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# PETROLOGY AND GEOCHEMISTRY OF GRANITES IN AND AROUND NARKETPALLE MANDAL, NALGONDA DISTRICT, T.S., INDIA

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**ABSTRACT**

Granites of Narketpalle area are located close to Hyderabad, have been selected for a systematic study. Petrographic studies and nodal analyses were carried out on granites of Narketpalle area to decipher the crustal evolution. 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 six samples have been analysed for trace elements. The data obtained and plotted for 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

## 1. INTRODUCTION

The area under investigation forms part of toposheet no. 56 O/4 and is bounded by Long: 79º 05' E – 79º 15' E and Lat: 17º 10' N – 17º 15' N of Narketpalle, Nalgonda dist, Telangana state which covers an area of 140 km$^2$. Topographically the study area is undulating with isolated and structural features. Granites were exposed outcrops as boulders and sheet rocks in the area investigated (Fig 1).

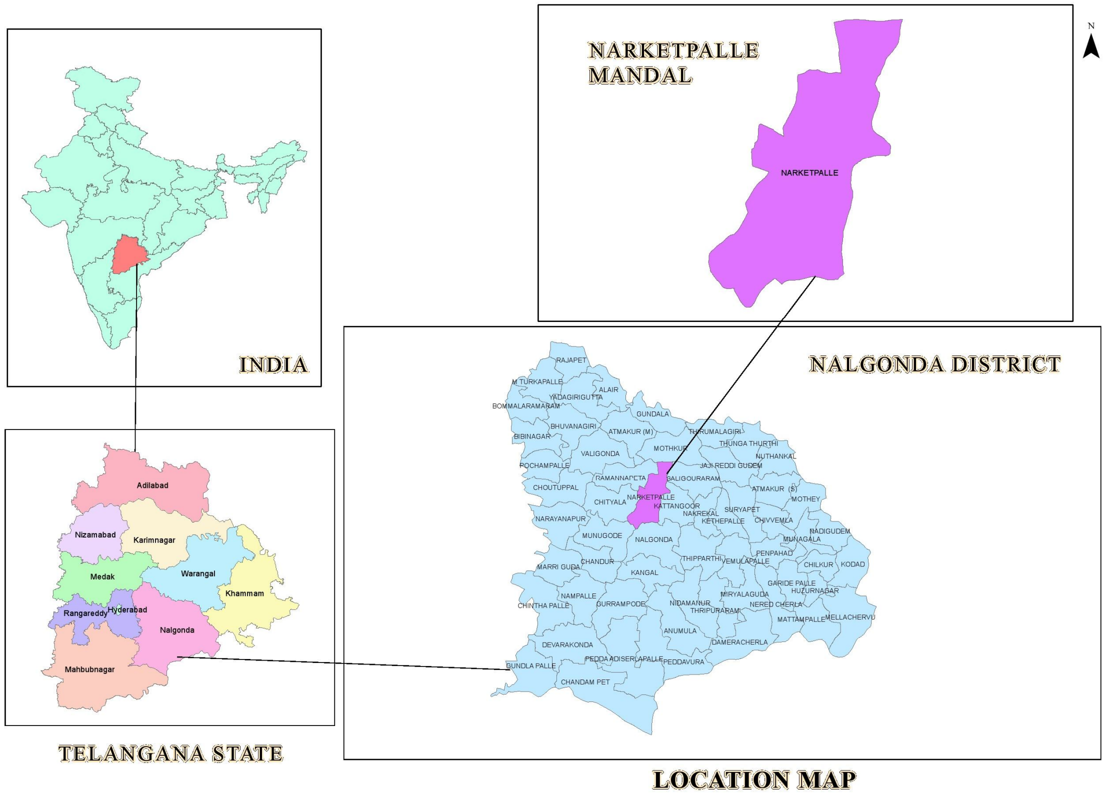


**Fig. 1:** Location map of the Narketpalle area

## 2. GEOLOGY

The geology area is under investigation containing the oldest rocks of peninsular gneissic complex of south India (GSI, 1999) and resting on pre-cambrian basement. The rocks have been classified into two major groups. The first group comprises of grey granites which include the porphyritic, gneissic, pyroxene and equi granular grey granites. The second group comprises of pink granites which include the fine and coarse grained granites and Alaskites. The granites in area are also separated based on the mineralogical abundances, textural characters as augen gneisses, epidotes, granites and leuco granites. Intrusive features like basic dykes (dolerite) and gabbro, quartz and feldspathic veins are present in the area (Fig 2).

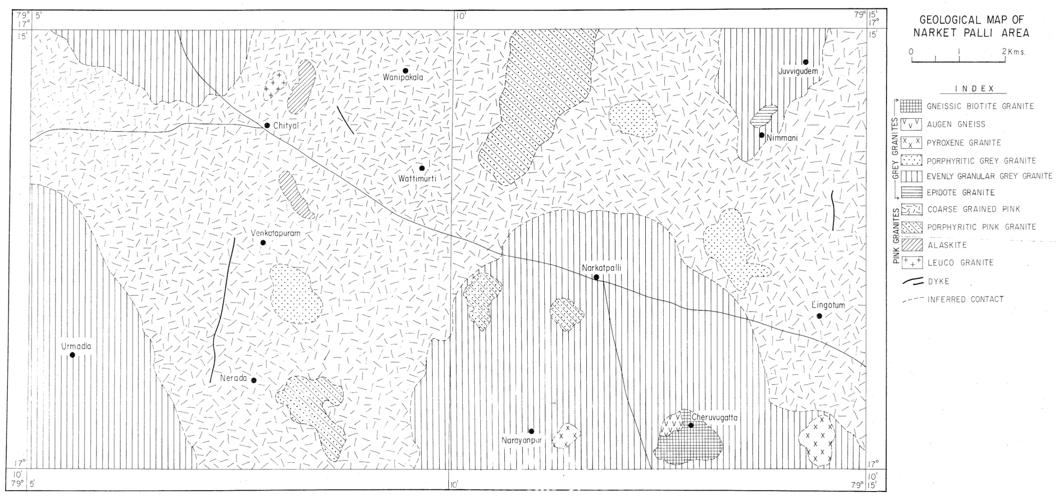


**Fig. 2:** Geological map of Narketpalle area

## 3. PETROGRAPHY

The mode of mineral constituents for 17 granite samples of various types is presented in Table-1. In thin sections, the rocks chiefly contain quartz, plagioclase (Fig 3 & 4), perthites (Fig 5) and K-felspars. Presence of myrmekite (Fig 6) 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.

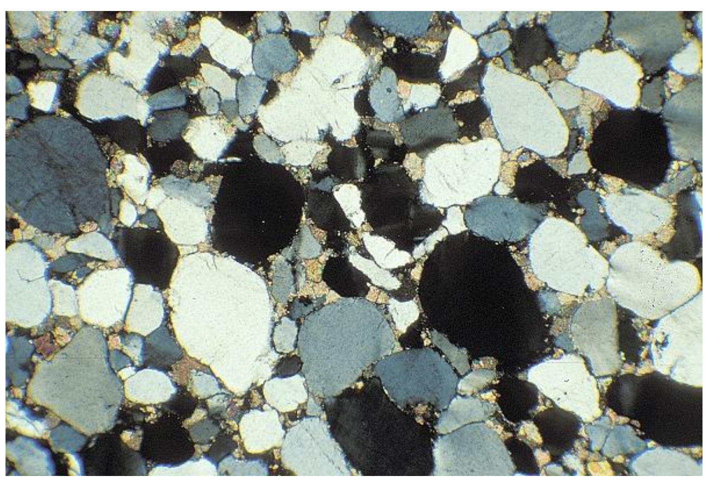

**Fig. 3:** Photomicrograph of Quartz

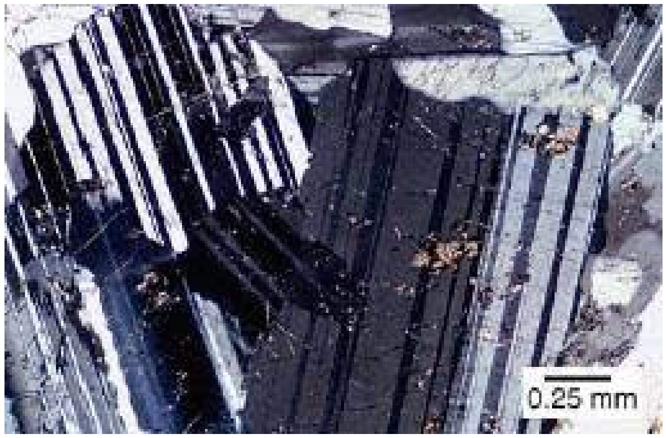


**Fig. 4:** Photomicrograph of Plagioclase

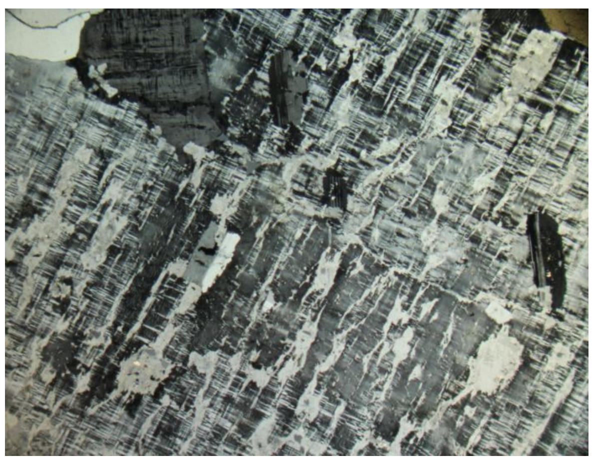

**Fig. 5:** Photomicrograph of Perthite

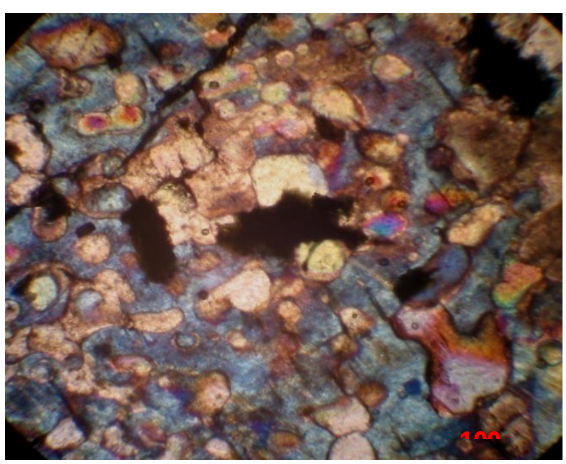

**Fig. 6:** Photomicrograph of Myrmekite

**Table 1:** Moal 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 |

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.

## 4. 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.

**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 |

By observing the diagram (Fig 7), 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 7 and 8) suggest that they are formed by mixing of mafic and felsic magmas in various proportions (Kumar and Rino, 2006).

Ca − Na − K diagram (Fig 9) 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 10) 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 11) 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. 12). Fig 13 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. 14).

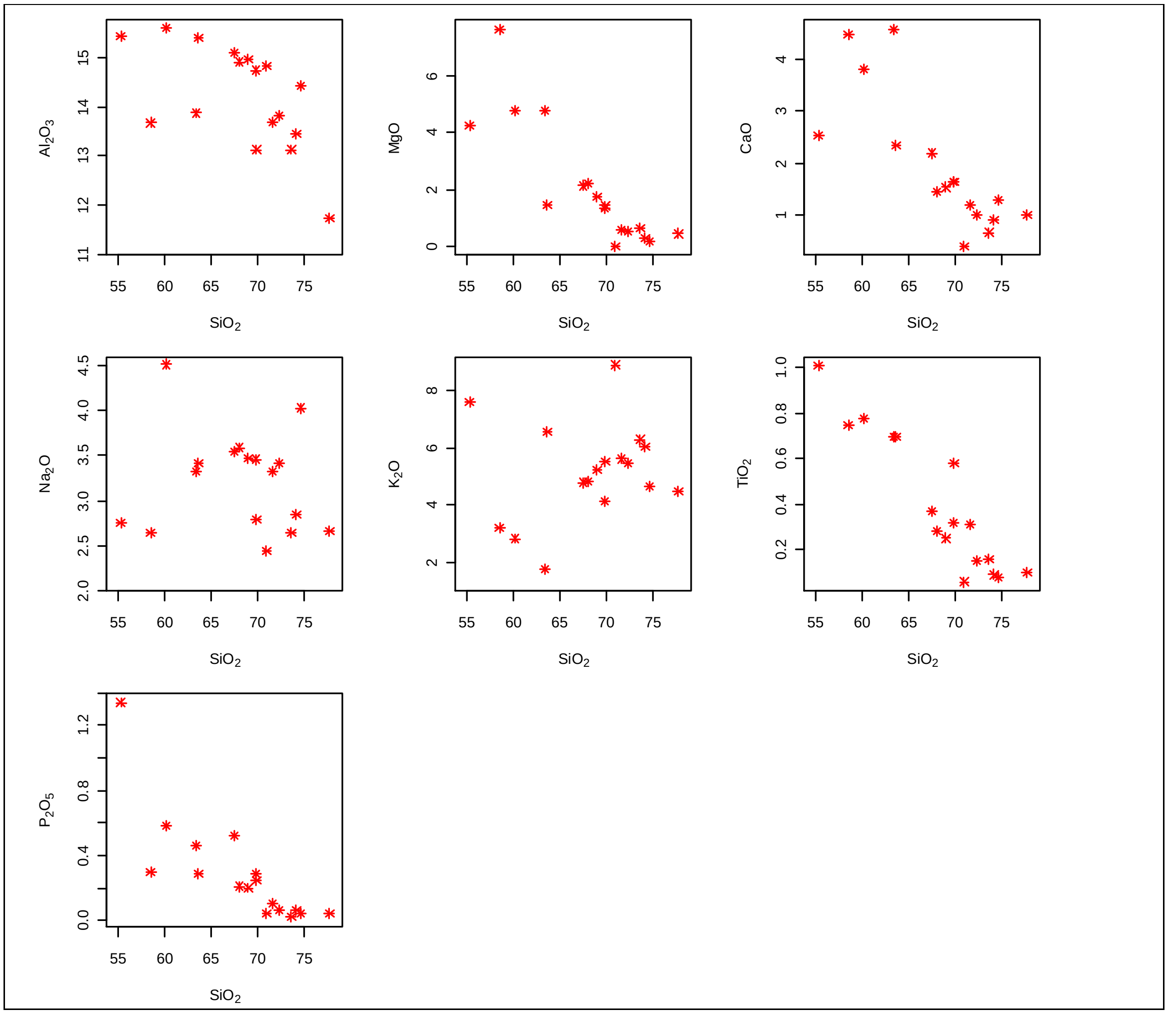


**Fig 7:** Harkar's variation diagrams of $SiO_2$ vs selected major oxides for Narketpalle granites.

$SiO_2$ vs ($Na_2O$ + $K_2O$) plots of the investigated granites (Fig 15) straddle in the field for granite and reveal their sub alkaline 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 discrimination diagram (Fig 16) based on multi cationic $R_1 - R_2$ factors as proposed by De La Roche et al., (1980), Narketpalle granite samples plot dominantly in syn-collisional field.

Fig 17 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 sub-continental lithospheric mantle (Selvam et al., 1995).

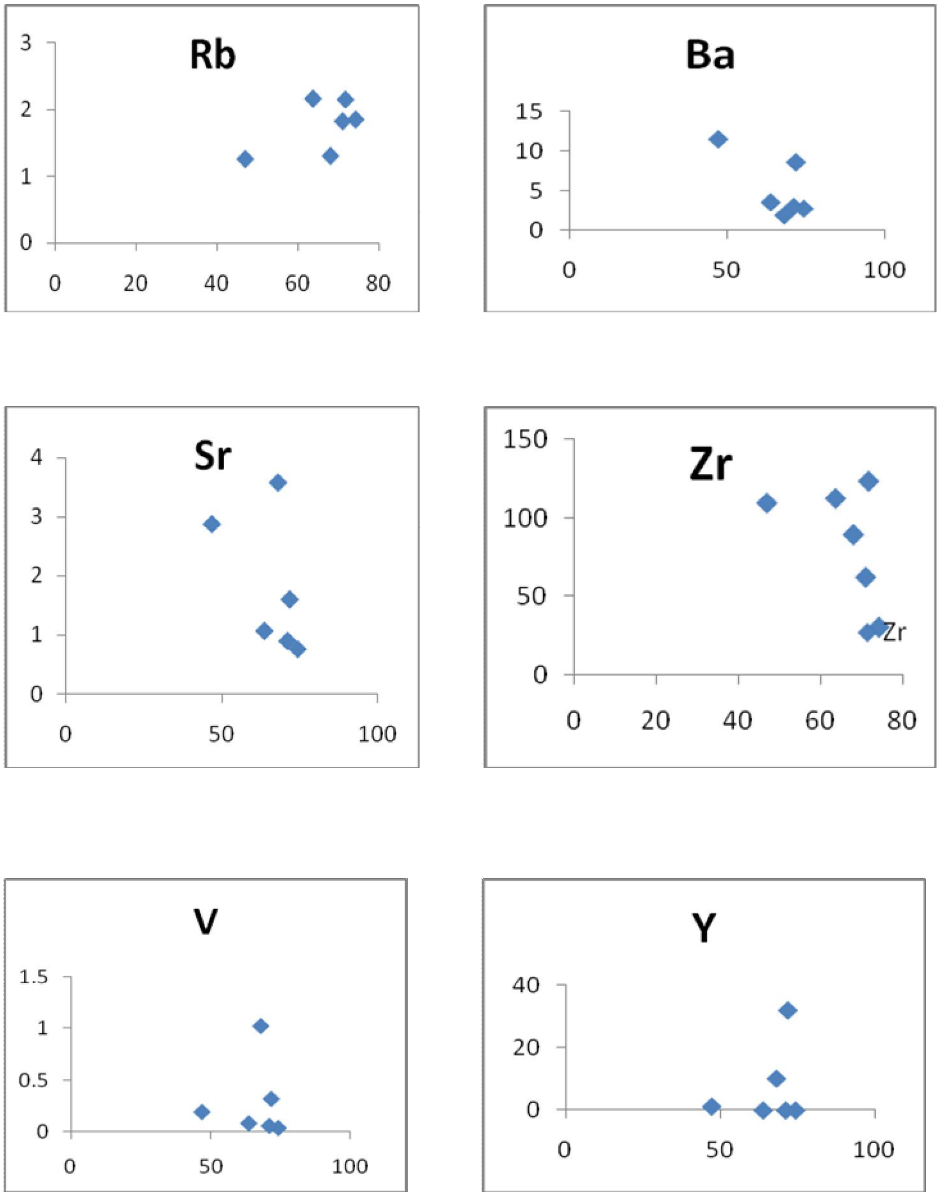


**Fig. 8:** Variation of trace elements in granite

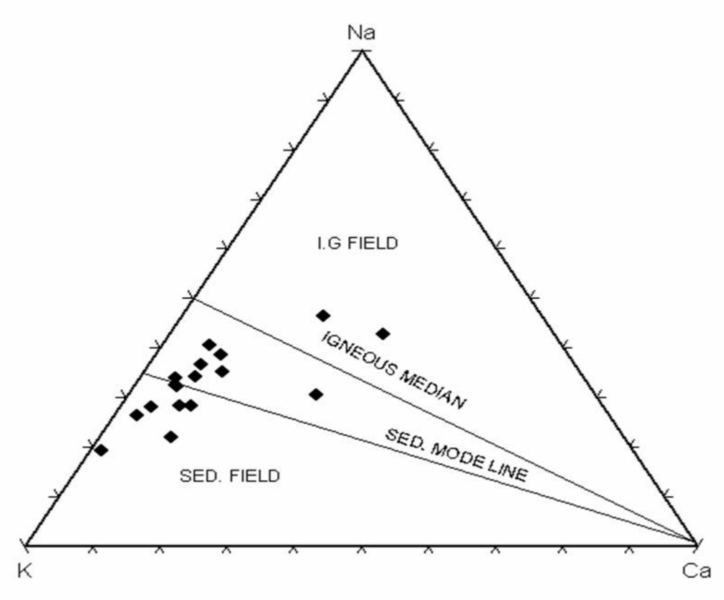


**Fig. 9:** Green and Poldervaart (1958), Ca – Na − K diagram

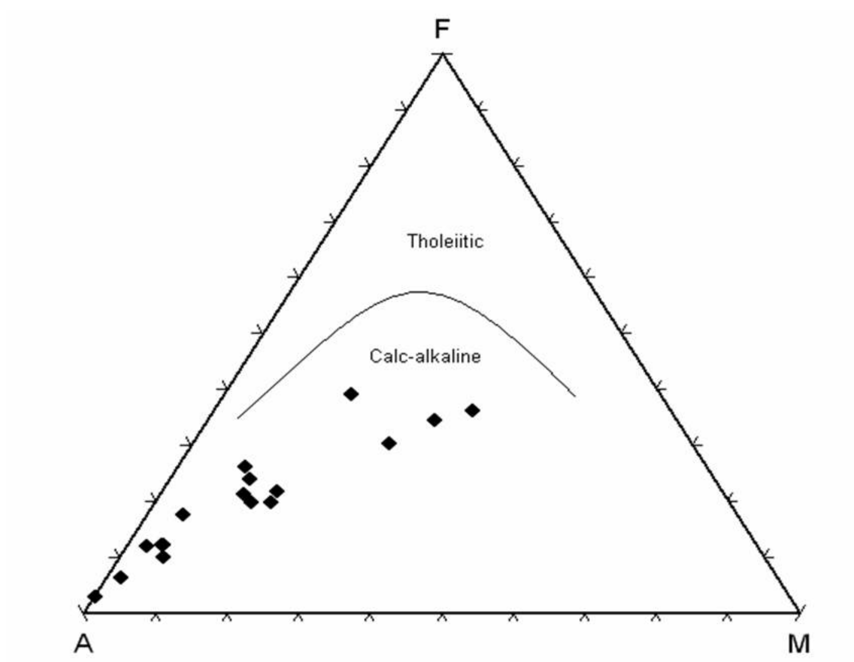


**Fig. 10:** AFM diagram (after Irvine and Baragar, 1971) of granite

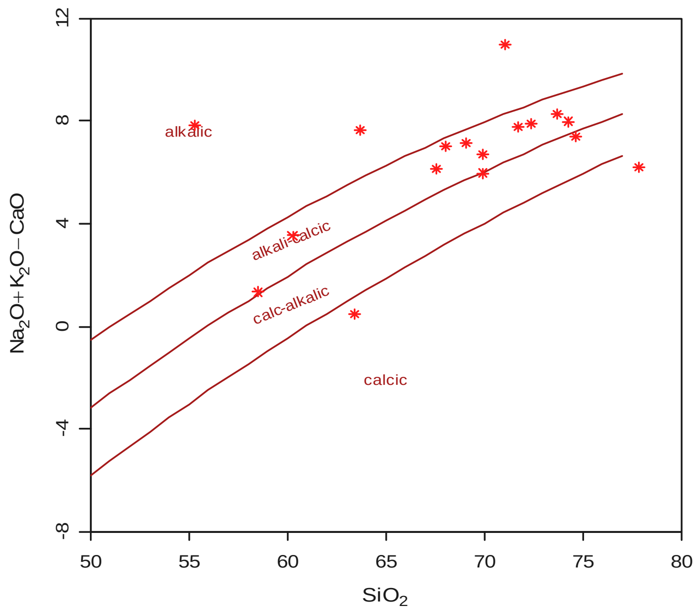


**Fig 11:** Modified alkali − lime index MALI ($SiO_2$ vs $Na_2O + K_2O - CaO$) for Narketpalle granites (after Frost et al., 2001).

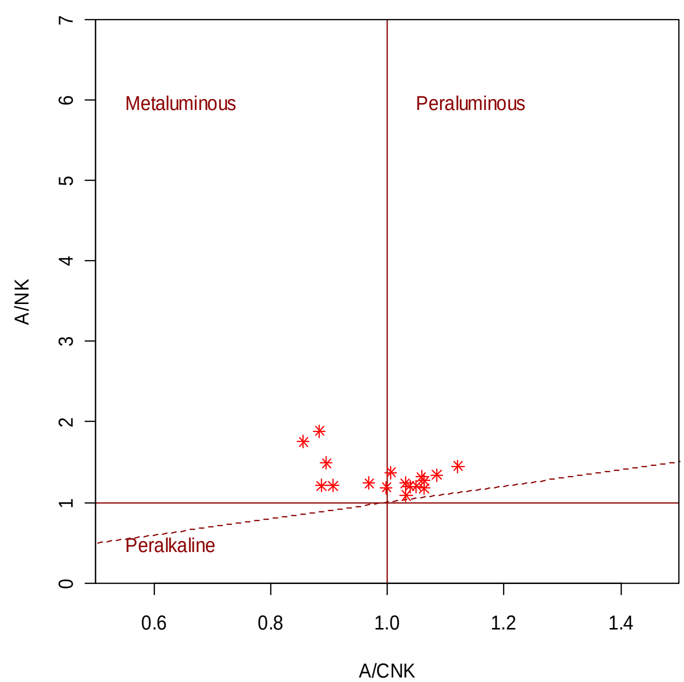


**Fig 12:** A / CNK – A / NK plot (after Maniar and Poccolli, 1989) of Narketpalle granite.

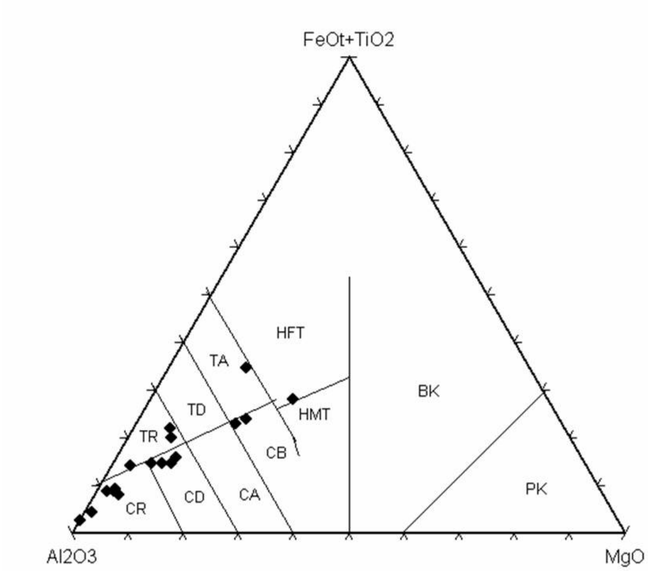


**Fig. 13:** $Al_2O_3$ – ($FeO^t$ + $TiO_2$) – MgO ternary plot showing the evolutionary trend of Narketpalle granites. The various fields are taken from Jensen (1976). CD – calc − alkaline dacite, CA – calc − alkaline andesite, CB –calc − alkaline basalt, HFT-high Fe tholeiitic basalt, HMT-high Mg tholeiitic basalt.

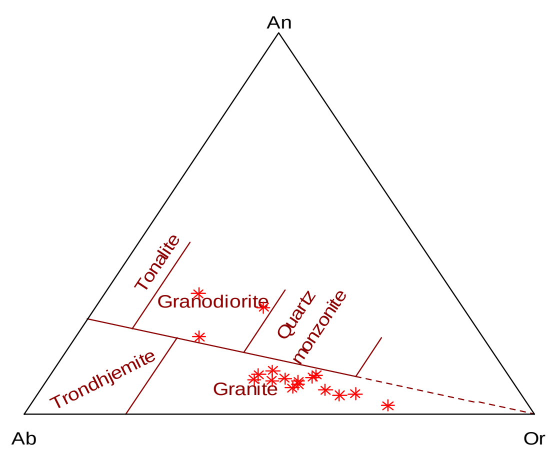


**Fig. 14:** Normative Albite (Ab), Anorthite (An), Orthoclase (Or) diagram for Narketpalle granites (Barker, 1979).

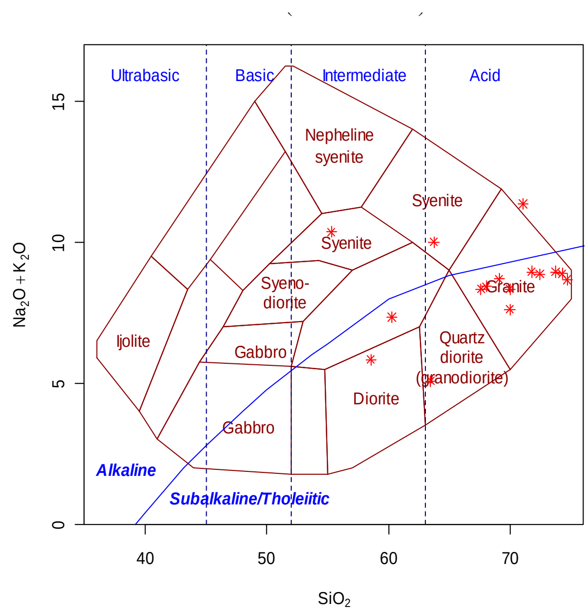


**Fig. 15:** $SiO_2$ vs $Na_2O$ + $K_2O$ plots of the investigated granites in total alkali silica (TAS) diagram (Cox et al., 1979; adapted by Wilson, 1989 for plutonic rocks).

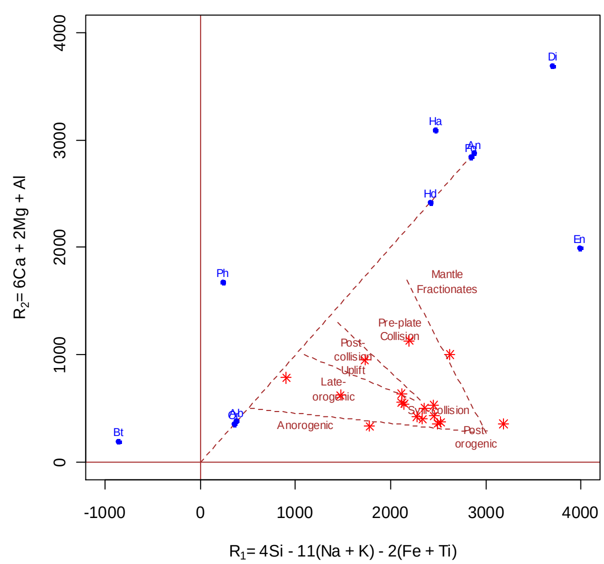


**Fig. 16:** $R_1 – R_2$ Multicationic diagram (after De La Roche et al., 1980) showing various tectonic fields (after Batchelor and Bowden, 1985).

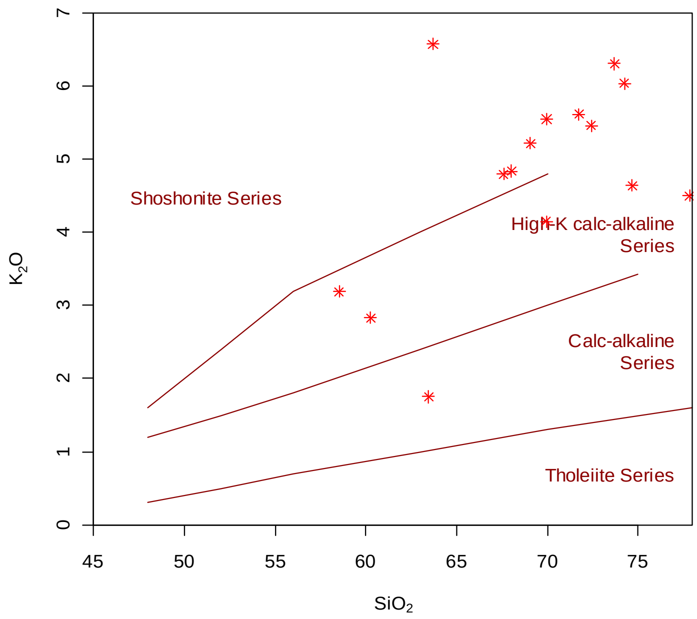


**Fig. 17:** $SiO_2$ vs $K_2O$ binary diagram for Narketpalle granites (after Peccerillo and Taylor, 1976).

## 5. 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.

## 6. ACKNOWLEDGEMENTS

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