

POTASSIUM-ARGON AGES OF TWO GRANITOIDS NORTHWEST OF KUMASI, GHANA

E. K. AGYEI

Department of Physics, University of Ghana, Legon, Ghana

Summary

Four granitic samples from two granitoids northwest of Kumasi, Ghana, have been dated using the conventional K-Ar method. Two samples NB1 NB2 from a road-cutting at Nyamebekyere village, located about 60 km from Kumasi on the Kumasi-Sunyani road gave biotite ages of 2144 ± 11 Ma and 2144 ± 7 Ma, respectively. The biotite ages for two samples NTN1 and NTN2 from Kassardjan quarry, located about 3 km south of the Kumasi-Sunyani road at Ntensere village some 20 km northwest of Kumasi were 2070 ± 10 Ma and 2099 ± 14 Ma, respectively. A hornblende age of 2169 ± 26 Ma was obtained for NTN2 which suggests a slow cooling during the uplift of the granitoid. Although the biotite ages obtained here for the two G2 granitoids are older than most of the reported biotite ages which happen to be for G1 granites, it is too premature to generalize that G2 granitoids are older than G1 granitoids.

Introduction

Until we are able to have an extensive and exhaustive geochronological study of Ghana undertaken, every bit of carefully collected geochronological data should be very much treasured. It has often been pointed out how much geochronological data in Ghana lag behind those of our neighbouring Francophone countries (Agyei *et al.* (1987); Agyei & Manu, 1988; Agyei & Van Landewijk, 1988). Not only will such studies in West Africa give more insight to the continental drift hypothesis in relation to West Africa and northeastern South America, but it might help to resolve some burning local geological controversies. For example, the stratigraphy of the Birimian System in Ghana is believed to be just the reverse of the Birimian System in La Côte d'Ivoire and Burkina-Faso. During a recent UNESCO-sponsored geotraverse of the Birimian by a group of international geologists which addressed itself to this problem, it was recommended, among other things, that a comprehensive and detailed geochronological and geochemical studies be undertaken (Kesse & Barning, 1985).

The result presented here on granitoid intrusives in the Birimian is a moderate contribution to the recommendation of the geotraverse

and also to the International Geological Correlation Project 108/44 which has been concerned with the Precambrian of West Africa and its correlation with eastern Brazil (Vace, 1982). The IGCP itself has not produced any new dates for Ghana so far.

Experimental

Geology and sample locations

Recently, the geology of West Africa has been summarized by several authors (Bessoles, 1977); Bessoles & Trompette, 1980; Wright *et al.* (1985) and that of Ghana in particular by Kesse (1985) and that of Ghana in particular by Kesse (1985), Agyei *et al.* (1987) and Agyei & Van Landewijk (1988)

The granite samples analysed in this work were taken from two locations along the Kumasi-Sunyani Highway. The NB samples were collected from a Kassardjan new road cutting through a granite outcrop at Nyamebekyere village located about 60 km from Kumasi at lat. $7^{\circ} 0' 41''$ N. long. $1^{\circ} 57' 58''$ W. The NTN samples come from a granite quarry about 3 km to the south of the main road at Ntensere village 20 km from Kumasi at lat. $6^{\circ} 43' 34''$ N. long. $1^{\circ} 46' 1''$ W.

As indicated in Fig. 1, i.e. the geological map

of northwest of Kumasi (Ghana), the samples come from the G2 (the Dixcove type of granitoids in Ghana or Bondoukou type in La Côte d'Ivoire and Burkina-Faso). These, together with the G1 (the Cape Coast and Winneba type in Ghana and Baoule' type in La Côte d'Ivoire) granitoids and the Bongo type granitoids intruded into the Birimian during the Eburnian Orogeny (1500-2600 Ma). The G1 granitoids are more massive and abundant than the G2 type. The

For example, the stratigraphic concept of the Francophone workers is just the reverse of the Ghanaian concept (Kesse, 1985; Attah, 1980).

The present concept of the Birimian system in Ghana is that it is made up of Lower and Upper Series.

The Lower Series which makes up about 75 per cent of the area occupied by the whole of the Birimian System consists predominantly of metasedimentary rocks. These include phyllites,

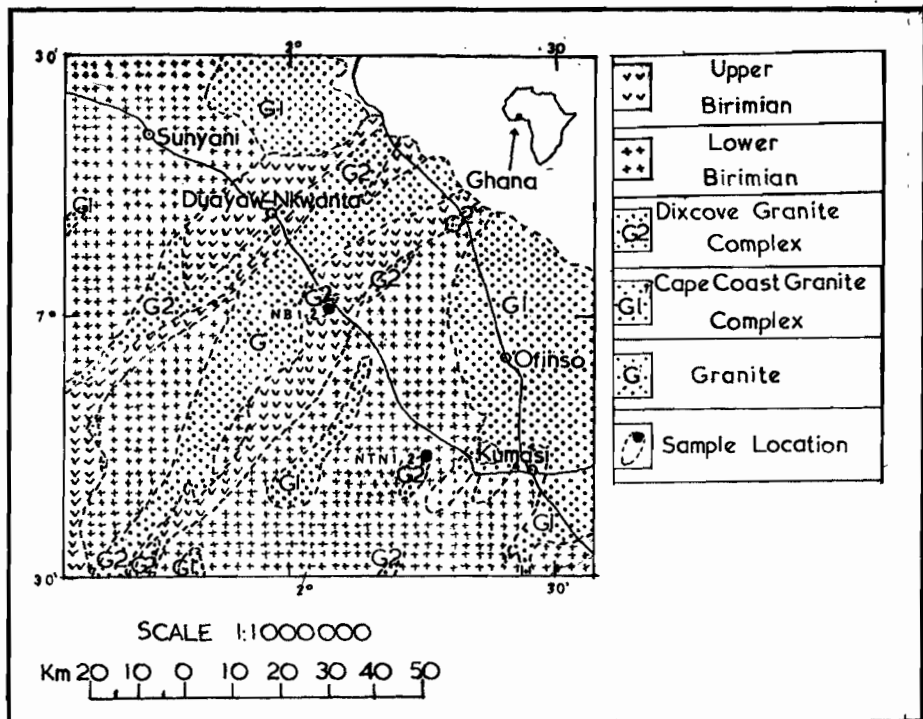


Fig. 1. Geological map of northwestern Ghana

Bongo types are rare and found mostly in the northern part of Ghana and are not indicated on Fig. 1.

The Birimian are volcanic and sedimentary rocks which have been metamorphosed. There have been several concepts concerning the stratigraphy of the Birimian rocks which cut across geographical and international boundaries.

schists, tuffs and greywackes.

The Upper Series which unconformably overlies the Lower Birimian covers about 25 per cent of the area occupied by the Birimian System of Ghana. This Series is made up predominantly of metavolcanic rock assemblages of phyllites, schists, tuff, lava, pyroclastic rocks, hypabassal basic intrusive and greywacke.

The G1 granites are well foliated, often migmatitic, potash-rich and consist of biotite-muscovite granites and granodiorites. These may be characterised by the presence of many pockets of schists and gneisses and are generally associated with Birimian metasediments. They are generally concordant with the regional structures. The Cape Coast granitoid complex is believed to be the outcome of a four stage magmatic intrusions, the last of which is associated with deposition of Upper Birimian metasediments (Kesse, 1985).

The G2 type granites consist of discordant and typically unfoliated hornblende granite or granodiorite grading locally into quartz diorite and hornblende diorite. They may also range from hornblende- and biotite-bearing to diorites, monzonites and syenites.

The Bongo granites are hornblende-microcline plutonic granites that are predominantly found in northeastern Ghana. There are also occasional and scattered undifferentiated granites labelled G.

Previous work and age of the granitoids

An extensive review of the geochronology of West Africa has been given by Black (1980), Cahen & Snelling (1984). A summary of the dates reported for the Birimian of Ghana can also be found in a recent publication by Agyei *et al.* (1987). Birimian metamorphic rocks from around the lake Bosumtwi crater were dated by Kolbe *et al.* (1967), using Rb-Sr method as 2100 Ma. Schnetzler *et al.* (1966) also found Rb-Sr ages of 2085 Ma for rocks around Lake Bosumtwi area. Similar ages on basement rocks of the West African craton in Ghana were reported by Priem *et al.* (1967). Tugarinov & Vernadskiy (1967) reported 15 K-Ar ages for what they called "Cape Coast granites" on the western flank of Ghana. These ages determined for various minerals range from 1670 Ma. to 2190 Ma. Tugarinov *et al.* (1968) and Attoh (1980) have again provided similar ages for these gran-

ites. Bessoles (1977) also reports a K-Ar date of 1800 Ma. for a pegmatite determined by Tugarinov. In the recent work by Agyei *et al.* (1987), rocks from the Cape Coast granite complex gave a Rb-Sr isochron age of 2051 Ma and the biotites an isochron age of 1974 Ma. The ages of 13 rocks using K-Ar method ranged from 1787 Ma to 2047 Ma. Agyei & van Landewijk (1988) have also given K-Ar dates ranging from 1983 to 1997 Ma for biotites of five migmatites and a granite from the southern end of the Cape Coast granite complex.

No systematic age measurements have been made to resolve the differences in the time of emplacement of the three different types of granitoids in the Birimian. However, according to Kesse (1985), field evidence indicates that the Dixcove (G2) type of granite is younger than the Cape Coast (G1) type and the Bongo type still younger than the Dixcove type. This statement seems to contradict observations by Kesse (1985) and Tugarinov (1967) that the ages of the granitoids of Ghana fall into two well defined groups, with the granodiorite massives that intruded the Birimian rocks having ages of about 2100 Ma whilst the most abundant granites i.e. the Cape Coast type cutting both the Birimian and the Tarkwaian rocks usually having ages of about 1800 Ma. This has never been quite clear in the catalogue of radiometric age data.

This work

Two fresh hand granite specimens were collected from each of the two locations already described. The samples were crushed, sieved and the biotite separated from the 180 μm fraction of each sample using L - I Frantz magnetic separator and heavy liquids (Bromoform and methyl iodide) techniques. Biotite was also separated from the 250 μm fraction and hornblende from the 180 μm fraction of the NTN2 sample. The purity of the minerals in all cases was nearly 100 per cent. Radiogenic argon-40 and K_2O were determined by the routine and conventional meth-

ods adopted in this laboratory (see Appendix 1). The constants used in the K-Ar age calculations are as follows:

$$\lambda_e = 0.581 \times 10^{-10} \text{ yr}^{-1}$$

$$\lambda_\beta = 4.962 \times 10^{-10} \text{ yr}^{-1}$$

$$^{40}\text{K}/\text{K} = 0.0001167 \text{ (Steiger \& Jager, 1977)}$$

The disagreement of the NTN2 250 μm biotite age of 2112 ± 8 Ma with its corresponding 180 μm biotite age of 2085 ± 14 Ma is almost within the experimental variation and cannot be real. However, the disparity between the hornblende age of 2169 ± 26 Ma and the minimum of the NTN biotite ages appear to be significant. This

TABLE 1

K-Ar age data of granitoids northwest of Kumasi, Ghana

Sample	Mineral Size/ μm	K_2O (%)	^{40}Ar rad/ $\text{mm}^3 \text{g}^{-1}$	^{40}Ar atmos. %	Sample weight for Ar line/g	Age/ Ma	Mean age/Ma
NB1	Biotite	8.03 ± 0.11	1.0729	6	0.04528	2157	2144 ± 11
	180	(2)	1.0657	7	0.03567	2148	
			1.0471	6	0.04441	2126	
NB2	Biotite	8.03 ± 0.09	1.0729	9	0.04528	2157	2144 ± 7
	180	(3)	1.0657	6	0.03567	2128	
			1.0703	7	0.03795	2152	
NTN1	Biotite	7.65 ± 0.03	0.94491	6	0.06327	2057	2070 ± 10
	180	(3)	0.95104	5	0.04641	2065	
			0.96878	3	0.04624	2089	
NTN2	Biotite	8.07 ± 0.08	1.0453	11	0.05027	2117	2112 ± 8
	180	(3)	1.0276	6	0.05407	2096	
			1.04998	3	0.04719	2089	
NTN2	Biotite	8.19 ± 09	1.03152	11	0.04024	2082	2085 ± 14
	250	(3)	1.02516	3	0.05306	2074	
			1.01680	2	0.04433	2068	
NTN2	Hornblende	1.17 ± 0.02	0.15467	46	0.04343	2143	2169 ± 26
	180	(3)	0.16104	21	0.06894	2195	

Errors indicated are one standard deviation of the mean.

Figures in brackets are numbers of determinations.

Results and discussion

The results of the analyses are shown in Table 1. The agreement of the results of the analyses between the K-Ar biotite ages, 2144 ± 11 Ma and 2144 ± 7 , of the two NB samples is remarkable. Two of the NTN biotite samples also agree in age, namely 2070 ± 10 Ma and 2085 ± 14 Ma.

can be explained by the gradual cooling of the granitoid from the blocking temperature of the hornblende to that of biotite deep inside the craton (Fairbairn & Hurley, 1970; Cahen & Snelling, 1984).

It is too premature to say with certainty, from the biotite ages of the two granitoids obtained

here, whether or not they differ in their times of emplacement. It is certain, however, that both are older than most of the reported biotite ages referred to in this report, which are mainly for the G1 type granitoids. The results are not enough to conclude that generally the G2 granites are older than the G1 granites and more work needs to be done.

The emplacement of the granitoids could have been polymagmatic as has been suggested by Kesse (1985) in an attempt to explain the relationship between time and space of the various types of granites. One important factor in arriving at the apparent age which may have been overlooked is the size of the granitoid intrusion. It is easy to see how, in the process of cooling, the smaller intruded granitic mass may go through the biotite blocking temperature faster than the bigger mass will and hence appear to be older. If this hypothesis is correct, one should see a correlation between the biotite ages and sizes of granitoids of the same type.

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