Characterisation of feldspar mineral deposits, Kandukuru and surrounding areas of Ranga Reddy District, Telangana State

***D. Mahesh and G. Prabhakar**
Department of Geology, Osmania University, Hyderabad- 500007, India.

Abstract

The feldspar deposits occurred around Kandukuru area of Ranga Reddy District of Telangana state covers the northern part of the Eastern Dharwar Craton (EDC) in South India. This region is predominantly consists of quartzo-felspathic veins and pegmatites occurred within the Archean granitic terrain. The production of feldspar mineral deposits are mainly from these pegmatites and feldspathic veins of the area and an average production is about 48000 tones for year in the Ranga Reddy district alone. The feldspar deposits of Kandukuru and surrounding areas ($N17^0$ 4' 5'' E 78^0 30' 11'') are well exposed, ellipsoidal to lenticular pegmatite masses with intrusive relationship with granites, trending NW-SE directions.

Mineralogically the deposits are mainly composed of perthites and antiperthites as essential constituents. Orthoclase, plagioclase and quartz present as accessory minerals. These minerals are coarse grained with extreme irregularity textures, show remarkable variation in coarseness, whereas the coarser bodies are commercially valuable for their feldspar. Perthites are mostly string, vein to coarse vein types, shows simple twining with occasional micro fractures. Geochemical characteristics shows that the K_2O contents ranges from 5.63 to 12.2 wt.%, Na_2O ranges from 1.65 to 2.3 wt.%, CaO from 0.3 to 1.2 wt.% and SiO_2 ranges from 59.4 to78.33 wt.%. MgO and Fe_2O_3 ranges from 0.01 to 0.48 wt.% and 0.32 to 1.59 wt.% respectively. The occurrence of perthite intergrowths indicates the hypersolvus nature of the feldspars and the estimated melting temperature 1200^0C is also conforms the same. When plotted in K_2O - Na_2O - CaO ternary diagram on the basis of X-ray fluorescence major oxides the feldspar occupies the alkali orthoclase feldspar field.

Keywords: Feldspar, Mineral Deposits, Ranga Reddy, Eastern Dharwar Craton.

1. Introduction

Feldspar is most dominant and important rock forming mineral, has many applications in different industrial applications. They used in painting, rubber and plastics industries and also in many other household items. Feldspars mix with the clay to make better quality ceramics. They control the viscosity of glass and lower their temperatures too. Feldspars serve principally as a source of alumina, which acts as a stabilizer, improves durability, and increases viscosity during glass formation. Mineralogically the feldspar mineral

deposits can be exhibits as orthoclase, plagioclase, albite anorthite, perthite and antiperthite. Geochemically they consists silicates of Al, Na, Ca, K, Fe and Ba and also combinations of these elements (Perkins D 2015). Traditionally, feldspar was extracted from pegmatites by hand sorting, but today**,** the new flotation techniques make it possible to extract feldspars easily from the wide variety of felsic plutonic rocks and also from metavolcanic rocks **(**Harben et al 1997; Palomba et al 2010).

The high demand of feldspar for industrial activities (especially ceramics and glass manufactures) leads to consider alternative resources during recent years. This gave the feldspar producing industries a British Geological Survey's Centre for Sustainable Mineral Development (2019) report, major boost worldwide and today the use of feldspar is extensive in many countries in the world. As par the main producer countries are Italy, Turkey, China, USA and France. World map of the feldspar producing countries can be seen in Fig. 1. India is also producing notable amount of feldspar (1300000 and 1500000 metric tons in the year 2017 and 2018 respectively). The Telangana state is one of the feldspar producing states in India; particularly the erstwhile Mahaboobnagar District is producing nearly 333974 Tonnes/year.

The feldspar mineral deposits located in Eastern Dharwar Craton; particularly in the Ranga Reddy and Mahaboobnagar district of Telangana state is pegmatite types, hosted by the granitic rocks. The erstwhile Ranga Reddy district of Telangana state, located the northern part of the Eastern Dharwar Craton (EDC) in South India. The study area is a part of the Ranga Reddy is located 70Km away from Hyderabad city towards south, is largely composed of pink and grey granites, granodiorites, aplites and dolerite dykes. This region is predominantly consists of quartzo-felspathic veins and pegmatites occurred within the granitic terrain of the EDC. The feldspar and quartz mineral deposits are spatially associated with the dolerite dykes. The production of feldspar mineral deposits are mainly from these pegmatites and feldspathic veins of the area and the average production is about 48000 tones for year in Ranga Reddy district. The distribution map of Quartz and Pegmatite feldspar mineral deposits of Rangareddy showed in the fig.2. This area is suitable for quartz and feldspar exploration and there are scarce investigations on their petrogenesis. This paper reports the petrographical and geochemical data as well as the economic potential of feldspar mineral deposits.

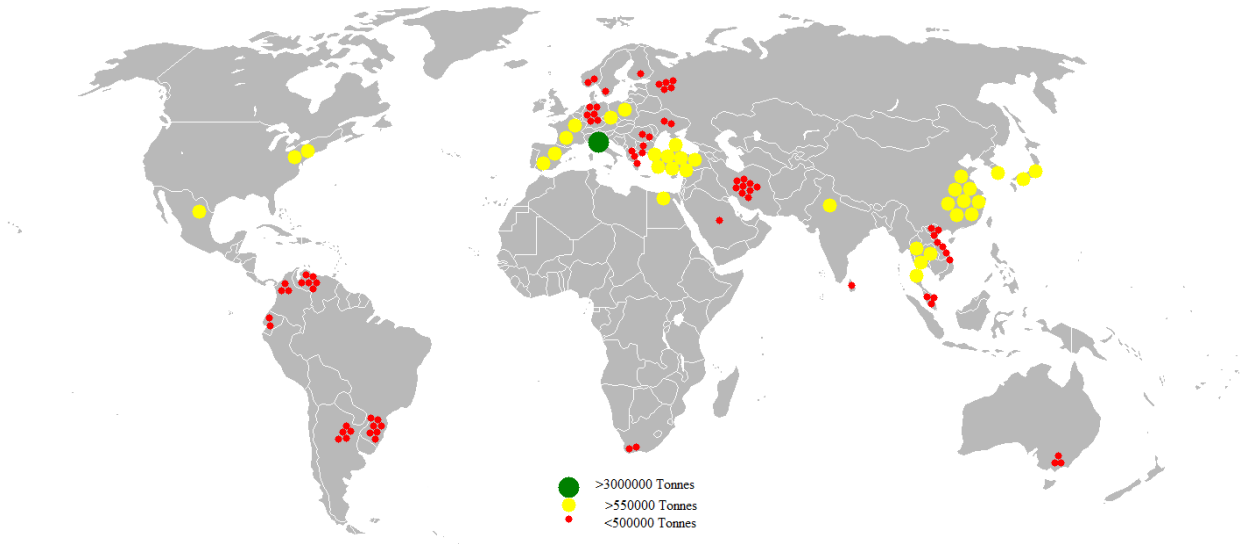

Fig. 1 World map illustrating the feldspar producing countries (British Geological Survey, 2013)

2. Geological setting

The study area forms part of the Eastern Dharwar Craton (EDC), mainly consists of rocks of Peninsular Gnessic Complex (PGC) consists of tonalite, trondhjemite, granodiorite, adamellites and also older metamorphic rocks comprising metabasalt and schist are also exposed in the area. Many dolerite and gabbro late stage dykes intruded into granitoids, trending E-W, N-S, NW-SE and NE-SW directions. The quartz reef/veins and pegmatite form acid intrusives. Most of the quartz and feldspar deposits occurred as pegmatites form masses, excellently exposed to the surface that are -plainly intrusive in association with granitoids. Praveen et al (2018) carried out petrological and geochemical investigation on Hyderabad granite batholith. Narshimha et al (2016) studied intergrowth textures in Koheda pink granite and interpreted their origin to Autometamorphic origin. Pahari et al (2020) characterized the Hyderabad granites and attributed their origin to remelting of older TTG crust. Narshimha et al. (2018) carried out petrological and geochemical investigation on a hypersolvus granite occurred to the eastern margin of EDC. Nature of enclaves and their petrogenesis were discussed by Narshimha et al. (2017). Many workers carried out the geological investigations in Hyderabad, Ranga Reddy and adjoining Mahabubnagar districts (Nayak and Kashivishvanathan, 1987; Rao and Chowdhary, 1989; Gopal Reddy et al., 1992 and Kashivishvanathan, 2002). The Occurrence of the feldspar mineral deposits are located in the Achampet (16^0 19':$78^0$58'), Charakunda (16^0 42':78^0 45'), Kalvakurthi (16^0 40':78^0 29'), Kotakunda (16^0 45':77^0 39'), Mamunapuram (16^0 48':78^0 38') and several other places in this region.

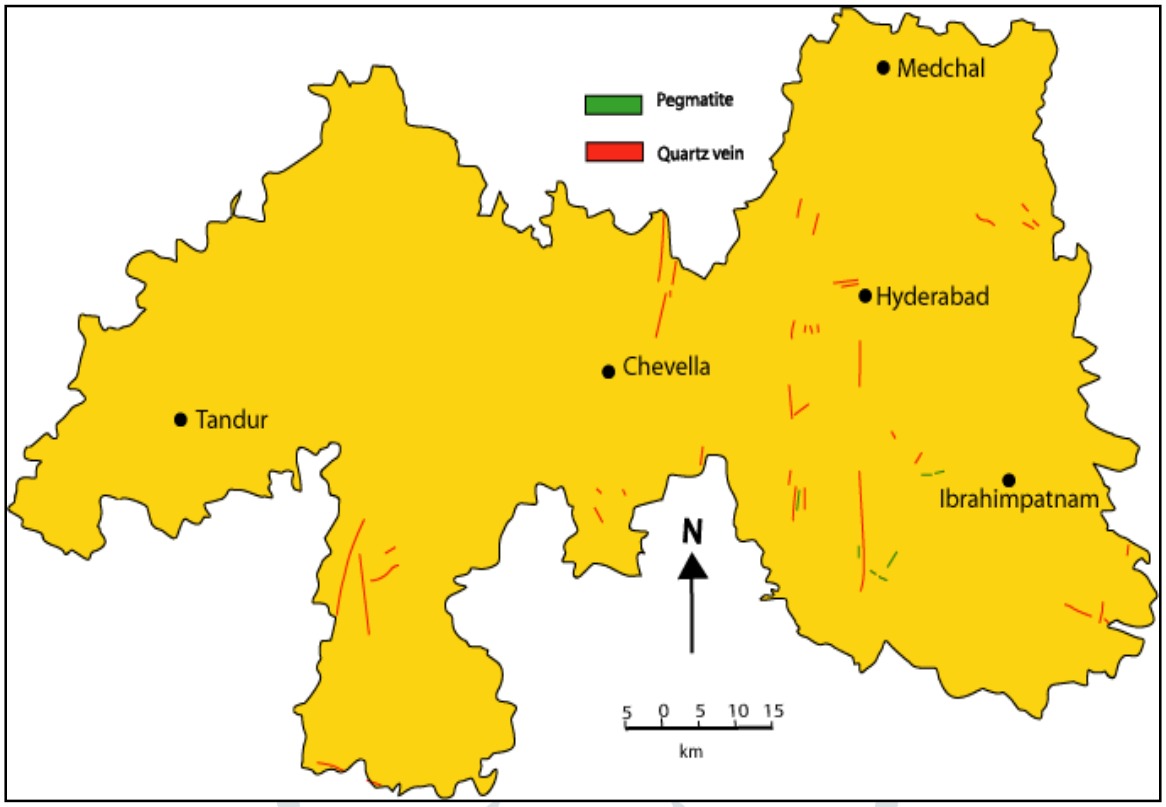

Fig.2 Distribution map of Quartz and Pegmatite feldspar mineral deposits of Rangareddy and Hyderabad Districts of Telangana State.

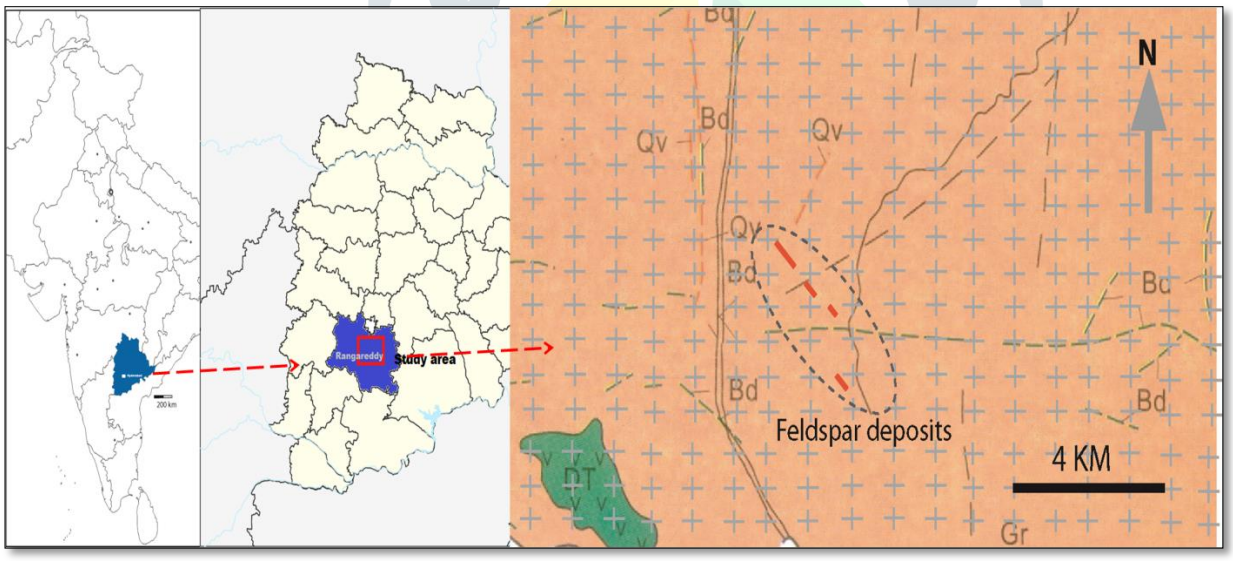

Fig.3. Geological map of the study area showing location of quartz, feldspar mineral deposits Qv: Quartz vein, Bd: Basic dyke, DT: Deccan Traps; Gr: Granite (modified after, Mahaboobnagar DRM, 1995).

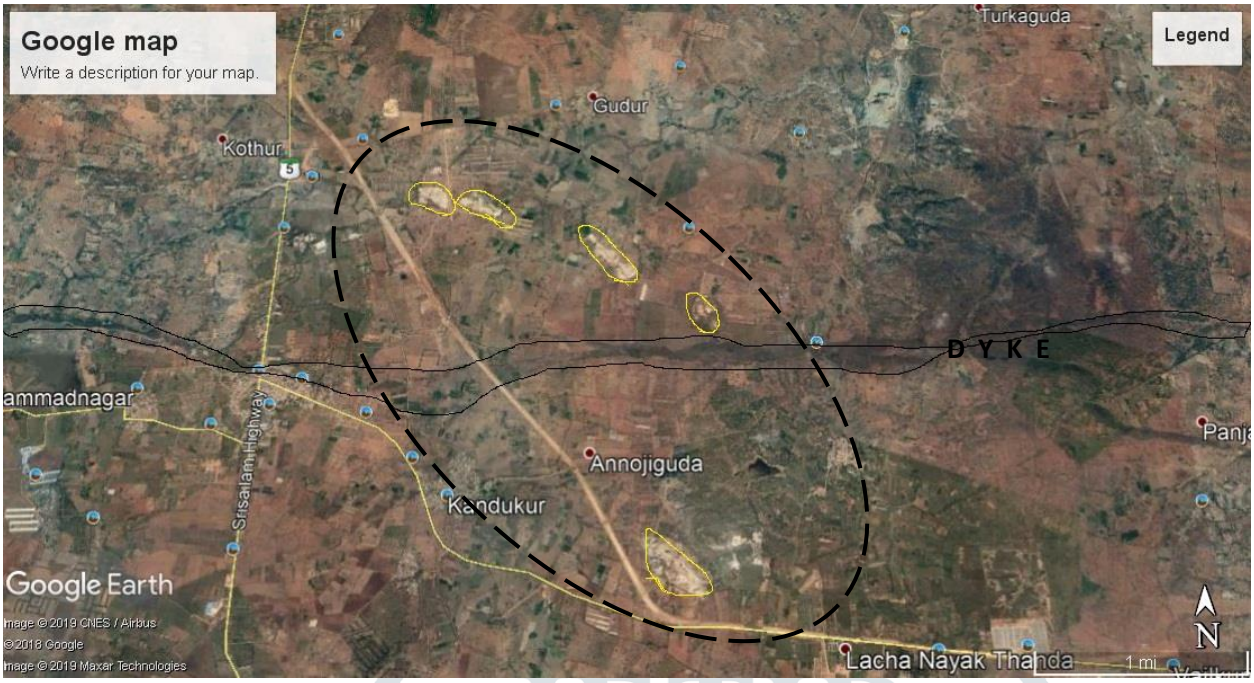

Fig.4 Google location map of feldspar mineral deposits of Kandukur and surrounding areas of Rangareddy District, Telangana.

3. Field relations and Petrography

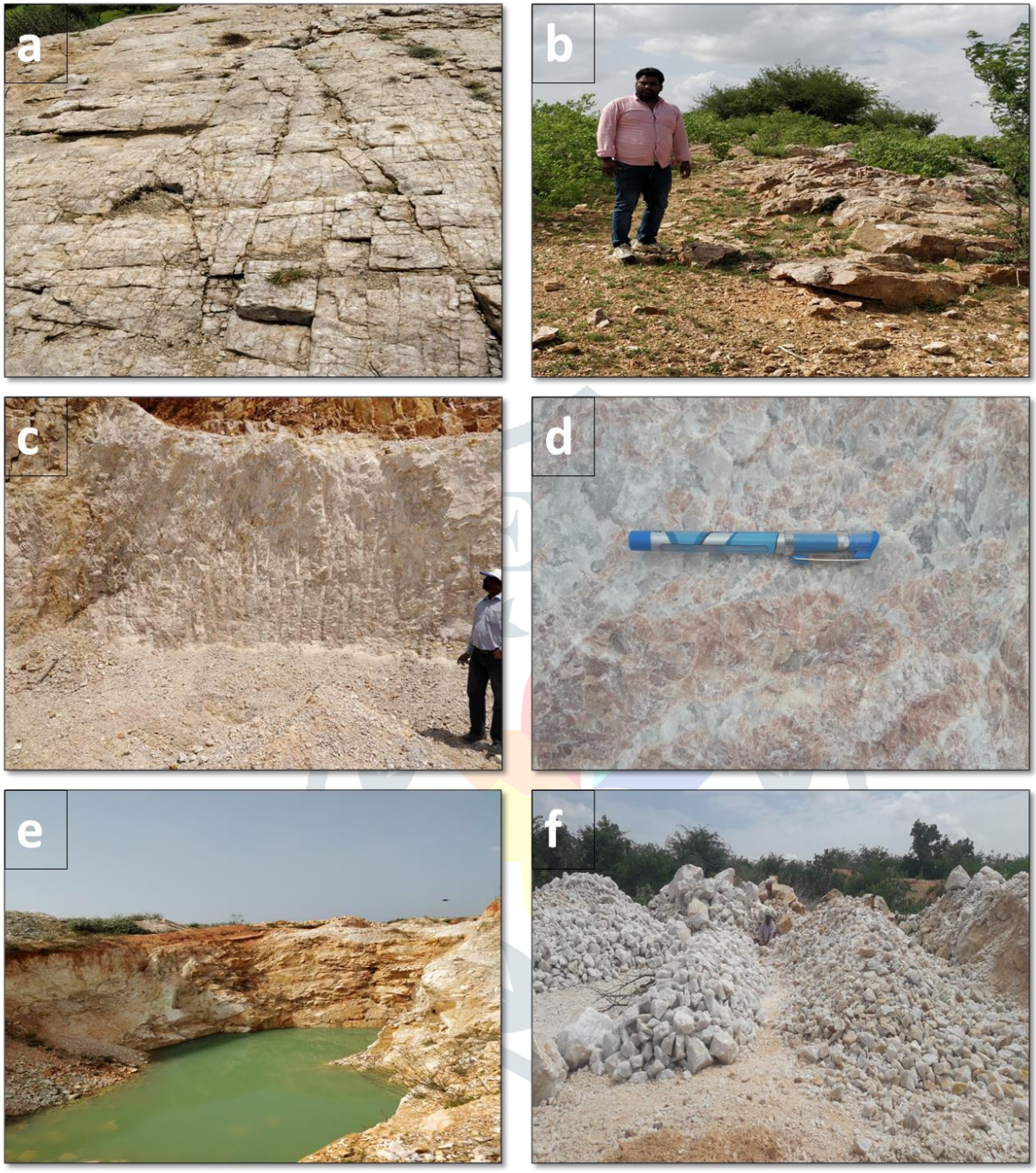

Fig.5 Field photographs a & b) well exposed outcrops of feldspar mineral deposit, c) fresh cutting of feldspar deposit in a mine in the study area, d) Orthoclase (flesh red) and plagioclase (ash grey) intergrowths, e) an abandoned Feldspar quarry from the study area, f) Stockpile of crude feldspar from the study area.

The feldspar mineral deposits occurred in Ranga Reddy, Hyderabad and Mahaboobnagar districts are ellipsoidal to lenticular bodies, intrusive nature, with close spatial association with granitoids. These deposits are well exposed to the surface trending NS, NW-SE, NE-SW directions with vertical diping. The minimum and maximum width of the deposits is 30- 70 meters and length is about 70-150 meters. The maximum depth of the deposits is about 150 meters. This feldspar deposit occurs as massive bodies showing fractures and

joints. At some places these deposits are covered by the aplite rocks. The aplites are fined grained rock consists quartz, orthoclase as essential minerals, formed as cap rocks with 5 to 10 meters thickness. The feldspar deposits are also covered by thin (~2-3merers) red soil, wherever these are running parallel to the basic dykes swarms. A total 12 fresh samples were collected from the study area during the field work. Thin sections were prepared and petrographical studies were carried out using petrological microscope.

Mineralogically the deposits are mainly composed of perthites and antiperthites with interstitial quartz. In general, perthite is a mineral, formed due to intergrowth of orthoclase and plagioclase feldspars. The host grain of k-rich alkali feldspar ($KAlSi_3O_8$) includes exsolved lamellae or irregular intergrowths of sodic alkali feldspar (near albite, $NaAlSi_3O_8$, in composition). Perthites occur due to both exsolution (relatively high temperature phenomenon) and replacement (functioning at lower temperatures) processes in different conditions. Typically they display wide textural variations. However the genesis of the different perthitic textures provides keys to address to many questions to solve the petrogenetic problems. The intergrowth forms by exsolution due to cooling of a grain of alkali feldspar with a composition intermediate between K-feldspar and albite. There is complete solid solution between albite and K-feldspar at temperatures near 700°C and pressures like those within the crust of the Earth, but a miscibility gap is present at lower temperatures. If an alkali feldspar grain with an intermediate composition cools slowly enough, K-rich and more Na-rich feldspar domains separate from one another. In the presence of water, the process occurs quickly.

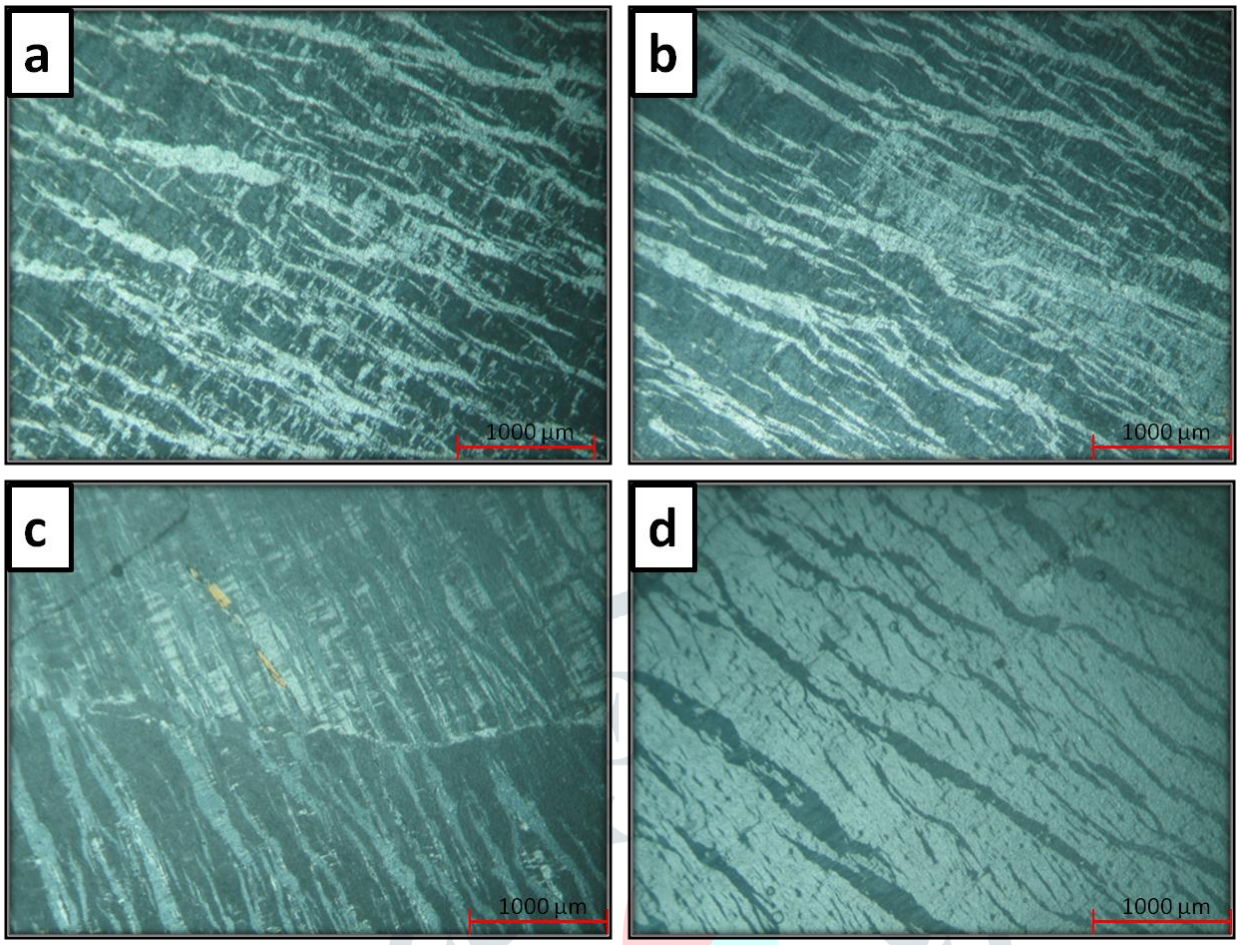

Fig.6 Microphotographs illustrating the different types of perthites and antiperthites. a & b) string to patch type microcline microperthites. c) perthite with simple twine having biotite inclusion. d) Antiperthite with dominant albite content. All images in XPL.

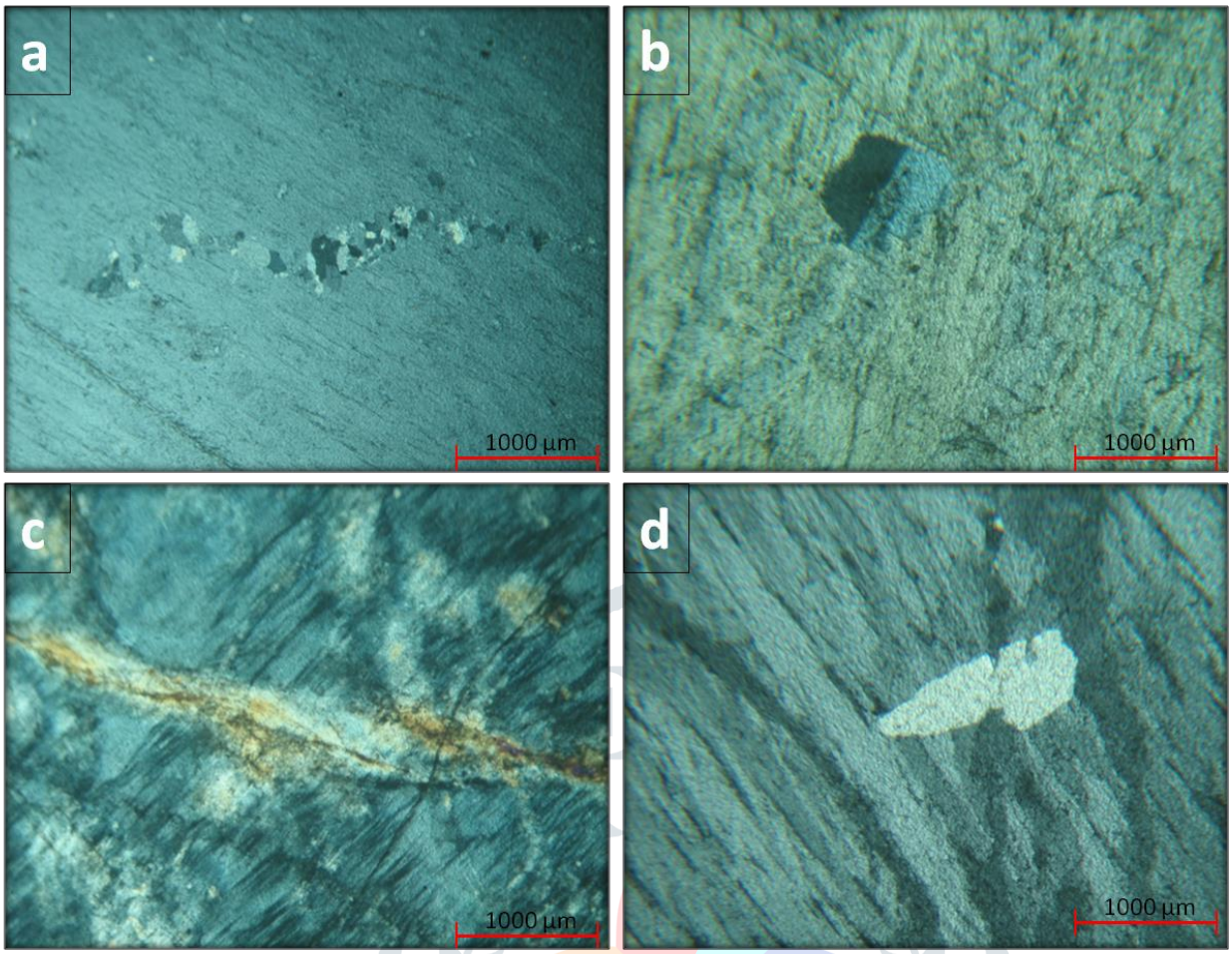

Fig.7 Microphotographs showing inclusions and altered perthites. a) Layered quartz inclusions in orthoclase. b & d) quartz inclusions. c) Altered perthite with microfractures.

Mineralogically the deposits are mainly composed of perthites, antiperthites, orthoclase and plagioclase as constituents. These minerals are coarse grained, extreme irregularity textures, show remarkable variation in coarseness, whereas the coarser bodies are commercially valuable for their feldspar. Intergrowths of orthoclase and plagioclase can be seen by necked eye. Perthites are mostly string, vein to coarse vein types, shows simple twining with occasional micro fractures. Perthites are also hosts for quartz inclusions. Quartz present as an accessory mineral mostly formed as interstitial grains, showing wavy extinction.

4. Geochemistry

A sum of 12 representative samples were analysed for the major oxide geochemical data and the results are presented in Table 1. The K_2O contents in these feldspar deposits range from 5.63 to 12.2 wt.%. Na_2O range from 1.65 to 2.3 wt.%, CaO from 0.3 to 1.2 wt.% and SiO_2 ranges from 59.4 to 78.33 wt.%. MgO and Fe_2O_3 ranges from 0.01 to 0.48 wt.% and 0.32 to 1.59 wt.% respectively. The average Na_2O+ K_2O is 11.39 wt%. This variation is due to the heterogeneous distribution of the feldspar minerals that present in the original granitic rocks. The iron oxides occurred in a low quantity in the analyzed samples. The percentages

vary from 0.01 to 1.5% which are thought to be produced from the alteration of the mafic minerals that present in the deposits. The highest values of K_2O contents correspond to K-feldspar of granitic facies. Optical analyses demonstrate that the potassium content may be influenced more by the albite content as perthite than the degree of geochemistry evolution.

Table 1 Major oxide analyses of the Feldspar mineral deposits

Sl. No	Sample Name	SiO_2	Al_2O_3	K_2O	Na_2O	CaO	MgO	Fe_2O_3	LOI	Total
1	KFD-1	75.02	13.18	6.96	2.28	1.21	0.16	0.51	0.41	99.73
2	KFD-2	78.33	11.95	5.63	2.05	0.87	0.24	0.53	0.28	99.88
3	KFD-3	75.83	12.66	7.37	2.06	0.88	0.32	0.45	0.29	99.86
4	KFD-4	74.88	14.41	7.64	0.59	1.09	0.16	0.35	0.59	99.71
5	KFD-5	70.53	17.4	7.97	1.68	0.33	0.1	0.32	1.32	99.65
6	KFD-6	73.41	14.06	7.87	1.65	1.18	0.48	0.33	0.54	99.52
7	KFD-7	65.85	17.22	12.2	2.4	0.9	0.1	0.76	0.3	99.73
8	KFD-8	67.59	17.15	11.4	1.9	0.82	0.22	0.51	0.27	99.86
9	KFD-9	65.8	17.21	11.8	2.25	0.82	0.1	1.59	0.25	99.82
10	KFD-10	66.63	18.33	11.23	2.32	0.71	0.06	0.07	0.31	99.66
11	KFD-11	66.85	18.45	10.89	2.39	0.72	0.05	0.06	0.19	99.6
12	KFD-12	66.13	18.3	11.67	2.25	0.75	0.08	0.07	0.21	99.46

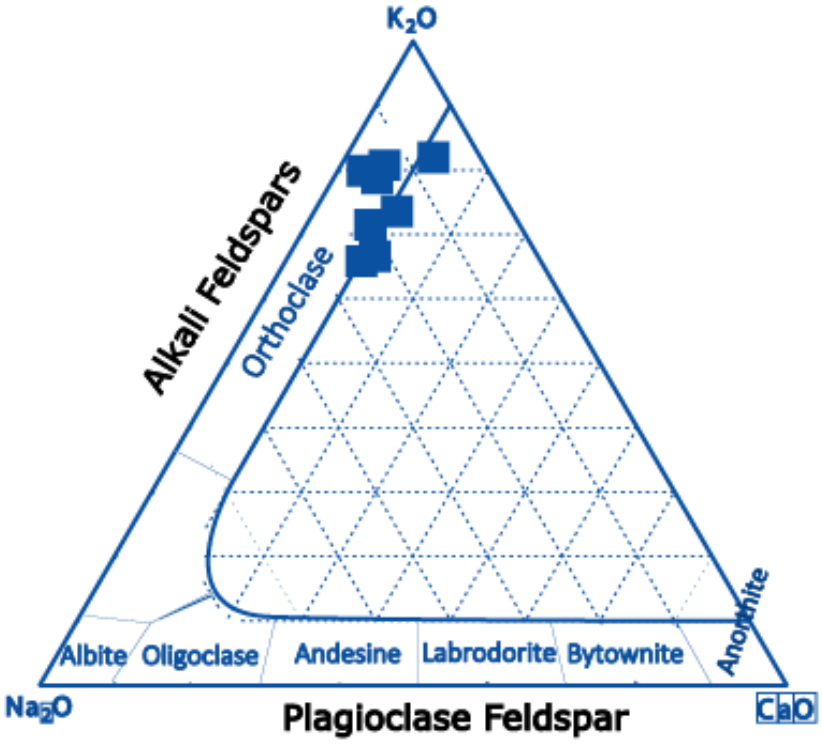

Fig. 8 K_2O-Na_2O -CaO ternary diagram on the basis of X-ray fluorescence major oxides showing the placement of the feldspar

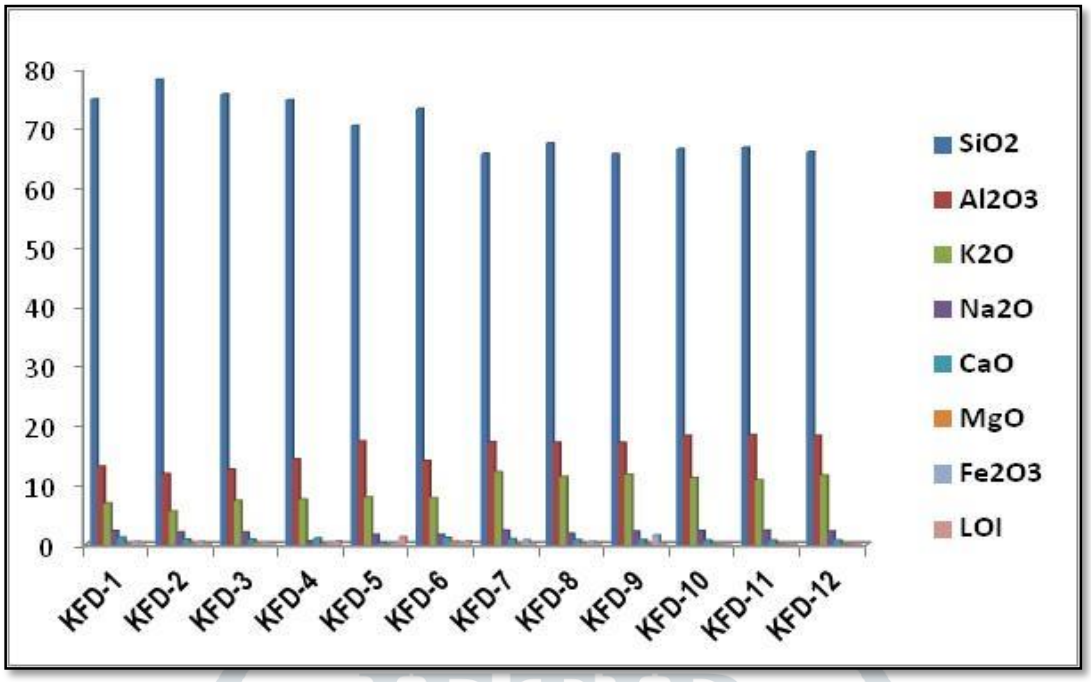

Fig. 9 Column chart showing the average concentrations for depicting variations and similarities for KFD samples.

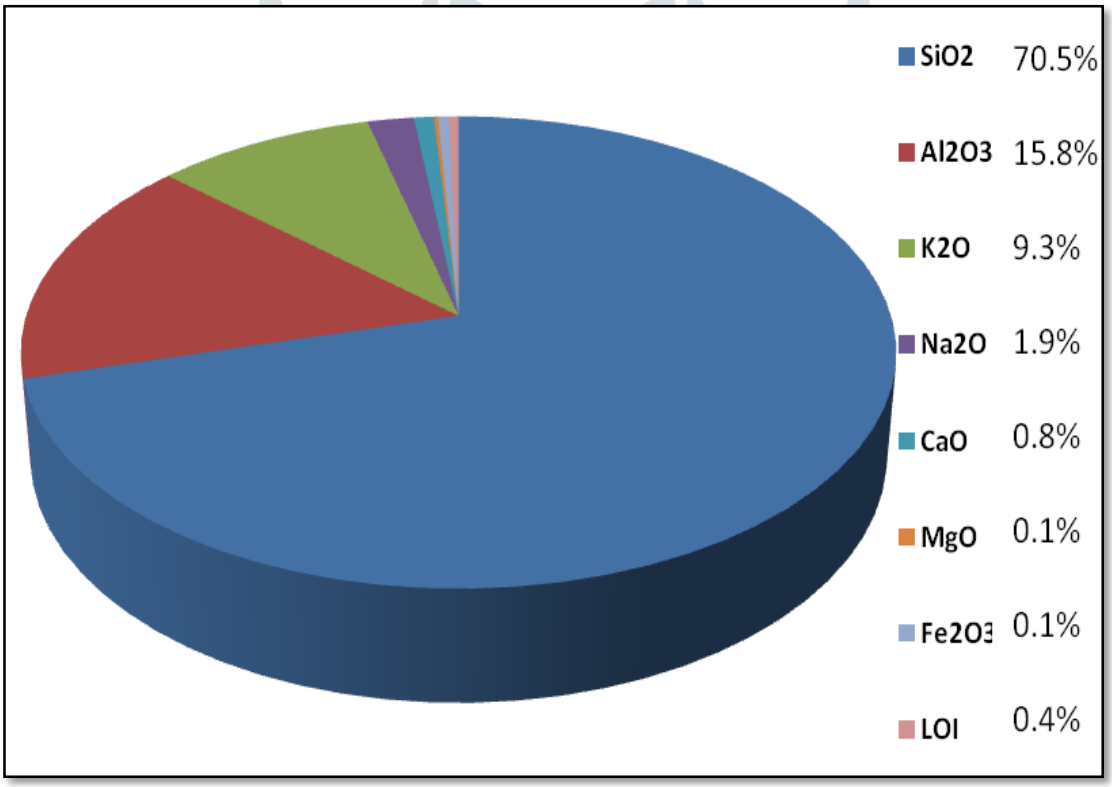

Fig.10 Pie chart showing Percentages of average concentrations of major oxides for KFD samples.

5. Discussion and Conclusion:

The occurrence of pegmatite veins and pockets are common in large granitic batholith regions. The EDC of south India largely consists of granitic rocks and associated quartz and pegmatitic veins. The pegmatitic veins are main source for the feldspar mineral deposits in this region. The feldspar deposits of the study area are massive pegmatites with intrusive relationships with granites, exposed as ellipsoidal to lenticular bodies with NW-SE trend, occurred in vicinity to mafic dyke. Quench of a mafic dyke swam into the pegmatite feldspar deposits indicates the intrusive relationship with the mafic dyke in the vicinity. Occurrence of impurities near the contact is possibly due to assimilation process. Aplites formed as cap rocks, they are fine grained rocks consists quartz and feldspars as essential minerals.

This pegmatitic pockets consists almost entirely of perthite and antiperthites as essential constituents whereas, the orthoclase and quartz present as accessory minerals. The coarser bodies are believed to be commercially valuable. The perthite and antiperthite intergrowths with simple twinning indicate the magmatic origin of the pegmatite veins. Perthites are mostly string, vein to coarse vein types. The micro fractures and patchy type of perthites are developed due to post crystallization effects. Inclusions in perthite are quartz and biotite inclusions. These inclusions are angular and elongated and at place twinned. Geochemical characteristics shows that the pegmatite consists rich SiO_2 (59.4 to78.33 wt.%.) and alkaline in nature. MgO ranges from 0.01 to 0.48 wt.% , whereas Fe_2O_3 ranges 0.32 to 1.59 wt.%. The occurrence of perthite intergrowths indicates the hypersolvus nature of the feldspars and the estimated melting temperature 1200^0C is also conforms the same. When plotted in K_2O - Na_2O - CaO ternary diagram on the basis of X-ray fluorescence major oxides the feldspar occupies the alkali orthoclase feldspar field.

References:

1. Harben P, KuZ ˇ vart M. Industrial minerals: A global geology. 3rd ed. London: Industrial Minerals Ltd. Metal Bulletin PLC; 1997, pp. 490.
2. Kashivishvanathan, C. V. K., 2002: A report on the geoenvironmental studies in the drought prone Kalwakurty and Achampet talukas of Mahabubnagar district, Andhra Pradesh. Unpubl. Rep. Geol. Surv. India, FS: 1997-98.
3. Narshimha Ch, Praveen K, Subramanyam K S V and Reddy U V B (2016) Origin of intergrowth textures in Koheda Pink granite, east of Hyderabad city, India: Implications for autometamorphic conditions. International Journal of Earth Sciences and Engineering., Vol. 09, No. 05, , pp. i-ii.
4. Narshimha Ch, Reddy U V B, Sesha Sai V V and Subramanyam K S V (2018) Petrological and geochemical characterisation of the Punugodu Granite Pluton, Nellore Schist Belt; Implications for

proterozoic anorogenic granite magmatism in the Eastern Dharwar Craton, southern India; J. Indian Geophys. Union 22 187–97.

5. Narshimha Ch, Subramanyam K S V and Reddy U V B (2017) Characterisation and Petrogenesis of Enclaves in Punugodu Granite Pluton, Prakasam District, Andhra Pradesh, India. International Journal of Earth Sciences and Engineering 10(4):924-930
6. Nayak, S. S. and Kashivishvanathan, C. V. K., 1987: Systematic geological mapping in parts of Mahabubnagar district, Andhra Pradesh. Unpubl. Rep. Geol. Surv. India, FS: 1984-85.
7. Pahari A, Prashanth P, Devleena M Tiwari, Manikyamba C and Subramanyam K S V (2020) Subduction–collision processes and crustal growth in eastern Dharwar Craton: Evidence from petrochemical studies of Hyderabad granites. J. Earth Syst. Sci. (2020) 129:32.
8. Palomba M, Padalino G, Baldracchi A. (2010) An unusual occurrence of an exploitable K-feldspar deposit hosted in the Ordovician porphyroids (Southern Sardinia) geology, mineralogy, geochemical features and economic potential. Ore Geol Rev. 2010;37:202–221.
9. Perkins D. Mineralogy. Upper Saddle, NJ: Prentice-Hall Inc; 2015.
10. Praveen K, Anjaneyulu M, Narshimha C and Reddy U V B 2018 Petrology and geochemistry data of the precambrian granitoids from the Hyderabad area, part of Eastern Dharwar Craton, Telangana state, India; Data in Brief 21 1909–1917.
11. Rao, M. V. N. and Choudhary, D. K., 1989: Systematic geological mapping in parts of Mahabubnagar and Nalgonda districts, Andhra Pradesh. Unpubl. Rep. Geol. Surv. India, FS: 1987-88.