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GEOCHEMISTRY OF GRANITES IN AND AROUND NARKETPALLE MANDAL, NALGONDA DISTRICT, TELANGANA STATE, INDIA

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Abstract

Granites of Narketpalle area are located close to Hyderabad have been selected for a systematic study. Petrographic studies are carried out on granites include modal analysis. These studies indicate that the original magmatic structures have been completely obliterated, because of the onset of subsequent petrogenetic processes. Further, replacement structures and textural intergrowth of perthite and myrmekite are commonly observed. Seventeen representative granite samples were subjected to major elemental analysis and 6 samples have been analysed for trace elements. The data obtained and plotted various binary, ternary diagrams and trends of the major oxides and trace elements are observed. Geochemical variation diagrams do not indicate any definite origin for the granites of the investigated area.

Keywords: Geochemistry, granites, binary, ternary, Harker's diagrams

INTRODUCTION

The area under investigation falls in toposheet no. 56 O/4 and is located (Fig. 1) in the Nalgonda district of Andhra Pradesh (Long: 79º 05' E – 79º 15' E and Lat: 17º 10' N – 17º 15' N). The investigation area is distance from Hyderabad is about 80 kms and it falls in East of Hyderabad.

In the present study, an area of about 150 sq. kms is selected. Five major categories of rock types have been recognized on the basis of field, occurrence, mineralogy and texture in addition to colour.

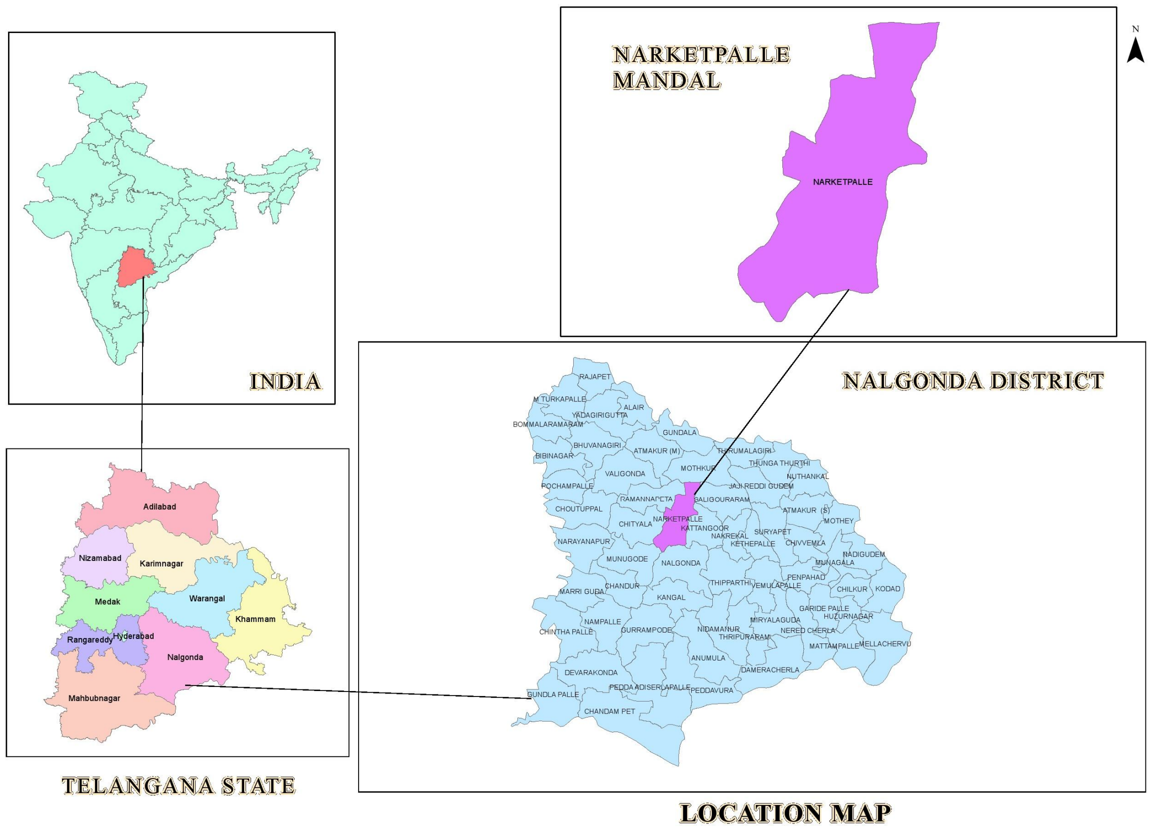

Fig 1: Location map of the Narketpalle area

GEOLOGY

The area is sampled on the grid pattern and based on this sampled material; the rocks have been classified into five major groups. The first group comprises of grey granites which include the porphyritic, gneissic, pyroxene and evenly granular grey granites. The second group comprises of pink granites which include the fine grained pink granites, pink alaskites and the coarse grained porphyritic varieties. The third group includes those rocks which have gradational characters. The fourth group comprises of those granites which have some characteristic features. In this group come the augen gneiss, epidote granites and leuco granites. The fifth group comprises of the basic dykes and the other pegmatite and quartz veins. A geological map of the area is prepared subsequently on the scale of 2cms to 1 km. It is observed that most of the rock types show gradational contacts, and are found to occur in close proximity (Fig. 2).

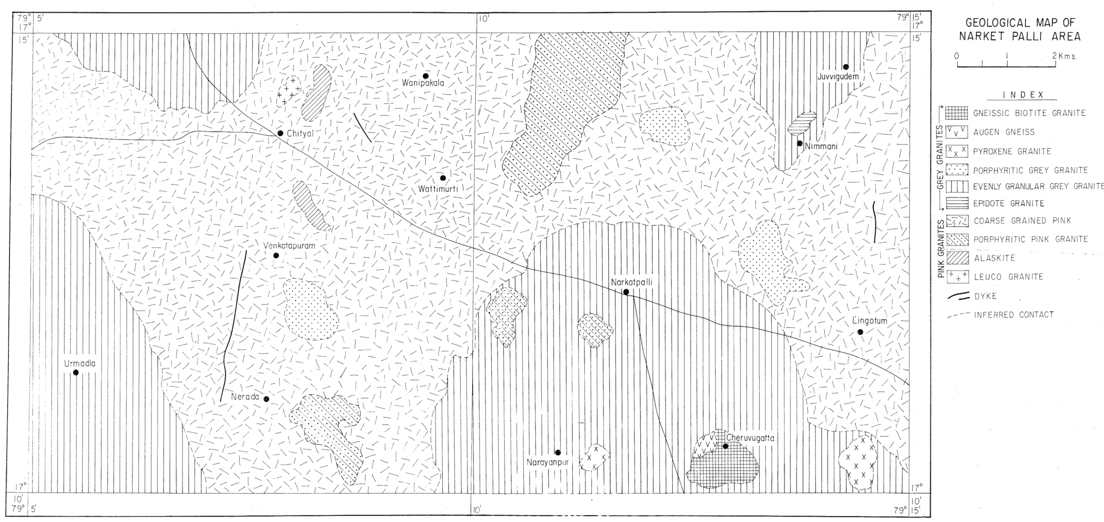

Fig 2: Geological map of Narketpalle area

PETROGRAPHY

The mode of mineral constituents for 17 granite samples of various types is presented in Table-1. In thin sections (Fig. 3), the rocks chiefly contain quartz, plagioclase, perthites (Fig.4) and K-felspars. Presence of myrmekite (Fig. 5) can also be observed. Among the accessory minerals, biotite is the most important. Other accessories include sphene, epidote and magnetite, rarely hornblende, apatite and zircon are seen.

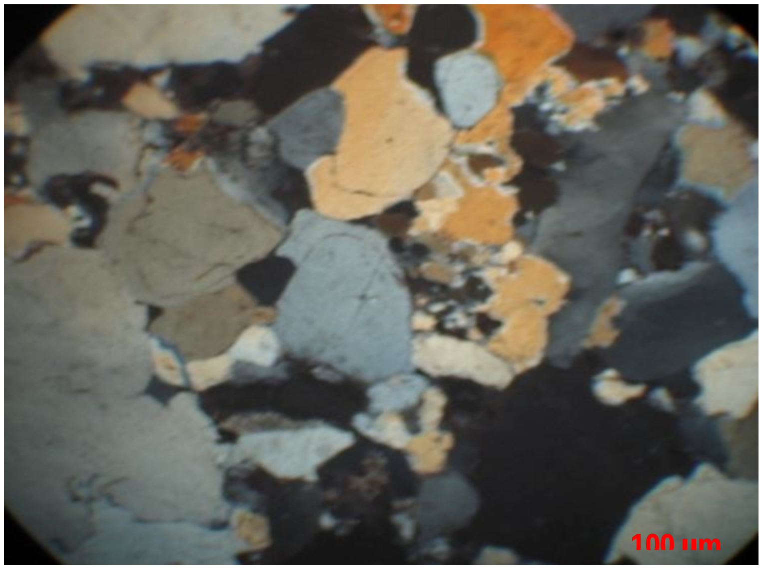

Fig 3: Photomicrograph of pink Granite

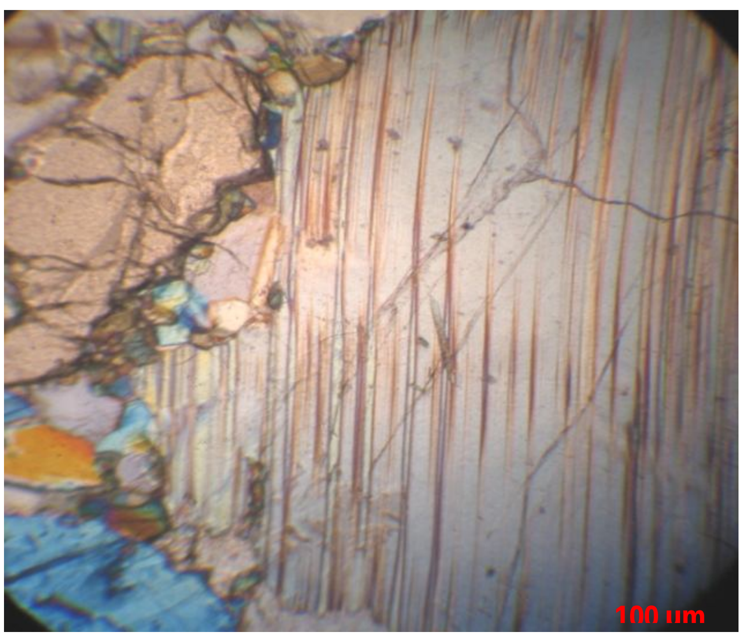

Fig 4: Photomicrograph of Perthite

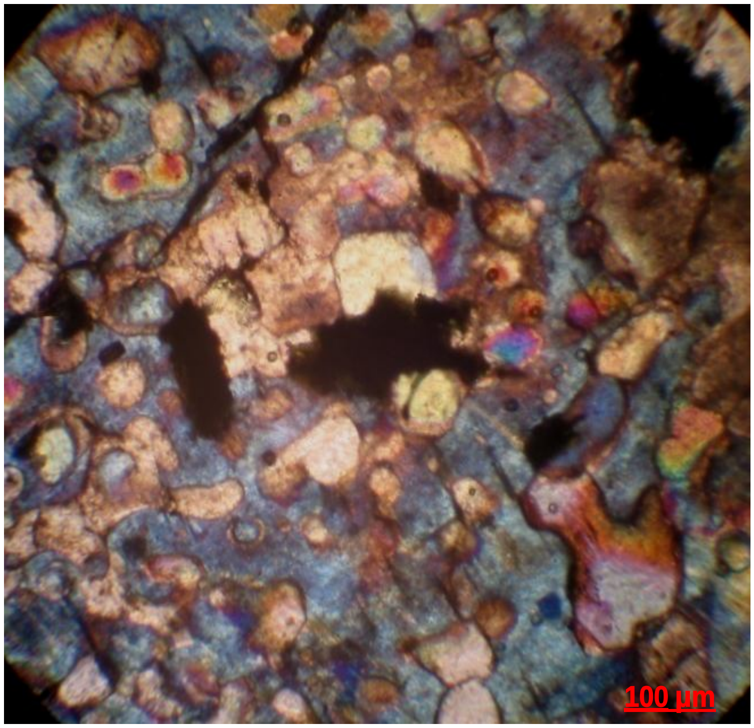

Fig 5: Photomicrograph of Myrmekite

Orthoclase is the partially ordered monoclinic variety of potash feldspar whereas those which are nearly or completely ordered are the microclines and in between these two are ends different amounts of triclinicity is exhibited by the natural occurrence. Hence perfect cross-hatched twinning in microcline is indicative of high triclinicity. This is why it has been argued that the orthoclase of old rocks will be converted into microcline by simple ageing (Mackenzie & Smith, 1959). However, Eskola (1952) has attributed this change from orthoclase to microcline due to mechanical deformation.

Twinning is a characteristic feature of plagioclase and has often been employed to make a distinction between magmatic and non magmatic granitic rocks. Turner (1951) gave the general characters of metamorphosed plagioclases. In the observed thin sections the lamellae tend to curve and taper to a point. They form clusters and tend to be thicker and more numerous at grain boundaries.

GEOCHEMISTRY

Seventeen representative granite samples were subjected to major elemental analysis and 6 samples have been analyzed for trace elements. The data obtained is plotted in various binary and ternary diagrams and the trends of the major oxide and trace elements are observed.

The major oxides data along with their C I P W Norms are given in tables 2, 3 and the trace elemental data is given in table 4.

By observing the diagram (Fig. 6), it is seen that with the increase in SiO_2 content, oxides like TiO_2, MgO, P_2O_5, Al_2O_3 and CaO show a slightly decreasing trend, while the oxide like Na_2O shows marked scatter and K_2O shows a slight increase. Variation diagrams of trace elements versus SiO_2 (Fig. 7) depicts mild to moderate negative trend with Sr, Ba, Zr and V and positive trend of Rb while Y do not define any discernible trend. The plots of SiO_2 against various oxides and trace elements (Fig 6 and 7) suggest that they are formed by mixing of mafic and felsic magmas in various proportions (Kumar and Rino, 2006).

Ca − Na − K diagram (Fig. 8) indicates broad range in composition of feldspars which in turn points to different sources of parent materials (Green and Poldervaart, 1958). $Na_2O + K_2O - FeO^t$ – MgO (A F M) triangular plot (Fig. 9) indicates the fractional crystallisation (Nockolds and Allen, 1953; Thornton and Tuttle, 1969). In this modified alkali-lime index ($Na_2O + K_2O$ – CaO vs SiO_2) diagram (Fig. 10) most of the plots fall in alkali – calcic field while few of them fall in calc – alkalic, calcic and alkalic field.

The diagram of Al_2O_3 / CaO + Na_2O + K_2O vs Al_2O_3 / Na_2O + K_2O (Maniar and Piccolli, 1989) shows weak to moderate peraluminous to metaluminous nature of Narketpalle granites (Fig. 11). Fig 12 in terms of (FeO^t + TiO_2) – Al_2O_3 − MgO indicates the various types of magmatic parental material (Jensen, 1976) for Narketpalle granites. In normative Albite (Ab) – Anorthite (An) – Orthoclase (Or) diagram (Barker, 1979) most of the samples are clustered mainly in granite field and a few low silica grey granites straddle close to the boundary between granite and granodiorite field (Fig. 13).

SiO_2 vs (Na_2O + K_2O) plots of the investigated granites (Fig. 14) straddle in the field for granite and reveal their subalkaline nature. The formation of granites with such geochemical characteristics is known to take place from the partial melting of crustal metasedimentary rocks (Chappell and White, 1974). On the geotectonic descrimination diagram (Fig. 15) based on multicationic $R_1 - R_2$ factors as proposed by De La Roche et al., (1980), Narketpalle granite samples plot dominantly in syn-collisional field.

Fig 16 indicates that most likely the source materials for melt (for Narketpalle granites) appear hydrated, high K calc-alkaline andesite and basaltic andesite which may evolve into shoshonite. The inferred source materials could be derived from enriched subcontinental lithospheric mantle (Selvam et al., 1995).

Table 1: Modal analysis (vol. %) for the representative samples of the Narketpalle granites

Minerals	Sample Numbers																
	Gr 39	Gr 54	Gr 42	Gr 55	Gr 28	Gr 06	Gr 71	Gr 35	Gr 34	Gr 56	Gr 72	Gr 36	Gr 66	Gr 68	Gr 40	Gr 75	Gr 15	Average
Quartz	35.48	31.12	41.57	20.85	45.02	38.75	27.42	36.78	40.07	31.55	26.77	36.78	25	27.84	34.3	37.49	27.22	33.1771
Plagioclase	21.7	25.65	8.24	17.15	8.56	11.54	22.51	23.44	13.45	17.62	28.51	23.44	21.52	27.8	25.2	18.2	28.54	20.1806
Perthite	20.95	22.38	27.85	29.87	28.51	31.02	30.75	24.23	15.72	38.17	31	24.23	23.02	23.68	23.05	14.62	19.02	25.1806
K-felspar	18.37	10.94	20.51	19.92	14.49	16.7	9.35	12.38	20.76	5.98	9.54	12.38	16.02	18.2	13.3	21.75	15.51	15.0647
Myrmekite	0.75	-	1.02	0.24	2.56	1.86	-	0.83	0.27	1.56	0.21	0.83	4.94	0.45	1.32	-	1.05	1.0524
Biotite	1.2	4.71	0.24	6.07	0.51	-	2.07	0.98	7.95	3.72	1.95	0.98	-	1.1	1.33	6.82	6.24	2.6982
Magnetite	0.42	0.64	-	-	0.23	-	-	0.11	0.51	0.16	0.51	0.11	-	0.35	0.7	0.42	0.21	0.2571
Epidote	-	1.15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0676
Hornblende	-	3.12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1835
Augite	-	-	-	4.58	-	-	5.92	-	-	-	-	-	7.8	-	-	-	-	1.0765
Others	1.1	0.21	0.58	1.33	0.12	0.14	1.98	1.73	1.27	1.26	1.48	1.25	1.7	0.58	0.8	0.71	2.21	1.0853
Total	99.97	99.92	100.01	100.01	100.00	100.01	100.00	100.00	100.00	100.02	99.99	100.00	100.00	100.00	100.00	100.01	100.00	99.9965

Table 2: Major oxide composition (wt. %) of the rocks of Narketpalle granite

Sample	SiO_2	Al_2O_3	TiO_2	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	Total
RJ39	69.95	14.74	0.32	2.42	0.03	1.34	1.63	3.46	4.15	0.29	98.34
RJ54	69.07	14.95	0.25	2.59	0.02	1.76	1.52	3.47	5.22	0.20	99.04
RJ42	71.04	14.84	0.06	0.35	0.00	0.02	0.39	2.44	8.92	0.04	98.11
RJ55	55.31	15.42	1.01	9.41	0.04	4.26	2.54	2.76	7.60	1.34	99.69
RJ28	74.25	13.46	0.09	1.23	0.01	0.29	0.89	2.84	6.04	0.06	99.17
RJ6	71.74	13.68	0.31	2.03	0.03	0.59	1.18	3.33	5.62	0.10	98.67
RJ71	60.27	15.59	0.78	5.28	0.08	4.79	3.81	4.51	2.83	0.58	98.52
RJ35	72.42	13.83	0.15	1.30	0.02	0.51	0.99	3.41	5.46	0.06	98.14
RJ34	74.67	14.43	0.08	0.60	0.01	0.19	1.29	4.03	4.64	0.04	99.96
RJ56	68.03	14.91	0.28	2.94	0.02	2.21	1.43	3.59	4.84	0.21	98.47
RJ72	69.96	13.13	0.58	3.08	0.04	1.43	1.63	2.79	5.55	0.25	98.43
RJ36	73.71	13.13	0.16	1.06	0.01	0.65	0.65	2.64	6.31	0.02	98.37
RJ66	58.53	13.67	0.75	7.62	0.13	7.65	4.5	2.64	3.19	0.30	98.98
RJ68	67.59	15.09	0.37	2.58	0.03	2.13	2.19	3.54	4.80	0.52	98.86
RJ40	77.83	11.73	0.10	1.05	0.02	0.44	0.98	2.66	4.50	0.04	99.35
RJ75	63.46	13.87	0.70	5.16	0.07	4.79	4.59	3.32	1.75	0.46	98.16
RJ15	63.71	15.40	0.70	4.07	0.04	1.46	2.33	3.42	6.58	0.29	98.01
Average	68.3259	14.2276	0.3935	3.1041	0.0341	2.03	1.9141	3.2455	5.1765	0.2824	98.6629

Table 3: CIPW normative minerals of representative granites of Narketpalle

NORM	RJ39	RJ54	RJ42	RJ55	RJ28	RJ06	RJ71	RJ35	RJ34	RJ56	RJ72	RJ36	RJ66	RJ68	RJ40	RJ75	RJ15
Quartz	28.574	22.788	21.869	0.00	32.04	27.18	8.324	28.58	30.362	21.946	26.815	31.61	9.288	21.51	42.155	20.729	11.769
Corundum	2.286	1.306	0.557	1.243	0.775	0.212	0.00	0.654	0.528	1.668	0.168	0.823	0.00	1.334	0.797	0.00	0.00
Orthoclase	24.525	30.849	52.714	44.91	35.695	33.212	16.724	32.26	27.421	28.603	32.799	37.29	18.852	28.36	26.594	10.342	38.886
Albite	29.278	29.362	20.647	23.35	24.031	28.178	38.162	28.85	34.101	30.378	23.608	22.34	22.339	29.99	22.508	28.093	28.939
Anorthite	6.192	6.234	1.647	3.847	4.023	5.201	13.936	4.52	6.139	5.722	6.453	3.094	16.028	7.468	4.601	17.774	7.234
Nepheline	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Diopside	0.00	0.00	0.00	0.00	0.00	0.00	0.939	0.00	0.00	0.00	0.00	0.00	3.462	0.00	0.00	1.59	1.981
Hypersthene	4.864	6.148	0.24	14.38	1.608	2.69	14.706	2.134	0.855	7.508	5.223	2.249	22.701	6.881	1.835	14.41	4.951
Olivine	0.00	0.00	0.00	1.752	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Magnetite	3.509	3.755	0.507	13.64	1.783	2.943	7.656	1.885	0.87	4.263	4.466	1.537	11.048	3.741	1.522	7.482	5.901
Ilmenite	0.608	0.475	0.114	1.919	0.171	0.589	1.482	0.285	0.152	0.532	1.102	0.304	1.425	0.703	0.19	1.33	1.33
Apatite	0.687	0.474	0.095	3.174	0.142	0.237	1.374	0.142	0.095	0.497	0.592	0.047	0.711	1.232	0.095	1.09	0.687
Total	100.52	101.39	98.41	108.2	100.27	100.44	103.30	99.32	100.52	101.11	101.22	99.29	105.85	101.1	100.29	102.83	101.67

Table 4: Trace elemental concentrations (ppm) of the rocks of Narketpalle granite

Samples	Zr	Ba	Sr	V	Y	Rb
Gr 06	124	8.58	1.6	0.316	32	2.156
Gr 35	113	3.58	1.07	0.083	0	2.17
Gr 36	31	2.77	0.76	0.039	0	1.852
Gr 40	63	3.01	0.9	0.059	0	1.826
Gr 54	110	11.45	2.87	0.192	1.2	1.262
Gr 66	90	1.93	3.57	1.02	10.2	1.309
Average	88.5	5.22	1.795	0.2848	7.2333	1.7625

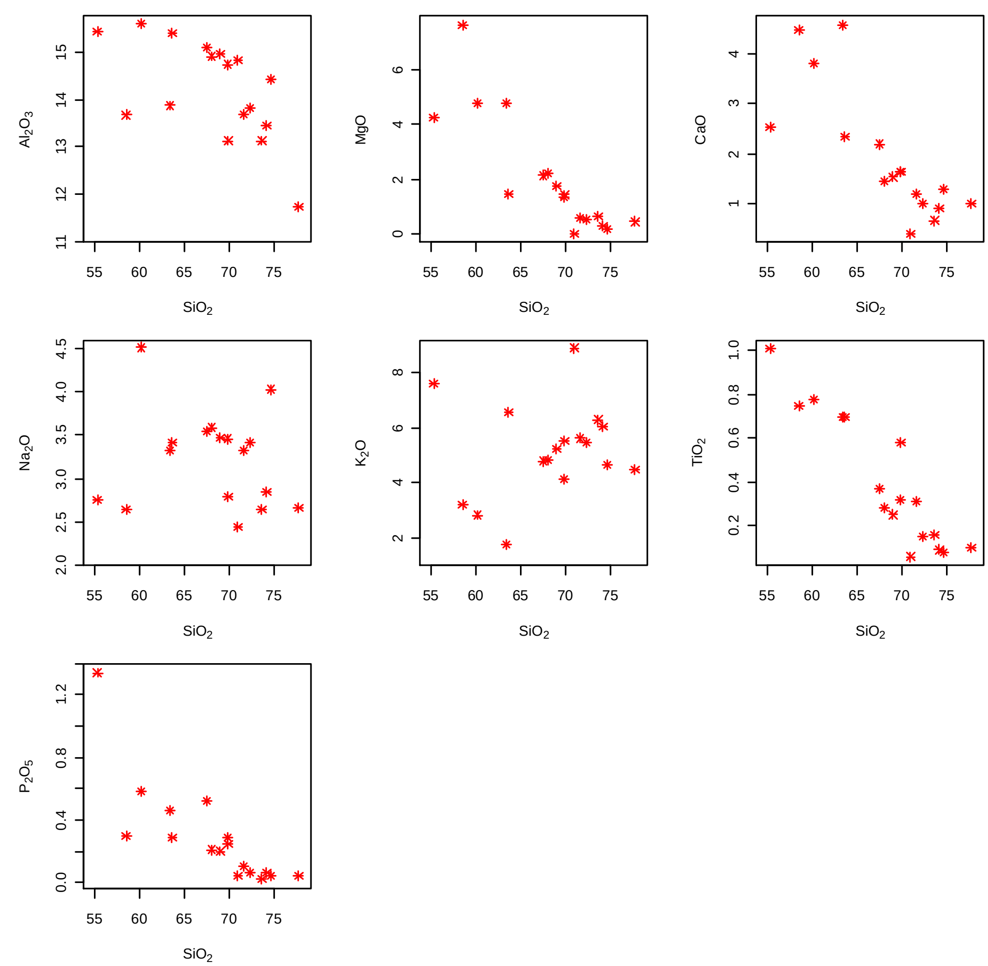

Fig. 6: Harkar's variation diagrams of SiO_2 vs selected major oxides for Narketpalle granites.

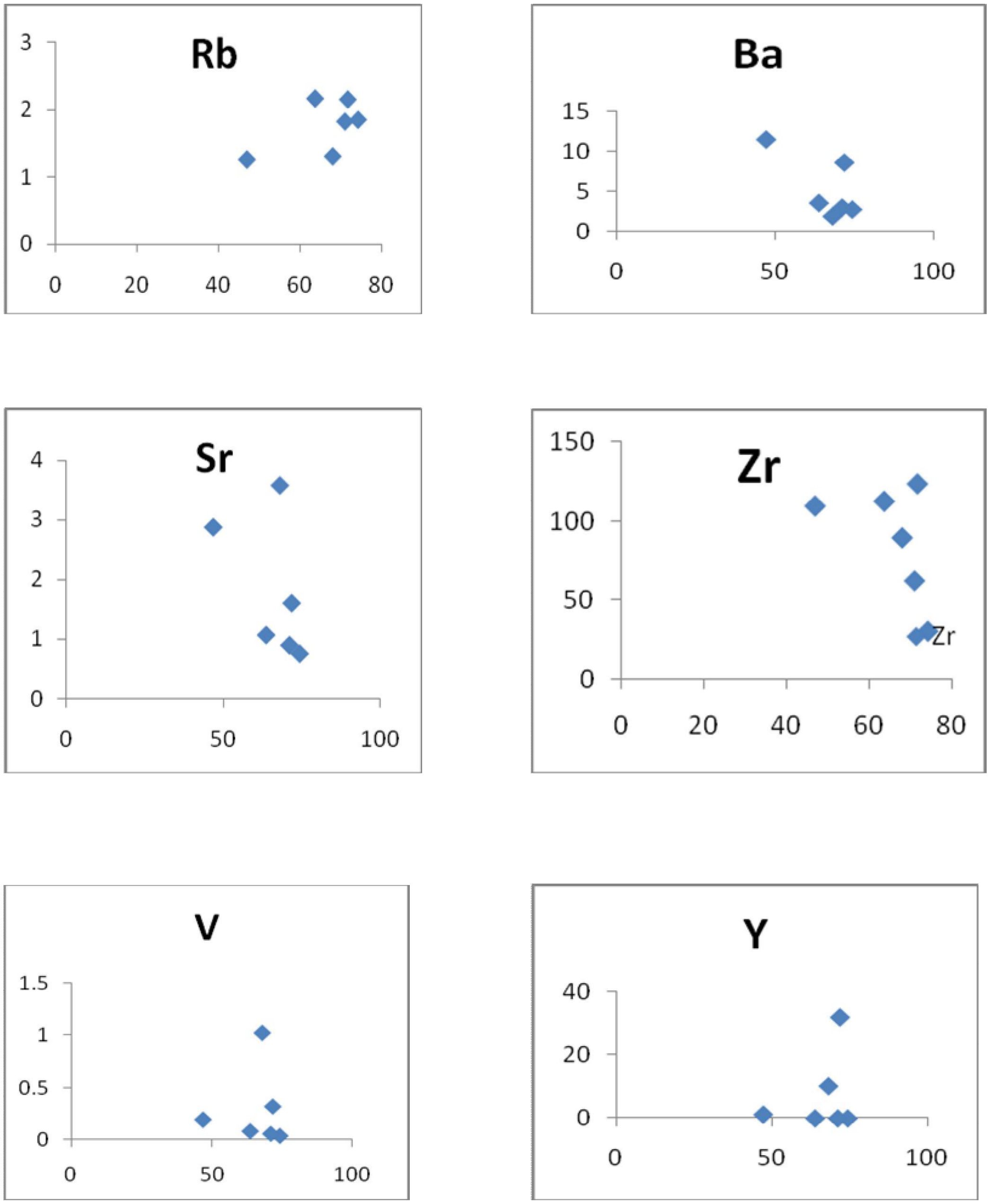

Fig. 7: Variation of trace elements in granite

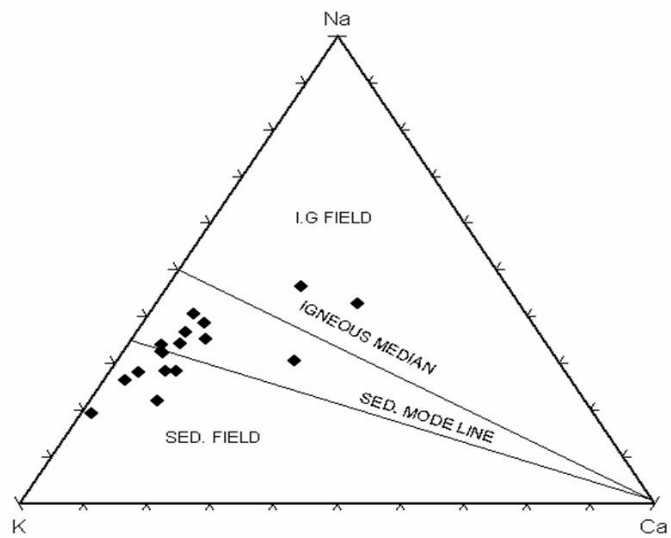

Fig. 8: Green and Poldervaart (1958), Ca – Na – K diagram.

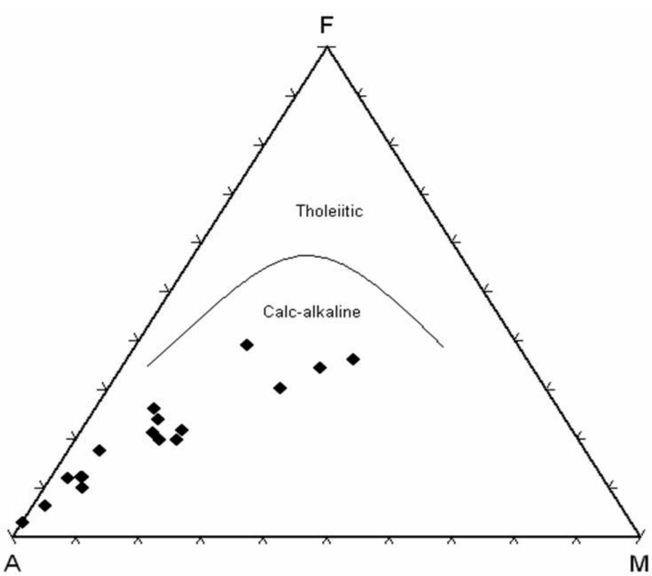

Fig. 9: AFM diagram (after Irvine and Baragar, 1971) of granite.

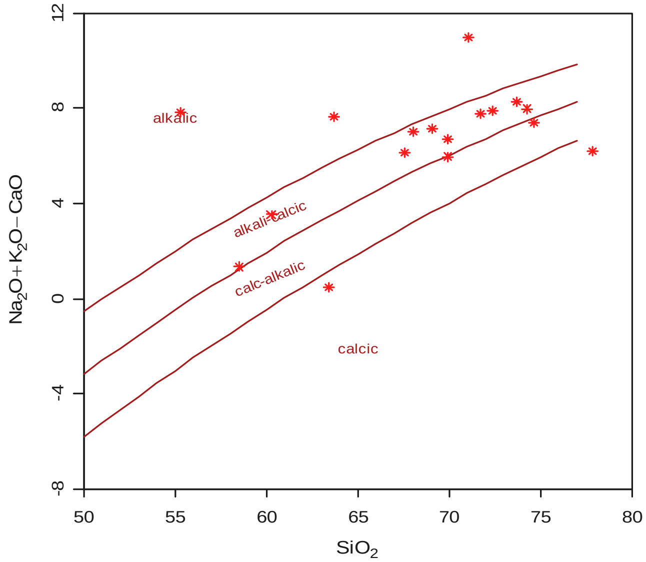

Fig. 10: Modified alkali – lime index MALI (SiO_2 vs $Na_2O + K_2O - CaO$) for Narketpalle granites (after Frost et al., 2001).

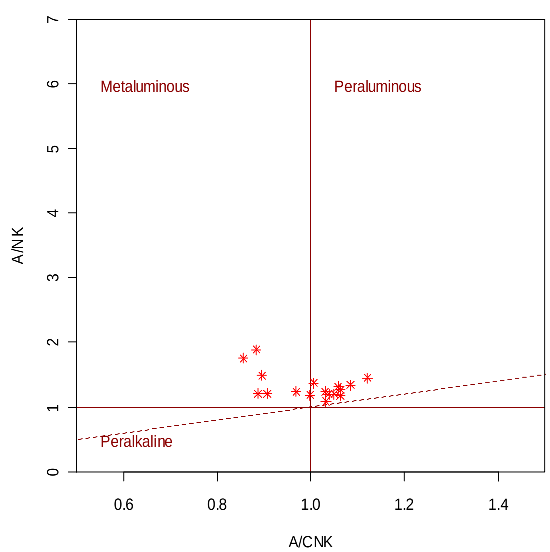

Fig. 11: A / CNK – A / NK plot (after Maniar and Poccolli, 1989) of Narketpalle granite.

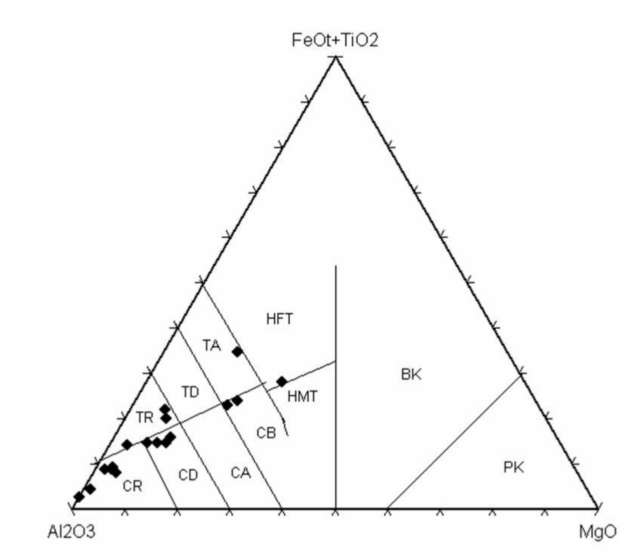

Fig. 12: Al_2O_3 – (FeO^t + TiO_2) – MgO ternary plot showing the evolutionary trend of Narketpalle granites. The various fields are taken from Jensen (1976). CD – calc − alkaline dacite, CA – calc − alkaline andesite, CB –calc − alkaline basalt, HFT-high Fe tholeiitic basalt, HMT-high Mg tholeiitic basalt.

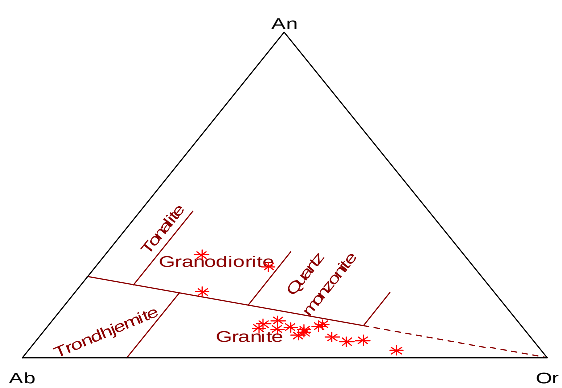

Fig. 13: Normative Albite (Ab), Anorthite (An), Orthoclase (Or) diagram for Narketpalle granites (Barker, 1979).

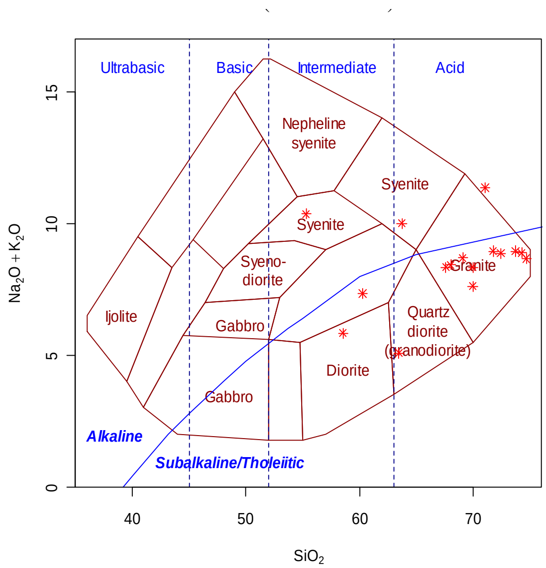

Fig. 14: SiO_2 vs $Na_2O + K_2O$ plots of the investigated granites in total alkali silica (TAS) diagram (Cox et al., 1979; adapted by Wilson, 1989 for plutonic rocks).

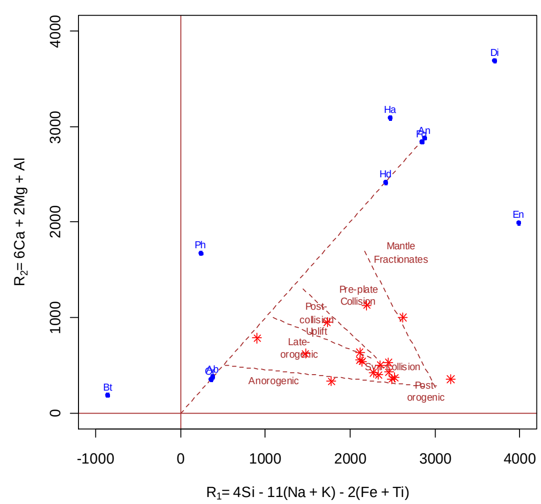

Fig. 15: $R_1 - R_2$ Multicationic diagram (after De La Roche et al., 1980) showing various tectonic fields (after Batchelor and Bowden, 1985).

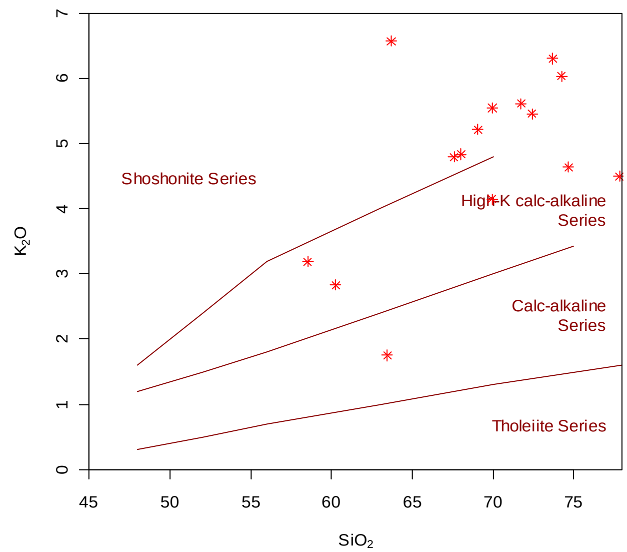

Fig.16: SiO_2 vs K_2O binary diagram for Narketpalle granites (after Peccerillo and Taylor, 1976).

CONCLUSIONS

Field investigations and petrographic studies are indicate that the original magmatic characters present in the basement rocks have been completely obliterated, because of the onset of subsequent petrographic processes. Geochemical variation diagrams do not give a definite origin for the granites of the investigated area.

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