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New Rb-Sr age of Kanara granite, South Kanara district, Karnataka State

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Abstract

New Rb-Sr isotopic age is presented for the porphyritic phase of Kanara batholith of South Kanara, Karnataka. The porphyritic granite has a good spread of Rb/Sr ratio and indicates an isochron age of 2681 ± 236 Ma with an initial ratio of 0.7022 ± 0.004. The observed low initial Sr ratio suggests its derivation from mantle without much crustal contamination.

Introduction

The western part of the South Kanara district of Karnataka State exposes a batholithic body of granite-granodioritic composition emplaced within a country rock of migmatised tonalitic gneissic complex. The area has been studied in detail by Balasubrahmanyan (1963–67) and the petrogenetic evolution as also the geochronological relationships between the different lithologic units have been established.

The Kanara batholith consists of granodiorite, quartz monzonite and granite forming a composite intrusive unit with pegmatite and aplite veins. The entire sequence of granite and gneissic complex is overlain by metasediments and metavolcanics of the Dharwar Supergroup.

Previous isotopic age data

Earlier, Balasubrahmanyan (1978) investigated the geochronology of the Gneissic Complex and the Kanara batholith and gave a minimum K-Ar age of 3200 Ma for the gneissic complex. On the other hand, three non-prophyritic granites of the Kanara batholith indicated a Rb-Sr isochron age of 2669 ± 60 Ma with an initial $^{87}Sr/^{86}Sr$ ratio of 0.7056. From trace element and isotope data it was concluded that the granite complex evolved due to partial melting of a tonalitic gneissic complex The field relations as also petrography suggested that the prophyritic phase and the pegmatite belonged to a later phase of granitic activity.

Present work

The present work forms a part of the detailed and continuous dating programme of the Geochronology and Isotope Geology Division, Geological Survey of India for the Precambrian granite-greenstone belt of Peninsular India. The data presented here are the first of this series and pertain to five whole-rock samples of granite of porphyritic phase collected from the central portion of the co-magmatic suite, north of Sitanadi (Toposheet Nos. 48K/14 and 48K/15) spread over a radius of about 10 km.

Petrographically, the porphyritic phase (sample SK 156) consists of microcline phenocrysts set in a matrix of biotite, oligoclase and quartz. Sometimes a gneissic texture has developed as in sample SK 155. Biotite granite (SK 64, SK 65, SK 73) is the most common type. This shows hypidiomorphic granular texture and is composed of plagioclase, biotite, microcline and quartz with accessory zircon and apatite. All the samples analysed in the present work are free from alteration: A more detailed petrographic description and chemical analysis of the member of the Kanara batholith is given by Balasubrahmanyan (1978).

For isotopic analysis each sample weighed at least 3 kg for biotite granite and minimum sample weight for the prophyritic granite was 6 kg.

Analytical procedure

$^{87}Rb/^{86}Sr$ ratios were calculated from Rb/Sr ratios determined by X-ray fluorescence method on pellets and the measured $^{87}Sr/^{86}Sr$ ratios. Norelco X-ray flourescence Spectrometer with Mo tube, LiF 220 analysing crystal and scintillation counter was used for analysis. For isotopic analysis of Sr, the usual method of ion-exchange chromatography was followed. The whole rock samples were dissolved in HF-$HClO_4$ medium and Rb was extracted with ethyl acetate. The sample solution minus Rb was passed through Dowex cation exchange resin. This usually yielded sufficiently pure Sr for isotopic analysis. However, the purified Sr was passed through a second cation exchange resin column in HCl medium to obtain a purer Sr. Isotopic analyses were carried out on a 30 cm radius, 60° sector mass spectrometer manufactured by Nuclide Analysis Associates. The measured $^{87}Sr/^{86}Sr$ ratios were normalised to a value of 8.375 for the $^{88}Sr/^{86}Sr$ ratios. The analytical error on $^{87}Sr/^{86}Sr$ is estimated at 0.4% and that on $^{87}Rb/^{86}Sr$ at 2.5%. The analytical errors on each determination are shown in Fig. 1.

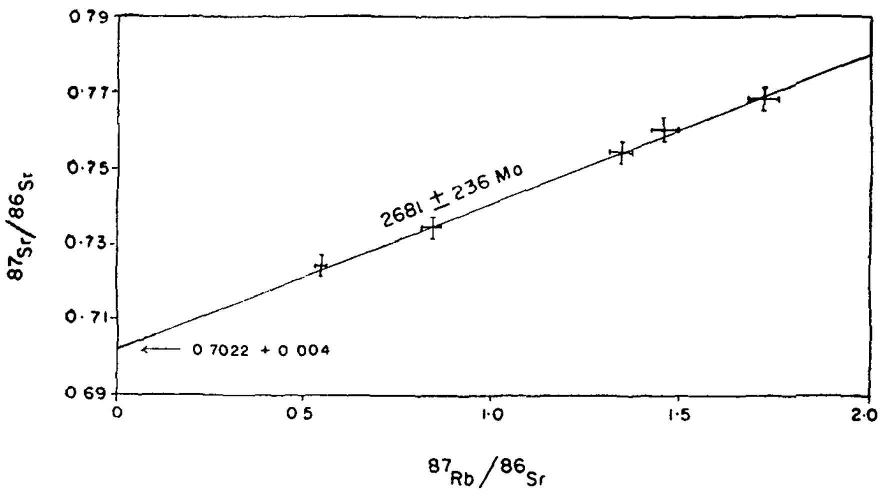

Figure 1. Rb-Sr isochron plot for Kanara granite. Data in Table I.

Results

The Rb/Sr ratios and the isotopic composition of strontium in respect of five porphyritic granite samples are given in Table I and the data is presented in an isochron diagram in Fig. 1. The best fit line has been calculated following Williamson (1968).

The porphyritic phase rocks (Table I) show a good spread in Rb/Sr ratios and define a 2681 ± 236 Ma (1σ) isochron age assuming a decay constant of $1.42 \times 10^{-11}a^{-1}$ The calculated initial ratio is 0.7022 ± 0.004. This age is very similar to the reported age of 2669 Ma determined by Balasubrahmanyan (1978) for the non-porphyritic phase of the Kanara batholith. Thus, even if the porphyritic rocks represent a different phase of magmatic activity, the time gap was not significantly different. In that case the present and the earlier data can be regarded as defining two parallel isochrons, the initial Sr ratio being higher in the non-porphyritic phase rocks. On the other hand, if the present data is regressed along with the earlier data of Balasubrahmanyan *(op. cit)* a slightly different isochron age of 2754 Ma (assuming $\lambda = 1.42 \times 10^{-11} a^{-1}$) is obtained. It is pointed out that the combined data is well correlated (correlation co-efficent, $r = 0.98$).

TABLE I. Analytical data for samples of South Kanara

Sample No.	Locality	Rock type	Rb/Sr	$^{87}Rb/^{86}Sr$	$^{87}Sr/^{86}Sr$
SK 73	Shirua - Kok-karani Road (13°28′ : 74°50′)	Biotite granite	0.187	0.542	0.7238
SK 65	East of Avarse (13°32′ : 74°52′)	- do -	0.289	0.836	0.7337
SK 64	- do -	- do -	0.458	1.331	0.7538
SK 156	Belave - Shirugoli Dodabalu Road (13°31′ : 74°55′)	Porphyritic granite	0.497	1.445	0.7596
SK 155	- do -	- do - (gneissic)	0.586	1.706	0.7688

Discussion

Initial Sr and Pb isotopic data provide a good evidence for evolution of igneous rocks. It is generally agreed that $^{87}Sr/^{86}Sr$ ratio in the upper mantle grew linearly from an initial value of 0.699 to a present day value of 0.703 in 4600 Ma corresponding to a Rb/Sr ratio of about 0.02 (Moorbath, 1977). In recent years the interpretation of the measured initial Sr isotopic ratio in continental igneous rocks has become more complex because of possible contamination by sialic crust. Thus rocks having initial Sr ratio in the range of 0.699 to 0.703 are believed to have been derived from the mantle. Rocks with higher initial Sr ratio generally imply derivation from the crust. With the increasing availability of isotopic data from different environments, it has been shown that various mechanisms such as Sr isotope exchange from the country rocks (Pankhurst, 1969), loss and addition of ^{87}Sr by post-consolidation alteration (Bottino *et al.*, 1970), or simple crustal contamination (Faure *et al.*, 1974) can significantly increase the Sr ratio. But the initial Sr ratio of 0.7022 obtained for the porphyritic facies rocks of the Kanara batholith would imply their derivation from the mantle (Brown, 1977) without significant crustal contamination. However, due to analytical uncertainty in the initial $^{87}Sr/^{86}Sr$ ratio, the nature of the source region of the Kanara batholith cannot be definitely postulated.

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