PETROCHEMISTRY OF THE GRANITE NEAR VANDANMEDU, IDUKKI DISTRICT, KERALA, INDIA

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ABSTRACT

The present study deals with the discordant granite pluton near Vandanmedu in Idukki district of Kerala, emplaced within the Precambrian metamorphics. Mineralogical and textural relations categorize the rock as granite. K_2O/Na_2O ratio indicates granite–adamellite range and A CNK value its peraluminous nature. K/Rb ratio suggests Rb depletion tendency and the major, trace element variations and critical trace element ratios Rb/Sr and Ba/Sr, suggest limited crystal fractionation. SiO_2, Na_2O+K_2O levels and Fe/Mg, Ga/Al ratios point to an A-type affinity. Relation of Ga/Al vs major oxides and agpaitic index further confirm the A-type nature. Since A-type granites are likely sources for Sn, Mo, Nb, W, Ta and F, further studies on these lines are suggested.

INTRODUCTION

THE Kerala region, forming part of the western continental margin of India, presents evidence of a tectogenetic episode during the Late-Precambrian–Early Palaeozoic period with associated rifting and granitic activity[1-4]. Several bodies of intrusive granites associated with this activity have been reported from this region. The granite of the present study occurs as a circular pluton covering an area of about 8 km^2 near Vandanmedu, in Idukki district of Kerala (figure 1).

GEOLOGICAL SETTING

The granite is medium to coarse-grained, emplaced within Precambrian crystallines which comprise biotite–hornblende gneisses (migmatite) and charnockite (figure 1). The granite body shows sharp contact with the surrounding country rocks. The regional strike is NNE with dips of 45–60° toward ESE. However, at places, due to development of marginal foliation and presence of pink appurtenances of granite in surrounding migmatite, the contact appears gradational.

There does not seem to be any disturbance of the structures in the host rock due to the emplacement of granite. This passive role of the country rock during emplacement coupled with the sinuous contacts, lack of internal structure, irregular shape and minor stoping structures at the border, categorises the pluton as a discordant type[5]. Small enclaves of biotite gneiss with locally diffused contacts are observed within the granite especially towards the periphery. The surrounding country rocks are polymetamorphosed with the biotite–hornblende gneiss indicating a retrogressive amphibolite facies overprinted on the original granulite facies prevalent in the area[6,7]. The age of the granite is not known. However, considering the occurrence of similar granites in other parts of Kerala region[2,4,8,9], a Late-Precambrian–Early Palaeozoic correlation is suggested for this granite.

PETROGRAPHY

The chief mineral constituents are K-feldspar, plagioclase feldspar, quartz, biotite ± hornblende; set in a hypidiomorphic granular texture. The predominating alkali-feldspar is the perthite variety of microcline. The plagioclase feldspar is myrmekitized and often corroded by the alkali-feldspar. Determination using universal stage on 24 grains of plagioclase indicates a range in composition from An_{95}–Ab_5 to An_{85}–Ab_{15}. The quartz occurs as anhedral grains with tongues projecting into adjacent mineral phases partially engulfing them. In addition, quartz occurs as small droplets within potash feldspar, small interstitial grains with irregular shape and also as myrmekitic quartz. Laths of brown pleochroic biotite constitute the major mafic component. Hornblende is very limited and often altered to granular aggregate with associated iron ores. Sphene and apatite are the chief accessories.

The modal composition of 8 samples, when plotted in the Q–A–P triangular diagram[10] falls in the granite field (figure 2). The isotropic nature of

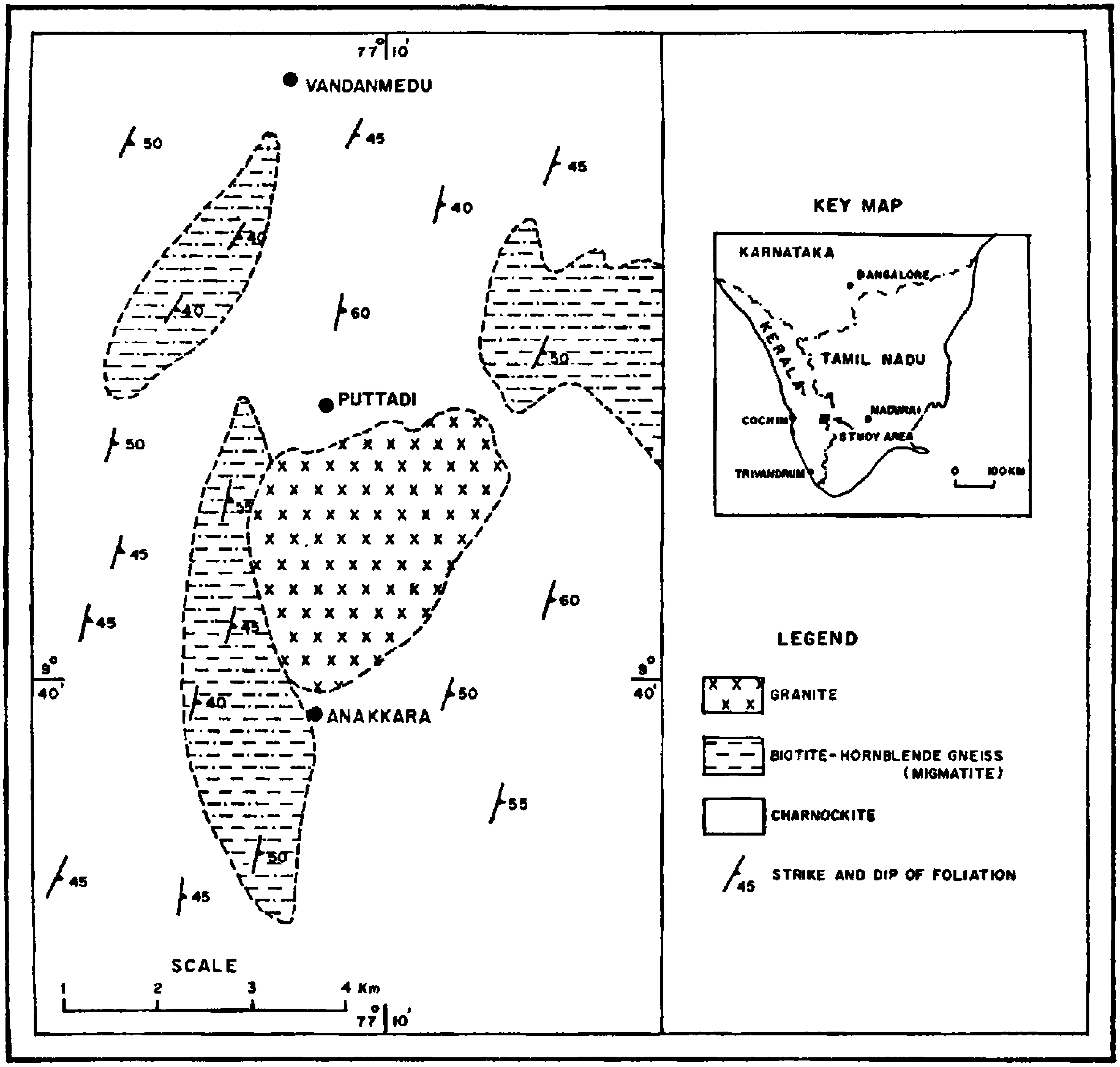

Figure 1. Geological map.

fabric and absence of strain induced recrystallization are suggestive of post-tectonic emplacement. The lower An content of plagioclase feldspar is a feature commonly noted in post-kinematic granites[11].

GEOCHEMISTRY

The chemical analysis of eight samples from the granite are presented in table 1. Pulverized (−200 mesh) and homogenized samples were analysed for major elements by the conventional wet chemical method, trace elements, Na and K by AAS. Georeference standards Sy_2, Sy_3 and MRG_1 were used to check precision. The analytical uncertainties are, for SiO_2 about 1%, Al_2O_3 and FeO about 2% and for the rest of major elements about 5% of the amount present. Regarding trace elements, the analytical uncertainty for concentration more than 100 ppm is better than 4% and for lesser concentrations about 10% of the amount present.

The SiO_2 and Al_2O_3 values indicate a granite to granodioritic nature. The K_2O/Na_2O values are

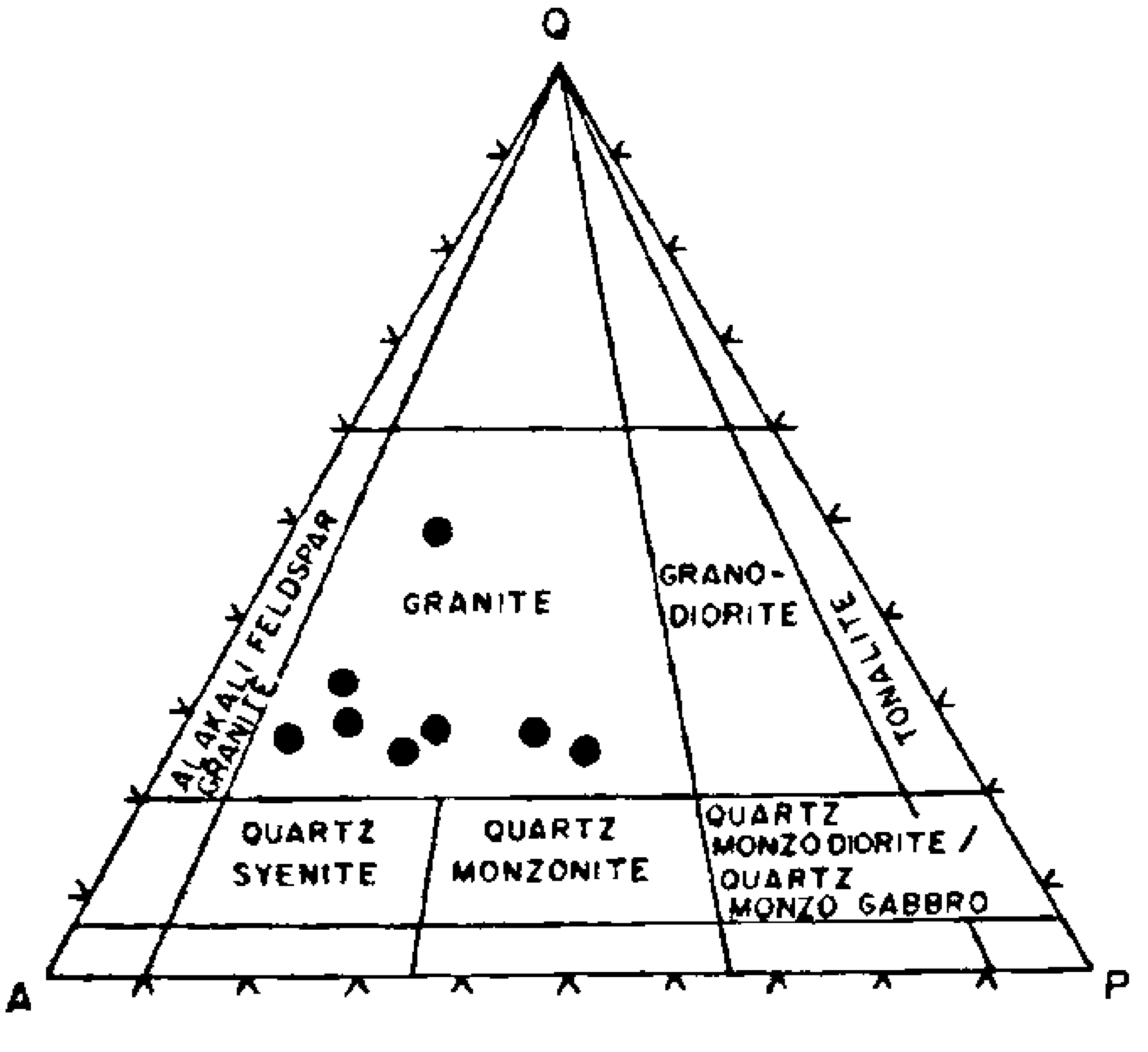

Figure 2. Q–A–P Triangular diagram[10].

generally above unity bringing out the potassic nature of the granite. The higher level of alkalies with dominance of K_2O (av. 4.49%) is a typical geochemical character noted in the post-tectonic granites of this region[12]. Based on K_2O/Na_2O ratios[13] the rock type chemically show granite–adamellite range (figure 3). Since the A/CNK values

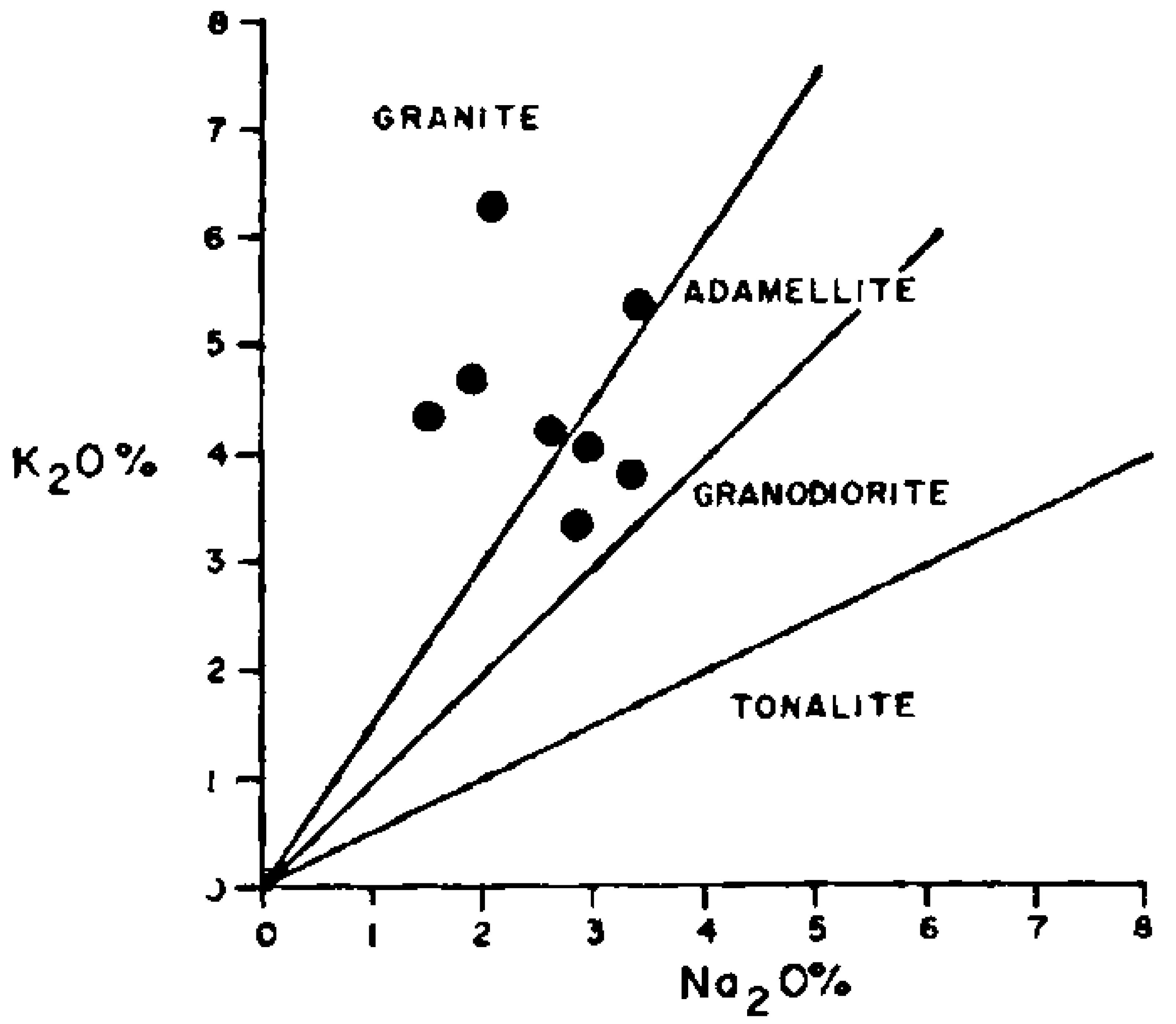

Figure 3. K_2O vs Na_2O diagram[13].

Table 1 *Chemical composition of eight samples of granites from Vandanmedu*

Sample No.	Gr 1	Gr 2	Gr 3	Gr 4	Gr 5	Gr 6	Gr 7	Gr 8	Range	Mean	SD
SiO_2	71.05	76.54	72.26	72.13	72.38	71.76	69.09	72.70	69.09–76.54	72.24	2.08
Al_2O_3	14.78	11.73	14.28	14.28	15.28	14.77	17.33	14.28	11.73–17.33	14.59	1.54
FeO	0.66	0.18	0.52	0.62	0.65	0.97	0.90	0.80	0.18–0.97	0.66	0.25
Fe_2O_3	0.90	2.05	2.35	1.86	1.03	1.23	1.15	1.60	0.90–2.35	1.52	0.53
CaO	1.12	1.35	1.57	1.79	1.34	1.12	1.79	1.35	1.12–1.79	1.43	0.27
MgO	0.64	0.16	0.81	0.81	0.64	0.48	1.12	0.97	0.16–1.12	0.70	0.30
Na_2O	3.40	1.85	2.83	2.90	3.30	2.08	2.53	2.46	1.85–3.40	2.67	0.55
K_2O	5.30	4.70	3.34	4.07	3.79	6.20	4.13	4.37	3.34–6.20	4.49	0.91
TiO_2	0.84	0.18	0.41	0.25	0.26	0.17	0.21	0.30	0.17–0.84	0.33	0.21
MnO	0.21	0.01	0.06	0.04	0.04	0.01	0.01	0.02	0.01–0.21	0.05	0.06
Moist	0.17	0.40	0.18	0.24	0.17	0.13	1.05	0.16	0.13–1.05	0.31	0.30
LOI	0.38	0.12	0.40	0.50	0.39	0.27	0.36	0.20	0.12–0.50	0.33	0.12
P_2O_5	0.07	0.05	0.05	0.07	0.02	0.02	0.02	0.09	0.02–0.09	0.05	0.03
Rb	88	128	83	69	100	170	124	114	69–170	110	30
Cu	8	5	11	14	1	2	2	8	1–14	6	4
Ba	308	367	277	232	480	200	255	238	200–480	295	85
Bi	128	28	94	106	nf	6	3	102	0–128	58	51
CO	78	78	46	42	52	70	39	41	39–78	56	16
Ni	104	91	90	97	120	52	52	99	52–120	88	23
Zn	98	52	56	40	52	15	14	21	14–98	44	26
V	160	nf	30	20	60	—	—	20	0–160	48	53
Pb	18	114	27	28	52	65	59	6	6–114	46	32
Ga	37	46	31	27	38	16	58	30	16–58	35	12
Sr	354	46	527	652	507	214	106	627	106–652	379	220
Mo	nf	nf	nf	nf	14	25	nf	nf	0–25	5	9
Cr	151	83	212	138	—	—	—	111	83–212	139	43
Li	13	5	13	13	—	—	—	15	5–15	12	3

Major and minor elements in wt. %
Trace elements in ppm
nf, not found; — not determined.

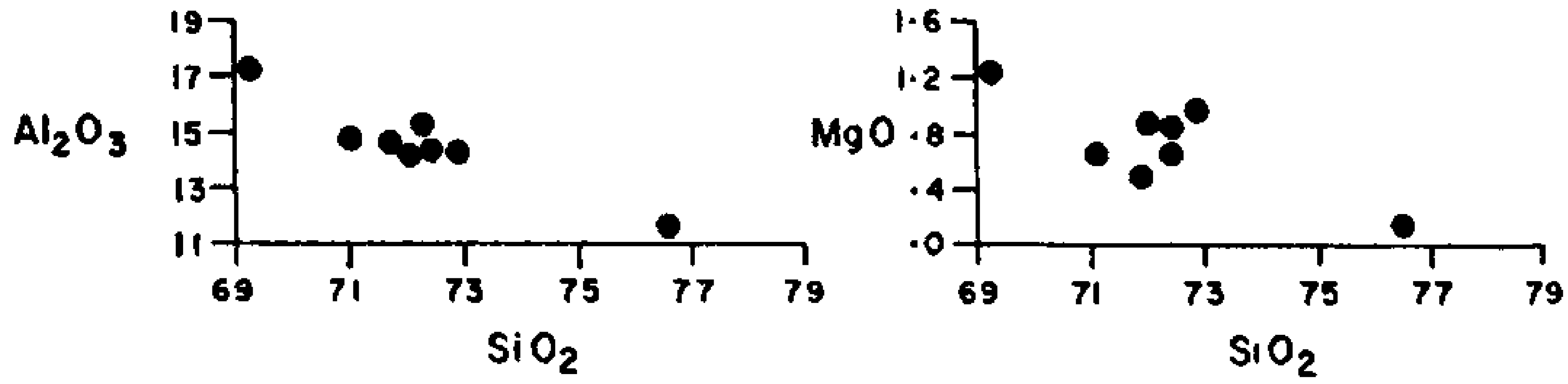

Figure 4. Harker variation diagram for MgO and Al_2O_3.

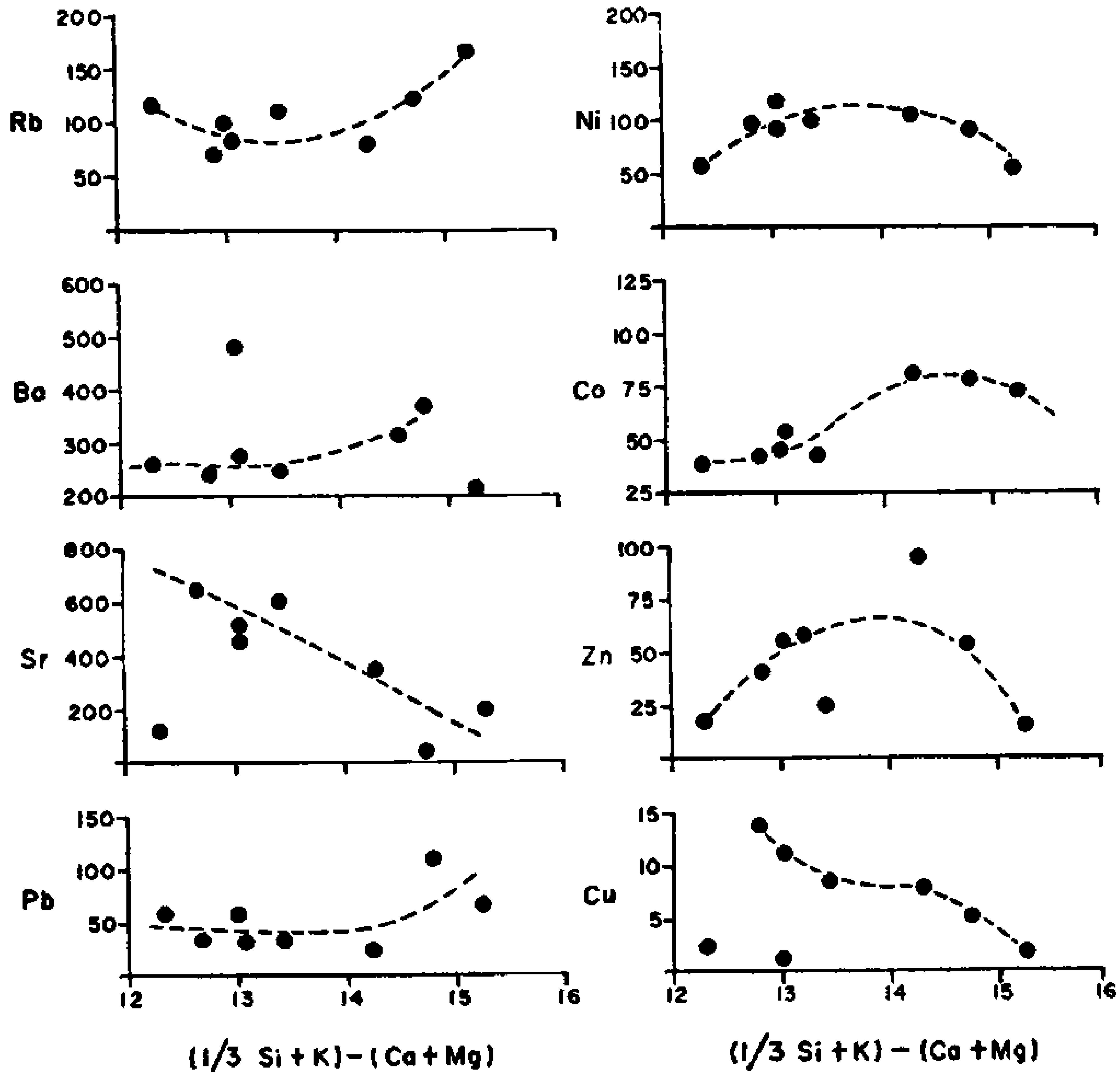

Figure 5. Variation diagrams—(1/3 Si+K)−(Ca+Mg) vs trace elements.

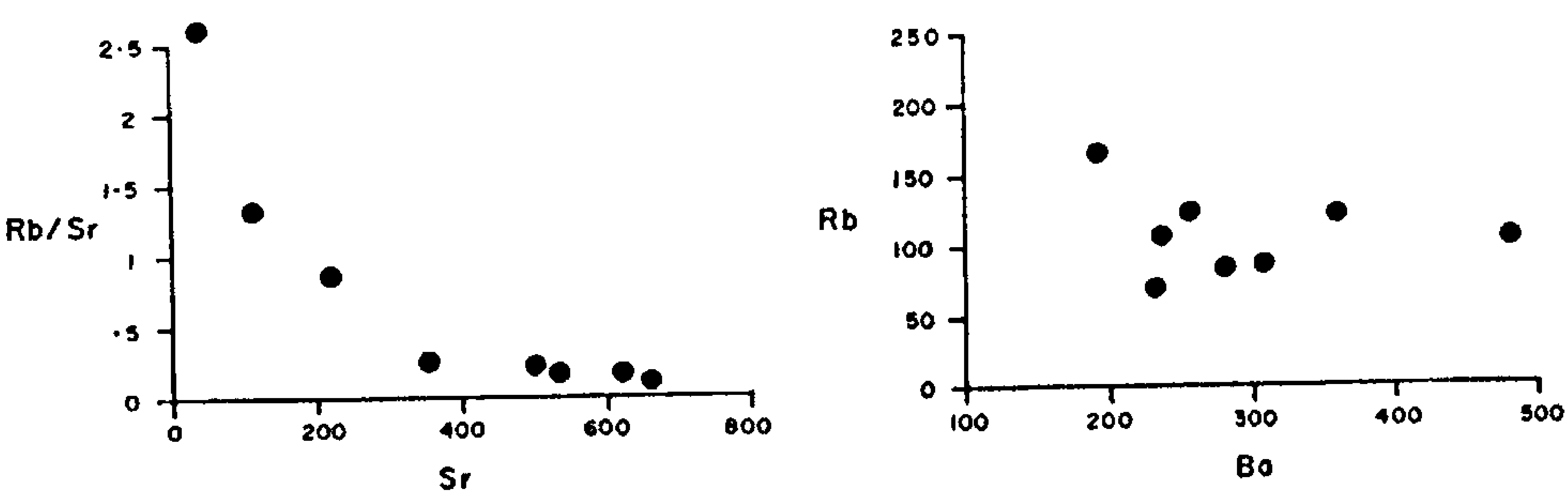

Figure 6. Rb/Sr vs Sr and Rb vs Ba plots.

of the granite range from 1.11 to 1.67 the granite could be categorized as peraluminous[14].

Harker variation diagrams in respect of Al_2O_3 and MgO are given in figure 4. Variation of trace elements is plotted against the index of differentiation (1/3 Si + K)-(Ca + Mg) (figure 5). K/Rb ratio ranges from 256 to 490 (av. 321) indicating a Rb depletion tendency. Critical trace element variation such as inter-dependence of Rb and Rb/Sr with Ba and Sr respectively (figure 6) indicates crystal fractionation

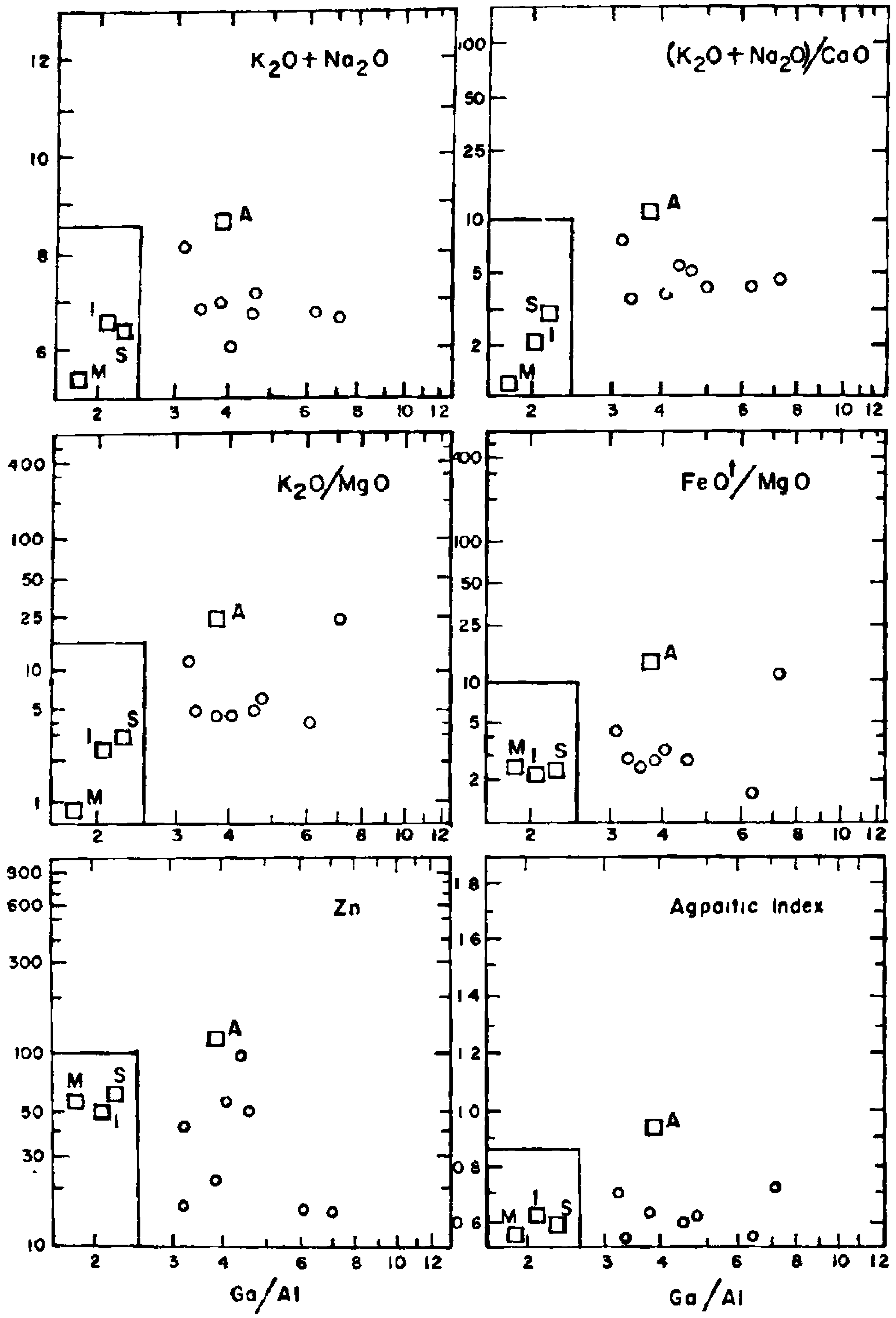

Figure 7. Ga/Al vs K_2O+Na_2O, $(K_2O+Na_2O)/CaO$, K_2O/MgO, FeO^t/MgO, Zn and agpiatic index plots. Coordinates indicate field of I-, S- and M-type granites. Square boxes are I-, S-, M- and A-type granite averages[26].

as an inherent process in the evolution of this granite[15].

DISCUSSION

Geochemical characters of the granite favour an igneous source. A genetic classification has been suggested for granitic rocks into those originated from sedimentary protoliths (S-type) and those evolved from igneous protoliths (I-typ)[16]. Subgroups of I-type granites are those derived from recycled, dehydrated continental crust (A-type)[17,18] and those evolved directly from subducted ocean crust or overlying mantle (M-type)[19-21]. The present granite with its moderately high SiO_2, Na_2O+K_2O, Fe/Mg, Ga/Al and low Ba and Sr is comparable with the A-type[17,18,22]. It was demonstrated that good discrimination can be obtained between A-type granites and most orogenic granites (M–I- and S-type) in plots employing Ga/Al ratios[23]. Figure 7 shows plots to Ga/Al vs K_2O+Na_2O, K_2O/MgO, $(K_2O+Na_2O)/CaO$, FeO/MgO, Zn and agpiatic index. All plots of samples clearly fall away from M–I–S-type granite field and indicate their A-type designation.

A-type granites are currently considered to represent the final plutonic event in both orogenic belts and the rift-related anorogenic magmatism of shield areas[23]. It has been suggested that the younger granite bodies of Kerala region are associated with the taphrogenesis of the continental margin[12,24,25] and many of the major lineaments in this region are rift-related[26]. Similar granite plutons in this region are correlated with the Pan-African thermotectonic regime recognized in other shield areas[12].

Among the petrogenetic models suggested, the partial melting model[18,27-30] seems to be more applicable in the present case. The granulite country rocks would have served as a viable source of dehydrated reasonably sialic crest for the generation of the magma. The attainment of the high melting temperature ($>830°C$) required to partially melt this dehydrated granulitic source to generate A-type granite magma might have been achieved by the emplacement of mantle derived mafic magmas into the lower crest. The fracture lineaments which are rift-related[26] and prevalent in the region must have served as conduits to lead the magma to high level. A-type granites are economically potential source for Sn, Mo, Nb, W, Ta and F[18,20]. Further investigations are needed to confirm the economic potential of these types of granites in Kerala region.

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