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Autor: Wen Ji, Chen / Hurford, Anthony J. / Jäger, Emilie

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K / Ar dating of Quaternary volcanic rocks from the Huabei Area, China

by *Chen Wen Ji**, *Anthony J. Hurford*[1] and *Emilie Jäger*[1]

Abstract

17 K/Ar ages have been determined on eight Cenozoic basalts from the Huabei Area of North China. Samples from the Da Tong volcanic area yielded Quaternary ages, whilst basalts from Zhang Jia Khou, Wu An and Da Hei Shan Island give Pliocene and Miocene results, in contrast to their previously supposed Quaternary age.

Keywords: Cenozoic, Basalt, China, K/Ar dating.

INTRODUCTION

Palaeogene volcanic rocks are widespread in Eastern China, apparently restricted to Cenozoic sedimentary basins containing hydrocarbon deposits (Liu et al., 1983). Cong et al. (1979), Zheng et al. (1978), and Zheng (1980) consider that while early Tertiary basalts of a transitional type or tholeiite are derived from the Upper Mantle by extensional fracturing and partial melting, late Tertiary and Quaternary basalts of continental type are controlled by fracturing due to rifting. Volcanic rocks considered to be of Quaternary age outcrop in the Huabei Area, Northeast China, Guangdong and Yunnan Provinces and in the South China Sea (Fig. 1, inset). Determination of young radiometric ages has become possible in China since 1980, with the availability of expertise in analytical techniques and the acquisition of new mass spectrometers. For example, in the Huabei Area (Shan Xi, Hebei, Shandong and Henan Provinces, together with the northern part of Jiangsu and the southern part of Liaoning) many

[1] Laboratory for Isotope Geology, University of Berne, Erlachstrasse 9a, CH-3012 Berne, Switzerland.
* Present Address: Institute of Geology, State Seismological Bureau, Beijing, China.

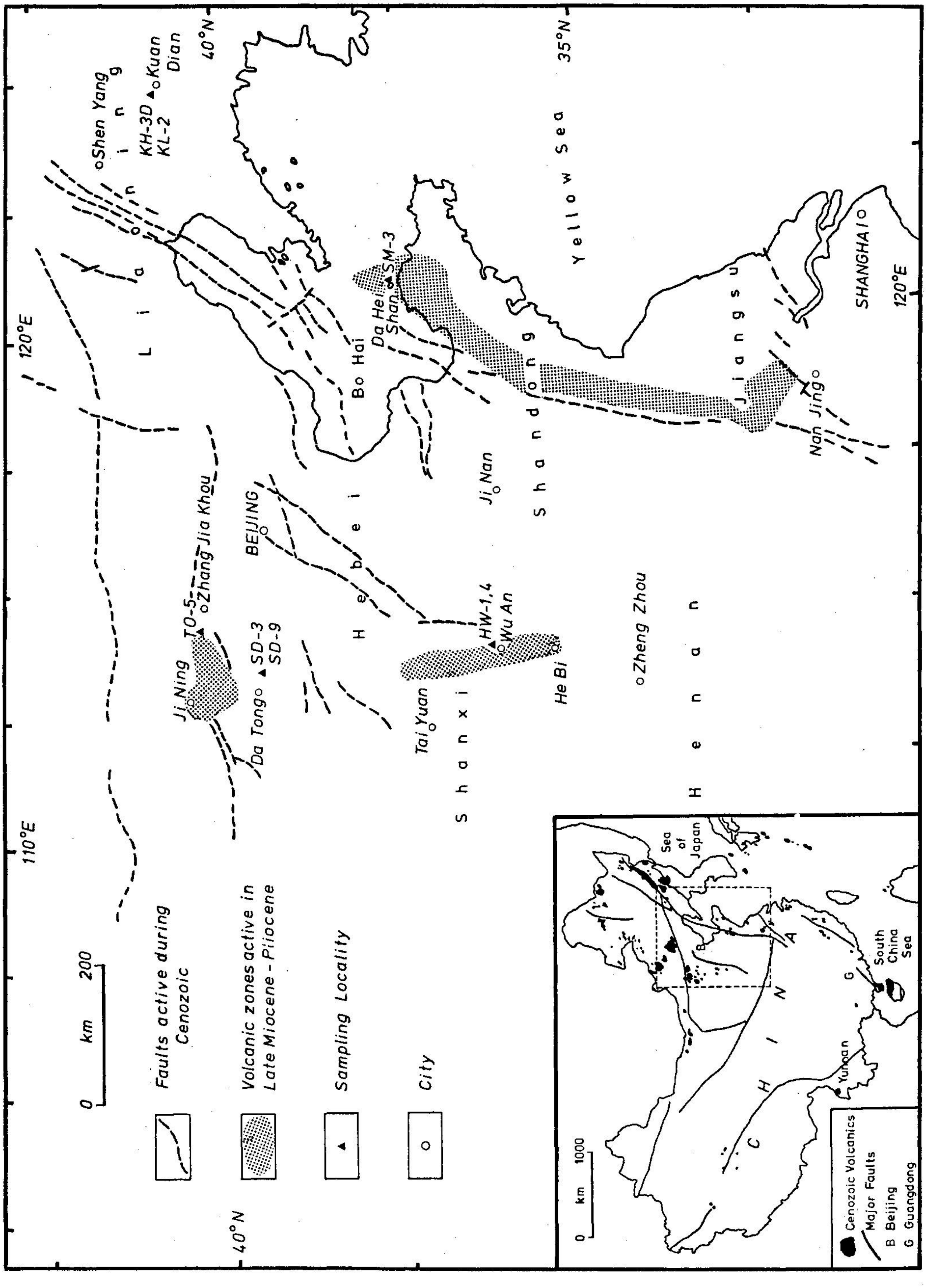


Figure 1 Map of the Huabei Area, North China, showing principal cities, sampling localities, together with faults and volcanic zones active during the Cenozoic.

K/Ar ages have been determined for Tertiary volcanic rocks (e.g. LIU et al., 1982). In the present study, we have determined K/Ar ages on basaltic rocks believed by geologists to be of Quaternary age, from the Da Tong volcanic area in northern Shan Xi province, the Zhang Jia Khou area in northern Hebei Province, Wu An in Hebei Province, Da Hei Shan Island in the Bo Hai Sea and Kuan Dian in southern Liaoning Province (see Fig. 1).

ANALYTICAL METHODS AND RESULTS

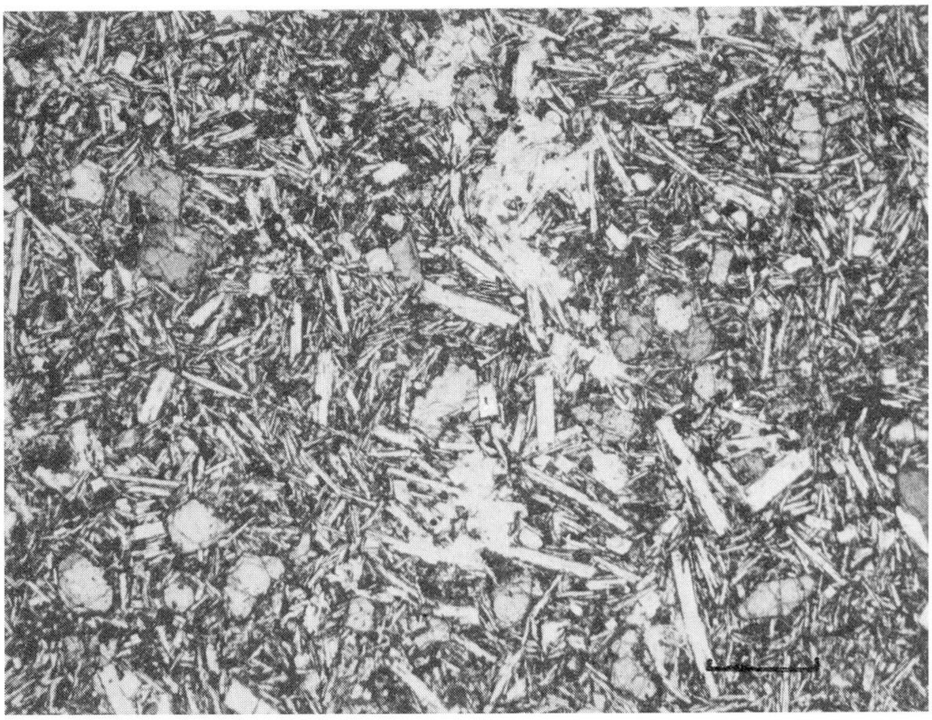
Fresh basalt samples of ~1 kg, free from weathered surfaces and alteration, were crushed and sieved to different mesh fractions. Because of the young age of the samples, great care was taken to ensure that the separate aliquots used for potassium and argon analysis were homogeneous and truly representative: each sample was divided with a sample splitter until the required weights (~1 g for argon and ~0.5 g for potassium) were obtained. As a control of the representative nature of different size fractions, four different grain size fractions were analysed for sample SD-3.

Potassium concentrations were determined using a Beckmann flame photometer, without an internal standard. Two diluted solutions were measured for each sample, results agreeing to better than ± 1.5%. For the argon analyses, aliquots of each rock sample were fused using an RF generator and the evolved gases passed through a 2-stage purification system, using Ti and Cu/CuO getters (FLISCH, 1982). Isotopic analyses were measured in Berne with a Micromass 1200 mass spectrometer in static mode employing an enriched ^{38}Ar spike (SCHUMACHER, 1975) calibrated against both known air volumes and the standard minerals B4-M, B4-B, LP-6 and Gl-O (FLISCH, 1982). Blank correction measurements were made prior to sample extractions, where blank values for ^{40}Ar of around 4×10^{-8} ccm were found. Measured sample $^{40}Ar/^{36}Ar$ ratios were corrected for the mass discrimination by the mass spectrometer, using the ratio of the accepted $^{40}Ar/^{36}Ar$ value to the measured value, viz. 295.5/303. Such a mass discrimination correction becomes particularly important when the atmospheric component of the total argon is high, as is the case with the young samples in the present study. Certain of the samples were measured using a modified Christmas Tree extraction and purification system, permitting up to twelve samples to be analysed serially.

The analytical results for the potassium and argon measurements are shown in Table 1. Ages were calculated using the IUGS recommended constants (STEIGER and JÄGER, 1977) and fall into two distinct age groups (Table 1): one Quaternary with ages ranging between 0.124 and 0.458 Ma, the other, Pliocene with ages around 4 Ma.

Table 1 *K/Ar dating results for volcanic rocks from North China.*

Location	Mesh Fraction	K%	ccm $^{40}Ar_{rad}$ (STP)/g ($\times 10^{-7}$)	$^{40}Ar_{rad}$ %	Age (Ma. $\pm 1\sigma$)	Mean Age (Ma. $+1\sigma$)
Da Tong Volcanic Area						
SD-3	20/40	1.72	0.2290	14.78	0.342±0.081	
Hao Tian Si	40/50	1.72	0.2612	9.72	0.391±0.095	
40°10'N 113°40'E	50/80	1.66	0.2246	3.64	0.348±0.117	
	50/80	1.66	0.2651	6.44	0.411±0.100	0.383±0.028
	50/80	1.66	0.2483	6.42	0.385±0.074	
	50/80	1.66	0.2645	6.98	0.410±0.042	
	80/100	1.55	0.2387	4.13	0.396±0.117	
SD-9	60/80	0.79	0.0242	0.76	0.079±0.221	
Yi Gea Zhia	80/100	0.80	0.0635	1.84	0.204±0.205	
39°58'N 113°46'E	80/100	0.80	0.1290	4.04	0.415±0.197	
Zhang Jia Kou						
TO-5						
Xiao Suan Gou	60/80	0.72	1.228	52.73	4.38±0.29	
N40°50' E114°50'						
Wu An						
HW-4						
Bai Cao Peng,	60/80	1.71	2.339	45.17	3.52±0.11	
N36°40' E113°10'						
HW-1	60/80	1.98	3.373	18.57	4.38±0.14	
Bai Cao Peng,	60/80	1.98	3.581	17.88	4.65±0.11	4.52±0.14
N36°40' E113°10'						
Da Hei Shan Island						
SM-3	60/80	1.14	3.586	45.88	8.08±0.16	
Kuan Dian						
KH-3D						
Huang Yi Shan	60/80	1.15	0.1224	6.85	0.274±0.132	
N40°40' E124°50'						
KL-2						
Liu Jia	60/80	1.70	0.0818	3.34	0.124±0.105	
N40°40' E124°50'						



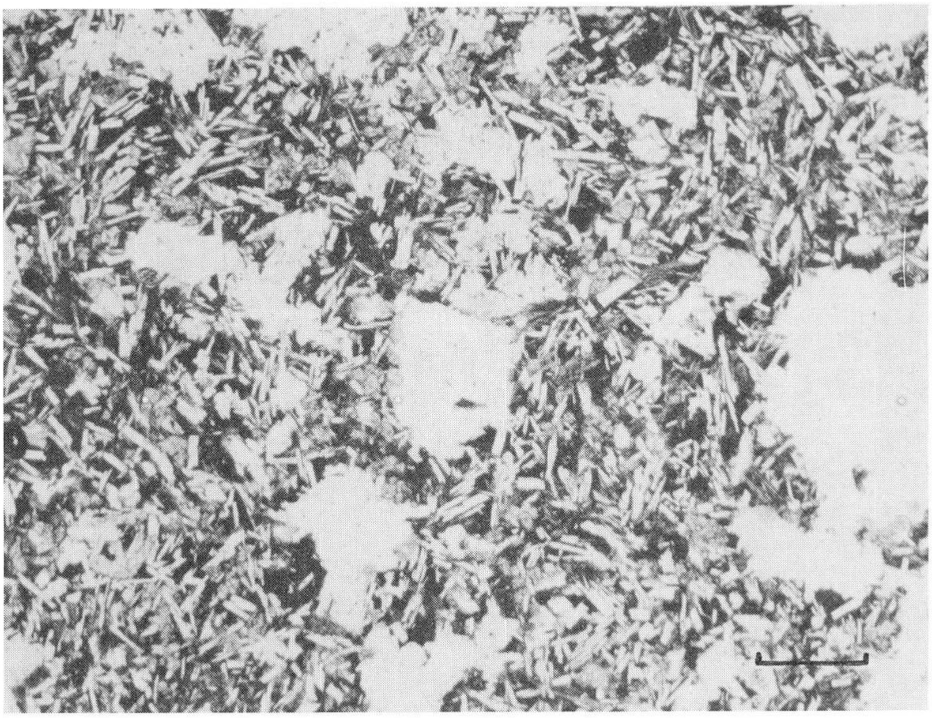


Figure 2 Photomicrographs of two Basalt Samples:
2a) Sample SD-3: alkali-olivine basalt, Hao Tian Si, Da Tong.
2b) Sample SD-9: glass rich tholeiite, Yi Gea Zhia, Da Tong.
Scale bars are 0.5 mm.

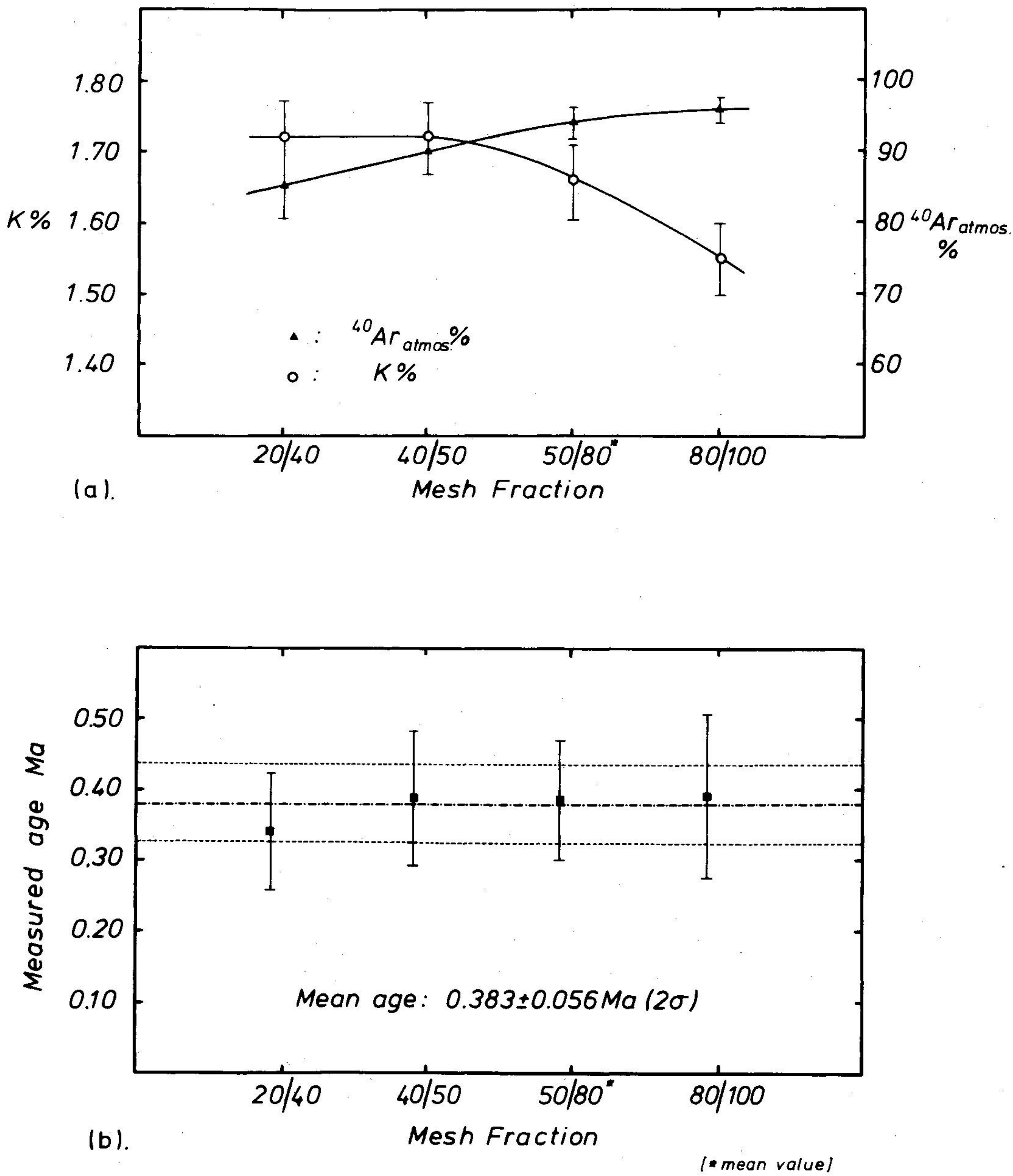


Figure 3 Sample SD-3:
3a) Variation of atmospheric argon and potassium contents with grain size. Error bars are 1 σ.
3b) Variation of measured age with grain size. Error bars are 1 σ.

DISCUSSION

Four different grain size fractions were analysed from sample SD-3 (Table 1), a glass-free, fine-grained, holocrystalline alkali-olivine basalt (Fig. 2a) from the south of Hao Tian Si volcanic cone, Da Tong. Apparent correlations exist between grain size and both potassium content and $^{40}Ar_{atmos.}$% (Fig. 3). With decreasing grain size, there is a marked decrease in potassium content, which may result from a lower content of plagioclase feldspar. Conversely, the $^{40}Ar_{atmos.}$% increases with decreasing grain size, probably as a function of the increasing surface area of the smaller grains and the consequent increase in adsorbed atmospheric argon. Despite these variations with grain size, the measured ages for the six analyses agree within experimental error, giving a mean age of 0.383 ± 0.028 Ma (Fig. 3). Such reproducibility of results on a young basalt with low potassium content, suggests that this rock may be suitable as a Quaternary, interlaboratory K/Ar standard: at present no such young (~400,000 a) standard, with a potassium content of ~1.5%, is available.

The other sample from Da Tong, SD-9, is a porphyritic tholeiitic basalt from Yi Gea Zhia, containing glass spherules up to ~1 mm in diameter (Fig. 2b). Repeat analysis of this sample showed a wild scatter of results for argon analysis and hence calculated age (Table 1), although potassium content remained constant at ~0.8%. Lack of reproducibility is attributed to an unrepresentative sample-splitting, glass spherules being lost by rolling. These results indicate that fine-grained, glass-free, holocrystalline basalt is the material best suited to K/Ar analysis.

Older Pliocene ages were obtained from a single basalt sample TO-5 from Xiao Suan Guo, Zhang Jia Khuo area (4.38 ± 0.29 Ma) and from two basalt samples HW-1, HW-4 from Bai Cao Peng, Wu An area. Sample SM-3 from Da Hei Shan island in the Bo Hai Sea yielded a Miocene age of 8.08 ± 0.16 Ma. These Pliocene and Miocene K/Ar ages contrast sharply with the Quaternary age assigned to these four samples by geologists on the basis of their regional situation. Such Neogene ages would demand serious reconsideration of the geology in these areas, although more extensive dating studies are required to accurately determine the age of eruption of these lavas.

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References

CONG BO LIN, ZHANG WEN HUA and YE BAN IAN (1979): A study on the Cenozoic basalts in the North China fault block. Acta Geologica Sinica, 2, 112–124 (in Chinese).

FLISCH, M. (1982): Potassium-argon analysis in Numerical Dating in Stratigraphy (Odin, G.S., ed.), John Wiley, Chichester.

LIU RUO XIN, SUN JIAN ZHONG and CHEN WEN JI (1983): Cenozoic basalts in North China – their distribution, geochemical characteristics and tectonic implications. Geochemistry, 2, 17–33.

LIU RUO XIN et al. (in press): K/Ar dating of some Cenozoic volcanic rocks in North China (in Chinese).

SCHUMACHER, E. (1975): Herstellung von 99.9997% ^{38}Ar für die K/Ar-Geochronologie. Chimia 29, 441–442.

STEIGER, R.H. and JÄGER, E. (1977): Subcommission on geochronology: convention on the use of decay constants in geo- and cosmochronology. Earth Planet. Sci. Letts. 36, 359–362.

ZHENG XUE ZHENG et al. (1978): Discussion on the petrochemistry of Cenozoic basaltic rocks in Eastern China. Scientia Sinica 3, 253–263.

ZHENG XUE ZHENG (1980): Some deep-seated inclusions in basalt from the North China fault block region and problems on basalts, in Formation and Development of the North China Fault Block Region, Science Press, Beijing, China.

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