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Lree and Y in Enriched Darsi Granite Prakasam District Andrapradesh

Janaki Vallakeerthi[1], Dr. G. Nagendra Babu[2], Prof. I. Pandu Ranga Reddy[3]

[1]Research Scholar, Department of Geology, Osmania University, Hyderabad
[2]Ex-Scientific Officer, Atomic Mineral Directorate, Exploration and research Begumpet, Hyderabad
[3]Professor, Department of Geology, Osmania University, Hyderabad.

Abstract

Rare earth elements (La to Lu, Y and Sc) importance increased with the advent of domestic and industrial uses. Rare Earth Elements (REE) are indispensable to the production of future generation automobiles such as hybrid and electric cars. Rare earth metals are also called as *'Critical Metals'* and are used for high efficiency, high performance and to reduce the body weight of the automobile vehicle. Any country wishing to advanced technology to practical use needs to secure rare metal resources. The REEs occur in rock forming minerals, younger granites, pegmatites, and in riverine and beach placers. A series of granite plutons are sandwiched between the eastern margin of Cuddapah Basin and Eastern Ghat Belt (EGB) and traced from Vinukonda in the north to Pamuru in the south. These granites are intrusive into the Nellore Schist Belt (NSB) and age range from 995 Ma to 1600 Ma. The granite of Darsi is one such pluton and occur 50 km north east of established rare metal and rare earth bearing Kanigiri granite. The granite samples (n=12) were analysed for REE and Y. The analysis indicates very high values of La (65 -220 ppm), Ce (134-374 ppm), Pr (13 – 38 ppm), Nd (43- 142ppm), Sm (7 – 26 ppm), Y (39-129ppm), LREE (271 -813 ppm), and HREE (13 - 46 ppm). The granite samples show enrichment of LREE over HREE.

Keywords: Darsi, Kanigiri, Nellor Schist Belt, Granite and REE.

1. Introduction

The Proterozoic felsic and mafic magmatism has been witnessed at the western and eastern margin of Cuddapah Basin **(Seshasai, 2013).** Mantle-derived magmas, have contributed significantly in the evolution of calc-alkaline, meta-luminous (I-type) to peraluminous (S-type) granites formed in subduction to post-collision tectonic zones. Anorogenic (A-type) granites are commonly reported in post-collision to rift environments. Majority of the granites are aged between Palaeo-Proterozoic to Meso-Proterozoic. Granites of Neo-Proterozoic are also reported in India. As a whole, Proterozoic mafic-felsic magmatism contributed greatly in the crustal architecture and evolution of Indian subcontinent (**Santosh Kumar etal., 2020).** Write the research paper's title and keywords in Title Case (capitalize first character of each word). However, write common words like a, an, the, using, for, among etc. in lower case in both title and keywords. A series of granite plutons of varying dimensions are located along a NE-SW trending deep seated crustal fracture within the NSB, from north of

Vinukonda (Guntur district) to the south of Pamuru (Prakasam district), in Andhra Pradesh. There is a narrow belt of schistose rocks belonging **to' Nellore Schist Belt-(NSB)**'. Sandwiched between the eastern margin of Cuddapah Basin (CB) and the Eastern Ghat Mobile Belt (EGMB), all these granites are intrusive into the NSB and are dated around 1600 Ma **(Sastry, 2016 and Gupta etal., 1984)**.The study area is 5km NW of Darsi town and 20km NE of Podile. The granites occur as three isolated hillocks and are found in NE-SW trend, occupying an area approximately 90 Sq.km and are exposed west of Darsi, between Bandavelikandla - Tsalivendra - Pe**d**dakaltiappa in parts of toposheet number 57 M/9 **(Fig-1).**

2. Geology of the Area

Granites of study area are pale to dark grey, coarse to very coarse (pegmatoidal), crude foliation with visible specks of fluorite and pyrite, associated with syenites, calc-silicates, grano-diorites, dolerites, quartzites and schistose rocks **(Rao,1974)**. Fluorite is found as disseminations and as thin veinlets within granites. Fluorite is a late- stage mineral in granite and other magmatic rocks. These are traversed by calcite veins, quartzo-feldspathic veins and quartz veins. Xenoliths or enclaves of undigested portion of parent rock are observed. Alterations like silicification, ferruginisation, and sericitisation are noticed. These granites are emplaced along the contact of chlorite schist, agglomerate tuffs and intercalated quartzite belonging to Udayagiri Group of rocks and younger granites and basic intrusives of Nellore Schist Belt. The stratigraphy of the study area is detailed in **Table-1 (Srinivasan and Roopakumar, 1995).**

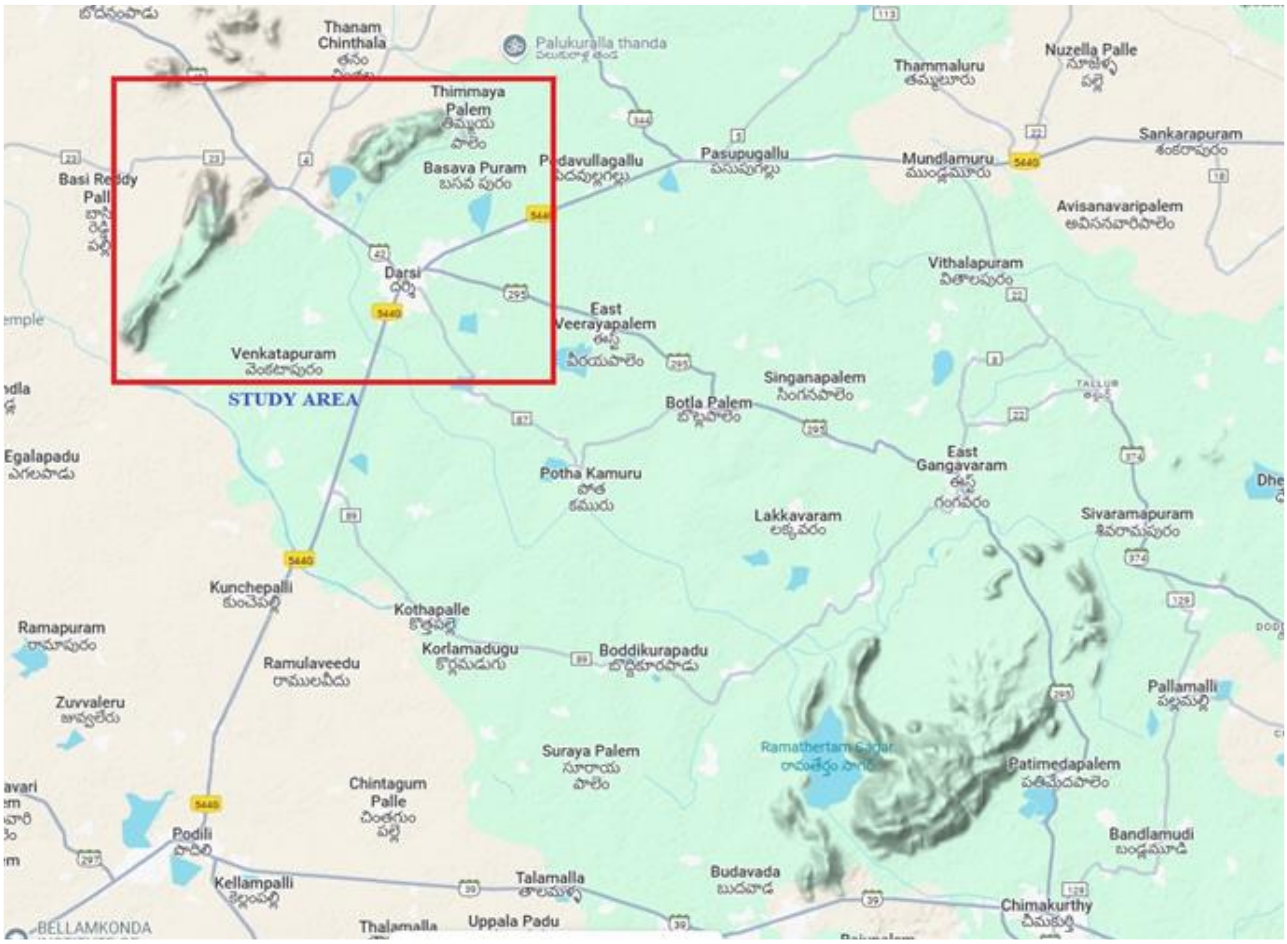

Fig-1: Location map of study area (Darsi), Prakasam District, Andhra Pradesh.

Table 1: Generalised stratigraphic succession of the study area

	Formation/ Complexes	Lithology / Rock units
	Prakasam Alkaline and Non-alkaline Complex (PANIC)	Alkali and Alkali feldspar granite (Kanigiri/ Podile/ Darsi), gabbro-norite dykes, syenites, gabbro variants, pyroxenites (Inukruti / Chima-kurti)
		Alkali lamprophyres, nepheline syenites (Elchuru /Purimetla / Uppalapadu / Settupalli / Kommala-padu /Pasupugallu)
Nellore Super-group	**Mafic Dykes (Phase II, >1600 Ma)**	Dolerite dykes
	Udayagiri Group (Sitaram Puram Formation)	Quartz-chlorite schist ±sericite, muscovite, with intercalated quartzite(upper), (interbanded with basic and acid volcanics and mafic -ultramafic rocks)

3. Geochemistry

3.1 Rare Earth Elements (REE)

All the samples (n=12) were analysed by inductively coupled plasma emission mass spectrometry (ICP-MS) for all the elements from La to Lu, Y and Sc and are given **table-2.** The analytical data of Darsi granite is compared with the data of Low Calcic granite (**Turekian and Wedepohl, 1961).** Values of both the granites are compatible and synchronous. The data of granites assayed La(65-220ppm); Ce(134-374ppm); Pr (13-38); Nd(43-142ppm); Sm(285-844ppm); Y(39-129ppm); Total REE (285-844ppm); LREE (271-844ppm); HREE(13-46ppm) and LREE/HREE ratio varies from 9.84 to 20.11. The REE data is in ppm and normalized by chondrite values of **Boynton (1984)** for preparing spider diagram. The REE data of granites show strong europium anomaly with minor variation. This may be due to crustal contamination during granite ascent to the surface. **(Fig-2).** The europium anomalies are chiefly controlled by feldspars, particularly in felsic magmas. Thus, the removable of feldspar from magmatic melt by crystal fractionation or by the partial melting of a rock in which feldspar is retained in the magmatic source will lead to a **negative Europium anomaly (Rollinson.1992).**

Table-2: Rare Earth Elemental analysis of Darsi Granite, Prakasam district, Andhra Pradesh

REE (ppm)	Low Ca gran-ite#	DR/ 6	DR/ 7	DR/ 8	DR/ 9	DR/ 10	DR/ 11	DR/ 12	DR/ 13	DR/ 14	DR/ 15	DR/ 16	DR/ 17
La	**55**	147	167	65	111	161	122	206	136	220	149	108	135
Ce	**92**	275	309	134	199	279	213	381	227	374	276	195	236
Pr	**8.8**	22	25	13	15	22	20	31	22	38	23	20	20
Nd	**37**	103	122	43	70	73	74	118	80	142	81	74	70
Sm	**10**	19	21	7	16	12	13	26	15	23	18	14	16
Eu	**1.5**	1.2	0.5	0.5	0.9	0.59	0.76	1.45	0.67	0.34	0.44	0.36	0.61

Gd	**10**	14	17	9	12	14.66	9.76	21.03	9.84	16.93	15.79	11.62	14.35
Tb	**1.5**	3	3	1.7	1.5	1.98	2.04	2.64	2.24	3.27	2.34	2.36	2.09
Dy	**7.0**	12	16	7	14	17.19	14.44	17.89	14.09	`19.79	16.19	16.60	14.61
Ho	**2.0**	1.5	3	1.8	2.4	3.45	2.93	3.49	3.15	3.74	3.50	3.37	3.02
Er	**4.0**	7	9	3	10	11.13	8.52	10.17	8.40	9.41	9.85	9.20	9.12
Tm	**4.0**	1.6	1.8	2.3	2.7	1.70	1.20	1.46	1.17	1.32	1.62	1.25	1.24
Yb	**1.2**	7	8.8	3.5	12.3	9.42	9.81	8.32	7.75	10.59	6.70	8.80	7.38
Lu	**3.9**	1.4	1.5	0.5	1.5	1.60	1.80	1.86	1.60	1.93	1.38	1.48	1.30
Y	**40**	76	83	39	93	68	104	87	105	129	72	107	62
Sc	**7.0**	2.5	2.7	3.0	2.4	1.0	4.0	1.0	4.0	4.0	<1.0	1.0	<1.0
∑REE	**247.90**	614.60	674.60	285.00	468.30	609.70	492.93	829.89	529.82	844.21	605.27	466.74	528.71
∑LREE	**224.30**	581.20	631.50	271.50	423.90	565.21	452.19	786.06	491.42	813.95	563.69	423.68	489.95
∑HREE	**23.60**	33.40	43.10	13.50	44.40	44.99	40.74	45.83	38.40	30.26	41.58	43.06	38.76
LREE/HREE	**9.50**	17.40	14.65	20.11	9.55	12.56	11.10	17.15	12.80	26.90	13.55	9.84	12.64

 # Turekian and Wedepohl, 1961.

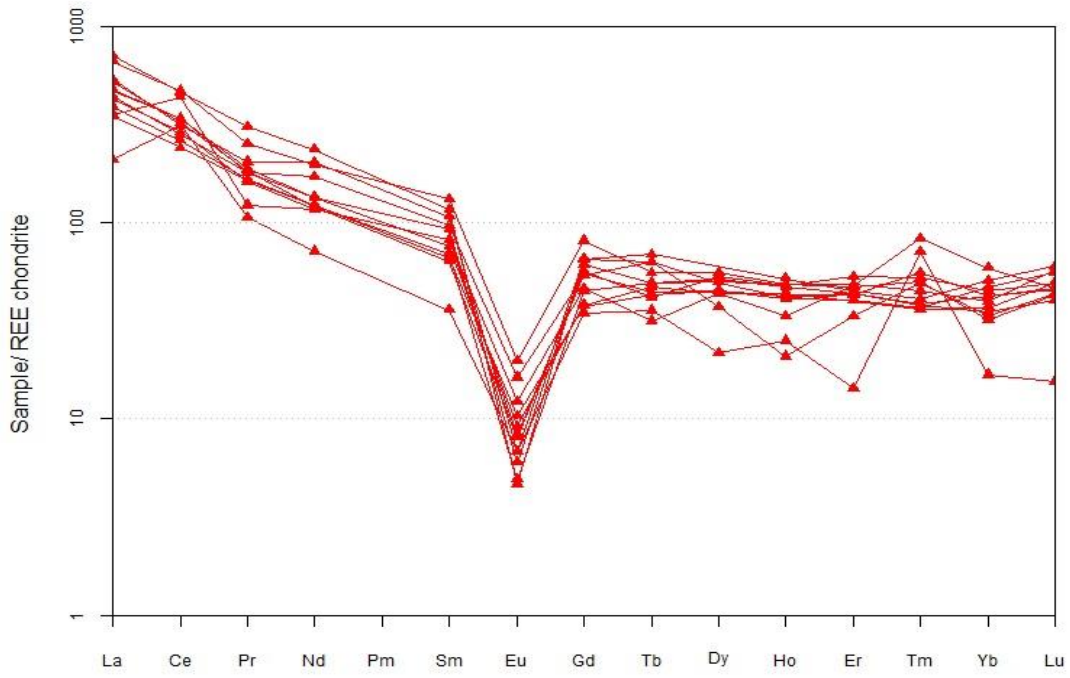

Fig-2: Spider Plot – REE distribution pattern of Darsi granite (Boynton, 1984)

4. Discussion

The Darsi granites indicated on analysis K_2O (4.60 -8.18%), Na_2O (3.32-4.40%), Total K_2O +Na_2O (8.14-11.50%), low CaO (0.42-1.05%) and high Rb (132-369ppm). All these point towards A-Type nature of granites. Anorogenic Granites (A-Type) are good mineralisers and are enriched in rare metals and rare earths. The presence of fluorine in granites act as complexing agent for the aqueous phase transport of various critical and strategic elements. Thus, the Darsi granite is enriched in potassium, LREE and low in calcium. The enrichment of Zr, La, Ce and Y in the granite indicates possible presence of discrete mineral phases like zircon (Zr), monazite (La, Ce), and xenotime (Y).

5. Conclusion

Based on the analytical data, it is established that the Darsi granite is A-type with enrichment of rare earth elements. This granite can form potential for critical elements. Equation editor feature of your word processing software to create equation if equation contains division, or multiple lines.

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