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K-Ar AGES OF SAMPLES FROM THE SUBINAL FORMATION AND COLOTENANGO BEDS, GUATEMALA

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This study presents K-Ar ages of three volcanic clasts from the Colotenango beds of northwest Guatemala and an andesite flow fragment from the Subinal formation in southeast Guatemala. It is part of a continuing investigation of the Neogene tectonics of northern Central America and in particular the tectonics related to sinistral offsets across the transcurrent faults thought to represent the modern plate boundary.

DISCUSSION

The Polochic and Motagua faults have been considered the present boundary between the North American and Caribbean plates (Muehlberger and Ritchie, 1975). Relative motion along these faults is left lateral, and recent activity suggests that the Motagua fault zone is currently the active plate margin (Plafker, 1976). On the basis of geologic features, stratigraphy, and geomorphological match, Burkart (1978, 1983) has suggested a model indicating about 130 km of slip along the Polochic fault during late Tertiary. Deaton and Burkart (1984) investigated the Colotenango beds of northwest Guatemala in terms of substantiating the model of sinistral slip along the Polochic fault. The Colotenango beds are a Tertiary fluvio-volcanic sequence (including a pebble to boulder conglomerate) located on the northern block of the Polochic fault; they are believed to contain clasts deposited by north-flowing streams from source beds south of the fault as the blocks slipped by each other. It has been suggested by Anderson (1969) and Anderson and others (1973) that the clasts in the Colotenango beds are Miocene or older. Deaton and Burkart (1984) were able to demonstrate at least partial synchroneity between the sinistral offset across the Cayman Tough segment of the North American-Caribbean plate boundary reported by Macdonald and Holcombe (1978) and the sinistral slip across the Polochic reported by Burkart (1978, 1983). Ages reported here are instrumental in understanding that time relationship.

COLOTENANGO BEDS

The three volcanic clasts, part of more than fifty volcanic clasts studied petrographically for freshness and suitability for age determination, were taken from different localities of the conglomerate in the Colotenango beds. Thin sections of all the clasts were examined for amount of glass and degree of devitrification before the three were selected for K-Ar age determination. On the basis of the stratigraphic and petrographic studies and K-Ar ages, the Colotenango beds were found to consist of two distinct parts, differing in locality, clast composition, assortment, and age. Because ignimbrites such as these form quickly in terms of geologic time, the ages of the clasts in the conglomerate are reliable indicators of the time of sedimentation of the beds. The older section of the conglomerate contains clasts which all show considerable glass devitrification, and two clasts from this unit have ages of 12.3 ± 1.0 and 10.3 ± 1.0 m.y. We interpret the measured ages of the clasts along with the uniform devitrification of other clasts in this part of the conglomerate as setting a limit on the maximum age of sedimentation; thus this unit has an age of 10.3 m.y. or less. The younger part of the beds contains clasts with some devitrification but also has clasts containing pristine glass at 6.6 ± 0.3 m.y. old. We interpret the age of sedimentation of this section of the Colotenango beds to be 6.6 m.y. or less.

Our studies from central Guatemala (Deaton and Burkart, 1984) indicate that the provenance of the older part of the Colotenango beds is the region near Salama in central Guatemala containing large serpentinite thrust sheets. The provenance of the younger part of the conglomerate is not well established but is believed to be the region south of the conglomerate today, along the southern flank of the Cuilco River Valley. The older section of the Colotenango beds appears to have been deposited 10 m.y. ago or less when the serpentinite thrust sheets now in central Guatemala were just south of the present location of the beds. We believe that major motion across the Polochic fault was initiated at approximately this time. The youngest age of major offset cannot be set with certainty because the precise source of the younger conglomerate is not known, but it lies somewhere between the 6.6 m.y. age and the age of the uppermost volcaniclastic fill in which the Polochic is not a throughgoing fault (Erdlac and Anderson, 1982). If it is assumed that the younger part of the Colotenango beds has not undergone significant sinistral slip, then the present study has bracketed the time of motion across the Polochic fault as being roughly from 10 m.y.b.p. to 6 m.y.b.p., with a total slip of 130 km. The synchroneity of spreading in the Cayman through (Macdonald and Holcombe, 1978) with the bracketed ages above is in accord with the correlation proposed by Burkart (1983). At some time in its history the Polochic may have matched the 40-mm-per-year strain rate across the Mid-Cayman spreading center determined by Macdonald and Holcombe (1978). However, that high rate obviously could not be sustained for more than 3.4 m.y. for the 130 km of measured offset.

SUBINAL FORMATION

The Subinal formation lies south of the Rio Motagua and consists of a series of conglomeratic redbeds believed to be middle Tertiary (McBirney, 1963; Burkart and others, 1973). Because these redbeds probably formed during a period of crustal extension, determination of their age is of considerable interest in the tectonic interpretation of northern Central America. No prior direct radiometric age determination of these beds has been published. The andesite boulder from which the present sample was collected lies southwest of Esquipulas, Guatemala, near Apantes, and it is an andesitic flow fragment. Volcanism that accompanied the graben development in this region was the source of the andesite flows and tuffs which today crop out as andesite boulder breccias. The K-Ar age of the sample from the andesite boulder breccia was found to be 42 ± 2 m.y., fixing the age of the enclosing Subinal formation at less than 42 m.y.

ANALYTICAL PROCEDURES

Laboratory analyses were carried out by Teledyne Isotopes, 50 Van Buren Ave., Westwood, New York

07675, with potassium determinations duplicated in our laboratory by atomic absorption spectrophotometry. Data used in calculating the radiometric ages are given in table 1. Constants used were: $\lambda = 4.962 \times 10^{-10}$ yr^{-1}, $\lambda = 0.581 \times 10^{-10}$ yr^{-1}, and $K^{40} = 1.167 \times 10^{-4}$ atom per atom of natural potassium.

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SAMPLE DESCRIPTIONS

1. *79-G-58V1* K-Ar

   Welded tuff clast (15°24'23"N, 91°4'0"W; at marker 285 km on the Pan American Highway road cut 2 km E of Colotenango, Guatemala). From the older unit of the Colotenango beds containing crystalline biotite, potassium feldspar, quartz, and plagioclase. *Analytical data:* $\%^{40}K = 4.32\%, 4.63\%$; $^{*40}Ar = 0.201 \times 10^{-5}$ cc/gm, 0.228×10^{-5} cc/gm; $^{40}Ar^{rad}/^{40}Ar^{tot} = 16.6\%, 20.3\%$. *Comment:* Collected by B. C. Deaton.

   (biotite) 12.3 ± 1 m.y.

2. *80-G-74V* K-Ar

   Welded tuff clast (15°24'19"N, 91°41'40"W; at marker 286 km on the Pan American Highway road cut 1 km E of Colotenango, Guatemala). From the conglomerate of the older unit of the Colotenango beds containing crystalline biotite, potassium feldspar, quartz, and plagioclase. *Analytical data:* $\%^{40}K = 4.68\%, 4.68\%$; $^{*40}Ar = 0.169 \times 10^{-5}$ cc/gm, 0.205×10^{-5} cc/gm; $^{40}Ar^{rad}/^{40}Ar^{tot} = 24.7\%, 28.7\%$. *Comment:* Collected by B. Burkart.

   (biotite) 10.3 ± 1. m.y.

3. *79-G-87V1* K-Ar

   Welded tuff clast (15°23'53"N, 91°47'30"W; just above the contact between the metamorphic base and the Colotenango beds 1.5 km SE of Estantia, Guatemala, in the Cuilco River Valley). At the base of the younger part of the Colotenango beds having the external appearance of an impure obsidian containing minor amounts of feldspar and pumice fragments. *Analytical data:* $\%^{40}K = 4.03\%, 4.08\%$; $^{*40}Ar = 0.103 \times 10^{-5}$ cc/gm, 0.106×10^{-5} cc/gm; $^{40}Ar^{rad}/^{40}Ar^{tot} = 37.3\%, 38.6\%$. *Comment:* Collected by B. C. Deaton.

   (glass shards) 6.63 ± 0.3 m.y.

4. *79-G2-5* K-Ar

   Andesite boulder (14°33'5"N, 89°23'27"W; from N road cut in Subinal formation 4.5 km SW of Esquipulas and 2 km NE of Apantes, Guatemala). Welded tuff containing plagioclase and a small amount of quartz in a fine-grained matrix. *Analytical data:* $\%^{40}K = 0.53\%, 0.53\%$; $^{*40}Ar = 0.086 \times 10^{-5}$ cc/gm, 0.089×10^{-5} cc/gm; $^{40}Ar^{rad}/^{40}Ar^{tot} = 47.1\%, 39.6\%$. *Comment:* Collected by B. Burkart.

   (feldspar) 42.0 ± 2 m.y.

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TABLE 1. Data used in radiometric age calculations (analyses by Teledyne Isotopes, Westwood, N.J.).

Sample	Run number	Vol Ar^{40} Rad per gm sample ($\frac{cm^3}{gm}$)	$\%^{40}K$	Radiometric age (m.y.)	Average age (m.y.)
79-G-87 V1 (glass)	1	0.103×10^{-5}	4.03	6.59	6.63 ± .3
	2	0.106×10^{-5}	4.08	6.68	
80-G-74V (biotite)	1	0.169×10^{-5}	4.68	9.27	10.3 ± 1
	2	0.205×10^{-5}	4.68	11.2	
79-G-58V (biotite)	1	0.201×10^{-5}	4.32	12.0	12.3 ± 1
	2	0.228×10^{-5}	4.63	12.6	
79-G2-5 (feldspar)	1	0.086×10^{-5}	0.53	41.3	42.0 ± 2
	2	0.089×10^{-5}	0.53	42.7	