behaviour of natural lakes. This logistic model approach will be of use in segregating lakes according to their behaviour. The accuracy and validity of the logistic model approach to predict the dynamical behaviour depends mainly on the computation of the strength of nonlinearity.

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Petrogenesis and tectonic setting of Malani rhyolites: Evidence by trace elements and oxygen isotope composition

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The trace element and oxygen isotope studies of Malani rhyolites from Gurapratap Singh and Diri area, district Pali, Rajasthan, indicate rift-related, within-plate nature of these rhyolites. The rhyolites have probably been derived by partial melting of crustal rocks.

THE Malani volcanism marks a late proterozoic tectonomagmatic event over an area of 50,000 km^2 in western and southwestern Rajasthan[1]. The rocks are exposed in isolated hills and ridges and are characterized by a preponderance of rhyolitic rocks over the intermediate and basic rocks. The present communication describes in brief the results of trace element and oxygen isotope studies of Malani rhyolites from Gurapratap Singh and Diri area, district Pali, Rajasthan (latitude 25°35′–25°40′N and longitude 73–73°10′E). The study volcanics are confined to hill ranges running E–W to NE–SW in semiarcuate fashion and have been extruded on a basement of argillaceous rocks belonging to the Aravalli or Delhi Supergroup.

The rhyolites from Gurapratap Singh and Diri area are fine-grained/glassy and sparsely phyric[1]. The phenocrysts are mainly of plagioclase feldspar and quartz. The presence of devitrified glass shards, angular phenocrysts of feldspar and collapsed pumice fragments indicates tuffaceous nature of these volcanics[2], though a few true rhyolite flows have also been encountered in the area.

Table 1. Major (wt %) and trace element (ppm) analyses, CIPW norms and oxygen isotope composition of Malani rhyolites from Gurapratap Singh and Diri, Pali district, Rajasthan. Major element data are from Srivastava *et al.*[1] (WR – whole rock, Qtz – quartz mineral separate)

	D41	G151	G25	G24
SiO_2	73 08	75.11	75 11	76 56
TiO_2	0.2	0.22	0 17	0 03
Al_2O_3	14.85	12.91	14 30	13 44
Fe_2O_3	1.14	1 63	1 64	0 57
FeO	0.72	0 2	0 12	0 4
MnO	0 05	0.03	0 01	0 01
MgO	0 08	0.2	0 19	0.19
CaO	0.8	1.3	0 85	0.32
Na_2O	3.05	2 7	2.35	0 55
K_2O	5.0	4 4	3 65	7.0
P_2O_5	0 09	0 03	0.02	0 0
LOI	0.8	1.2	0.6	0.0
Total	99 86	99 93	99 01	99 07
Rb	224	220	136	332
Ba	501	402	949	582
Sr	85	63	41	14
Zr	242	196	158	65
Th	28	26	17	18
Y	79	110	65	111
Nb	19	19	15	17
La	56	68	32	29
Ce	139	138	65	47
V	5	15	7	6
$\delta^{18}O$	2.61WR		9.19Qtz	11.94WR
CIPW norms				
q	34 80	39 66	44 10	45 54
or	29.47	26 13	22.24	41 14
ab	25.68	22.53	20.96	4 72
an	3.06	6.39	4 17	1 67
c	3 26	1.33	4 59	4.39
hy	0 46	0.50	0 50	0 76
mt	1.61	–	–	0 70
hm	–	1.60	1 60	–
il	0.30	0 50	0 30	–
ap	0 23	–	–	–

The trace element analyses were done by XRF using a Philips PW 1400 spectrometer on powder pellets according to international recommended methods[3,4] at Istituto di Mineralogia, Dell Universita, Italy. The oxygen isotope determinations were made at Labise, UFPE, Brazil. The experimental data are reported in the standard s notation, with all data reported relative to SMOW. NBS 28 was used as a standard reference material and is defined as +9.60 per mil SMOW.

The major, trace and oxygen isotope data are presented in Table 1. The rhyolites are characterized by diagnostic features of A-type (anorogenic) granitoids[5,6], i.e. high SiO_2, K_2O/Na_2O, Fe/Mg, Nb and Y contents and low CaO and Sr contents. The peraluminous nature of rhyolites is manifested by the appearance of normative corundum (up to 4.59). The alkali content in rhyolites ranges from 6 to 8.05%, though one of the rhyolites (G24) had a high K_2O content (7%).

On the Nb vs Y and Rb vs Nb + Y tectonic discrimination diagrams[7], the rhyolites fall in the field of within-plate granites (Figure 1). Utilizing the multielement spiderdiagram (Figure 2), the within-plate character of these rhyolites is emphasized. Rb and Th are significantly enriched relative to Nb. The rhyolites show

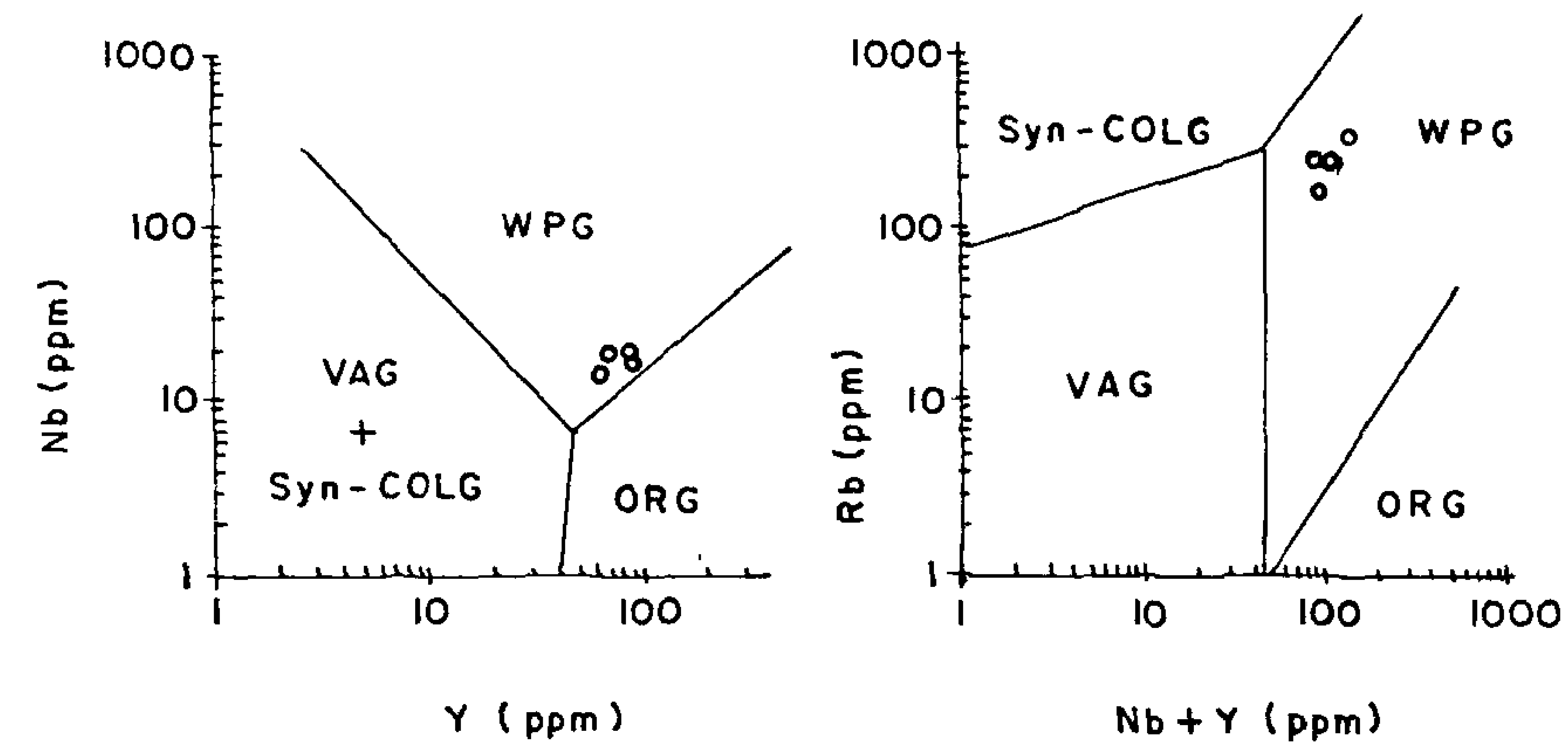

Figure 1. Distribution of Malani rhyolites on the Nb–Y and Rb–Nb + Y tectonic discrimination diagrams of Pearce *et al*[7]. WPG – within-plate granite; VAG – volcanic-arc granites; SYN-COLG – collision granite; ORG – ocean-ridge granite.

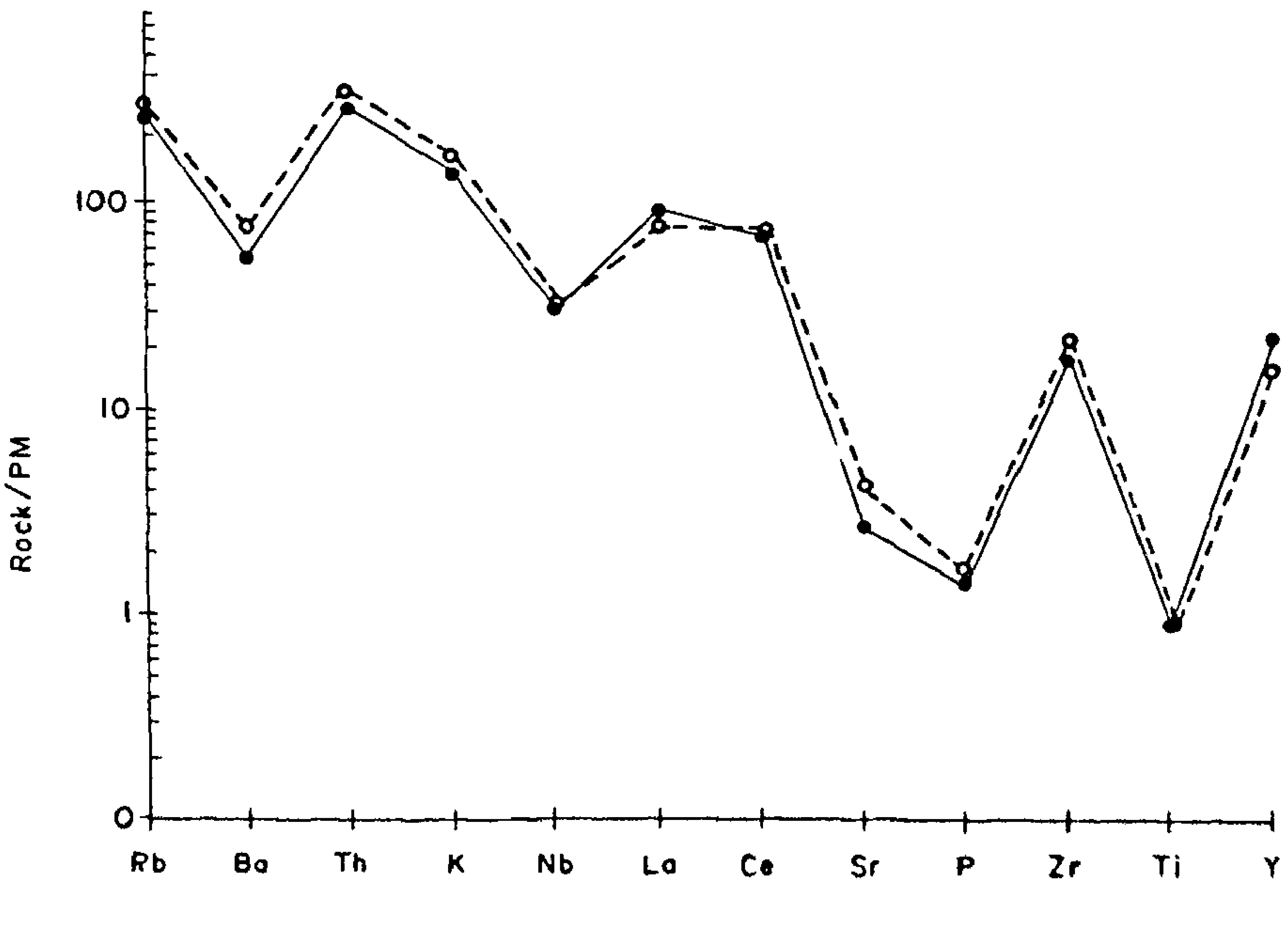

Figure 2. Normalized incompatible element abundance pattern for the Malani rhyolites G151 (●) and D41 (○). Primordial mantle data for normalization are from Wood *et al*[12]

a feature typical for rift-related granitoids, namely, the presence of a pronounced negative Ba anomaly[8] and a general increase in normalized abundance from Y to Rb. Such enrichment of rhyolites in Rb, Th and Ce may be attributed to crustal involvement in their genesis[9].

Oxygen isotope analysis is a comparatively unambiguous means of separating the relative contribution of crust and mantle. Most continental granitic rocks have s ^{18}O values between +6 and +9 per mil. Low s ^{18}O values (< 6 per mil) in granitic rocks are produced by interaction with large hydrothermally convecting reservoirs of meteoric water; high s ^{18}O values (> +9 per mil) are generally assumed to be produced by melting or massive assimilation of high s ^{18}O crustal rocks[10]. A high-temperature hydrothermal process may result in the lowering of whole rock s ^{18}O; however, the quartz s ^{18}O would not deviate and hence may be used to correct whole-rock s ^{18}O in such cases.

Oxygen isotopic compositions of study rhyolites are presented in Table 1. As the studied rhyolites are sparsely phyric, only one sample could be analysed for its quartz s ^{18}O. The lower whole-rock s ^{18}O of one sample (D41) may be attributed to high-temperature hydrothermal solutions acted on these rhyolites. The quartz s ^{18}O of one sample gave a value of 9.19 per mil, indicating the extensive interaction with s ^{18}O-rich supracrustal rocks during the generation of these rhyolites. Interestingly, these rhyolites at places are underlain by argillaceous rocks.

To conclude, the Malani rhyolites from Gurapratap Singh and Diri area are chemically equivalent to A-type granites. They have chemically patterns similar to rift-related, within-plate granites and rhyolites. Most probably, rhyolites were formed by partial melting of crustal rocks at elevated temperatures. The conclusion is in agreement with the views expressed by earlier workers[10,11]. A detailed paper on the petrogenesis of these rhyolites is under preparation.

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An alkaline lamprophyre (*Camptonite*) from Ravipadu, Prakasam province, Andhra Pradesh, India

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An alkaline lamprophyre (*camptonite*) dyke cuts across, and extends beyond, the sub-alkaline gabbro pluton of Ravipadu in the Prakasam province of Andhra Pradesh, India. The rock is characterized by porphyritic and panidiomorphic textures with phenocrysts of olivine and clinopyroxene that are set in a mesostasis of clinopyroxene, olivine, biotite and plagioclase. When compared to average alkaline lamprophyre and camptonite, the lamprophyre of Ravipadu has higher amounts of SiO_2 and MgO, similar amounts of Al_2O_3, CaO, Na_2O and K_2O, and lesser amounts of Fe_2O_3, TiO_2 and P_2O_5. The rock is 'sodi–potassic' and alkaline in character. The rock is enriched in Cr, Ni and Ba and depleted in V, Zn, Sr, Y, Zr and Nb; it has very low contents of U, Th, Pb, Ga, Cu and Sc, and moderate of Co and Ta. The lamprophyre is enriched in LREE and depleted in HREE [$(La/Lu)_N = 17.86$; $(Ce/Yb)_N = 9.27$]. Based on olivine liquid exchange equilibria (K_D), it is deciphered that the lamprophyric magma was in equilibrium with an olivine of $Fo_{84.2}$ with liquidus temperature of 1277°C. The lamprophyre was possibly derived from the host gabbro as a late-stage differentiate.

LAMPROPHYRES represent the latest magmatic event in the Prakasam province of Andhra Pradesh[1]. They cut across the alkaline plutons of Elchuru[2], Settupalle[3], and Purimetla[4] and sub-alkaline (tholeiitic) gabbro pluton of Kellampalle[5]. The present report deals with a new occurrence of lamprophyre cutting across, and extending beyond, the sub-alkaline (tholeiitic) gabbro pluton of Ravipadu (79°47′13″E; 15°29′49″N) in the Prakasam province.

The lamprophyre, trending NS with a dip of 85°E, occurs as a dyke (18 m long and 0.3 m wide) at a place 3.2 km SW of Ravipadu. It has sharp contacts with host gabbro and amphibolite, and is devoid of chilled margins,