0.2	8.0	12.5	2.8	1.1	0.6	1.0	1.5	2.4	0.5	2.9	98.3	12.9	0.53	1.60	SOPET 2005
2005	JA17	05JA17AD05b2		42.0	4.2	15.3		8.5	3.5	0.2	6.1	10.7	2.4	1.6	0.7	1.4	2.0	3.3	0.1	3.3	98.4	11.2	0.50	1.82	SOPET 2005
2005	JA17	05JA17AD07r1		38.4	3.5	12.8		9.7	3.7	0.3	7.7	13.9	2.1	0.9	0.9	1.9	2.8	4.7	0.1	4.9	98.9	12.5	0.52	1.61	SOPET 2005
2005	JA17	05JA17AD07r2		53.0	0.2	20.6		3.3	0.7	0.2	0.7	0.9	0.1	5.7	0.0	0.9	3.8	4.7	0.2	5.0	90.4	3.6	0.26	4.97	SOPET 2005

Table 1 Continued.

Year	Seamount	Sample ID	Rock type	(wt%) SiO_2	TiO_2	Al_2O_3	Fe_2O_3t	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	H_2O^+	H_2O^-	H_2O_{total}	CO_2	LOI	Total	FeO*	Mg#	FeO*/MgO	Project name
2005	JA17	05JA17AD07r3		43.6	4.3	16.7		8.1	2.0	0.1	4.5	10.5	2.4	1.9	0.8	1.5	1.7	3.2	0.1	4.1	98.9	9.3	0.46	2.06	SOPET 2005
2005	JA17	02JA17BMS01A																							SOPET 2005
2018	JA17	18JA17#145BMS01B	Altered basalt	46.4	1.2	17.6	4.3			1.0	1.9	9.0	3.5	4.3	3.7	2.1	2.3	4.4		8.3	101.1	3.8	0.33	2.01	SRAPT 2018
2018	JA17	18JA17#146BMS01C	Basalt	42.8	3.4	16.4	11.7			0.7	5.1	9.8	2.7	1.9	1.1	2.3	3.4	5.7		4.9	100.3	10.5	0.33	2.06	SRAPT 2018
2018	JA17	18JA17#147BMS01A	Basalt	38.4	2.5	12.7	12.9			0.5	7.0	13.6	1.6	1.4	2.6	3.4	4.8	8.2		6.9	99.9	11.6	0.38	1.64	SRAPT 2018
2018	JA17	18JA17#147BMS01B	Basalt	39.5	2.8	14.8	11.8			0.7	6.6	12.3	4.0	1.6	1.3	2.2	3.7	5.9		4.6	99.9	10.6	0.39	1.59	SRAPT 2018
2018	JA17	18JA17#147BMS01C	Basalt	37.9	2.0	12.9	11.8			1.3	5.2	14.7	2.5	1.2	4.6	2.5	3.3	5.8		6.1	100.1	10.6	0.33	2.02	SRAPT 2018
2018	JA17	18JA17#147BMS01D	Basalt	44.9	2.2	15.1	12.1			0.2	5.7	11.3	3.6	1.7	0.7	1.2	2.0	3.2		2.9	100.2	10.9	0.34	1.91	SRAPT 2018
2019	JA17	19JA17#142BMS01C	Fresh basalt gravel	46.2	1.9	20.2	7.6			0.8	2.0	6.6	6.7	4.8	0.5					3.9	101.1	6.8	0.23	3.44	SRAPT 2019
2019	JA17	19JA17#150BMS01C	Basalt	42.7	2.5	13.6	13.4			0.5	7.4	12.6	3.8	1.4	1.1					1.6	100.5	12.1	0.38	1.62	SRAPT 2019
1990	JA19	90JA19AD01C	Augite olivine basalt	44.8	1.8	9.5		4.9	7.0	0.4	16.9	6.8	1.7	2.3	0.4					3.1	99.4	11.4	0.60	0.67	DMRS 1990
1990	JA19	90JA19AD04D	Augite olivine basalt	38.2	2.8	11.7		7.1	4.5	0.3	7.4	12.8	1.5	2.8	0.9					10.4	100.4	10.9	0.41	1.46	DMRS 1990
1990	JA22	90JA22AD05D	Altered basalt	42.2	3.2	13.3		9.9	0.3	2.0	1.8	7.7	3.0	4.5	2.4					9.9	100.0	9.1	0.16	5.16	DMRS 1990
1990	JA22	90JA22AD11B	Augite olivine basalt	39.1	1.6	10.7		7.7	1.8	0.4	2.6	17.8	2.7	3.1	2.2					11.2	100.7	8.7	0.23	3.42	DMRS 1990
2005	MT472	05DSMT472AD01r1-1		42.9	4.2	17.0		8.8	2.2	0.2	1.8	9.1	2.8	1.7	2.2	2.5	2.2	4.7	0.4	5.3	98.1	10.1	0.24	5.66	SOPET 2005
2005	MT472	05DSMT472AD01r1-2		43.8	4.3	17.2		8.6	2.2	0.1	1.9	7.8	2.8	1.8	1.6	4.1	2.0	6.1	0.3	6.8	98.8	9.9	0.24	5.37	SOPET 2005
2005	MT472	05DSMT472AD01a3		43.0	4.3	17.1		8.7	2.4	0.2	1.8	8.8	2.7	1.7	1.9	2.5	2.2	4.7	0.5	5.3	97.9	10.3	0.24	5.65	SOPET 2005
2005	MT473	MT473BMS02A-2																							SOPET 2005
2005	MT474	MT474BMS04A																							SOPET 2005
2019	Takuyo-Daigo	19TAKUYO5BMS41B	Volcaniclastic tuff	29.8	1.6	9.9	14.8			12.3	3.0	7.9	2.3	2.8	4.3					11.0	99.5	13.3	0.19	4.39	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS50B	Basalt	49.1	2.3	18.3	9.1			0.5	4.8	8.1	3.5	2.4	0.6					2.6	101.2	8.2	0.37	1.71	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS57B	Basalt	42.2	2.3	16.6	12.5			0.4	5.8	11.4	4.0	1.6	0.5					2.5	99.8	11.2	0.34	1.93	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS57C	Basalt	47.1	1.6	18.4	12.0			0.8	3.0	8.9	5.4	2.2	0.9					1.6	101.7	10.8	0.22	3.63	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS58C	Basalt	42.8	2.2	16.3	12.8			1.0	5.5	10.2	4.2	1.7	0.8					2.0	99.3	11.5	0.32	2.09	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS59A	Basalt	45.4	2.1	16.4	12.8			0.3	5.8	11.6	4.5	1.5	0.5					0.9	101.8	11.5	0.34	1.97	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS59B	Porous basalt	45.6	2.3	20.5	10.6			0.4	3.9	6.0	2.9	2.2	1.4					4.4	100.0	9.5	0.29	2.44	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS52A	Basalt gravel	43.0	2.2	14.6	14.5			0.7	7.7	11.1	2.5	1.1	1.0					3.0	101.3	13.0	0.37	1.68	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS55C	Basalt gravel?	40.6	2.0	13.1	13.7			0.3	8.9	11.8	2.1	1.3	1.4					3.1	98.2	12.3	0.42	1.39	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS52A	Hyaloclastite	36.4	1.9	13.2	12.7			0.4	6.3	15.8	2.4	1.7	0.6					10.5	101.7	11.4	0.36	1.81	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS52B	Hyaloclastite	42.8	2.2	15.3	15.6			0.7	5.4	4.3	3.0	3.5	1.1					7.2	101.0	14.0	0.28	2.61	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS53B	Hyaloclastite	37.8	2.6	14.2	15.8			0.6	5.6	6.4	3.3	3.2	0.5					11.4	101.1	14.2	0.28	2.55	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS53D	Hyaloclastite	27.3	2.3	12.6	11.1			0.5	2.0	19.9	2.4	2.1	4.2					17.0	101.2	10.0	0.17	4.97	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS53E	Hyaloclastite	40.2	3.0	16.2	15.5			0.1	4.2	2.5	3.8	3.7	1.0					9.4	99.5	13.9	0.23	3.33	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS52A	Hyaloclastite including basalt gravel	43.0	2.2	15.6	14.5			0.2	6.8	6.9	3.0	2.7	0.6					6.4	101.8	13.0	0.34	1.93	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS53B	Hyaloclastite (calcite filling)	33.4	1.6	14.5	10.9			1.2	4.2	12.9	1.9	1.7	0.4					17.8	100.4	9.8	0.30	2.33	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS53D	Hyaloclastite (calcite filling)	24.7	1.8	9.5	8.6			0.2	4.6	28.2	1.6	1.1	0.5					19.4	100.1	7.7	0.37	1.70	SRAPT 2019
2020	Takuyo-Daigo	19TAKUYO5BMS53D_1a	Basalt		2.7	15.0	12.4			0.1	6.3				1.8							0.4	0.95	0.06	ESCRC 2020
2020	Takuyo-Daigo	19TAKUYO5BMS53D_1b	Basalt		2.9	16.0	14.1			0.1	8.0				1.2							0.4	0.95	0.05	ESCRC 2020
2020	Takuyo-Daigo	19TAKUYO5BMS53D_2a	Basalt		1.9	9.7	11.1			0.2	4.6				0.6							0.3	0.94	0.07	ESCRC 2020
2020	Takuyo-Daigo	19TAKUYO5BMS53D_2b	Basalt		1.6	9.4	10.1			0.2	3.7				0.4							0.3	0.93	0.08	ESCRC 2020
2020	Takuyo-Daigo	19TAKUYO5BMS53E_1a	Fe-rich basalt		2.0	11.4	11.3			0.0	3.3				0.3							0.2	0.93	0.07	ESCRC 2020
2020	Takuyo-Daigo	19TAKUYO5BMS53E_1b	Fe-rich basalt		2.0	11.5	12.9			0.1	3.8				0.6							0.2	0.94	0.07	ESCRC 2020
2020	Takuyo-Daigo	19TAKUYO5BMS53F_1a	Basalt		2.2	12.5	12.1			0.0	3.7				0.4							0.3	0.94	0.07	ESCRC 2020
2020	Takuyo-Daigo	19TAKUYO5BMS53F_1b	Basalt		2.1	11.4	12.8			0.1	3.9				0.9							0.3	0.94	0.06	ESCRC 2020
2020	Takuyo-Daigo	19TAKUYO5BMS53F_2a	Basalt including carbonate		1.4	7.7	7.1			0.1	4.1				0.6							0.4	0.91	0.10	ESCRC 2020
2020	Takuyo-Daigo	19TAKUYO5BMS53F_2b	Basalt including carbonate		2.5	13.9	12.4			0.2	6.7				0.9							0.4	0.95	0.06	ESCRC 2020
2020	Takuyo-Daigo	19TAKUYO5BMS53F_3a	Fe-rich basalt		1.5	8.4	9.8			0.2	3.8				0.4							0.3	0.93	0.08	ESCRC 2020
2020	Takuyo-Daigo	19TAKUYO5BMS53F_3b	Fe-rich basalt		1.6	9.0	10.2			0.2	3.4				0.3							0.3	0.93	0.08	ESCRC 2020

Total was calculated by using major element composition and LOI. FeO*: FeO+Fe_2O_3, Mg#: MgO/(MgO+FeO*)

DMRS: Deep-sea mineral resource surveys

SOPET: Survey on offshore petroleum exploration technology (basic survey on exploration technology for deep water petroleum resources)

SRAPT: Survey on resource assessment and production technology for the development of marine mineral resources

ESCRC: Environmental study in the area for exploration of cobalt-rich crusts

Table 2 Minor elemental compositions of basement rocks from seamounts in the JA area

Year	Seamount	Sample ID	(ppm) V	Cr	Rb	Sr	Y	Zr	Nb	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Pb	Th	U	Project name
1999	JA01	99JA01AD12	284		23	523	106	339	75	235	106.0	137.0	18.7	75.9	14.0	4.6	14.3	2.2	12.1	2.6	7.2	0.9	5.4	0.8				DMRS 1999
1999	JA01	99JA01AD13	338		28	564	38	227	42	247	40.2	73.2	8.9	37.3	7.9	2.8	7.8	1.3	6.8	1.4	3.8	0.5	3.0	0.4				DMRS 1999
1999	JA01	99JA01AD18	295		18	1300	35	369	92	214	68.6	126.0	13.8	54.6	10.4	3.5	9.2	1.4	6.9	1.2	3.2	0.4	2.2	0.3				DMRS 1999
1999	JA01	99JA01AD23	189		106	586	27	687	198	394	73.1	127.0	12.3	42.6	7.3	2.4	6.1	1.0	5.1	1.0	2.8	0.4	2.4	0.4				DMRS 1999
2001	JA02	01JA02BM02C	260		14	1470	42	236	85	807	87.5	158.0	18.7	76.8	13.6	4.6	12.4	1.8	9.1	1.6	3.9	0.4	2.9	0.4				DMRS 2001
2001	JA02	01JA02BM03A	297		10	1450	31	269	94	516	61.4	112.0	13.3	55.2	10.1	3.5	9.3	1.3	6.8	1.2	2.9	0.4	2.2	0.3				DMRS 2001
2001	JA02	01JA02BM05A	312		17	910	32	252	92	605	64.5	116.0	13.7	56.6	10.0	3.4	9.0	1.3	6.6	1.2	2.8	0.3	2.1	0.3				DMRS 2001
2002	JA02	02JA02BMS06B	224		11	643	27	182	68	240	49.6	88.8	9.9	38.0	7.3	2.5	6.9	1.0	5.5	1.0	2.5	0.3	1.9	0.3				DMRS 2002
2005	JA02	01JA02BMS05B	290	528	26	573	26	171	48	315	28.0	56.9	7.1	30.8	6.9	2.2	6.2	1.0	5.3	0.9	2.3	0.3	1.9	0.3	1.9	2.9	0.7	SOPET 2005
2005	JA02	01JA02BMS02B	251	309	12	1346	41	256	82	713	80.6	157.7	18.7	72.4	14.1	4.1	11.5	1.7	8.2	1.5	3.6	0.5	2.6	0.3	4.6	10.3	2.2	SOPET 2005
2005	JA02	02JA02BMS06B	227	236	9	687	28	186	80	287	54.8	97.0	11.1	43.1	8.1	2.4	7.4	1.1	5.7	1.1	2.4	0.4	2.0	0.3	3.0	6.7	1.7	SOPET 2005
2005	JA02	02JA02BMS07A	208	392	42	851	30	222	70	625	52.3	102.3	12.2	48.9	9.3	3.0	8.5	1.2	6.3	1.1	2.7	0.4	2.0	0.3	2.6	5.0	1.4	SOPET 2005
2018	JA02	18JA02#016BMS01A	231	400	18	320	27			205	21.6	40.7	5.1	21.0	5.4	1.5	5.2	0.8	4.5	1.0	2.5	0.3	1.8	0.3	5.8	2.0	0.8	SRAPT 2018
2018	JA02	18JA02#016BMS01C	227	290	17	342	36			289	29.1	36.2	5.5	24.9	5.7	1.6	6.4	0.9	5.2	1.1	2.8	0.4	2.3	0.3	4.6	1.8	0.8	SRAPT 2018
2018	JA02	18JA02#018BMS01A	250	600	48	567	67			730	72.3	128.5	13.6	54.3	11.3	2.9	10.2	1.4	7.7	1.6	4.7	0.6	3.4	0.5	65.0	5.2	2.1	SRAPT 2018
2018	JA02	18JA02#018BMS01C	315	690	33	736	41			478	43.8	90.9	9.4	39.9	9.1	2.7	8.6	1.3	6.9	1.3	3.4	0.5	2.8	0.4	45.1	4.2	1.7	SRAPT 2018
2018	JA02	18JA02#019BMS01A	186	450	17	239	17			181	15.7	30.5	3.6	15.9	3.7	1.3	4.0	0.6	3.5	0.7	1.8	0.2	1.5	0.2	2.3	1.9	0.5	SRAPT 2018
2018	JA02	18JA02#020BMS01A	229	330	21	349	28			298	29.9	50.4	6.1	25.9	5.7	1.7	6.0	0.8	4.7	0.9	2.6	0.3	1.8	0.3	5.1	2.7	0.9	SRAPT 2018
2018	JA02	18JA02#020BMS01B	218	430	29	342	35			366	38.4	84.8	8.1	34.1	7.5	2.0	7.6	1.1	6.0	1.3	3.2	0.5	2.5	0.4	58.3	3.3	2.0	SRAPT 2018
2018	JA02	18JA02#020BMS01C	237	350	26	333	31			324	33.8	90.9	7.2	30.4	7.0	2.0	6.9	1.1	5.7	1.2	3.1	0.4	2.4	0.4	58.6	3.2	1.4	SRAPT 2018
2018	JA02	18JA02#021BMS01B	286	590	17	1355	41			616	68.7	112.0	14.2	55.6	10.0	2.8	9.0	1.3	6.4	1.3	3.5	0.5	2.9	0.4	9.3	6.2	1.2	SRAPT 2018
2018	JA02	18JA02#021BMS01C	305	430	27	661	73			510	58.2	103.0	10.3	44.2	9.1	2.6	9.9	1.4	8.8	1.9	5.2	0.7	4.8	0.7	74.6	3.6	2.8	SRAPT 2018
2018	JA02	18JA02#033BMS01A	183	480	31	524	195			165	131.0	90.5	15.7	70.3	13.8	3.7	19.5	2.7	17.1	4.0	11.3	1.4	9.3	1.3	95.6	2.0	2.5	SRAPT 2018
2018	JA02	18JA02#033BMS01B	209	350	26	448	51			210	36.1	116.5	6.6	29.0	6.8	2.1	8.4	1.3	7.7	1.6	4.2	0.6	4.0	0.6	129.5	2.1	2.0	SRAPT 2018
2018	JA02	18JA02#034BMS01A	150	290	23	454	49			103	41.0	44.6	7.6	32.2	7.2	2.1	7.8	1.1	6.7	1.3	3.4	0.5	3.1	0.5	12.3	1.7	2.4	SRAPT 2018
2018	JA02	18JA02#034BMS01B	134	240	11	335	21			138	21.2	43.2	4.8	20.2	4.8	1.5	4.6	0.8	3.9	0.8	2.2	0.3	1.6	0.3	7.0	1.9	0.9	SRAPT 2018
2018	JA02	18JA02#034BMS01C	136	340	28	558	131			170	88.1	48.8	12.3	54.4	10.5	3.0	14.1	1.9	12.2	2.8	8.3	1.2	7.0	1.0	15.7	2.3	2.4	SRAPT 2018
2018	JA02	18JA02#038BMS01A	295	750	10	276	27			329	42.0	96.1	9.5	38.5	8.4	2.3	7.2	1.1	5.5	1.1	2.6	0.4	2.2	0.3	38.1	5.1	1.4	SRAPT 2018
1997	JA03	97JA03AD19	386		17	470	24	162	54	290	35.1	70.9	8.4	34.9	7.3	2.1	7.2	1.0	5.1	0.9	2.4	0.3	1.9	0.3				DMRS 1997
2002	JA03	02JA03BMS04B-1	21		170	863	27	484	135	1210	97.9	148.3	13.9	44.8	6.7	2.2	4.7	0.7	5.1	1.0	2.9	0.5	3.0	0.4				DMRS 2002
2005	JA03	02JA03BMS04B-2	21	1	155	656	25	488	126	826	97.7	153.5	13.8	43.8	6.3	1.9	5.5	0.7	4.5	0.9	2.7	0.4	2.7	0.4	16.8	27.5	3.1	SOPET 2005
2019	JA03	19JA03#052BMS01C	252	192	43	859				560															77.1	9.8	2.9	SRAPT 2019
2019	JA03	19JA03#054BMS01C	281	97	16	1165				860															118.0	14.1	3.0	SRAPT 2019
2019	JA03	19JA03#062BMS01A	304	382	22	1230				940															17.2	6.7	1.7	SRAPT 2019
2019	JA03	19JA03#064BMS01A	265	351	13	2310				830															58.5	8.5	2.1	SRAPT 2019
2019	JA03	19JA03#064BMS01C	287	472	16	1720				900															10.0	7.4	1.7	SRAPT 2019
2019	JA03	19JA03#072BMS01B	231	95	38	859				540															51.6	10.4	3.0	SRAPT 2019
2019	JA03	19JA03#072BMS01D	363	287	60	596				1630															85.0	8.3	3.6	SRAPT 2019
2002	JA05	02JA05BMS01B	114		45	1850	60	798	213	1840	146.5	283.6	31.6	122.2	21.0	6.5	16.0	2.1	12.5	2.1	5.5	0.7	4.3	0.6				DMRS 2002
1997	JA06	97JA06AD20	224		31	665	53	226	77	471	64.4	76.8	9.9	39.0	7.6	2.4	8.2	1.1	5.7	1.2	3.2	0.5	2.6	0.4				DMRS 1997
2018	JA06	18JA06#085BMS01B	314	20	30	731	36			440	58.3	123.0	13.4	54.3	10.4	3.0	8.3	1.3	7.0	1.3	3.3	0.4	3.0	0.4	28.2	6.6	1.9	SRAPT 2018
2018	JA06	18JA06#086BMS02A	280	540	29	557	27			304	43.4	88.6	10.8	42.3	8.2	2.3	6.7	1.0	5.3	1.0	2.4	0.3	2.1	0.3	3.9	4.6	1.3	SRAPT 2018
2018	JA06	18JA06#086BMS02B	278	490	25	500	31			283	44.7	90.0	10.3	42.4	8.1	2.4	7.0	1.0	5.7	1.1	2.6	0.4	2.6	0.4	14.1	4.7	1.3	SRAPT 2018
2018	JA06	18JA06#089BMS01C	411	2010	16	458	31			280	35.9	88.2	9.3	37.2	7.5	2.2	6.5	1.0	5.4	1.1	2.8	0.4	2.4	0.3	33.4	3.5	1.6	SRAPT 2018
2018	JA06	18JA06#089BMS01D	320	1710	25	498	40			381	41.5	105.0	9.3	37.8	8.0	2.3	7.8	1.2	6.2	1.3	3.4	0.5	3.1	0.5	69.4	3.9	2.2	SRAPT 2018
2018	JA06	18JA06#093BMS01A	287	420	23	660	39			355	56.2	108.0	12.6	50.9	9.6	2.6	7.3	1.2	6.6	1.2	3.3	0.5	2.8	0.4	15.1	6.1	2.0	SRAPT 2018
2018	JA06	18JA06#096BMS01A	384	390	21	494	38			268	44.7	87.2	10.3	41.7	8.8	2.6	8.0	1.2	6.5	1.3	3.3	0.5	2.8	0.4	21.3	4.9	1.4	SRAPT 2018
2018	JA06	18JA06#096BMS01B	323	480	30	643	141			480	122.0	107.0	15.3	62.7	10.5	3.0	12.4	1.7	10.6	2.5	7.5	1.0	6.3	1.0	42.5	4.7	2.6	SRAPT 2018
2018	JA06	18JA06#096BMS01C	370	460	20	549	52			459	54.4	101.0	11.0	44.4	9.8	2.7	9.4	1.2	6.9	1.5	3.9	0.6	3.4	0.6	47.9	4.5	1.8	SRAPT 2018
2018	JA06	18JA06#100BMS01A	345	210	15	778	44			414	65.7	133.5	14.5	60.6	12.3	3.1	10.2	1.4	7.7	1.4	3.6	0.5	2.7	0.4	42.8	6.3	1.6	SRAPT 2018
2018	JA06	18JA06#100BMS01B	280	480	22	516	28			321	42.6	87.2	10.4	41.7	8.5	2.2	7.2	1.0	5.2	1.0	2.7	0.3	2.3	0.3	5.2	4.8	1.3	SRAPT 2018
2018	JA06	18JA06#100BMS01C	258	330	24	709	34			507	57.0	132.5	12.3	48.8	9.5	2.6	8.4	1.2	6.4	1.3	3.5	0.5	2.9	0.4	48.6	6.8	2.1	SRAPT 2018
2018	JA06	18JA06#086BMS01A	284	580	24	622	94			611	74.5	83.4	12.0	47.6	10.3	2.6	10.3	1.4	8.3	2.0	5.8	0.8	4.4	0.8	29.9	4.4	2.0	SRAPT 2018
2018	JA06	18JA06#087BMS01A	338	270	25	844	53			418	63.5	151.0	12.8	51.8	10.3	2.9	9.0	1.3	7.3	1.5	4.0	0.5	3.5	0.5	78.8	5.2	2.2	SRAPT 2018
2018	JA06	18JA06#087BMS01B	351	110	24	750	81			474	80.7	211.0	15.4	65.1	12.2	3.5	12.2	1.7	9.8	2.2	5.6	0.8	5.1	0.8	139.0	5.7	2.3	SRAPT 2018

Table 2 Continued.

Year	Seamount	Sample ID	(ppm) V	Cr	Rb	Sr	Y	Zr	Nb	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Pb	Th	U	Project name
2018	JA06	18JA06#087BMS01C	333	90	29	797	36			412	53.5	114.0	13.0	52.3	10.6	2.9	9.3	1.3	7.0	1.3	3.7	0.5	2.9	0.4	22.5	5.5	1.5	SRAPT 2018
2018	JA06	18JA06#088BMS01C	270	90	26	660	29			378	46.8	100.5	10.9	43.3	8.7	2.6	7.6	1.0	5.7	1.2	2.7	0.4	2.4	0.3	19.4	5.9	1.5	SRAPT 2018
2018	JA06	18JA06#091BMS01A	264	380	27	687	35			399	59.1	140.0	13.1	52.9	9.5	2.8	9.0	1.3	6.7	1.3	3.6	0.5	2.8	0.4	66.1	6.9	2.0	SRAPT 2018
2018	JA06	18JA06#091BMS01B	260	400	28	689	32			371	56.4	116.0	12.8	50.8	9.8	2.5	8.6	1.1	6.2	1.1	3.3	0.4	2.7	0.3	22.3	6.7	1.9	SRAPT 2018
2018	JA06	18JA06#091BMS01C	250	420	29	648	30			358	54.3	113.0	12.4	49.1	10.0	2.5	8.0	1.1	6.0	1.1	2.8	0.4	2.5	0.3	17.1	6.9	1.7	SRAPT 2018
2018	JA06	18JA06#092BMS01C	325	130	41	643	57			1045	55.1	86.2	12.0	49.1	10.1	2.7	8.7	1.2	8.0	1.7	4.6	0.6	4.0	0.5	12.5	4.6	1.9	SRAPT 2018
1998	JA09	98JA09AD18	105		44	800	216	245	15	2030	148.0	83.0	14.5	59.0	10.0	2.7	11.0	1.8	11.0	2.7	8.9	1.4	8.0	1.4				DMRS 1998
1998	JA09	98JA09AD20-1	328		82	521	34	238	34	368	36.0	57.0	7.5	32.0	6.7	2.5	5.3	0.9	4.7	0.8	2.4	0.3	1.8	0.3				DMRS 1998
1998	JA09	98JA09AD20-2	318		46	469	22	206	30	453	26.0	49.0	6.6	28.0	5.8	2.0	4.6	0.8	4.1	0.7	2.0	0.3	1.5	0.2				DMRS 1998
1999	JA09	99JA09AD34-1	96		55	651	38	168	48	1110	85.2	145.0	15.3	58.4	10.6	3.4	8.6	1.2	5.7	1.0	2.5	0.3	1.6	0.2				DMRS 1999
1999	JA09	99JA09AD34-2	139		38	760	48	174	54	918	96.7	167.0	18.0	69.1	12.6	4.0	10.1	1.4	7.0	1.2	3.2	0.4	2.5	0.4				DMRS 1999
1999	JA09	99JA09AD34-3	74		34	868	30	145	46	848	87.9	153.0	16.5	62.5	11.3	3.6	8.8	1.2	5.7	0.9	2.1	0.3	1.4	0.2				DMRS 1999
1999	JA09	99JA09AD35-1	204		41	590	36	161	35	520	37.6	61.8	7.6	30.7	5.9	2.2	5.9	0.9	5.0	1.0	2.8	0.4	2.1	0.3				DMRS 1999
1999	JA09	99JA09AD35-2	184		40	562	31	176	38	591	39.3	65.2	7.6	30.8	6.1	2.1	5.7	0.9	4.6	0.9	2.4	0.3	1.6	0.2				DMRS 1999
2000	JA09	00JA09AD54-1	204		36	475	23	90	18	171	16.9	30.2	4.5	19.1	4.6	1.9	5.2	0.8	4.6	0.9	2.4	0.3	1.8	0.2				DMRS 2000
2000	JA09	00JA09AD54-2	322		34	744	157	178	48	452	146.0	83.0	23.4	98.8	18.7	5.9	21.0	3.4	20.4	4.4	12.9	1.7	10.7	1.6				DMRS 2000
2000	JA09	00JA09AD58	209		48	580	93	219	37	395	78.4	67.5	12.1	49.7	9.4	3.1	10.9	1.6	9.6	2.0	5.6	0.8	4.5	0.6				DMRS 2000
2000	JA09	00JA09CB69	183		40	317	17	55	12	130	12.8	21.4	2.9	13.6	3.4	1.3	3.4	0.6	3.4	0.6	1.6	0.2	1.1	0.2				DMRS 2000
1989	JA10	89JA10AD04-E								358																		DMRS 1989
1999	JA10	99JA10AD11	294		28	361	28	279	59	206	57.2	115.0	12.8	49.5	9.1	3.0	7.7	1.1	5.4	1.0	2.5	0.3	1.7	0.3				DMRS 1999
1999	JA10	99JA10AD17	346		46	972	33	315	101	640	80.4	168.0	19.2	75.2	13.0	4.2	10.0	1.4	6.9	1.2	3.2	0.4	2.6	0.3				DMRS 1999
2000	JA10	00JA10AD33	269		19	852	33	252	93	504	105.0	193.0	21.1	80.1	13.3	4.1	11.3	1.4	7.0	1.2	2.9	0.3	1.9	0.2				DMRS 2000
2000	JA10	00JA10AD34	213		56	657	36	261	114	710	87.7	161.0	17.7	69.3	12.1	3.8	10.4	1.4	6.7	1.1	2.8	0.3	1.8	0.2				DMRS 2000
2000	JA10	00JA10AD37	300		39	833	29	201	96	468	60.2	118.0	13.8	51.6	9.8	3.3	9.3	1.3	6.5	1.2	2.9	0.4	2.1	0.3				DMRS 2000
2000	JA10	00JA10AD41	296		45	576	25	175	51	458	39.4	77.7	9.2	35.3	6.9	2.3	7.0	1.0	5.5	1.1	2.7	0.4	2.1	0.3				DMRS 2000
2002	JA10	02JA10BMS02B	342		27	870	36	372	75	912	69.7	138.1	16.1	63.2	11.9	3.9	10.2	1.4	7.9	1.4	3.5	0.4	2.6	0.4				DMRS 2002
2001	JA11	01JA11BM01A	330		38	822	50	487	73	378	62.7	119.0	16.1	72.9	14.6	4.9	13.3	2.0	9.7	1.7	4.0	0.5	2.9	0.4				DMRS 2001
2001	JA11	01JA11BM02A	355		36	579	42	383	55	342	41.3	88.0	11.8	55.7	11.9	4.1	11.6	1.8	9.0	1.6	3.8	0.5	2.9	0.4				DMRS 2001
2005	JA11	02JA11BMS06A																										SOPET 2005
1989	JA12	89JA12AD07-A								985																		DMRS 1989
2002	JA12	02JA12BMS03A	427		17	792	33	210	91	948	58.3	104.9	12.2	48.4	9.2	3.1	8.1	1.1	6.2	1.1	2.8	0.4	2.3	0.3				DMRS 2002
2002	JA12	02JA12BMS04A	160		30	515	24	117	46	550	35.8	56.7	6.8	27.9	5.5	2.0	5.1	0.7	4.5	0.8	2.1	0.3	1.7	0.2				DMRS 2002
2019	JA12	19JA12#101BMS01A	216	369	33	1495				400															10.9	5.1	4.4	SRAPT 2019
2019	JA12	19JA12#101BMS01B	260	419	41	713				500															10.3	7.1	4.8	SRAPT 2019
2019	JA12	19JA12#101BMS01C	265	266	24	1015				390															15.0	4.9	2.7	SRAPT 2019
2019	JA12	19JA12#103BMS01C	210	153	39	586				40															32.0	7.9	4.6	SRAPT 2019
2019	JA12	19JA12#105BMS01A	91	352	11	666				50															7.7	7.9	4.1	SRAPT 2019
2019	JA12	19JA12#105BMS01C	170	292	11	289				40															14.1	11.2	2.3	SRAPT 2019
2002	JA13	02JA13BMS02B	188		37	865	31	307	82	403	62.4	125.4	14.5	58.0	10.6	3.4	8.7	1.1	6.5	1.1	2.7	0.3	2.2	0.3				DMRS 2002
1989	JA14	89JA14AD06-B								806																		DMRS 1989
1998	JA15	98JA15AD10CA01	147		34	435	74	127	22	319	45.0	41.0	6.6	29.0	6.2	1.9	6.1	1.1	6.7	1.4	4.1	0.6	3.4	0.6				DMRS 1998
1998	JA15	98JA15AD12CA01	215		45	517	29	277	35	752	48.0	91.0	10.7	42.0	7.9	2.3	6.4	1.0	5.1	0.9	2.6	0.3	2.0	0.3				DMRS 1998
1998	JA15	98JA15AD13CA01	132		37	759	73	210	17	411	62.0	65.0	8.5	33.0	6.0	1.8	5.9	1.0	5.9	1.3	4.1	0.6	3.8	0.7				DMRS 1998
1998	JA15	98JA15AD19CA01	61		69	260	16	184	24	961	23.0	55.0	6.0	25.0	5.7	1.8	4.3	0.7	3.6	0.6	1.6	0.2	1.1	0.2				DMRS 1998
1989	JA16	89JA16AD01								895																		DMRS 1989
1990	JA17	90JA17AD01C																										DMRS 1990
2005	JA17	05JA17AD05b1	294	636	14	787	29	220	83	560	52.8	107.1	12.3	48.7	9.4	2.8	7.8	1.2	5.9	1.1	2.8	0.4	2.1	0.3	2.4	6.0	1.4	SOPET 2005
2005	JA17	05JA17AD05b2	280	217	31	790	35	275	80	435	49.5	103.2	12.0	51.0	9.9	3.0	8.4	1.3	6.6	1.3	3.0	0.4	2.5	0.4	3.1	5.2	1.5	SOPET 2005
2005	JA17	05JA17AD07r1	306	355	16	808	36	267	120	170	77.9	144.2	16.5	65.1	11.1	3.4	9.5	1.3	6.9	1.3	3.2	0.4	2.5	0.4	4.0	9.5	1.5	SOPET 2005
2005	JA17	05JA17AD07r2	18	0	170	690	36	668	182	453	105.2	149.1	11.3	32.3	4.1	1.3	3.9	0.7	4.5	1.1	3.5	0.6	4.1	0.6	17.9	26.5	8.8	SOPET 2005

Table 2 Continued.

Year	Seamount	Sample ID	(ppm) V	Cr	Rb	Sr	Y	Zr	Nb	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Pb	Th	U	Project name
2005	JA17	05JA17AD07r3	294	2	36	824	36	353	75	448	51.8	104.6	13.0	55.5	10.6	3.4	9.8	1.4	7.2	1.4	3.4	0.5	2.7	0.4	4.0	5.6	1.7	SOPET 2005
2005	JA17	02JA17BMS01A	207	10	39	1323	50	335	123	694	99.3	192.4	22.3	89.9	16.5	5.0	14.2	1.9	10.0	1.8	4.5	0.6	3.6	0.5	4.4	9.6	2.4	SOPET 2005
2018	JA17	18JA17#145BMS01B	98	70	102	1080	125			913	147.5	195.0	24.4	92.3	15.0	4.0	15.8	2.2	13.2	3.2	9.3	1.3	8.6	1.2	51.7	17.8	4.9	SRAPT 2018
2018	JA17	18JA17#146BMS01C	262	60	40	1070	38			611	68.9	151.5	16.4	64.8	13.1	3.6	10.9	1.4	7.9	1.5	4.1	0.5	3.0	0.4	31.0	7.2	2.2	SRAPT 2018
2018	JA17	18JA17#147BMS01A	313	900	30	1060	66			669	67.9	103.0	11.1	42.9	8.8	2.5	9.0	1.2	6.9	1.7	4.1	0.5	3.6	0.5	36.1	5.6	2.5	SRAPT 2018
2018	JA17	18JA17#147BMS01B	301	180	16	1325	47			848	94.4	180.0	19.3	73.9	12.9	3.6	11.3	1.6	8.3	1.6	4.4	0.6	3.7	0.6	33.7	9.6	3.0	SRAPT 2018
2018	JA17	18JA17#147BMS01C	256	400	25	766	112			545	73.8	79.6	10.8	44.9	8.8	2.6	10.4	1.6	9.8	2.3	6.6	0.9	6.2	0.9	52.5	3.7	2.8	SRAPT 2018
2018	JA17	18JA17#147BMS01D	242	310	39	1090	28			703	47.1	87.2	9.5	37.5	8.3	2.2	7.1	1.0	5.4	1.1	2.8	0.4	2.4	0.3	6.1	5.7	2.0	SRAPT 2018
2019	JA17	19JA17#142BMS01C	153	5	76	2270				1950															44.1	12.7	5.8	SRAPT 2019
2019	JA17	19JA17#150BMS01C	231	167	36	1800				960															23.5	8.2	3.0	SRAPT 2019
1990	JA19	90JA19AD01C																										DMRS 1990
1990	JA19	90JA19AD04D																										DMRS 1990
1990	JA22	90JA22AD05D																										DMRS 1990
1990	JA22	90JA22AD11B																										DMRS 1990
2005	MT472	05DSMT472AD01r1-1	241	136	29	627	82	312	42	219	63.1	71.7	15.9	76.5	16.6	5.2	18.2	2.7	14.2	2.8	7.2	1.0	5.4	0.8	6.0	2.8	1.1	SOPET 2005
2005	MT472	05DSMT472AD01r1-2	201	132	30	552	63	297	41	158	44.1	72.5	10.9	51.7	11.5	3.8	11.9	1.8	9.5	2.0	5.0	0.7	3.9	0.5	3.0	2.6	1.4	SOPET 2005
2005	MT472	05DSMT472AD01a3	230	149	30	638	76	301	43	195	58.2	70.5	13.8	65.7	14.4	4.5	15.3	2.3	12.4	2.5	6.2	0.9	4.7	0.7	5.0	2.7	1.0	SOPET 2005
2005	MT473	MT473BMS02A-2	327	22	36	650	52	270	54	317	44.2	77.7	11.7	51.9	11.4	3.7	10.8	1.6	8.8	1.7	4.5	0.7	3.4	0.5	1.7	3.6	2.4	SOPET 2005
2005	MT474	MT474BMS04A																										SOPET 2005
2019	Takuyo-Daigo	19TAKUYO5BMS41B	244	221	52	652				2250															304.0	2.8	4.1	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS50B	196	154	45	712				530															21.4	10.6	2.1	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS57B	285	68	31	1075				530															17.8	7.2	2.0	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS57C	136	3	52	933				640															40.5	12.4	3.1	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS58C	224	57	45	737				610															27.5	7.6	2.2	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS59A	231	50	37	774				540															7.5	8.0	2.0	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS59B	215	62	27	793				730															16.4	8.5	1.9	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS52A	247	234	16	821				210															33.3	3.9	1.7	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS55C	226	328	23	622				300															13.6	2.8	1.3	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS52A	157	198	26	449				130															13.5	3.5	0.9	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS52B	154	236	55	316				160															29.7	3.4	1.7	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS53B	191	127	49	197				230															32.5	3.8	1.9	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS53D	196	128	32	3270				130															25.7	3.9	3.3	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS53E	155	117	47	480				240															10.0	4.0	2.2	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS52A	157	254	27	412				130															8.2	3.3	1.1	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS53B	170	95	37	244				370															69.3	3.4	1.5	SRAPT 2019
2019	Takuyo-Daigo	19TAKUYO5BMS53D	165	84	19	458				240															9.7	2.8	0.7	SRAPT 2019
2020	Takuyo-Daigo	19TAKUYO5BMS53D_1a	271	217	26	487	23	189	58	150	36.1	72.5	8.5	36.0	7.1	2.4	7.6	1.0	5.1	0.9	2.4	0.3	1.9	0.3	2.4	4.4	1.8	ESCRC 2020
2020	Takuyo-Daigo	19TAKUYO5BMS53D_1b	274	220	36	458	23	207	63	148	37.9	78.0	8.8	36.5	7.4	2.5	7.6	1.1	5.3	1.0	2.5	0.3	1.9	0.2	2.8	4.8	2.0	ESCRC 2020
2020	Takuyo-Daigo	19TAKUYO5BMS53D_2a	153	118	28	129	13	124	39	87	23.8	48.6	5.6	22.7	4.4	1.5	4.6	0.6	3.2	0.6	1.5	0.2	1.1	0.1	1.4	2.9	1.2	ESCRC 2020
2020	Takuyo-Daigo	19TAKUYO5BMS53D_2b	153	115	31	109	11	111	35	65	17.8	35.0	4.3	17.5	3.5	1.2	3.5	0.5	2.6	0.5	1.3	0.2	1.0	0.1	1.3	2.5	1.0	ESCRC 2020
2020	Takuyo-Daigo	19TAKUYO5BMS53E_1a	139	89	50	228	29	180	50	185	55.8	71.9	10.9	43.8	8.1	2.5	8.7	1.1	5.9	1.1	3.0	0.4	2.3	0.3	18.4	3.8	1.7	ESCRC 2020
2020	Takuyo-Daigo	19TAKUYO5BMS53E_1b	140	106	47	327	55	169	52	180	59.5	61.5	11.3	47.1	9.3	2.7	10.8	1.5	8.7	1.8	5.1	0.7	4.1	0.6	20.2	4.0	1.9	ESCRC 2020
2020	Takuyo-Daigo	19TAKUYO5BMS53F_1a	139	91	46	248	29	189	47	176	57.6	75.8	10.5	42.3	7.7	2.3	8.2	1.1	5.7	1.1	2.9	0.4	2.3	0.3	17.2	3.6	1.6	ESCRC 2020
2020	Takuyo-Daigo	19TAKUYO5BMS53F_1b	127	105	41	302	56	162	45	155	56.8	59.2	10.2	43.2	8.4	2.5	10.0	1.4	8.0	1.7	5.1	0.6	3.9	0.6	17.9	3.5	1.6	ESCRC 2020
2020	Takuyo-Daigo	19TAKUYO5BMS53F_2a	145	96	17	395	12	99	30	153	20.6	38.5	4.7	19.7	4.0	1.4	4.1	0.6	2.9	0.5	1.4	0.2	0.9	0.1	1.1	2.3	0.6	ESCRC 2020
2020	Takuyo-Daigo	19TAKUYO5BMS53F_2b	269	179	37	573	21	178	53	368	33.5	67.6	8.0	33.2	6.8	2.3	7.0	1.0	4.8	0.9	2.3	0.3	1.8	0.2	1.9	4.1	1.1	ESCRC 2020
2020	Takuyo-Daigo	19TAKUYO5BMS53F_3a	146	108	28	121	14	115	40	90	24.9	49.9	5.8	23.8	4.6	1.6	4.9	0.6	3.3	0.6	1.5	0.2	1.1	0.2	1.5	2.9	1.3	ESCRC 2020
2020	Takuyo-Daigo	19TAKUYO5BMS53F_3b	165	127	35	114	12	115	39	77	20.5	40.4	4.9	20.1	4.1	1.4	4.3	0.6	3.1	0.5	1.4	0.2	1.1	0.1	1.6	3.0	1.2	ESCRC 2020

DMRS: Deep-sea mineral resource surveys
SOPET: Survey on offshore petroleum exploration technology (basic survey on exploration technology for deep water petroleum resources)
SRAPT: Survey on resource assessment and production technology for the development of marine mineral resources
ESCRC: Environmental study in the area for exploration of cobalt-rich crusts

The decrease in SiO_2 is observed with the increase in LOI. The alteration reflects two stages of magmatic activity: hydrothermal alteration (recrystallization of hydrous minerals, increase in H_2O^+) and seafloor weathering (formation of clay minerals, increase in H_2O^-). With alteration, calcite crystallizes in the voids and CO_2 increases. For the samples with >1 % P_2O_5, the effect of phosphatization is considered. It is known that many elements, including alkali elements, are lost in hydrothermal alteration and alkali elements are added in seafloor weathering. In addition, with the increase of calcite and phosphate, elements such as Ca, Ba, Y, and REE are added. Careful interpretation is needed since the chemical composition of the rock changes from the original composition due to hydrothermal alteration and phosphatization.

Although SiO_2 of most samples are reduced due to increased LOI and CaO, these samples are classified as basalt. These basalts show a wide range of undifferentiated basalts with high MgO and Mg# (MgO/MgO+FeO*, FeO* = FeO+Fe_2O_3) to highly differentiated basalts with low MgO and Mg#. The high Na_2O+K_2O (>3 %) and high TiO_2 (>2 %) relative to SiO_2 indicate the characteristics of alkaline rocks.

Figure 4 shows the Ti/1000-V diagram (after Shervais, 1982) and Figure 5 shows the Zr/4-2Nb-Y diagram (after Meschede, 1986). In the Ti/1000-V and Zr/4-2Nb-Y diagrams, the plots are in the oceanic island alkaline basalt region, although there is some variation. In the Zr/4-2Nb-Y diagram, samples with slightly higher Y values outside the oceanic island alkali basalt region are considered to be due to the increase in Y caused by phosphatization.

Figure 6 shows the Ba/Zr–Nb/Zr diagram. The Ba/Nb ratios of most of the samples are in the range of 4 to 10, which is similar to the basalts in the South Pacific Isotope and Thermal Anomaly (SOPITA) region where the seamounts in this area are thought to have been formed. The samples with Ba/Nb ratios higher than 10 are considered to have undergone Ba addition due to phosphatization. This is especially true for JA09 and JA15 Seamounts.

The MORB-normalized diagram is shown in Figure 7, and the REE chondrite-normalized diagram is shown in Figure 8. The reference values used for the normalization are those of Sun and McDonough (1989), and the figures are divided by seamounts. In the MORB normalized diagram, each seamount basically shows a smooth downward pattern enriched in incompatible elements. Rb, Ba, U, and K increase or decrease due to the influence of alteration, and the increase in Ba and Y may be due to phosphatization. For the samples with a large increase in Pb, MnO is also high, which may be due to the contamination of ferromanganese crusts. Ti-poor samples are found in JA02, JA03, JA05, JA09, JA15, and JA17 Seamounts. Since Ti is an element that is difficult to move during alteration, it may reflect the primary composition and may have been produced by different magmatic activities.

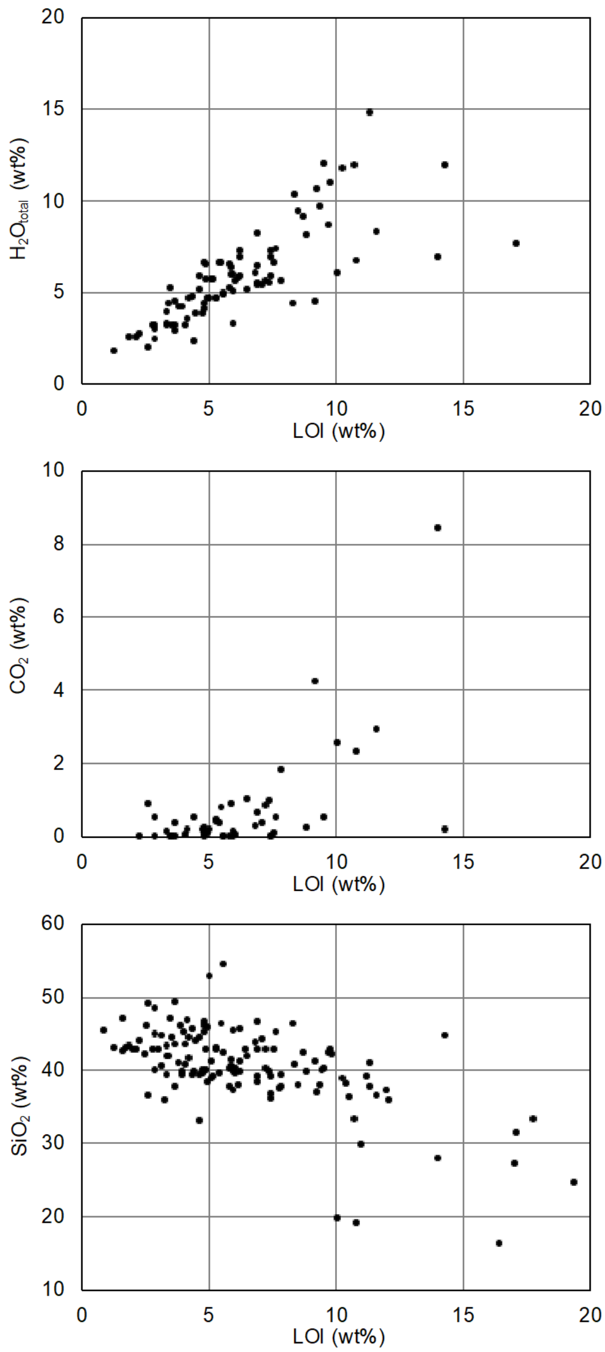

Fig. 2 H_2O, CO_2, and SiO_2 plots against LOI of seamount basement basalts.

The REE chondrite-normalization diagrams also show typical oceanic island alkaline basalt features enriched in LREEs for many samples. Two samples from the JA03 Seamount (02JA03BMS04B-1, 02JA03BMS04B-2) and one sample from the JA17 Seamount (05JAl7AD07r2) show a low MREE pattern that is different from the other samples. In the JA02 Seamount, JA09 Seamount, and MT472 Seamount, some samples show negative Ce anomalies. The negative Ce anomaly reflects the influence

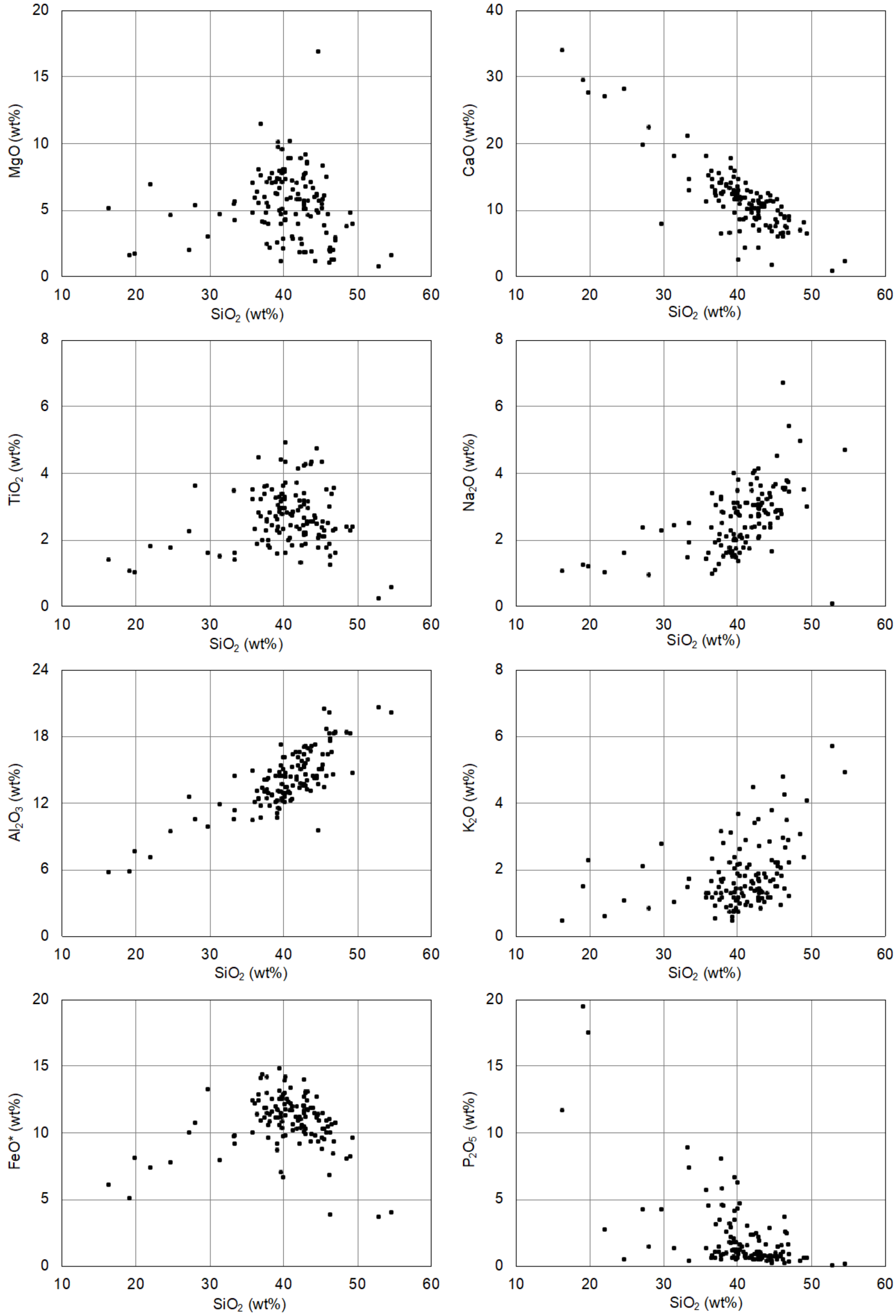

Fig. 3 Major elements plot against SiO_2 of seamount basement basalts.

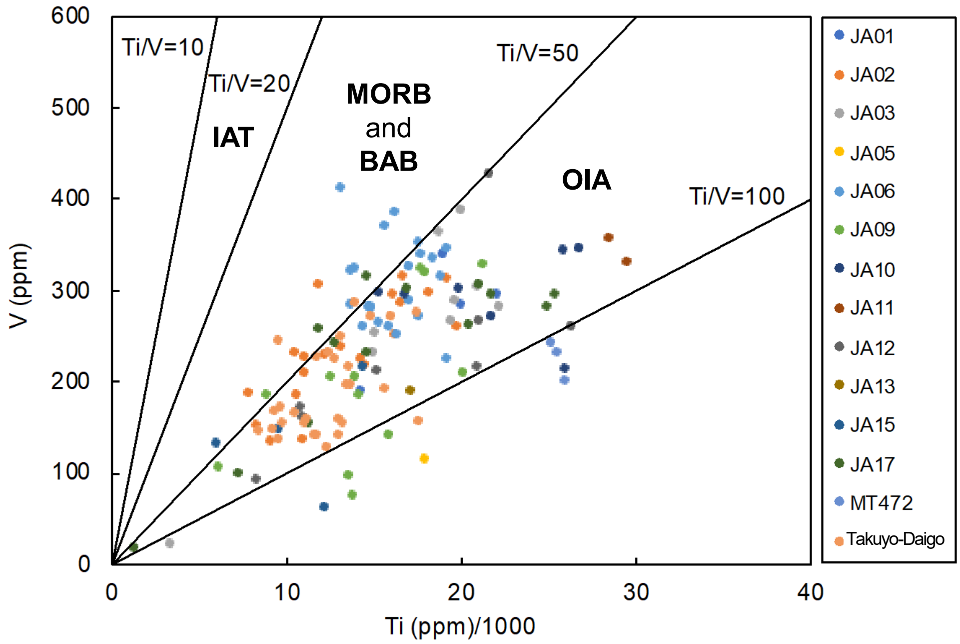

Fig. 4 Ti-V discrimination diagram for basalts (after Shervais, 1982). The fields are IAT-island arc tholeiite; MORB and BAB-mid-ocean ridge basalt and back-arc basin basalt; OIA-ocean island alkali basalt.

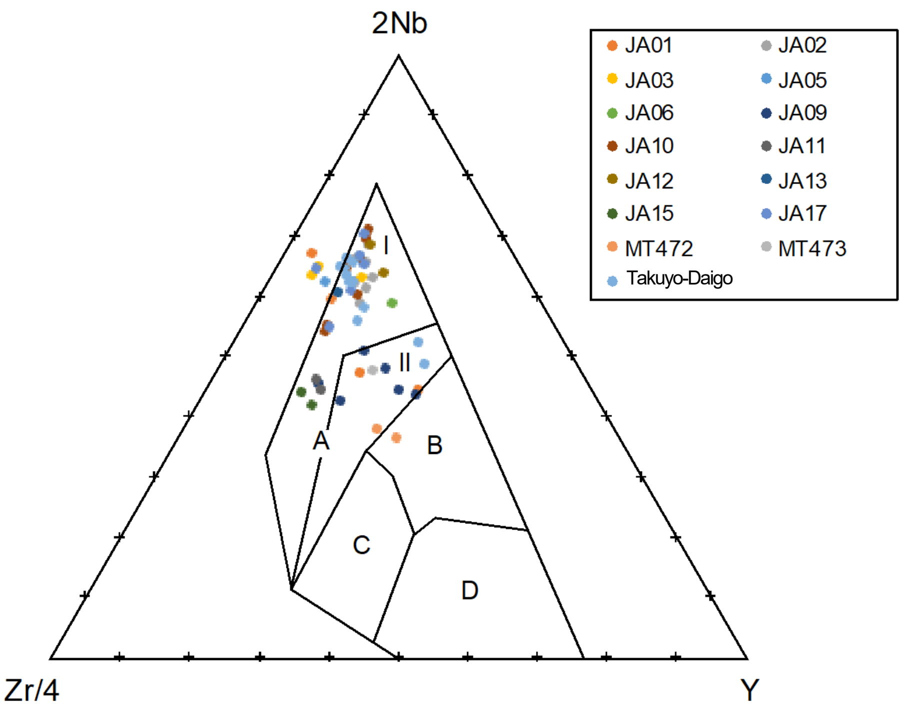

Fig. 5 Zr-Nb-Y discrimination diagram for basalts (after Meschede, 1986). Samples with P_2O_5>2 % were excluded because yttrium is increased by phosphatization. The fields are defined as follows: AI, within-plate alkali basalts; AII, within-plate alkali basalts and within-plate tholeiites; B, E-type MORB; C, within-plate tholeiites and volcanic-arc basalts; D, N-type MORB and volcanic-arc basalts.

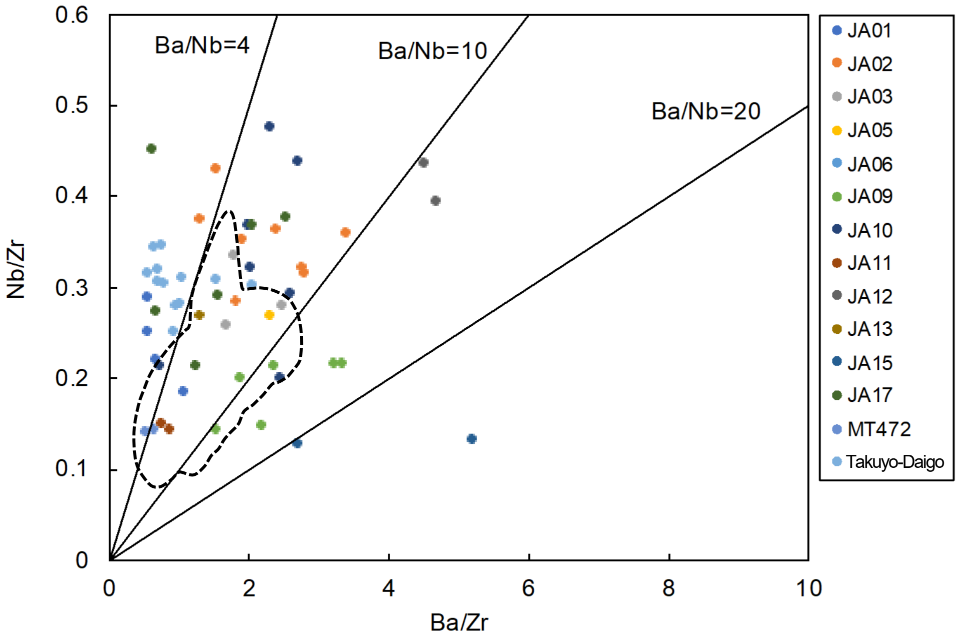

Fig. 6 Nb/Zr-Ba/Zr discrimination diagram for basalts. Samples with P_2O_5>2 % were excluded because barium is increased by phosphatization. The area enclosed by dashed line indicates SOPITA island chains (from Christie *et al.*, 1995).

of seawater and may be due to calcite crystallization, phosphatization, or limestone incorporation. On the other hand, some samples from JA02 Seamount and JA06 Seamount show positive Ce anomalies, suggesting contamination of ferromanganese crusts.

5. Formation age

The ages obtained from each seamount are summarized in Table 3. Below are the formation ages for the Marcus-Wake Seamount Group, Magellan Seamount Group, and Marshall Islands Seamount Group.

5. 1 Marcus-Wake Seamount Group

(1) JA01 Seamount (Miami Guyot)

Ar–Ar dating was performed on three samples with relatively little alteration, but no reliable age values were obtained from 99JA01AD12 and 99AD13K01. 99JA01AD18 yielded a plateau age of 85.7 ± 2.0 Ma. The stage-heating age spectra and inverse isochron diagrams are shown in Figure 9. The $^{40}Ar/^{39}Ar$ age measurement data are shown in Table 4. This age is slightly younger than the Ar–Ar age of 96.8 ± 1.2 Ma reported by Koppers *et al.* (2003).

(2) JA02 Seamount (Lamont Guyot)

Ar–Ar dating was carried out on three samples, but no plateau age was obtained for 01JA02BM02C due to alteration, and an isochron age value of 60.00 ± 16.92 Ma was obtained, which is not considered to be a valid result. A plateau age of 72.4 ± 1.4 Ma was obtained for 02JA02BM06B. Figure 10 shows the step heating age spectra and inverse isochron diagrams. The $^{40}Ar/^{39}Ar$ age measurement data are shown in Table 4. The ages obtained from the high-temperatures (9 to 12 steps) are much younger than those from the low-temperatures (1 to 8 steps) and the K/Ca ratios of each plateau decrease rapidly at high-temperatures, suggesting that the Ar–emitting mineral phases may differ between the high and low temperatures. In addition, the K/Ca ratio and $^{40}Ar^*$ (radiogenic ^{40}Ar) are generally low, suggesting that the ages obtained are not from the source rock but from secondary mineral phases. A plateau age of 82.4 ± 0.5 Ma was obtained for 02JA02BMS07A, which is in harmony with the Ar–Ar ages (81.6 ± 1.2 Ma, 87.2 ± 0.6 Ma) reported by Koppers *et al.* (2003).

(3) JA03 Seamount (Arnold Guyot)

K–Ar dating was performed on one sample and Ar–Ar dating on two samples. The K–Ar age of 47.5 ± 1 Ma obtained from 97JA03AD19 is unreliable due to alteration. A plateau age of 98.4 ± 0.4 Ma was obtained from 02JA03BMS04B. The stage-heating age spectra and inverse isochron diagrams are shown in Fig. 11. The $^{40}Ar/^{39}Ar$ age measurement data are shown in Table 4. The K/Ca ratio of each plateau is very high, suggesting that the main source of Ar emission is alkali feldspar in matrix, which is K-rich and has a high K/Ca ratio. Ar–Ar dating was performed again on another part of the 02JA03BMS04B, yielding a whole rock age of 100.6 Ma and an isochron age of 93.6 Ma.

(4) JA05 Seamount (Batiza Guyot)

Ar–Ar dating was performed on one sample, and the stage-heating age spectra diagram yielded an age of 98.4

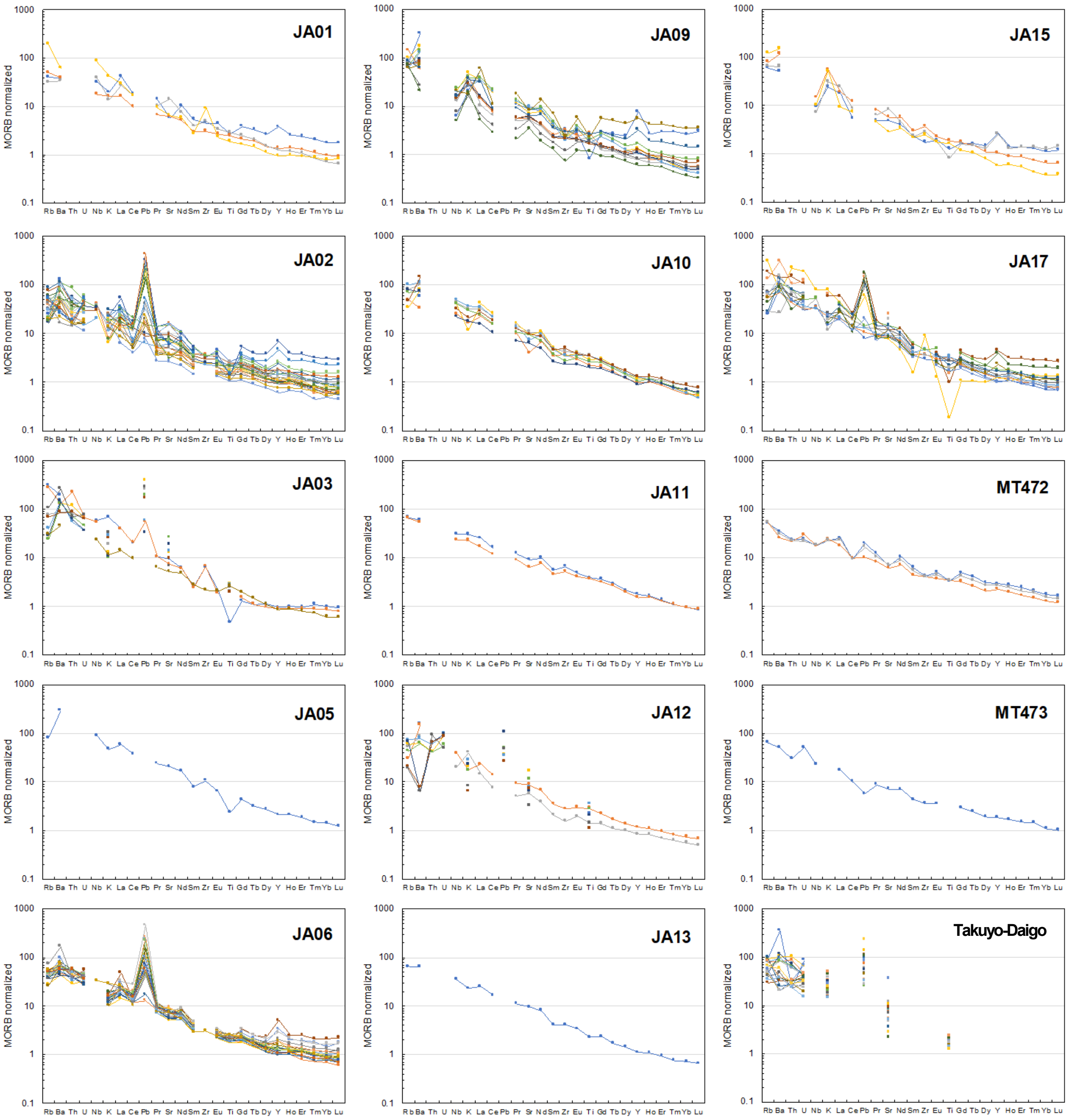

Fig. 7 MORB-normalized patterns of seamount basement basalts

± 0.4 Ma. However, the plateau age criterion is not met because there is no plateau greater than 50 % of ^{39}Ar. The inverse isochron diagram cannot be used to verify the plateau age because no isochron can be drawn. The stage-heating age spectra and inverse isochron diagram are shown in Figure 12. The ^{40}Ar/^{39}Ar age measurement data are shown in Table 4.

(5) JA06 Seamount (Xufu Guyot)

K–Ar dating was carried out on two relatively unaltered samples, which yielded the ages of Late Cretaceous (80.0 ± 2 Ma, 86.5 ± 2 Ma), but the results are not reliable due to alteration.

(6) JA11 Seamount (McDonnell Guyot)

Ar–Ar dating was carried out on two samples. The obtained plateau ages are 109.4 ± 0.3 Ma and 116.43 ± 4.94 Ma (Late Cretaceous: Albian), which are reasonable results. Figure 13 shows the stage-heating age spectra diagram of 01JA11BMS02A. The ^{40}Ar/^{39}Ar age measurement data are

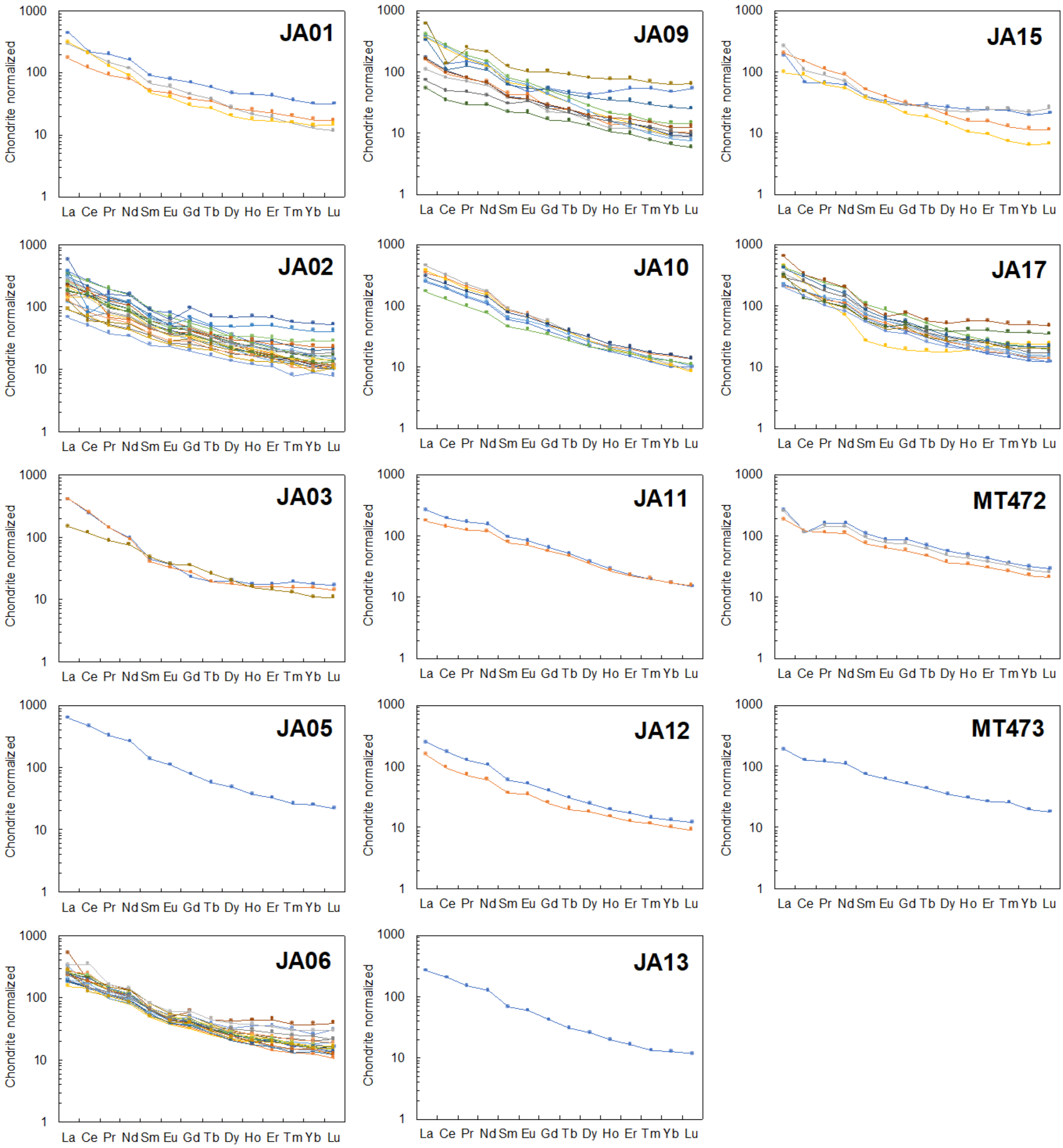

Fig. 8 REE patterns of seamount basement basalts

shown in Table 4.

(7) JA12 Seamount (Zhinyu Guyot)

K–Ar dating was performed on one sample and Ar–Ar dating on two samples. The K–Ar age of 72.4 ± 2.3 Ma obtained from 89JA12AD07-A is unreliable due to alteration. The stage-heating age spectra of 02JA12BMS03B gives an age of 85.6 ± 0.4 Ma. However, the plateau age criterion is not met because there is no plateau greater than 50 % of ^{39}Ar. The inverse isochron diagram cannot be used to verify the plateau age because no isochron can be drawn. Figure 14 shows the stage-heating age spectra and inverse isochron diagram. The ^{40}Ar/^{39}Ar age measurement data are shown in Table 4. A plateau age of 66.77 ± 0.17 Ma was obtained from 02JA12BMS04B.

(8) JA17 Seamount (Scripps Guyot)

K–Ar dating was performed on two samples and Ar–Ar dating on one sample. The K–Ar ages of 29.5 ± 1.9 Ma

Table 3 K–Ar/Ar–Ar ages of basement basalts from seamounts in the JA area

Seamount		Sample ID	Year	K-Ar age ± 1σ (Ma)	Ar-Ar age ± 1σ (Ma) Total integrated age	Inverse isochron age	$^{40}Ar/^{36}Ar$ intercept	Weighted mean plateau age	MSWD	^{39}Ar (%)	Project name
Marcus-Wake Seamount Group											
JA01	Miami	99JA01AD12	1999			-		-			DMRS 1999
		99JA01AD13	1999			-		-			DMRS 1999
		99JA01AD18	1999			-		85.7±2.0		62.9	DMRS 1999
		Koppers et al. (2003)						*96.8±1.2 (2σ)*			
JA02	Lamont	01JA02BMS02C	2001			60.00±16.92		-			DMRS 2001
		02JA02BMS06B	2002			72.53±1.36	294.4±7.0	72.4±1.4		67.3	DMRS 2002
		02JA02BMS07A	2005		82.3±1.1	80±5	724±315	82.4±0.5	1.24	92.1	SOPET 2005
		Koppers et al. (2003)						*87.2±0.6 (2σ)*			
		Koppers et al. (2003)						*81.6±1.2 (2σ)*			
JA03	Arnold	97JA03AD19	1997	47.5±1							DMRS 1997
		02JA03BMS04B-1	2002			98.00±0.22	845.9±27.1	98.4±0.4		60.0	DMRS 2002
		02JA03BMS04B-2	2005		100.58±0.17	-		-			SOPET 2005
JA04	Maloney	*Koppers et al. (2003)*						*100.8±0.6 (2σ)*			
		Koppers et al. (2003)						*97.7±0.6 (2σ)*			
JA05	Batiza	02JA05BMS01C	2002			-		98.8±0.4		37.2	DMRS 2002
JA06	Xufu	97JA06AD13	1997	80.0±2							DMRS 1997
		97JA06AD20	1997	86.5±2							DMRS 1997
JA11	McDonnell	01JA11BMS02A	2001			117.77±4.62		116.43±4.94		53.4	DMRS 2001
		02JA11BMS06A	2005		110.94±0.20	109.7±0.8	276±31	109.4±0.3	3.91	69.6	SOPET 2005
JA12	Zhinyu	89JA12AD07-A	1989	72.4±2.3							
		02JA12BMS03B	2002			-		85.6±0.4		31.2	DMRS 2002
		02JA12BMS04B	2005		70.9±0.5	68.3±0.7	-166±77	66.77±0.17	1.59	66.4	SOPET 2005
JA17	Scripps	90JA17AD01C	1990	29.5±1.9							DMRS 1990
		91JA17AD10A	1991	94.6±4.7							DMRS 1991
		02JA17BMS01A	2005		104.54±0.13	113±6	-7200±8600	105.29±0.19	0.53	46.0	SOPET 2005
		Koppers et al. (2003)						*101.4±1.4 (2σ)*			
JA18	Kimotsuki	04MT474BMS04A	2005		152.6±1.3	-		-			DMRS 2005
MT473	Tsunogai	04MT473BMS02A-1	2005		79.24±0.21	85.3±1.5	-747±770	84.4±0.3	0.60	37.9	SOPET 2005
		04MT473BMS02A-2	2005		74.80±0.09	79.5±0.6	545±235	79.77±0.21	1.20	37.2	SOPET 2005
Takuyo-Daigo		*NT09-02HPD#953-R11*						*101.4±2.3*		*83.0*	
		Tokumaru et al. (2015)									

Table 3 Continued.

Seamount		Sample ID	Year	K-Ar age ± 1σ (Ma)	Ar-Ar age ± 1σ (Ma) Total integrated age	Inverse isochron age	$^{40}Ar/^{36}Ar$ intercept	Weighted mean plateau age	MSWD	^{39}Ar (%)	Project name
Magellan Seamount Group											
JA09	Ioah (Fedorov)	98JA09AD20-1	1998	70.8±3.5							DMRS 1998
		98JA09AD20-2	1998	71.5±3.6							DMRS 1998
		99JA09AD34	1999					86.8±1.0		45.2	DMRS 1999
		99JA09AD35	1999					105±4		48.6	DMRS 1999
		00JA09AD58	2000			-		66.6±1.8		33.8	DMRS 2000
		00JA09CB69	2000			-		-			DMRS 2000
		Koppers et al. (2003)						*86.7±0.4 (2σ)*			
		Koppers et al. (2003)						*88.5±0.7 (2σ)*			
JA13	Magoshichi	89JA13AD03-D	1989	66.9±2.2							DMRS 1989
JA14	Govorov	89JA14AD06-E	1989	86.8±3.0							DMRS 1989
JA15	Pegas	98JA15AD10	1998	56.0±2.8							DMRS 1998
		98JA15AD13	1998	68.7±3.4							DMRS 1998
JA19	Hemler	90JA19AD01C	1990	79.6±2.6							DMRS 1990
		90JA19AD04C	1990	78.1±2.5							DMRS 1990
		Koppers et al. (2003)						*100.1±0.8 (2σ)*			
JA22	Butakov	90JA22AD05C	1990	53.3±1.9							DMRS 1990
		90JA22AD11B	1990	69.9±2.3							DMRS 1990
Marshall Islands Seamount Group											
JA10	Rykachev	89JA10AD04-E	1989	43.6±2.8							DMRS 1989
		99JA10AD11	1999			-		-			DMRS 1999
		99JA10AD17	1999			-		-			DMRS 1999
		00JA10AD34	2000			79.8±4.0	367±10	82.7±3.1	3.74	83.8	DMRS 2000
		00JA10AD37	2000			91.5±1.8	412±21	91.8±0.7	1.1		DMRS 2000
		00JA10AD41	2000			89.5±2.7	457±41	88.5±1.2	1.6		DMRS 2000
JA16	Changpogo	89JA16AD01	1989	54.1±2.1							DMRS 1989

Total integrated ages were calculated using sum of the total gas released.
MSWD: mean square of weighted deviates ((SUMS/(n-2))^0.5) in York (1969).
DMRS: Deep-sea mineral resource exploration
SOPET: Survey on offshore petroleum development technology (geological structure survey and analysis of resources for basic survey on exploration technology of petroleum resources in deep sea)

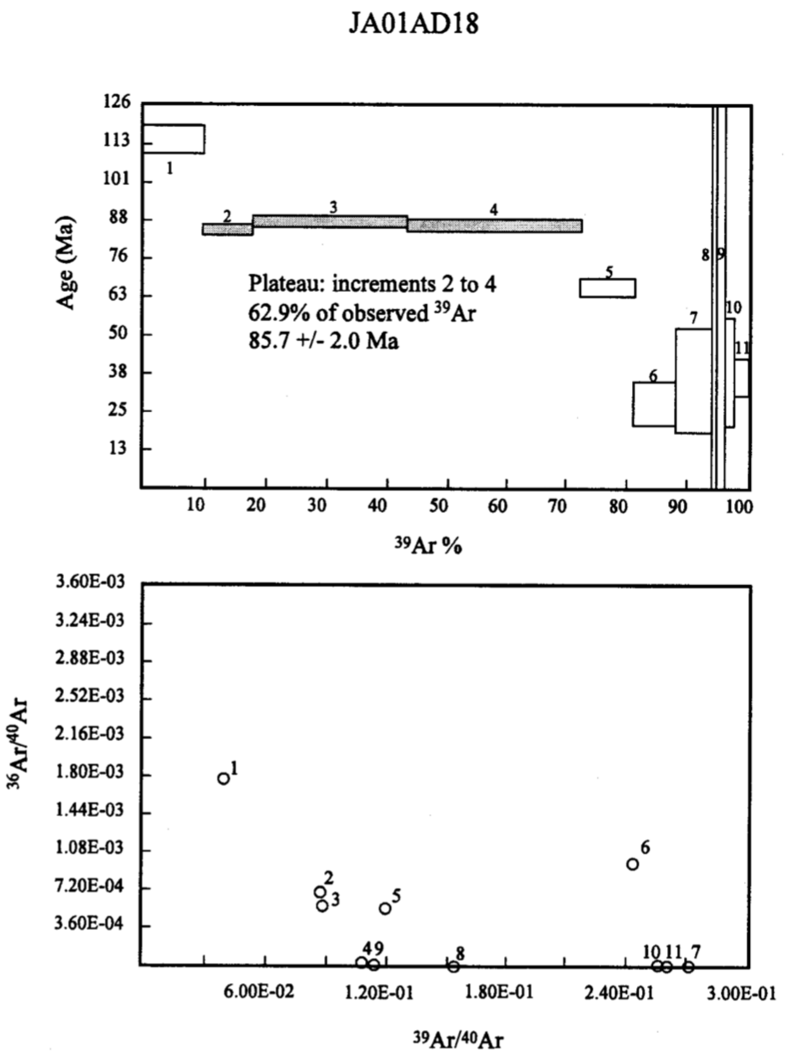

Fig. 9 Step heating age spectra and inverse isochron diagrams for Ar–Ar dating (JA01 Seamount)

and 94.6 ± 4.7 Ma are unreliable due to the effects of alteration. A plateau age of 105.29 ± 0.19 Ma was obtained from 02JA17BMS01A, which is consistent with the Ar–Ar age of 101.4 ± 1.4 Ma reported by Koppers *et al.* (2003). The $^{40}Ar/^{39}Ar$ age measurement data are shown in Table 4.

(9) JA18 Seamount (Kimotsuki Seamount)

Ar–Ar dating was carried out on one sample, but no plateau age was obtained. The $^{40}Ar/^{39}Ar$ age measurement data are shown in Table 4.

(10) MT473 Seamount (Tsunogai Seamount)

Ar–Ar dating was carried out on two samples and yielded plateau ages of 79.77 ± 0.21 Ma and 84.4 ± 0.3 Ma. The $^{40}Ar/^{39}Ar$ age measurement data are shown in Table 4.

5. 2 Magellan Seamount Group

(1) JA09 Seamount (Ioah/Fedorov Guyot)

K–Ar dating was performed on two samples and Ar–Ar dating on four samples. The ages obtained from 98JA09AD20 are 70.8 ± 3.5 Ma and 71.5 ± 3.5 Ma, corresponding to the Late Cretaceous (Maastrichtian), but it is likely that some of the Ar in the rocks was lost due to weathering and alteration, resulting in slightly younger ages. The Ar–Ar ages obtained from relatively less altered samples (99JA09AD34 and 99JA09AD35) are 86.8 ± 1.0 Ma and 105 ± 4 Ma, respectively, corresponding to the Late Cretaceous (Coniacian) and Middle Cretaceous (Albian). There is a large gap between these ages, suggesting that there were two distinct periods of volcanic activity. The Ar–Ar age from 00JA09AD58 is 66.6 ± 1.8 Ma and corresponds to the Late Cretaceous (Maastrichtian), but is unreliable because ^{39}Ar only accounts for 33.8 %. No plateau age was obtained from 00JA09CB69 due to alteration. Koppers *et al.* (2003) reported Ar–Ar ages of 86.7 ± 0.4 Ma and 88.5 ± 0.7 Ma. The stage-heating age spectra and inverse isochron diagrams of 99JA09AD34, 99JA09AD35, 00JA09AD58, and 00JA09CB69 are shown in Figure 15. The $^{40}Ar/^{39}Ar$ age measurement data are shown in Table 4.

(2) JA13 Seamount (Magoshichi Guyot)

K–Ar dating was carried out on one sample and yielded an age of 66.9 ± 2.2 Ma, but the results are not reliable

Table 4 $^{40}Ar/^{39}Ar$ age measurement data

sample ID: JA01AD12

Temp. (K)	$^{36}Ar/^{40}Ar$	$^{39}Ar/^{40}Ar$	$\%^{39}Ar$	$\%^{40}Ar^*$	Age (Ma)
800	1.292E+00 ± 1.419E+03	9.651E-02 ± 1.512E+02	0.00	0.00	
900	4.622E+00 ± 2.457E+03	1.225E-01 ± 8.085E+01	0.01	0.00	
1000	1.446E-02 ± 9.086E-03	1.932E-04 ± 5.046E-02	0.02	0.00	
1100	1.611E+00 ± 4.305E+02	1.766E+01 ± 4.721E+03	1.75	0.00	
1200	6.413E-03 ± 2.575E-03	1.179E-01 ± 3.354E-02	11.82	0.00	
1400	4.557E-04 ± 1.369E-03	1.301E-01 ± 6.455E-03	57.74	86.48	62.97 ± 29.11
1600	0.000E+00 ± 4.432E-03	5.650E-02 ± 2.023E-02	67.43	100.00	162.94 ± 211.40
1800	2.153E-04 ± 6.041E-04	2.576E-01 ± 2.940E-03	100.00	93.52	34.68 ± 6.56

sample ID: JA01AD13

Temp. (K)	$^{36}Ar/^{40}Ar$	$^{39}Ar/^{40}Ar$	$\%^{39}Ar$	$\%^{40}Ar^*$	Age (Ma)
800	1.169E-02 ± 1.508E+01	9.651E-02 ± 1.429E+02	0.01	0.00	
900	0.000E+00 ± 3.673E+00	1.514E-01 ± 9.151E+01	0.03	0.00	
1000	5.617E+00 ± 2.051E+03	1.537E-01 ± 6.104E+01	0.06	0.00	
1100	3.312E+00 ± 8.407E+02	1.360E-01 ± 3.844E+01	0.09	0.00	
1200	1.216E-02 ± 9.179E-03	6.037E-02 ± 4.528E-02	6.00	0.00	
1400	1.344E-03 ± 1.466E-03	1.180E-01 ± 1.087E-02	50.92	60.25	48.53 ± 33.80
1600	0.000E+00 ± 5.775E-03	2.339E-02 ± 2.633E-02	61.59	100.00	370.97 ± 685.40
1800	1.716E-03 ± 2.319E-03	2.373E-01 ± 6.468E-03	100.00	49.24	19.90 ± 27.53

sample ID: JA01AD18

Temp. (K)	$^{36}Ar/^{40}Ar$	$^{39}Ar/^{40}Ar$	$\%^{39}Ar$	$\%^{40}Ar^*$	Age (Ma)
800	1.745E-03 ± 6.814E-05	3.957E-02 ± 1.625E-04	9.32	48.41	114.16 ± 4.66
900	6.965E-04 ± 4.402E-05	8.816E-02 ± 4.256E-04	17.60	79.38	84.75 ± 1.46
1000	5.843E-04 ± 5.528E-05	8.936E-02 ± 2.951E-04	43.22	82.70	87.04 ± 1.73
1100	2.476E-05 ± 9.053E-05	1.086E-01 ± 4.642E-04	72.26	99.21	85.92 ± 2.31
1200	5.481E-04 ± 1.345E-04	1.204E-01 ± 4.744E-07	81.30	83.75	65.83 ± 3.09
1300	9.753E-04 ± 5.836E-04	2.437E-01 ± 1.340E-03	87.96	71.09	27.92 ± 6.72
1400	0.000E+00 ± 1.656E-03	2.705E-01 ± 7.494E-03	93.75	100.00	35.31 ± 17.11
1500	0.000E+00 ± 3.726E-03	1.564E-01 ± 1.499E-02	94.35	100.00	61.30 ± 66.50
1600	0.000E+00 ± 4.476E-03	1.142E+01 ± 1.988E-02	96.05	100.00	82.50 ± 107.50
1700	0.000E+00 ± 1.592E-03	2.564E+01 ± 6.876E-03	97.80	100.00	37.23 ± 17.35
1800	0.000E+00 ± 5.601E-04	2.607E-01 ± 3.505E-03	100.00	100.00	36.61 ± 6.01

sample ID: JA09AD34

Temp. (K)	$^{36}Ar/^{40}Ar$	$^{39}Ar/^{40}Ar$	$\%^{39}Ar$	$\%^{40}Ar^*$	Age (Ma)
800	2.164E-03 ± 1.709E-04	3.034E-02 ± 1.354E-03	2.11	36.04	110.96 ± 16.53
900	2.231E-04 ± 9.177E-05	1.135E-01 ± 2.456E-03	9.11	93.35	77.59 ± 2.80
1000	1.582E-04 ± 3.470E-05	1.017E-01 ± 1.154E-03	26.78	95.28	88.10 ± 1.40
1100	2.478E-05 ± 2.508E-05	1.083E-01 ± 8.329E-04	54.30	99.21	86.22 ± 0.96
1200	3.811E-05 ± 5.119E-05	1.143E-01 ± 8.930E-04	75.29	98.82	81.43 ± 1.40
1400	2.361E-06 ± 2.557E-05	1.311E-01 ± 5.542E-04	96.44	99.86	71.97 ± 0.67
1600	2.999E-04 ± 3.395E-04	1.502E-01 ± 1.525E-03	97.62	91.07	57.50 ± 6.26
1800	1.840E-04 ± 1.456E-04	1.514E-01 ± 4.541E-04	100.00	94.49	59.18 ± 2.66

Table 4 Continued.

sample ID: JA09AD35

Temp. (K)	$^{36}Ar/^{40}Ar$	$^{39}Ar/^{40}Ar$	$\%^{39}Ar$	$\%^{40}Ar^*$	Age (Ma)
800	7.499E-04 ± 2.233E-04	8.064E-02 ± 2.909E-03	2.60	77.81	90.66 ± 8.37
900	2.747E-04 ± 1.160E-04	8.414E-02 ± 1.759E-03	9.33	91.84	102.23 ± 4.32
1000	1.551E-04 ± 3.928E-05	8.179E-02 ± 1.179E-03	27.22	95.38	109.01 ± 2.06
1100	2.231E-05 ± 3.071E-05	8.972E-02 ± 1.066E-03	51.19	99.30	103.62 ± 1.56
1200	2.200E-05 ± 5.254E-05	9.972E-02 ± 1.245E-03	69.27	99.30	93.50 ± 1.86
1400	0.000E+00 ± 3.375E-05	1.057E-01 ± 9.426E-04	94.07	100.00	88.90 ± 1.20
1600	2.937E-04 ± 1.820E-04	1.154E-01 ± 1.216E-03	97.33	91.27	74.63 ± 4.39
1800	5.233E-05 ± 2.276E-04	1.031E-01 ± 3.097E-04	100.00	98.40	89.68 ± 5.99

sample ID: JA10AD11

Temp. (K)	$^{36}Ar/^{40}Ar$	$^{39}Ar/^{40}Ar$	$\%^{39}Ar$	$\%^{40}Ar^*$	Age (Ma)
800	1.705E+00 ± 2.664E+03	4.577E-02 ± 1.140E+02	0.00	0.00	
900	6.525E+00 ± 4.845E+03	9.449E-02 ± 8.521E+01	0.01	0.00	
1000	6.466E-03 ± 2.077E-03	4.608E-03 ± 1.353E-02	0.67	0.00	
1100	2.353E-03 ± 1.405E-03	7.936E-02 ± 1.484E-02	17.49	30.45	36.60 ± 51.16
1200	1.592E-03 ± 1.176E-03	7.257E-02 ± 6.582E-02	45.99	52.92	68.93 ± 45.32
1400	0.000E+00 ± 1.235E-03	9.778E-02 ± 6.128E-03	87.23	100.00	95.95 ± 34.58
1600	0.000E+00 ± 2.173E-02	4.537E-02 ± 9.573E-02	89.07	100.00	200.00 ± 1275.00
1800	0.000E+00 ± 2.427E-03	2.128E-01 ± 1.025E-02	100.00	100.00	44.75 ± 31.74

sample ID: JA10AD17

Temp. (K)	$^{36}Ar/^{40}Ar$	$^{39}Ar/^{40}Ar$	$\%^{39}Ar$	$\%^{40}Ar^*$	Age (Ma)
800	1.813E+01 ± 4.456E+04	3.430E-03 ± 1.278E+02	0.00	0.00	
900	1.526E+01 ± 2.801E+04	3.859E+00 ± 7.083E+05	3.46	0.00	
1000	4.390E-02 ± 8.598E-02	3.065E-01 ± 5.957E-01	6.07	0.00	
1100	2.723E-03 ± 4.652E-03	2.003E-02 ± 6.367E-03	9.51	19.53	91.58 ± 629.00
1200	3.119E-03 ± 3.299E-04	1.239E-02 ± 1.201E-03	15.04	7.82	59.81 ± 73.98
1400	2.270E-03 ± 5.674E-04	9.274E-02 ± 2.372E-03	55.68	32.90	33.86 ± 17.13
1600	0.000E+00 ± 3.492E-03	6.275E-02 ± 1.590E-02	94.07	100.00	147.30 ± 150.30
1800	0.000E+00 ± 2.827E-03	1.852E-01 ± 6.565E-03	100.00	100.00	51.32 ± 42.27

sample ID: 01JA02BM02C

Temp. (K)	$^{36}Ar/^{40}Ar$	$^{39}Ar/^{40}Ar$	$\%^{39}Ar$	$\%^{40}Ar^*$	Age (Ma)
900	4.973E-03 ± 1.104E-02	1.320E-01 ± 2.445E-03	10.34	0.00	
1200	3.490E-03 ± 2.066E-03	3.505E-02 ± 2.831E-03	12.13	6.28	
1400	7.160E-04 ± 7.670E-04	1.249E-01 ± 2.606E-03	50.88	78.72	56.53 ± 16.13
1823	2.921E-03 ± 1.791E-03	2.204E-01 ± 8.985E-03	100.00	13.64	5.63 ± 21.81

sample ID: 01JA11BM02A

Temp. (K)	$^{36}Ar/^{40}Ar$	$^{39}Ar/^{40}Ar$	$\%^{39}Ar$	$\%^{40}Ar^*$	Age (Ma)
900	2.290E-04 ± 8.520E-04	6.776E-02 ± 2.189E-02	4.06	93.18	121.14 ± 33.74
1100	7.920E-04 ± 5.940E-04	6.401E-01 ± 1.825E-03	16.83	76.56	105.79 ± 23.78
1300	7.200E-05 ± 1.330E-04	7.383E-02 ± 6.210E-04	53.39	97.81	116.62 ± 5.11
1500	1.430E-04 ± 9.500E-05	9.203E-02 ± 2.042E-03	80.02	95.72	92.34 ± 3.31
1823	4.280E-04 ± 3.460E-04	7.120E-02 ± 6.630E-04	100.00	87.29	108.35 ± 12.51

Table 4 Continued.

sample ID: 00JA09AD58

Temp. (K)	$^{36}Ar/^{40}Ar$	$^{39}Ar/^{40}Ar$	$\%^{39}Ar$	$\%^{40}Ar^{*}$	Age (Ma)
900	1.425E-03 ± 1.496E-05	2.792E-02 ± 1.535E-04	28.07	57.89	126.41 ± 2.71
1000	6.677E-05 ± 1.873E-05	5.896E-02 ± 3.056E-04	51.86	98.00	102.03 ± 2.13
1100	9.378E-05 ± 2.962E-05	6.988E-02 ± 3.142E-04	66.16	97.19	85.78 ± 1.88
1300	1.358E-04 ± 3.759E-05	8.770E-02 ± 2.450E-04	87.53	95.95	67.82 ± 1.55
1500	3.850E-04 ± 5.266E-05	8.477E-02 ± 1.939E-04	97.86	88.58	64.83 ± 1.70
1823	4.717E-04 ± 1.718E-04	8.488E-02 ± 4.263E-04	100.00	86.02	62.91 ± 3.87

sample ID: 00JA09CB69

Temp. (K)	$^{36}Ar/^{40}Ar$	$^{39}Ar/^{40}Ar$	$\%^{39}Ar$	$\%^{40}Ar^{*}$	Age (Ma)
900	1.438E-03 ± 2.750E-05	2.534E-02 ± 1.571E-04	30.27	57.49	137.84 ± 3.40
1000	1.750E-04 ± 8.436E-05	7.339E-02 ± 6.035E-04	46.58	94.80	78.80 ± 2.66
1100	3.985E-05 ± 6.480E-05	8.697E-01 ± 4.370E-04	60.46	98.78	70.36 ± 1.95
1300	1.202E-04 ± 7.984E-05	1.171E-01 ± 4.752E-04	88.13	96.39	51.29 ± 1.61
1500	4.576E-04 ± 8.664E-05	8.524E-02 ± 4.363E-04	94.70	86.44	62.95 ± 2.23
1823	5.337E-04 ± 2.237E-04	8.535E-02 ± 4.273E-04	100.00	84.19	61.26 ± 4.89

sample ID: 00JA10AD34

Temp. (K)	$^{36}Ar/^{40}Ar$	$^{39}Ar/^{40}Ar$	$\%^{39}Ar$	$\%^{40}Ar^{*}$	Age (Ma)
900	2.304E-03 ± 2.767E-05	1.206E-02 ± 1.537E-04	15.27	31.91	159.78 ± 5.79
1000	7.961E-04 ± 1.567E-04	5.166E-02 ± 7.085E-04	24.61	76.46	91.13 ± 5.84
1100	4.174E-04 ± 8.654E-05	6.354E-02 ± 2.487E-04	60.05	87.64	85.08 ± 2.96
1300	1.417E-04 ± 8.386E-03	7.542E-02 ± 4.063E-03	99.09	95.78	78.49 ± 2.55
1500	0.000E+00 ± 1.334E-03	5.204E-02 ± 5.953E-03	99.99	100.00	117.47 ± 46.73
1823	4.880E-03 ± 1.062E-03	9.566E-04 ± 2.353E-03	100.00	0.00	

sample ID: 00JA10AD37

Temp. (K)	$^{36}Ar/^{40}Ar$	$^{39}Ar/^{40}Ar$	$\%^{39}Ar$	$\%^{40}Ar^{*}$	Age (Ma)
800	1.313E-03 ± 6.891E-05	3.069E-02 ± 6.814E-04	4.88	61.18	121.69 ± 5.57
900	3.619E-04 ± 3.246E-05	5.746E-02 ± 4.240E-04	20.84	89.28	95.56 ± 2.23
1000	3.889E-05 ± 9.165E-06	6.638E-02 ± 1.815E-04	51.66	98.82	91.66 ± 1.82
1100	2.505E-05 ± 1.430E-05	6.632E-02 ± 9.300E-05	76.16	99.23	92.11 ± 1.84
1300	0.000E+00 ± 9.724E-05	7.578E-02 ± 4.579E-03	98.54	100.00	81.49 ± 2.83
1500	0.000E+00 ± 6.604E-04	6.797E-02 ± 2.352E-03	99.75	100.00	90.61 ± 17.60
1700	2.477E-03 ± 5.806E-04	3.752E-02 ± 1.935E-03	99.99	26.79	44.54 ± 28.31
1823	8.212E-03 ± 2.537E-03	4.589E-03 ± 3.598E-03	100.00	0.00	

sample ID: 00JA10AD41

Temp. (K)	$^{36}Ar/^{40}Ar$	$^{39}Ar/^{40}Ar$	$\%^{39}Ar$	$\%^{40}Ar^{*}$	Age (Ma)
900	6.763E-04 ± 4.190E-05	4.786E-02 ± 5.244E-04	20.68	80.00	102.59 ± 2.80
1000	2.329E-04 ± 5.225E-05	6.062E-02 ± 5.218E-04	33.78	93.09	94.47 ± 2.53
1100	1.019E-04 ± 3.088E-05	6.225E-02 ± 2.940E-04	49.20	96.96	95.79 ± 2.11
1300	0.000E+00 ± 6.493E-05	6.987E-02 ± 2.875E-04	92.08	100.00	88.21 ± 2.41
1500	0.000E+00 ± 2.501E-04	6.283E-02 ± 1.116E-03	98.92	100.00	97.82 ± 7.48
1823	2.142E-04 ± 3.601E-04	5.988E-02 ± 1.176E-03	100.00	93.64	96.17 ± 10.96

Table 4 Continued.

sample ID: 02JA02BMS06B

Temp. (K)	$^{36}Ar/^{40}Ar$	$^{37}Ar/^{40}Ar$	$^{38}Ar/^{40}Ar$	$^{39}Ar/^{40}Ar$	K/Ca	%^{39}Ar	%$^{40}Ar^*$	Age (Ma)
460	1.840E-03	5.815E-02	8.978E-05	3.453E-02	0.290	10.2	45.6	72.2 ± 1.7
500	1.817E-03	1.020E-01	9.872E-05	3.656E-02	0.180	19.2	46.3	69.3 ± 1.9
540	1.658E-03	2.184E-01	1.351E-04	3.752E-02	0.084	27.2	51.0	74.3 ± 2.1
580	1.559E-03	3.987E-01	2.948E-04	4.038E-02	0.050	35.7	54.0	73.1 ± 2.0
620	1.099E-03	5.201E-01	1.649E-04	4.997E-02	0.047	45.4	67.5	73.8 ± 1.6
660	5.085E-04	5.230E-01	6.519E-04	6.519E-02	0.061	55.4	85.0	71.3 ± 1.5
700	7.169E-04	3.680E-01	3.555E-04	5.925E-02	0.079	61.4	78.8	72.7 ± 2.5
740	9.689E-04	2.008E-01	1.205E-05	5.237E-02	0.130	64.8	71.4	74.5 ± 4.4
780	1.473E-03	1.751E-01	2.051E-04	4.661E-02	0.130	67.3	56.5	66.4 ± 5.8
850	1.444E-03	3.674E-01	0.000E+00	6.335E-02	0.084	69.4	57.4	49.8 ± 7.2
920	1.505E-03	7.867E-01	8.584E-04	1.010E-01	0.063	72.7	55.6	30.5 ± 4.5
1100	4.659E-04	1.106E+01	7.248E-04	1.294E-01	0.006	100.0	86.2	36.8 ± 0.7

sample ID: 02JA03BMS04B

Temp. (K)	$^{36}Ar/^{40}Ar$	$^{37}Ar/^{40}Ar$	$^{38}Ar/^{40}Ar$	$^{39}Ar/^{40}Ar$	K/Ca	%^{39}Ar	%$^{40}Ar^*$	Age (Ma)
460	8.117E-04	1.185E-03	0.000E+00	2.306E-02	9.500	2.6	76.0	174.9 ± 0.6
520	2.212E-04	1.783E-03	0.000E+00	4.514E-02	12.000	7.2	93.5	111.9 ± 0.3
580	2.167E-05	1.587E-03	0.000E+00	5.417E-02	17.000	19.4	99.4	99.4 ± 0.2
640	1.099E-05	1.407E-03	0.000E+00	5.495E-02	19.000	36.7	99.7	98.3 ± 0.2
670	1.098E-05	1.449E-03	0.000E+00	5.490E-02	19.000	47.6	99.7	98.4 ± 0.2
700	1.096E-05	1.562E-03	0.000E+00	5.481E-02	17.000	55.6	99.7	98.6 ± 0.2
730	5.493E-06	1.697E-03	0.000E+00	5.493E-02	16.000	61.9	99.8	98.5 ± 0.2
760	1.654E-05	1.891E-03	0.000E+00	5.515E-02	14.000	67.2	99.5	97.8 ± 0.2
790	1.669E-05	2.443E-03	0.000E+00	5.565E-02	11.000	71.0	99.4	96.9 ± 0.3
820	1.690E-05	3.307E-03	0.000E+00	5.633E-02	8.300	73.8	99.4	95.7 ± 0.3
850	2.271E-05	4.133E-03	0.000E+00	5.678E-02	6.700	76.6	99.3	94.9 ± 0.3
870	2.280E-05	4.627E-03	1.083E-05	5.699E-02	6.000	79.0	99.4	94.6 ± 0.3
930	1.159E-05	9.213E-03	0.000E+00	5.794E-02	3.100	83.9	99.6	93.3 ± 0.2
1000	1.724E-05	1.831E-02	0.000E+00	5.748E-02	1.500	93.0	99.5	93.9 ± 0.2
1080	5.576E-05	3.831E-02	0.000E+00	5.576E-02	0.710	100.0	98.3	95.6 ± 0.2

Table 4 Continued.

sample ID: 02JA05BMS01C

Temp. (K)	$^{36}Ar/^{40}Ar$	$^{37}Ar/^{40}Ar$	$^{38}Ar/^{40}Ar$	$^{39}Ar/^{40}Ar$	K/Ca	$\%^{39}Ar$	$\%^{40}Ar^*$	Age (Ma)
460	1.064E-04	4.571E-03	0.000E+00	5.068E-02	5.400	4.3	96.9	103.3 ± 0.3
520	3.649E-05	3.216E-03	0.000E+00	5.213E-02	7.900	12.7	98.9	102.5 ± 0.2
580	1.623E-05	1.785E-03	0.000E+00	5.410E-02	15.000	27.9	99.5	99.5 ± 0.2
640	1.639E-05	1.465E-03	0.000E+00	5.465E-02	18.000	41.7	99.5	98.5 ± 0.2
700	2.712E-05	1.974E-03	0.000E+00	5.424E-02	13.000	50.4	99.2	98.9 ± 0.2
770	3.781E-05	3.376E-03	0.000E+00	5.401E-02	7.800	57.6	98.9	99.1 ± 0.2
840	2.717E-05	6.754E-03	0.000E+00	5.434E-02	3.900	65.1	99.2	98.7 ± 0.2
910	2.223E-05	1.594E-02	0.000E+00	5.558E-02	1.700	72.9	99.3	96.8 ± 0.2
970	2.818E-05	3.019E-02	0.000E+00	5.637E-02	0.910	82.2	99.2	95.4 ± 0.2
1040	9.645E-05	2.513E-01	0.000E+00	5.674E-02	0.110	94.4	97.2	92.8 ± 0.2
1100	1.519E-04	5.011E-01	0.000E+00	5.425E-02	0.053	100.0	95.4	95.3 ± 0.2

sample ID: 02JA12BMS03B

Temp. (K)	$^{36}Ar/^{40}Ar$	$^{37}Ar/^{40}Ar$	$^{38}Ar/^{40}Ar$	$^{39}Ar/^{40}Ar$	K/Ca	$\%^{39}Ar$	$\%^{40}Ar^*$	Age (Ma)
460	2.591E-04	2.898E-02	0.000E+00	6.025E-02	1.000	9.0	92.4	83.2 ± 0.3
520	1.255E-04	3.219E-02	0.000E+00	6.275E-02	0.960	22.1	96.2	83.2 ± 0.2
570	6.345E-05	3.579E-02	0.000E+00	6.345E-02	0.870	36.6	98.1	83.9 ± 0.2
610	3.799E-05	3.247E-02	0.000E+00	6.332E-02	0.960	49.4	98.9	84.7 ± 0.2
640	1.261E-05	2.802E-02	0.000E+00	6.306E-02	1.100	59.3	99.6	85.7 ± 0.3
670	3.147E-05	2.701E-02	2.455E-05	6.294E-02	1.100	67.4	99.1	85.6 ± 0.3
710	4.376E-05	2.650E-02	0.000E+00	6.251E-02	1.200	74.5	98.7	85.6 ± 0.3
760	5.002E-05	2.810E-02	1.063E-04	6.252E-02	1.100	80.6	98.5	85.4 ± 0.4
820	6.355E-05	4.322E-02	0.000E+00	6.355E-02	0.720	84.8	98.1	83.7 ± 0.5
920	1.095E-04	1.784E-01	6.060E-05	7.302E-02	0.200	88.7	96.7	72.1 ± 0.5
1020	2.788E-04	8.221E-01	5.166E-04	8.200E-02	0.049	92.5	91.7	61.0 ± 0.6
1100	1.936E-04	5.858E+00	6.292E-04	6.914E-02	0.006	100.0	94.3	74.2 ± 0.4

Table 4 Continued.

Laser output (W)	^{40}Ar (±1s)	^{39}Ar (±1s)	^{38}Ar (±1s)	^{37}Ar (±1s)	^{36}Ar (±1s)	days after irradiation	K/Ca	$^{40}Ar^*$ (%)	$^{39}Ar_K$ fraction (%)	$^{40}Ar^*/^{39}Ar_K$ (±1s)	Age (±1s) (Ma)	adoption as plateau
sample ID: MT474BMS04A (JA18)												
J= 0.003097												
0.50W	1.04681 ± 0.00338	0.008849 ± 0.000035	0.000433 ± 0.000024	0.00481 ± 0.00023	0.002228 ± 0.000021	198.1	1.083	37.1	9.2	43.89 ± 0.80	229.94 ± 4.01	n
0.72W	2.21677 ± 0.01335	0.017747 ± 0.000108	0.000969 ± 0.000032	0.01008 ± 0.00045	0.005163 ± 0.000033	198.2	1.035	31.2	18.5	38.95 ± 0.96	205.45 ± 4.84	n
0.89W	1.66381 ± 0.00803	0.009663 ± 0.000052	0.000793 ± 0.000034	0.00625 ± 0.00028	0.004467 ± 0.000019	198.2	0.910	20.7	10.1	35.59 ± 1.02	188.64 ± 5.18	n
1.1W	0.57634 ± 0.00526	0.002753 ± 0.000033	0.000226 ± 0.000022	0.00348 ± 0.00022	0.001637 ± 0.000017	198.2	0.465	16.1	2.9	33.65 ± 2.67	178.85 ± 13.53	n
1.4W	0.06215 ± 0.00028	0.001284 ± 0.000009	0.000033 ± 0.000012	0.00118 ± 0.00023	0.000062 ± 0.000003	198.2	0.640	70.5	1.3	34.13 ± 0.76	181.26 ± 3.90	n
1.8W	0.27011 ± 0.00033	0.009674 ± 0.000043	0.000086 ± 0.000017	0.00731 ± 0.00029	0.000001 ± 0.000004	198.8	0.779	99.9	10.1	27.89 ± 0.18	149.46 ± 1.00	n
2.33W	0.34135 ± 0.00060	0.015651 ± 0.000047	0.000076 ± 0.000021	0.01956 ± 0.00047	0.000001 ± 0.000002	198.8	0.471	99.9	16.4	21.79 ± 0.09	117.82 ± 0.57	n
2.9W	0.38573 ± 0.00195	0.020254 ± 0.000139	0.000077 ± 0.000017	0.08744 ± 0.00121	0.000001 ± 0.000004	198.9	0.136	99.9	21.2	19.03 ± 0.17	103.31 ± 0.97	n
3.6W	0.17625 ± 0.00063	0.009808 ± 0.000039	0.000008 ± 0.000014	0.36025 ± 0.00217	0.000018 ± 0.000007	199.0	0.016	97.0	10.3	17.44 ± 0.23	94.90 ± 1.24	n
											no plateau	

Laser output (W)	^{40}Ar (±1s)	^{39}Ar (±1s)	^{38}Ar (±1s)	^{37}Ar (±1s)	^{36}Ar (±1s)	days after irradiation	K/Ca	$^{40}Ar^*$ (%)	$^{39}Ar_K$ fraction (%)	$^{40}Ar^*/^{39}Ar_K$ (±1s)	Age (±1s) (Ma)	adoption as plateau
sample ID: 02JA12BB04B												
J= 0.0030270												
0.50W	0.10533 ± 0.00079	0.00160 ± 0.00002	0.000045 ± 0.000010	0.00765 ± 0.00032	0.000211 ± 0.000005	227.0	0.123	40.9	0.1	26.87 ± 1.08	141.06 ± 5.48	n
0.8W	0.35461 ± 0.00287	0.00550 ± 0.00005	0.000125 ± 0.000013	0.00632 ± 0.00035	0.000695 ± 0.000010	227.0	0.512	42.1	0.4	27.14 ± 0.78	142.46 ± 3.97	n
1.15W	0.45720 ± 0.00698	0.00733 ± 0.00011	0.000224 ± 0.000020	0.00695 ± 0.00055	0.000940 ± 0.000017	227.0	0.621	39.3	0.5	24.48 ± 1.23	128.97 ± 6.25	n
1.55W	0.77435 ± 0.01329	0.01381 ± 0.00024	0.000354 ± 0.000022	0.00990 ± 0.00056	0.001673 ± 0.000016	227.1	0.821	36.1	1.0	20.26 ± 1.08	107.39 ± 5.55	n
1.9W	0.84662 ± 0.01281	0.01945 ± 0.00029	0.000309 ± 0.000045	0.01276 ± 0.00068	0.001720 ± 0.000022	227.2	0.896	40.0	1.4	17.39 ± 0.78	92.57 ± 4.08	n
2.25W	1.08345 ± 0.01309	0.03497 ± 0.00042	0.000436 ± 0.000042	0.01911 ± 0.00070	0.001897 ± 0.000020	227.2	1.076	48.3	2.6	14.95 ± 0.45	79.86 ± 2.36	n
2.52W	1.11840 ± 0.01351	0.04675 ± 0.00057	0.000374 ± 0.000051	0.02484 ± 0.00082	0.001586 ± 0.000013	227.2	1.107	58.1	3.4	13.90 ± 0.35	74.35 ± 1.82	n
2.78W	1.59213 ± 0.01456	0.10385 ± 0.00096	0.000233 ± 0.000079	0.05479 ± 0.00106	0.000514 ± 0.000010	227.2	1.115	90.5	7.6	13.87 ± 0.19	74.19 ± 1.03	n
2.97W	3.07162 ± 0.03080	0.22694 ± 0.00228	0.000059 ± 0.000336	0.12570 ± 0.00207	0.000143 ± 0.000009	228.9	1.062	98.6	16.6	13.35 ± 0.19	71.46 ± 1.03	n
3.1W	2.57277 ± 0.05420	0.19512 ± 0.00413	-0.000096 ± 0.000419	0.12935 ± 0.00267	0.000068 ± 0.000008	228.9	0.887	99.2	14.2	13.08 ± 0.39	70.07 ± 2.07	y
3.26W	2.84366 ± 0.04563	0.21839 ± 0.00352	-0.000263 ± 0.000333	0.19612 ± 0.00393	0.000080 ± 0.000008	229.0	0.655	99.2	15.9	12.91 ± 0.30	69.18 ± 1.56	y
3.41W	4.02234 ± 0.03347	0.32369 ± 0.00272	-0.000373 ± 0.000293	0.41792 ± 0.00517	0.000080 ± 0.000007	229.0	0.456	99.4	23.6	12.35 ± 0.15	66.23 ± 0.80	y
3.56W	0.68409 ± 0.00092	0.05394 ± 0.00009	-0.000174 ± 0.000032	0.07496 ± 0.00074	0.000025 ± 0.000004	229.0	0.423	98.9	3.9	12.55 ± 0.03	67.26 ± 0.27	y
3.85W	0.43228 ± 0.00125	0.03426 ± 0.00010	-0.000095 ± 0.000024	0.06887 ± 0.00088	0.000024 ± 0.000004	229.1	0.293	98.4	2.5	12.41 ± 0.06	66.53 ± 0.39	y
4.75W	0.60771 ± 0.00124	0.04839 ± 0.00010	-0.000120 ± 0.000032	0.17575 ± 0.00228	0.000031 ± 0.000007	229.1	0.162	98.5	3.5	12.37 ± 0.06	66.30 ± 0.36	y
6.2W	0.46347 ± 0.00096	0.03656 ± 0.00014	-0.000073 ± 0.000039	0.32655 ± 0.00240	0.000037 ± 0.000005	229.1	0.066	97.7	2.7	12.38 ± 0.07	66.36 ± 0.41	y
										Plateau Age	**66.77 ± 0.17**	

Laser output (W)	^{40}Ar (±1s)	^{39}Ar (±1s)	^{38}Ar (±1s)	^{37}Ar (±1s)	^{36}Ar (±1s)	days after irradiation	K/Ca	$^{40}Ar^*$ (%)	$^{39}Ar_K$ fraction (%)	$^{40}Ar^*/^{39}Ar_K$ (±1s)	Age (±1s) (Ma)	adoption as plateau
sample ID: MT473BMS02A-1												
J= 0.0031040												
0.9W	3.19226 ± 0.03840	0.20748 ± 0.00250	-0.00034 ± 0.00023	0.05258 ± 0.00134	0.000061 ± 0.000005	229.8	2.321	99.4	11.1	15.30 ± 0.26	83.70 ± 1.42	y
1.02W	2.97001 ± 0.02323	0.19343 ± 0.00152	-0.00028 ± 0.00017	0.07180 ± 0.00092	0.000029 ± 0.000002	229.8	1.585	99.7	10.4	15.31 ± 0.17	83.76 ± 0.94	y
1.14W	2.36620 ± 0.01187	0.15226 ± 0.00078	-0.00013 ± 0.00009	0.09415 ± 0.00116	0.000020 ± 0.000003	229.9	0.951	99.8	8.2	15.50 ± 0.11	84.79 ± 0.64	y
1.3W	2.35598 ± 0.00187	0.15226 ± 0.00023	-0.00020 ± 0.00004	0.13395 ± 0.00189	0.000028 ± 0.000004	229.9	0.669	99.7	8.2	15.42 ± 0.03	84.35 ± 0.29	y
1.55W	3.07132 ± 0.00863	0.20295 ± 0.00063	-0.00003 ± 0.00012	0.21227 ± 0.00129	0.000029 ± 0.000006	230.0	0.562	99.7	10.9	15.09 ± 0.06	82.59 ± 0.42	n
1.82W	2.55746 ± 0.00565	0.17107 ± 0.00038	-0.00011 ± 0.00009	0.18145 ± 0.00156	0.000036 ± 0.000004	230.0	0.555	99.6	9.2	14.89 ± 0.05	81.50 ± 0.35	n
2.13W	3.62409 ± 0.01708	0.25277 ± 0.00121	0.00001 ± 0.00017	0.21893 ± 0.00133	0.000063 ± 0.000003	230.0	0.679	99.5	13.6	14.26 ± 0.10	78.16 ± 0.56	n
2.35W	1.98127 ± 0.00339	0.14097 ± 0.00027	-0.00005 ± 0.00003	0.07876 ± 0.00078	0.000030 ± 0.000003	230.1	1.053	99.6	7.6	13.99 ± 0.04	76.70 ± 0.30	n
2.65W	1.28049 ± 0.00374	0.09372 ± 0.00029	-0.00004 ± 0.00007	0.04238 ± 0.00092	0.000011 ± 0.000003	230.1	1.301	99.7	5.0	13.63 ± 0.06	74.74 ± 0.38	n
3.1W	1.42942 ± 0.00662	0.10919 ± 0.00051	-0.00009 ± 0.00007	0.05112 ± 0.00115	0.000015 ± 0.000004	230.1	1.257	99.7	5.9	13.05 ± 0.09	71.64 ± 0.51	n
3.7W	1.17649 ± 0.00415	0.09504 ± 0.00036	-0.00009 ± 0.00005	0.04773 ± 0.00068	0.000019 ± 0.000004	230.2	1.171	99.5	5.1	12.32 ± 0.06	67.70 ± 0.40	n
4.6W	1.05250 ± 0.00382	0.09207 ± 0.00039	-0.00021 ± 0.00006	0.05154 ± 0.00093	0.000012 ± 0.000003	230.2	1.051	99.7	4.9	11.39 ± 0.06	62.70 ± 0.39	n
										Plateau Age	**84.35 ± 0.25**	

Table 4 Continued.

Laser output (W)	^{40}Ar (±1s)	^{39}Ar (±1s)	^{38}Ar (±1s)	^{37}Ar (±1s)	^{36}Ar (±1s)	days after irradiation	K/Ca	$^{40}Ar^*$ (%)	$^{39}Ar_K$ fraction (%)	$^{40}Ar^*/^{39}Ar_K$ (±1s)	Age (±1s) (Ma)	adoption as plateau
sample ID: 02JA17BMS01A												
J= 0.0031170												
0.8W	0.3937 ± 0.00562	0.01877 ± 0.00028	0.00003 ± 0.00003	0.01233 ± 0.00062	0.000309 ± 0.000007	230.2	0.896	76.8	1.6	16.10 ± 0.40	88.34 ± 2.14	n
0.95W	0.3910 ± 0.00519	0.02018 ± 0.00027	-0.00003 ± 0.00004	0.01328 ± 0.00050	0.000276 ± 0.000008	230.2	0.894	79.2	1.7	15.34 ± 0.35	84.29 ± 1.89	n
1.12W	0.3818 ± 0.00311	0.02067 ± 0.00017	0.00000 ± 0.00003	0.01195 ± 0.00057	0.000239 ± 0.000005	231.8	1.018	81.5	1.8	15.06 ± 0.20	82.75 ± 1.13	n
1.3W	0.5943 ± 0.00379	0.02601 ± 0.00018	0.00028 ± 0.00002	0.01304 ± 0.00049	0.000053 ± 0.000004	231.9	1.173	97.4	2.2	22.24 ± 0.22	120.94 ± 1.18	n
1.55W	1.7198 ± 0.00881	0.08138 ± 0.00042	0.00051 ± 0.00006	0.02408 ± 0.00086	0.000038 ± 0.000005	232.0	1.988	99.3	7.0	21.00 ± 0.15	114.36 ± 0.88	n
1.73W	2.2665 ± 0.00888	0.11370 ± 0.00046	0.00026 ± 0.00004	0.02365 ± 0.00074	0.000028 ± 0.000004	232.1	2.828	99.6	9.8	19.86 ± 0.11	108.37 ± 0.67	n
1.89W	2.2545 ± 0.00566	0.11607 ± 0.00030	0.00003 ± 0.00007	0.02553 ± 0.00060	0.000019 ± 0.000003	232.1	2.674	99.7	10.0	19.37 ± 0.07	105.78 ± 0.48	y
2.06W	2.1515 ± 0.00432	0.11165 ± 0.00026	-0.00007 ± 0.00004	0.02830 ± 0.00093	0.000024 ± 0.000003	232.1	2.321	99.7	9.7	19.21 ± 0.06	104.89 ± 0.44	y
2.22W	1.5056 ± 0.00409	0.07752 ± 0.00023	-0.00008 ± 0.00006	0.02526 ± 0.00094	0.000015 ± 0.000003	232.1	1.805	99.7	6.7	19.36 ± 0.08	105.73 ± 0.52	y
2.43W	1.4080 ± 0.00116	0.07254 ± 0.00007	-0.00008 ± 0.00003	0.02760 ± 0.00099	0.000015 ± 0.000004	232.2	1.546	99.7	6.3	19.35 ± 0.03	105.65 ± 0.34	y
2.7W	1.4854 ± 0.00419	0.07711 ± 0.00023	-0.00001 ± 0.00006	0.03670 ± 0.00069	0.000017 ± 0.000005	232.2	1.236	99.7	6.7	19.20 ± 0.08	104.84 ± 0.53	y
3.02W	1.4604 ± 0.00515	0.07639 ± 0.00030	-0.00005 ± 0.00005	0.04501 ± 0.00120	0.000015 ± 0.000004	232.2	0.998	99.7	6.6	19.06 ± 0.10	104.11 ± 0.62	y
3.4W	1.7308 ± 0.00153	0.09160 ± 0.00012	-0.00009 ± 0.00003	0.08418 ± 0.00130	0.000010 ± 0.000005	232.9	0.640	99.8	7.9	18.86 ± 0.03	103.07 ± 0.35	n
3.85W	2.0075 ± 0.00202	0.10761 ± 0.00013	0.00001 ± 0.00005	0.16458 ± 0.00171	0.000010 ± 0.000004	232.9	0.385	99.9	9.3	18.63 ± 0.03	101.82 ± 0.34	n
4.4W	1.5946 ± 0.00209	0.08555 ± 0.00013	-0.00002 ± 0.00004	0.19408 ± 0.00103	0.000014 ± 0.000004	232.9	0.259	99.7	7.4	18.59 ± 0.04	101.63 ± 0.36	n
5.08W	1.1088 ± 0.00124	0.05937 ± 0.00014	-0.00008 ± 0.00003	0.22895 ± 0.00220	0.000022 ± 0.000006	233.0	0.153	99.4	5.1	18.57 ± 0.06	101.49 ± 0.43	n
										Plateau Age	**105.29 ± 0.19**	

Laser output (W)	^{40}Ar (±1s)	^{39}Ar (±1s)	^{38}Ar (±1s)	^{37}Ar (±1s)	^{36}Ar (±1s)	days after irradiation	K/Ca	$^{40}Ar^*$ (%)	$^{39}Ar_K$ fraction (%)	$^{40}Ar^*/^{39}Ar_K$ (±1s)	Age (±1s) (Ma)	adoption as plateau
sample ID: 02JA11BMS06A												
J= 0.002966												
0.75W	0.5752 ± 0.00341	0.00706 ± 0.00005	0.00025 ± 0.00002	0.00862 ± 0.00075	0.001246 ± 0.000014	233.0	0.482	36.0	0.6	29.31 ± 0.77	150.40 ± 3.81	n
0.9W	0.5588 ± 0.00452	0.00739 ± 0.00007	0.00019 ± 0.00001	0.00662 ± 0.00078	0.001195 ± 0.000012	233.0	0.657	36.8	0.6	27.85 ± 0.81	143.20 ± 4.03	n
1.15W	0.8618 ± 0.00656	0.01252 ± 0.00010	0.00031 ± 0.00002	0.01113 ± 0.00088	0.001868 ± 0.000018	233.1	0.661	36.0	1.0	24.75 ± 0.71	127.80 ± 3.54	n
1.3W	1.1809 ± 0.00113	0.01893 ± 0.00003	0.00038 ± 0.00005	0.00011 ± 0.00463	0.001175 ± 0.000100	237.8	101.1	70.6	1.5	44.04 ± 1.56	221.51 ± 7.41	n
1.55W	2.2474 ± 0.01150	0.04648 ± 0.00024	0.00083 ± 0.00004	0.00011 ± 0.00465	0.004074 ± 0.000025	237.8	248.0	46.4	3.7	22.45 ± 0.31	116.31 ± 1.61	n
1.72W	3.8073 ± 0.00954	0.15704 ± 0.00040	0.00046 ± 0.00006	0.05757 ± 0.00119	0.001766 ± 0.000011	237.9	1.605	86.3	12.5	20.92 ± 0.08	108.61 ± 0.53	y
1.89W	9.1398 ± 0.01098	0.42957 ± 0.00073	0.00010 ± 0.00010	0.12751 ± 0.00190	0.000030 ± 0.000005	237.9	1.982	99.9	34.1	21.26 ± 0.04	110.30 ± 0.39	y
2.01W	6.1058 ± 0.00325	0.29023 ± 0.00060	-0.00014 ± 0.00008	0.11542 ± 0.00083	0.000030 ± 0.000004	238.1	1.479	99.9	23.0	21.01 ± 0.05	109.05 ± 0.39	y
2.08W	1.8336 ± 0.00185	0.08968 ± 0.00013	-0.00006 ± 0.00005	0.05381 ± 0.00086	0.000011 ± 0.000004	238.2	0.980	99.8	7.1	20.41 ± 0.04	106.03 ± 0.37	n
2.21W	1.0178 ± 0.00075	0.04970 ± 0.00005	0.00001 ± 0.00004	0.03419 ± 0.00082	0.000010 ± 0.000004	238.2	0.855	99.7	3.9	20.42 ± 0.03	106.09 ± 0.36	n
2.45W	1.0323 ± 0.00045	0.05134 ± 0.00006	-0.00007 ± 0.00003	0.03736 ± 0.00075	0.000006 ± 0.000004	238.3	0.808	99.8	4.1	20.07 ± 0.03	104.32 ± 0.35	n
2.85W	1.1739 ± 0.00166	0.05924 ± 0.00019	0.00000 ± 0.00004	0.05468 ± 0.00081	0.000001 ± 0.000004	238.2	0.637	100.0	4.7	19.81 ± 0.07	103.01 ± 0.48	n
3.55W	0.7773 ± 0.01256	0.04046 ± 0.00084	-0.00010 ± 0.00006	0.05842 ± 0.00246	0.000012 ± 0.000005	238.9	0.407	99.5	3.2	19.12 ± 0.50	99.52 ± 2.57	n
										Plateau Age	**109.44 ± 0.25**	

Table 4 Continued.

Laser output (W)	^{40}Ar (±1s)	^{39}Ar (±1s)	^{38}Ar (±1s)	^{37}Ar (±1s)	^{36}Ar (±1s)	days after irradiation	K/Ca	$^{40}Ar^*$ (%)	$^{39}Ar_K$ fraction (%)	$^{40}Ar^*/^{39}Ar_K$ (±1s)	Age (±1s) (Ma)	adoption as plateau
sample ID: 02JA03BMS04B-2												
J= 0.0029690												
0.75W	0.6129 ± 0.00267	0.01647 ± 0.00009	0.00016 ± 0.00003	0.0011 ± 0.0005	0.000589 ± 0.000005	238.9	8.599	71.6	0.6	26.64 ± 0.24	137.32 ± 1.24	n
0.92W	0.8740 ± 0.00556	0.02278 ± 0.00017	0.00020 ± 0.00003	0.0032 ± 0.0005	0.000846 ± 0.000013	239.0	4.240	71.4	0.8	27.40 ± 0.36	141.11 ± 1.82	n
1.15W	1.0866 ± 0.00942	0.02779 ± 0.00025	0.00020 ± 0.00003	0.0036 ± 0.0007	0.000985 ± 0.000013	239.0	4.524	73.2	0.9	28.62 ± 0.45	147.15 ± 2.24	n
1.3W	1.4555 ± 0.01449	0.03715 ± 0.00038	0.00024 ± 0.00004	0.0040 ± 0.0007	0.001189 ± 0.000016	239.1	5.526	75.9	1.3	29.72 ± 0.51	152.57 ± 2.54	n
1.64W	1.5985 ± 0.01511	0.04407 ± 0.00042	0.00026 ± 0.00005	0.0054 ± 0.0006	0.001062 ± 0.000011	239.1	4.778	80.4	1.5	29.15 ± 0.45	149.75 ± 2.25	n
1.74W	1.8964 ± 0.01619	0.06380 ± 0.00056	0.00012 ± 0.00006	0.0050 ± 0.0008	0.000770 ± 0.000007	239.1	7.543	88.0	2.2	26.16 ± 0.34	134.93 ± 1.75	n
1.84W	2.1616 ± 0.01215	0.09422 ± 0.00053	0.00012 ± 0.00005	0.0050 ± 0.0007	0.000331 ± 0.000008	239.2	11.128	95.5	3.2	21.90 ± 0.18	113.67 ± 0.96	n
1.93W	2.7384 ± 0.01428	0.13927 ± 0.00075	-0.00005 ± 0.00011	0.0055 ± 0.0007	0.000093 ± 0.000004	239.2	14.763	99.0	4.7	19.46 ± 0.15	101.35 ± 0.80	n
2.01W	6.9663 ± 0.04185	0.36355 ± 0.00240	-0.00030 ± 0.00017	0.0099 ± 0.0008	0.000047 ± 0.000005	239.2	21.692	99.8	12.3	19.12 ± 0.17	99.63 ± 0.91	n
2.06W	12.4168 ± 0.00561	0.66136 ± 0.00129	-0.00062 ± 0.00011	0.0201 ± 0.0004	0.000068 ± 0.000004	240.8	19.339	99.8	22.3	18.74 ± 0.04	97.71 ± 0.34	n
2.09W	5.5968 ± 0.00309	0.31529 ± 0.00023	-0.00047 ± 0.00007	0.0143 ± 0.0009	0.000046 ± 0.000003	240.9	12.990	99.8	10.6	17.71 ± 0.02	92.44 ± 0.28	n
2.13W	3.8877 ± 0.00099	0.21564 ± 0.00009	-0.00028 ± 0.00005	0.0107 ± 0.0005	0.000038 ± 0.000003	240.9	11.903	99.7	7.3	17.98 ± 0.01	93.80 ± 0.28	y
2.19W	1.9379 ± 0.00272	0.10586 ± 0.00016	-0.00009 ± 0.00004	0.0055 ± 0.0005	0.000017 ± 0.000004	241.0	11.299	99.7	3.6	18.26 ± 0.04	95.25 ± 0.34	y
2.36W	1.4966 ± 0.00212	0.08171 ± 0.00017	-0.00006 ± 0.00003	0.0036 ± 0.0005	0.000019 ± 0.000004	241.1	13.181	99.6	2.8	18.25 ± 0.05	95.18 ± 0.37	y
2.82W	2.0911 ± 0.00128	0.11612 ± 0.00013	-0.00026 ± 0.00005	0.0107 ± 0.0005	0.000021 ± 0.000003	241.1	6.377	99.7	3.9	17.96 ± 0.02	93.70 ± 0.30	y
3.6W	4.1056 ± 0.00179	0.23766 ± 0.00025	-0.00037 ± 0.00010	0.0501 ± 0.0008	0.000035 ± 0.000004	241.2	2.793	99.7	8.0	17.23 ± 0.02	90.01 ± 0.28	n
4.5W	7.6555 ± 0.00439	0.42316 ± 0.00092	-0.00076 ± 0.00011	0.1439 ± 0.0016	0.000048 ± 0.000003	241.2	1.729	99.8	14.3	18.06 ± 0.04	94.22 ± 0.34	n
											no plateau	

Laser output (W)	^{40}Ar (±1s)	^{39}Ar (±1s)	^{38}Ar (±1s)	^{37}Ar (±1s)	^{36}Ar (±1s)	days after irradiation	K/Ca	$^{40}Ar^*$ (%)	$^{39}Ar_K$ fraction (%)	$^{40}Ar^*/^{39}Ar_K$ (±1s)	Age (±1s) (Ma)	adoption as plateau
sample ID: 02JA02BMS07A												
J= 0.0029720												
0.8W	1.0044 ± 0.00314	0.04307 ± 0.00092	0.00037 ± 0.00007	0.02438 ± 0.00059	0.000976 ± 0.000004	241.9	1.039	71.3	7.9	16.62 ± 0.36	86.98 ± 1.87	n
1W	1.9655 ± 0.00573	0.12028 ± 0.00173	0.00050 ± 0.00014	0.04017 ± 0.00048	0.000168 ± 0.000005	241.9	1.761	97.5	21.9	15.93 ± 0.23	83.44 ± 1.22	y
1.25W	1.4725 ± 0.00844	0.08737 ± 0.00242	-0.00001 ± 0.00016	0.02955 ± 0.00066	0.000113 ± 0.000003	242.0	1.739	97.7	15.9	16.47 ± 0.47	86.22 ± 2.40	y
1.55W	1.0375 ± 0.00430	0.06471 ± 0.00028	0.00007 ± 0.00006	0.02898 ± 0.00086	0.000071 ± 0.000004	242.0	1.314	98.0	11.8	15.71 ± 0.10	82.33 ± 0.55	y
1.92W	1.1102 ± 0.00739	0.07197 ± 0.00415	0.00005 ± 0.00028	0.03570 ± 0.00083	0.000053 ± 0.000005	242.0	1.186	98.6	13.1	15.21 ± 0.88	79.75 ± 4.54	y
2.45W	1.1817 ± 0.00786	0.07774 ± 0.00433	-0.00015 ± 0.00029	0.05669 ± 0.00071	0.000042 ± 0.000004	242.1	0.807	98.9	14.2	15.04 ± 0.84	78.89 ± 4.33	y
3.2W	1.2963 ± 0.00099	0.08322 ± 0.00201	-0.00010 ± 0.00014	0.23013 ± 0.00163	0.000115 ± 0.000005	242.1	0.213	97.4	15.2	15.17 ± 0.37	79.54 ± 1.90	y
										Plateau Age	**82.4 ± 0.5**	

Laser output (W)	^{40}Ar (±1s)	^{39}Ar (±1s)	^{38}Ar (±1s)	^{37}Ar (±1s)	^{36}Ar (±1s)	days after irradiation	K/Ca	$^{40}Ar^*$ (%)	$^{39}Ar_K$ fraction (%)	$^{40}Ar^*/^{39}Ar_K$ (±1s)	Age (±1s) (Ma)	adoption as plateau
sample ID: MT473BMS02A-2												
J= 0.0031100												
0.60W	2.8529 ± 0.01174	0.19033 ± 0.00079	-0.00016 ± 0.00011	0.03165 ± 0.00161	0.000114 ± 0.000005	294.8	3.537	98.8	7.7	14.81 ± 0.09	81.25 ± 0.53	y
0.82W	3.0234 ± 0.00880	0.20838 ± 0.00063	-0.00041 ± 0.00009	0.05165 ± 0.00192	0.000034 ± 0.000005	294.9	2.373	99.7	8.5	14.46 ± 0.06	79.36 ± 0.40	y
0.94W	2.7555 ± 0.00858	0.18850 ± 0.00062	-0.00026 ± 0.00007	0.06621 ± 0.00200	0.000017 ± 0.000004	295.0	1.675	99.8	7.7	14.59 ± 0.07	80.06 ± 0.43	y
1.08W	3.0301 ± 0.01126	0.20879 ± 0.00081	-0.00029 ± 0.00009	0.09904 ± 0.00262	0.000024 ± 0.000003	295.0	1.240	99.8	8.5	14.48 ± 0.08	79.46 ± 0.48	y
1.24W	3.1841 ± 0.01215	0.22345 ± 0.00087	-0.00019 ± 0.00010	0.15990 ± 0.00337	0.000026 ± 0.000004	295.0	0.822	99.8	9.1	14.22 ± 0.08	78.05 ± 0.48	n
1.39W	2.3703 ± 0.00358	0.16827 ± 0.00028	-0.00014 ± 0.00007	0.15387 ± 0.00437	0.000024 ± 0.000005	295.1	0.643	99.7	6.8	14.04 ± 0.03	77.13 ± 0.29	n
1.58W	3.7568 ± 0.01094	0.27627 ± 0.00081	-0.00013 ± 0.00010	0.26278 ± 0.00306	0.000031 ± 0.000003	295.1	0.618	99.8	11.2	13.57 ± 0.06	74.55 ± 0.37	n
1.79W	3.4979 ± 0.00738	0.26653 ± 0.00057	-0.00021 ± 0.00010	0.21067 ± 0.00232	0.000035 ± 0.000006	295.2	0.744	99.7	10.8	13.08 ± 0.04	71.96 ± 0.30	n
2.0W	2.5349 ± 0.00255	0.19840 ± 0.00026	-0.00011 ± 0.00008	0.11007 ± 0.00173	0.000033 ± 0.000004	295.2	1.060	99.6	8.1	12.73 ± 0.02	70.04 ± 0.24	n
2.28W	2.2710 ± 0.00252	0.18283 ± 0.00022	-0.00015 ± 0.00006	0.07857 ± 0.00246	0.000045 ± 0.000005	295.2	1.369	99.4	7.4	12.35 ± 0.02	67.99 ± 0.23	n
2.62W	2.0961 ± 0.00106	0.17213 ± 0.00026	-0.00023 ± 0.00006	0.06716 ± 0.00178	0.000092 ± 0.000004	296.2	1.508	98.7	7.0	12.02 ± 0.02	66.20 ± 0.22	n
3.22W	2.1085 ± 0.00213	0.17440 ± 0.00026	-0.00039 ± 0.00006	0.07875 ± 0.00181	0.000094 ± 0.000004	296.2	1.303	98.7	7.1	11.93 ± 0.02	65.73 ± 0.23	n
										Plateau Age	**79.77 ± 0.21**	

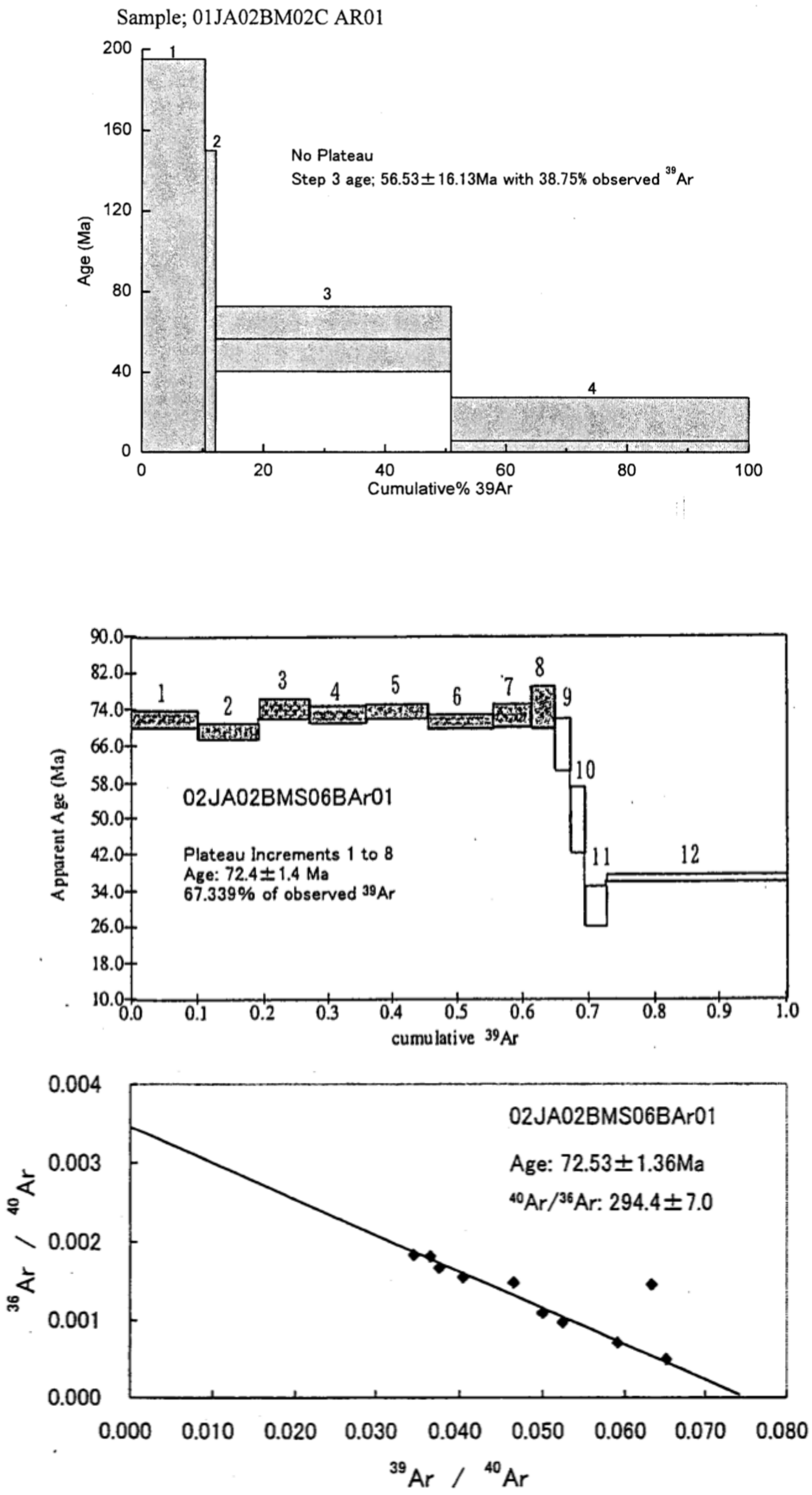

Fig. 10 Step heating age spectra and inverse isochron diagrams for Ar–Ar dating (JA02 Seamount)

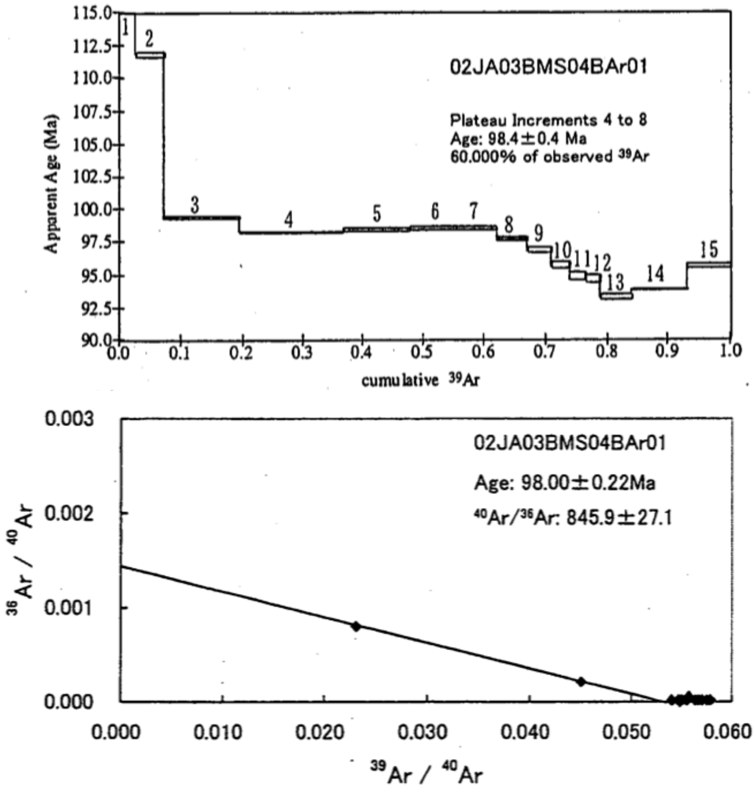

Fig. 11 Step heating age spectra and inverse isochron diagrams for Ar–Ar dating (JA03 Seamount)

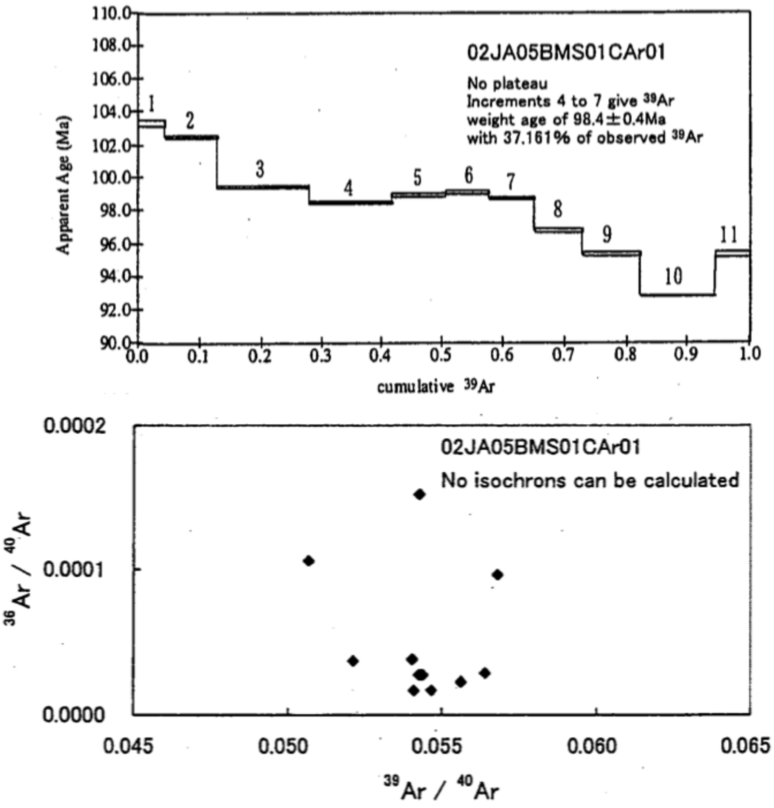

Fig. 12 Step heating age spectra and inverse isochron diagrams for Ar–Ar dating (JA05 Seamount)

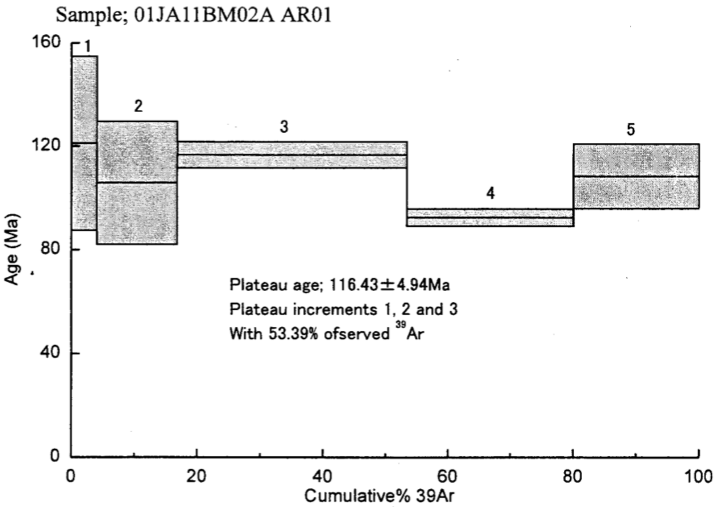

Fig. 13 Step heating age spectra diagram for Ar–Ar dating (JA11 Seamount)

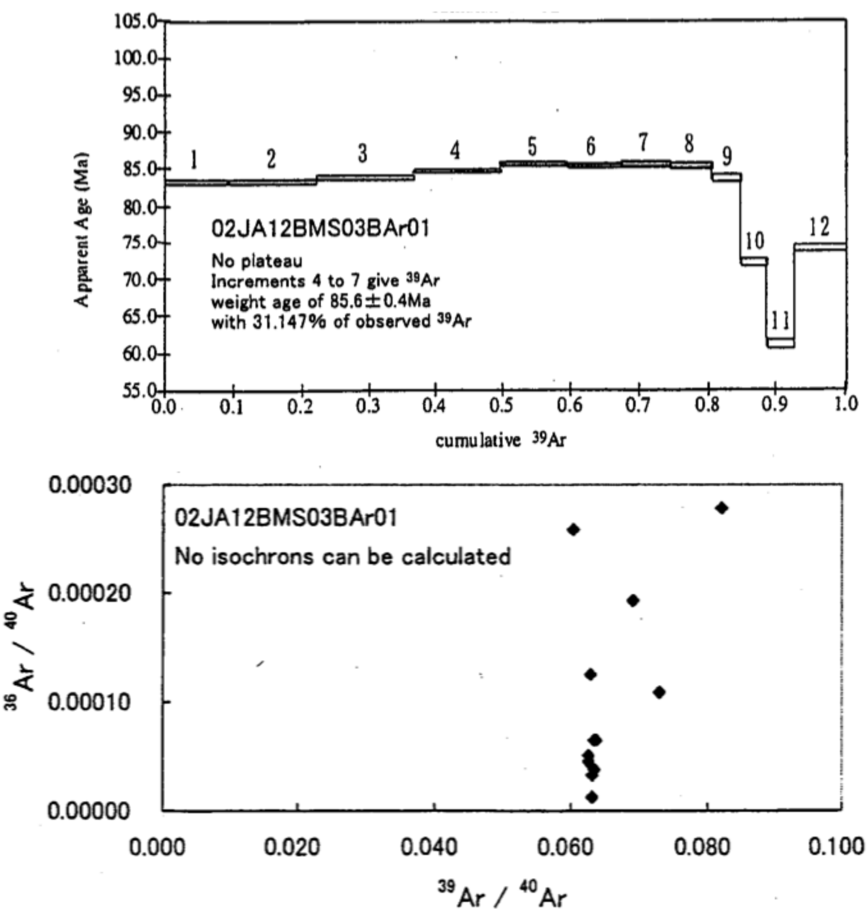

Fig. 14 Step heating age spectra and inverse isochron diagrams for Ar–Ar dating (JA12 Seamount)

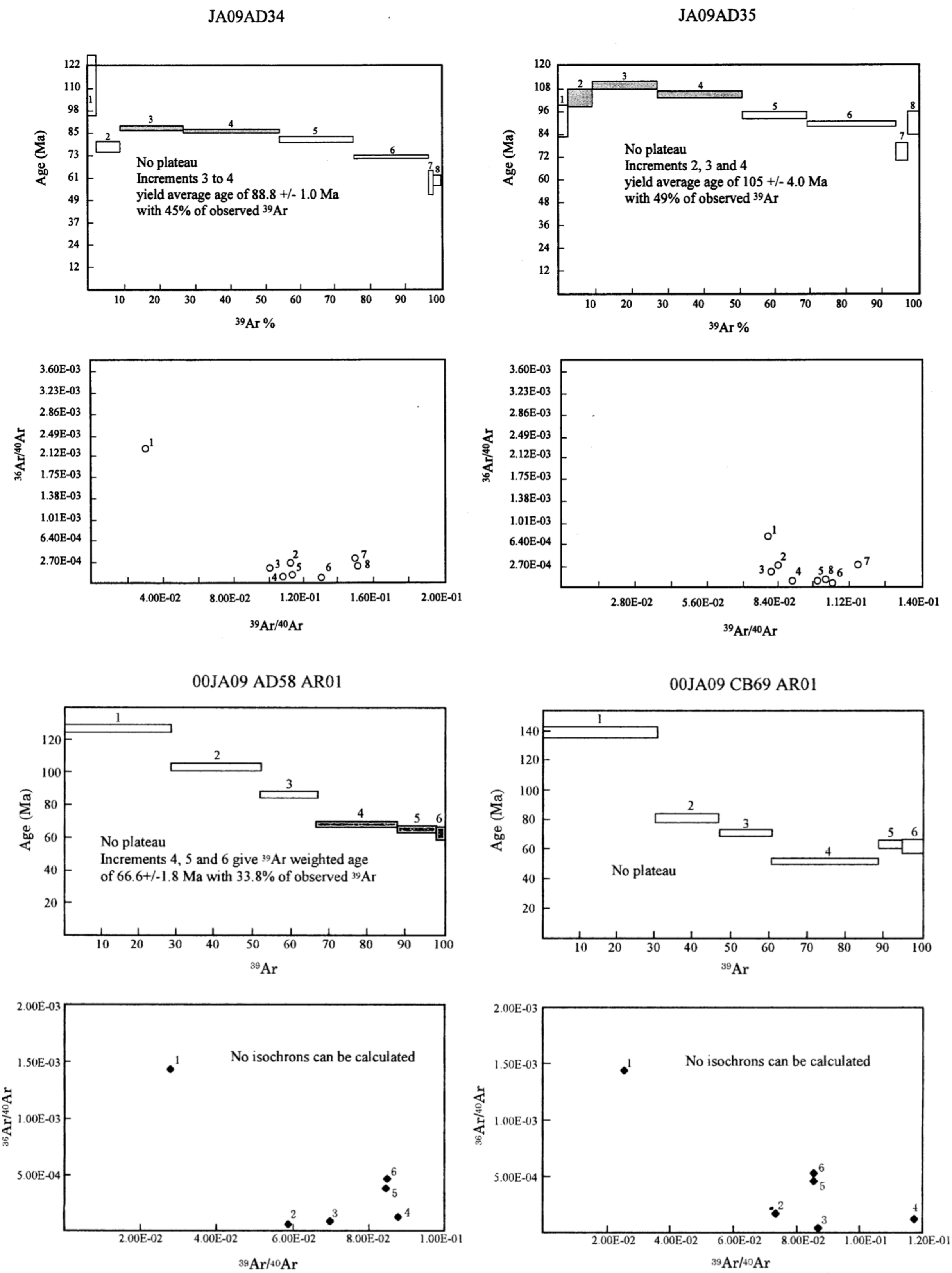

Fig. 15 Step heating age spectra and inverse isochron diagrams for Ar–Ar dating (JA09 Seamount)

due to alteration.

(3) JA14 Seamount (Govorov Guyot)

K–Ar dating was carried out on one sample and yielded an age of 86.8 ± 3.0 Ma, but the results are not reliable due to alteration.

(4) JA15 Seamount (Pegas Guyot)

K–Ar dating was carried out on two samples with a slightly higher degree of alteration. The obtained ages are 56.0 ± 2.8 Ma and 68.7 ± 3.4 Ma, corresponding to the Early Eocene to Late Cretaceous (Maastrichtian). However, these ages may be slightly young due to the loss of some Ar in the rocks through weathering and alteration after the magma solidified. This is supported by the facts that fossils from the Late Cretaceous (88–85 Ma) have been found in this seamount, and previous studies suggesting that the Magellan Seamounts were formed during the Aptian at the end of the Early Cretaceous (Smith *et al.*, 1989, Abrams *et al.*, 1993).

(5) JA19 Seamount (Hemler Guyot)

K–Ar dating was performed on two samples and yielded ages of 78.1 ± 2.5 Ma and 79.6 ± 2.6 Ma (Late Cretaceous), but the results are unreliable due to alteration. Ar–Ar age of 100.1 ± 0.8 Ma was reported by Koppers *et al.* (2003).

(6) JA22 Seamount (Butakov Guyot)

K–Ar dating was carried out on two samples, yielding ages of 53.3 ± 1.9 Ma and 69.9 ± 2.3 Ma, but the results are unreliable due to alteration.

5. 3 Marshall Islands Seamount Group

(1) JA10 Seamount (Rykachev Guyot)

K–Ar dating was performed on one sample and Ar–Ar dating on five samples. The K–Ar age of 43.6 ± 2.8 Ma obtained from 89JA10AD04-E is unreliable due to alteration. No reliable Ar–Ar ages were obtained from 99JA10AD11 and 99JA10AD17. An age of 82.7 ± 3.1 Ma (Late Cretaceous: Campanian) was obtained from 00JA10AD34 but is unreliable due to lack of agreement within the 95 % confidence limits. Plateau ages of 91.8 ± 0.7 Ma (Middle Cretaceous: Cenomanian) and 88.5 ± 1.2 Ma (Middle Cretaceous: Turonian) were obtained from 00JA10AD37 and 00JA10AD41, respectively, suggesting that the basement basalts of JA10 Seamount were formed during the Middle Cretaceous. Figure 16 shows the stage-heating age spectra and inverse isochron diagrams of 00JA10AD34, 00JA10AD37, and 00JA10AD41. The $^{40}Ar/^{39}Ar$ age measurement data are shown in Table 4.

(2) JA16 Seamount (Changpogo Seamount)

K–Ar dating was carried out on one sample with a slightly higher degree of alteration and yielded an age of 54.1 ± 2.1 Ma (Early Eocene to Late Cretaceous: Maastrichtian), but the reliability is low due to alteration.

6. Summary

The basement basalts of seamounts in the Northwest Pacific show characteristics of ocean island alkaline basalts similar to those of the basalts from the SOPITA region in the South Pacific, although many samples have been affected by alteration and phosphatization. The K–Ar ages of the basalts are likely to be younger than their actual ages due to alteration. On the other hand, Ar–Ar dating is more resilient to alteration than K–Ar dating, the plateau ages obtained by Ar–Ar dating are considered to be reliable. The basement basalts of JA01, JA02, JA03, JA11, JA12, JA17, and MT473 Seamounts in the Marcus Wake Seamount Group have Ar–Ar plateau ages of 67–116 Ma, the basement basalts of JA09 Seamount in the Magellan Seamount Group have Ar–Ar plateau ages of 87 Ma and 105 Ma, and the basement basalts of JA10 Seamount in the Marshall Islands Seamount Group have Ar–Ar plateau ages of 90 Ma.

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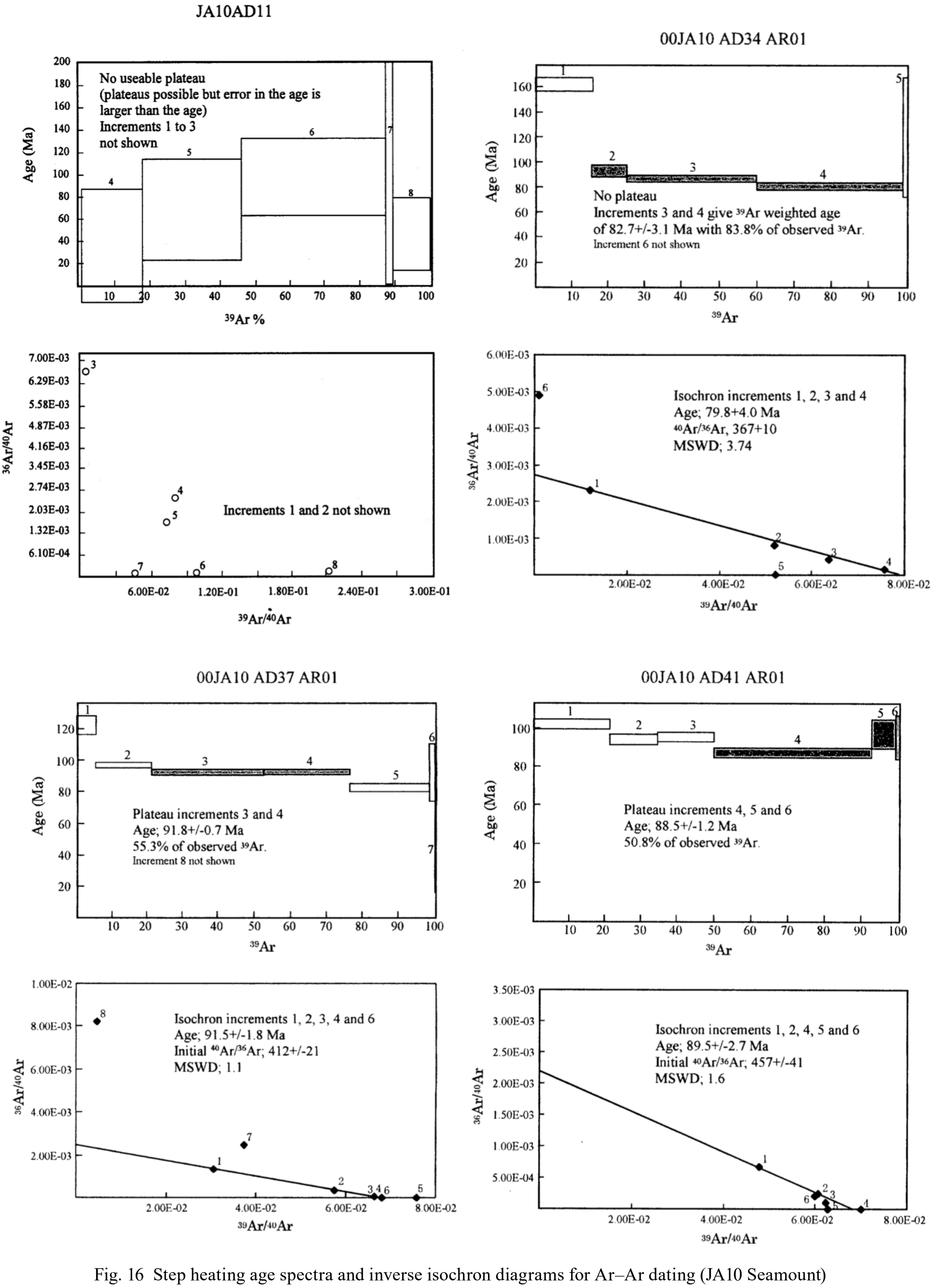

Fig. 16 Step heating age spectra and inverse isochron diagrams for Ar–Ar dating (JA10 Seamount)

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北西太平洋における海山基盤玄武岩の化学組成及び生成年代

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要　旨

北西太平洋海域におけるコバルトリッチクラスト鉱床の探査の一環として，海山基盤玄武岩が採取され，全岩化学組成分析及び K–Ar/Ar–Ar 法年代測定が実施された．海山基盤玄武岩は変質やリン酸塩化の影響を受けて初生的な化学組成の保存が良くないものの，試料が採取された 20 海山は全て典型的な海洋島アルカリ玄武岩の特徴を示した．生成年代については，K–Ar 法年代測定では変質の影響により信頼できる年代値が得られなかったが，Ar–Ar 法年代測定ではいくつかの海山から信頼性の高いプラトー年代が得られた．マーカス・ウェーク海山群に属する海山からは 67 ～ 116 Ma，マゼラン海山群に属する海山からは 87 Ma 及び 105 Ma，マーシャル諸島海山群に属する海山からは 90 Ma の生成年代が得られ，概ね先行研究で報告されている年代と一致した．