K/Ar AGE DETERMINATIONS ON DRILL CORE FROM DVDP HOLES 1 AND 2

Philip R. KYLE,

Institute of Polar Studies, The Ohio State University, Columbus, Ohio 43210, U.S.A.

John F. SUTTER

Department of Geology and Mineralogy, The Ohio State University, Columbus, Ohio 43210, U.S.A.

and

Samuel B. TREVES

Department of Geology, University of Nebraska, Lincoln, Nebraska 68508, U.S.A.

Abstract: Four conventional K/Ar ages were determined on two samples from each of DVDP drillholes 1 and 2. Apparent ages (calculated using the new 1977 calibration constants) range from 1.21 ± 0.11 m.y. to 1.34 ± 0.23 m.y. for samples from 25.52 m and 148.81 m depth respectively in DVDP 1. Age determinations on DVDP 2 are 1.16 ± 0.03 m.y. and 1.32 ± 0.16 m.y. for samples from depths of 62.38 m and 173.93 m respectively. The ages are statistically not significantly different from one another; and show the flows and pyroclastic units in DVDP 1 and 2 were erupted about 1.26 m.y. ago over a short period of time, probably less than 0.3 m.y.

1. Introduction

Dry Valley Drilling Project (DVDP) drillholes 1, 2 and 3 were drilled near McMurdo Station (Fig. 1) at the southern tip of Hut Point Peninsula on Ross Island. DVDP 1 penetrated over 200 m and consists of 40 stratigraphic units which have been subdivided into 6 eruptive sequences (Fig. 2). DVDP 2 and 3 are similar to each other as they were drilled only 3 m apart. DVDP 3 reached the greatest depth, 381 m and penetrated 15 stratigraphic units which comprise 4 eruptive sequences (Fig. 2). The petrographic character of the drillcores are shown on Fig. 2, typical the core consists of lava flows and pyroclastic units of basanite, Ne-hawaiite, Ne-mugearite and Ne-benmoreite compositions (KYLE, 1979).

The geology and inferred eruptive sequence of Hut Point Peninsula is summarised in Fig. 1. Surface exposures indicate that Hut Point Peninsula is composed of basanite lavas and pyroclasts with phonolite occurring at Observation Hill and

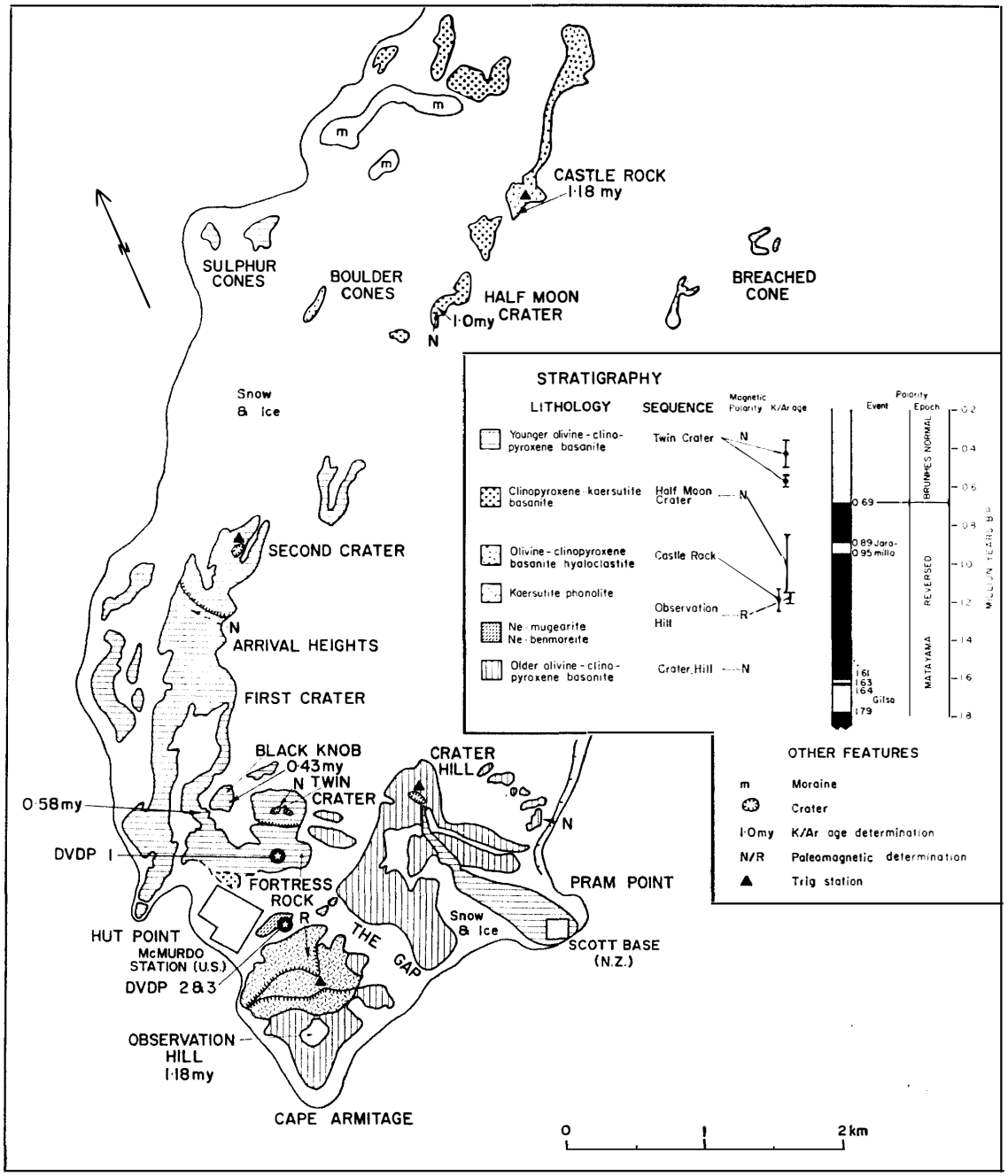

Fig. 1. Generalised geological sketch map of Hut Point Peninsula showing the location of DVDP 1, 2 and 3 drillsites and the location of surface samples dated by the K/Ar method (KYLE, 1979). Note that the ages indicated on the map are all calculated using the old decay constants, see Table 1 for revised values calculated using the new decay constants.

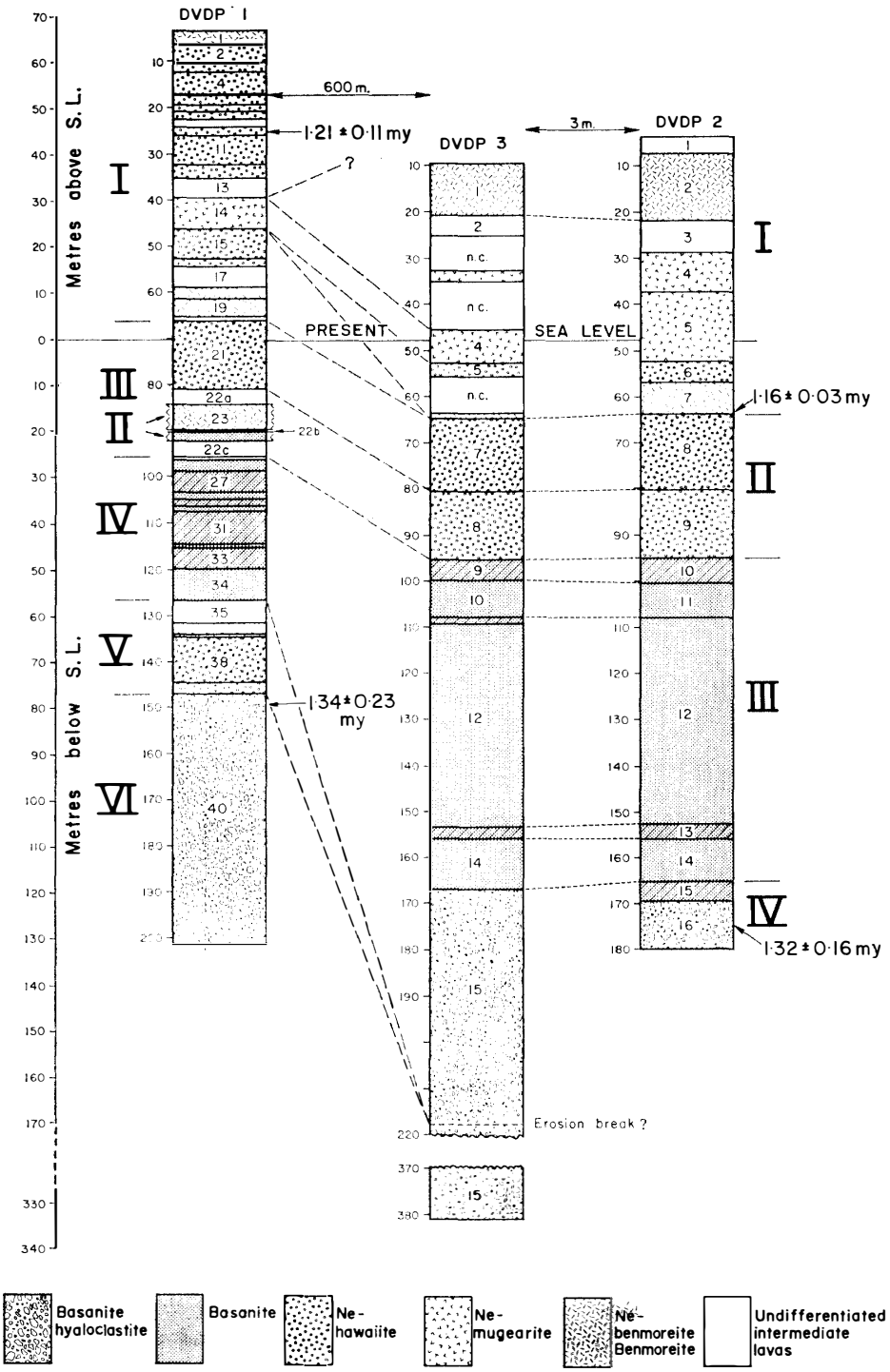

Fig. 2. Generalised geologic columns of the DVDP 1, 2 and 3 drill cores (KYLE, 1979). Pyroclastic units are denoted by cross hatching. Tentative correlations between DVDP 1 and DVDP 2, 3 are shown by fine dashed lines. All K/Ar ages were calculated using the new decay constants, see Table 2.

Table 1. Whole rock potassium-argon age determinations of samples from Hut Point Peninsula.

Sample number*	Sample	Location	Age** m.y.		Reference
			Old	New	
22892	Basanite lava flow	Black Knob	0.43±0.1	0.4 ±0.1	1
22900	Basanite lava flow	S.W. of Black Knob	0.58±0.06	0.6 ±0.06	1
22878	Basanite lava flow	Half Moon Crater	1.0 ±0.2	1.1 ±0.2	1
22879	Basanite dike	Castle Rock	1.18±0.05	1.21±0.05	2
	Phonolite	Observation Hill	1.18+±0.03	1.25±0.04	3

* Sample numbers refer to the petrology collection of the Department of Geology, Victoria University of Wellington.

** Calculated using old and new decay constants.
Old : $^{40}K\lambda_e = 4.72\times10^{-10}yr^{-1}$, $\lambda_\beta = 0.584\times10^{-10}yr^{-1}$, $^{40}K/K_{tot} = 0.0119$ atom/atom.
New: $^{40}K\lambda_e = 4.962\times10^{-10}yr^{-1}$, $\lambda_\beta = 0.581\times10^{-10}yr^{-1}$, $^{40}K/K_{tot} = 0.01167$ atom/atom.

\+ Mean of three samples.

References: (1) ARMSTRONG, 1978; (2) This paper, determined by J.E. GABITES, Institute of Nuclear Sciences, D.S.I.R., Lower Hutt, New Zealand; (3) FORBES *et al.*, 1974.

as a small flow on the north side of The Gap. Five informal eruptive sequences are recognised (Fig. 1). Conventional K/Ar age determinations on surface samples from Hut Point Peninsula are given in Table 1, included is a new determination on a basanite dike in hyaloclastite at Castle Rock. Sample locations are indicated on Fig. 1. The K/Ar age determinations show the geological evolution of Hut Point Peninsula has extended from about 0.4 m.y. to greater than 1.25 m.y. B.P.

K/Ar age determinations were undertaken on DVDP 1 and 2 core samples in an attempt to determine:

(1) The duration of the eruptive events represented by the drillcores;

(2) The relationships of the DVDP eruptive sequences to those recognised at the surface; and

(3) The possible correlation of units in DVDP 1 with those in DVDP 2 and 3.

Four age determinations were made, the results are statistically similar and cannot therefore be used to establish correlations between DVDP 1, 2 and 3. The dates do show that southern Hut Point Peninsula formed by eruptions which spanned a short period of time about 1.26 m.y. ago.

2. Analytical Techniques

Whole rock samples were crushed and sieved. The 80–100 mesh fraction was used for the argon analyses and a split of the same fraction was ground to less than 100 mesh for the potassium analyses. Potassium was determined, after chemical

separation of the alkalies (COOPER, 1963), on a single-channel Zeiss PF-5 flame photometer. Samples were run in either duplicate or triplicate and the pooled coefficient of variation for whole rock samples is approximately 0.5% of the amount present (FLECK *et al.*, 1977). Argon was liberated from the samples and purified using techniques described by DALRYMPLE and LANPHERE (1969, p. 62–65). The isotope composition and concentration of argon in the samples was measured by isotope dilution, with bulb-type ^{38}Ar tracers, using a Nuclide Corporation Model SGA-6-60 mass spectrometer. Error estimates are based on the analytical precision and were calculated using the equation given by COX and DALRYMPLE (1967). Quoted errors represent one standard deviation and thus have a 68% confidence level.

3. Results

Analytical data and the calculated apparent ages are given in Table 2, the sample locations and ages are also shown on the DVDP 1 and 2 columns (Fig. 2). At DVDP 1 an apparent age of 1.21±0.11 m.y. was determined for Ne-hawaiite flow unit 10 from a depth of 25.52 m. A basanite clast from near the top of hyaloclastite unit 40 in DVDP 1 as an apparent age of 1.34±0.23 m.y. At DVDP 2 age determinations are 1.16±0.03 m.y. for Ne-benmoreite flow unit 7 from a depth of 62.38 m and 1.32±0.16 m.y. for a basanite clast from near the top of hyaloclastite unit 16 at 173.93 m. The average of the four DVDP dates is 1.26±0.13 m.y.

None of the DVDP ages are significantly different from one another or the phonolite at Observation Hill (Table 1), at the 95% confidence level using the

Table 2. Whole rock K/Ar age determinations of DVDP 1 and 2 samples.

Hole and depth (m)	Unit	Rock type	K%	$^{40}Ar_R$ (moles/g) $\times 10^{-12}$	$^{40}Ar_R$ %	Apparent age (m.y.) $\pm 1\sigma$	Average
1-25.52	10	Ne-hawaiite	2.745	5.903	8.3	1.22±0.17	1.21±0.11
			2.803	5.807	6.4	1.20±0.06	
			2.816				
1-148.81	40	Basanite	1.109	2.505	10.3	1.30±0.25	1.34±0.23
			1.114	2.678	4.1	1.39±0.21	
2-62.38	7	Ne-benmoreite	3.303	6.500	42.1	1.13±0.04	1.16±0.03
			3.335	6.913	49.7	1.20±0.01	
2-173.93	16	Basanite	1.160	2.780	11.1	1.36±0.03	1.32±0.16
			1.197	2.613	10.5	1.28±0.30	

Calculated using $^{40}K/K_{tot} = 1.167 \times 10^{-4}$ atom/atom,
$\lambda_\beta = 4.962 \times 10^{-10}$/yr, and $\lambda_\varepsilon = 0.581 \times 10^{-10}$/yr.

Critical Value Test of DALRYMPLE and LANPHERE (1969, p. 120). The exact duration of volcanism cannot be determined without analyzing a large number of additional samples. It is probable however that the eruptive period represented by lavas in DVDP 1 and 2 was less than 0.3 m.y.

4. Discussion

Geological mapping and the 5 K/Ar age determinations on surface samples indicate a relatively simply geologic history for Hut Point Peninsula which lasted at least 0.75 m.y., from 0.43 to >1.18 m.y. (Fig. 1). However at DVDP 1 the drill core reveals a complex sequence of eruptions which apparently occurred over a relatively short duration, prior to the major development of Hut Point Peninsula. The most significant feature of the drill core is the abundance and diversity of lavas with intermediate compositions. Such lavas are generally absent in surface samples, both at Hut Point Peninsula and at other eruptive centers on Ross Island, particularly Cape Crozier, Mt. Terror and Cape Bird. At these locations phonolite cones similar to Observation Hill are common, however they appear to be mainly late in the eruptive history. The DVDP 1, 2 and 3 drill cores and the K/Ar ages have shown that fractionated lavas can occur early in the geologic evolution of a typical eruptive centre within the McMurdo Volcanic Group from the McMurdo Sound area.

Acknowledgments

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