

PAN-AFRICAN ALKALI GRANITES AND SYENITES OF KERALA AS IMPRINTS OF TAPHROGENIC MAGMATISM IN THE SOUTH INDIAN SHIELD

M. Santosh¹, S.A. Drury² and S.S. Iyer³

¹Centre for Earth Science Studies, P.B. 7250, Akkulam, Trivandrum 695 031, India

²Department of Earth Sciences, The Open University, Walton Hall, Milton Keynes MK7 6AA, England, U.K.

³IPEN, CNEN/SP, Cidade Universitaria, Butanta, Sao Paulo, Brazil.

Granite and syenite plutons with alkaline affinities ranging in age from 550 to 750 Ma sporadically puncture the Precambrian granulites of the Kerala region. All the bodies are small (20-60 sq km), E-W to NW-SE elongated elliptical intrusives with sharp contacts and lie on or close to major late Proterozoic lineaments.

Mineralogically, perthitic K-feldspar is the dominant constituent of all the plutons. The modal Q-A-P contents mainly fall in the quartz-alkali feldspar syenite, quartz-alkali feldspar granite and granite fields. Greenish hornblende is the dominant ferromagnesian phase, with subordinate amounts of biotite. Minerals typical of alkaline plutons such as riebeckite, aegirine and acmite occur in some of the plutons. Melanite garnet, monazite, zircon, apatite, calcite, epidote and phlogopite are accessories.

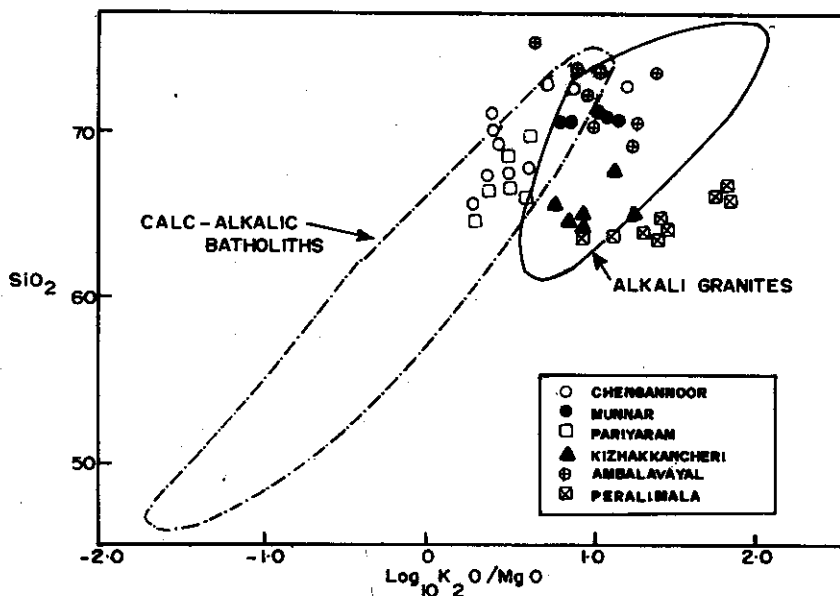


Fig.1 SiO_2 Vs. $\text{Log}_{10} \text{K}_2\text{O}/\text{MgO}$ plots of the Kerala granites (1)

Geochemical plots of A-F-M and An-Ab-Or relations show an apparent alkali enrichment trend on the former, but the plutons define relatively distinct fields on the latter. Most of the plutons are adamellite to granitic by chemistry. The variations of SiO_2 with $\log_{10} \text{K}_2\text{O}/\text{MgO}$ (1) brings out the distinct alkaline nature of the plutons (Fig. 1). Some of the granites are extremely potassic, like the Peralimala pluton, which shows upto 11.8% K_2O . On a $\text{SiO}_2 - \text{Al}_2\text{O}_3 - \text{Na}_2\text{O} + \text{K}_2\text{O}$ (mol %) plot, the plutons vary from peraluminous to peralkaline, but none are nepheline normative. Low MgO, low to moderate CaO and high $\text{Fe}_2\text{O}_3/\text{FeO}$ values are other common characteristics. Among trace elements, depletion of Ba, Sr and Rb with high K/Ba and K/Rb values are typical. Overall, the plutons show a trend of decreasing K/Rb ratio with increasing K content. Individual plutons show more clearly defined trends similar to those from granitic masses characterised by plagioclase fractionation. Many individual samples show greater Rb depletion relative to K than normal alkali granites.

In their analysis of means of discriminating granites from a variety of tectonic settings, Pearce et al (2) found the most useful elements to be Rb, Ta, Nb, Y and Yb. Plots of the Kerala plutons based on these parameters (eg. shown in Fig. 2) fall mainly in the volcanic arc granite field, close to the WPG-COLG-VAG triple point, except the Ambalavayal pluton which falls well in the within-plate field.

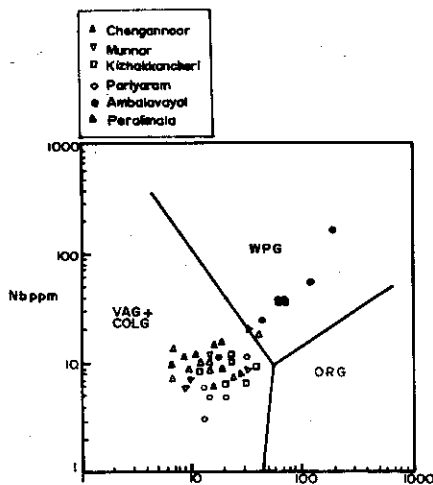


Fig.2 Nb Vs. Y plots of the Kerala plutons.

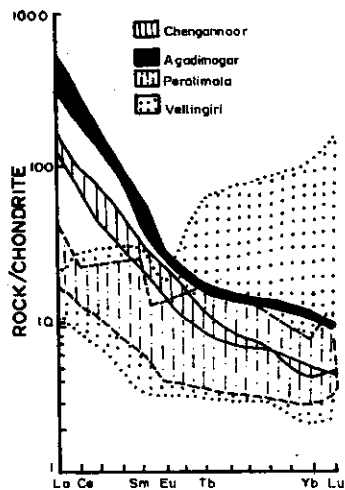


Fig.3 Chondrite normalised REE patterns of the Kerala plutons.

The total rare earth element (REE) contents in these plutons widely vary (32.4 to 425ppm) but show a close relationship with the agpaitic indices, the more alkalic plutons having low total REE levels. The chondrite normalised REE patterns (Fig.3) exhibit steep LREE to HREE slopes for some plutons whereas a few show HREE enrichment, attributed to variations in source compositions and/or subsequent fractionation history. Based on geochemical characteristics, the plutons could be regarded as two distinct groups. Those with lower K_2O , K_2O/Na_2O and K_2O/MgO as well as low agpaitic indices have high total REE levels, LREE/HREE ratios and $(Ce/Yb)_n$ values. These plutons exhibit steep LREE to HREE gradients and have no Eu anomaly. They also show low U and high Th values. The other group has markedly high K_2O , K_2O/Na_2O , K_2O/MgO and relatively higher agpaitic indices. These plutons show low total REE, LREE/HREE ratio, $(Ce/Yb)_n$ levels and consistently low U and Th values.

Petrogenetic considerations show that among the various models proposed for the origin of alkaline silicic plutons, decompression melting caused by crustal distension (3) is the most viable mechanism which could explain the generation of alkaline magmas in stable plate interiors as in the present case. The low initial Sr-isotope levels (0.7031-0.7032) for these plutons and the consistently high K/Rb values are consonant with this model and indicate a K-enriched Rb-depleted deep crustal or upper mantle source. Peralkaline plutonism is an essential part of pre-rift tectonics and is especially important in the early stages of tensional tectonics. Abnormal enrichment of alkalis is viewed to be the key-note of rift mechanism. Since the plutons are spatially related to regional fault-lineaments, some of which are taphrogenic in nature, it is envisaged that this alkaline magmatic regime is a probable manifestation of the pre-rift tectonics related to the taphrogenesis of the Indian continent and the supercontinent of which it was a part during the Pan-African.

REFERENCES

- (1) Rogers, J.J.W. and Greenberg, J.K. (1981) *Geol. Soc. Am. Bull.*, v. 92, pp. 57-93.
- (2) Pearce, J.A., Harris, N.B.W. and Tindle, A.G. (1984) *Jour. Petrol.*, v. 25, pp. 956-938.
- (3) Bailey, D.K. (1974) In: Sorensen, H. (Ed) *The alkaline rocks* John Wiley-Interscience, New York. pp. 148-159.