Dolomite Mineral Occurrence In Narpala Mandal In Ananthapuramu District, Andhra Pradesh, South India.

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Abstract: Dolomite is a carbonate rock that in its pure form consists essentially of a double carbonate corresponding to CaMg $(CO3)_2$. Dolomite is applied to a carbonate rock in which at least the minimum amount of 41 percent magnesium carbonate is present. Dolomite closely resembles limestone, but close inspection shows many differences between them. Replacement of calcium in limestone by magnesium results in the recrystallization of the limestone to form dolomite. This replacement process, called dolomitization, generally tends to destroy the original or earlier texture and structure of the rock. Complete recrystallization produces a rock in which many dolomite crystals are well outlined. In general, dolomite is more even grained and less fine grained than limestone. The weathered surface of dolomite commonly is mottled and shows the outlines of dolomitic grains and generally shows the extent of dolomitization. Factors governing the kind of materials found in limestone also apply to dolomite. Dharwar Super group, peninsular gneissic Complex-II and Cuddapah Super group. Small exposures of Meta basalt representing Kadiri Schist Belt and amphibolites representing Ramagiri Schist Belt are found in south east corner and west central part of the toposheets respectively. Western part of the toposheet is covered by rocks of PGC-II and is intruded by dolerite dykes and quartz veins. Conglomerate, dolomite, quartzite and shale belonging to Cuddapah Super group is exposed successively towards east. Basic sills are found within shale at top of hillocks in north eastern part. Barytes occurs as fractures filling in Vempalle Formation at several places.

Keywords: Dolomite, recrystallization, Dolomitization, Dharwar Super Group, Cuddapah Super Group.

1. INTRODUCTION

Dolomite is a carbonate rock that in its pure form consists essentially of a double carbonate corresponding to CaMg (CO3)2. An ideal dolomite would consist of 54.3 percent calcium carbonate and 45.7 percent magnesium carbonate, and thus unit 11 of table 30 is very near in composition to a theoretical. Dolomite. In this report the name dolomite is applied to a carbonate rock in which at least the minimum amount of 41 percent magnesium carbonate is present. Dolomite, CaMg(CO3)2, is a common mineral in ancient rocks and the thermodynamically stable carbonate phase in modern seawater, yet it is rare in modern marine environments. Why this is so has remained the subject of scientific inquiry of over 200 years. There is very little agreement concerning the details of dolomite formation except that most natural dolomites form at Earth-surface temperatures and pressures (Krauskopf and Bird 1995). Dolomite is an unusual carbonate mineral. It is common in ancient platform carbonates, yet it is rare in Holocene sediments and, without bacterial mediation, is near impossible to precipitate in the laboratory at earth surface temperatures. Some argue that widespread dolomite forms mostly in association with hypersaline brines, others that it can form from schizohaline waters, or that the time required to form large volumes of dolomite means that the process must be predominantly subsurface and perhaps tied to the long-term circulation of seawater through plat- form sediments (Land, 1985; Hardie, 1987) .Most modern dolomite occurrences are pen contemporaneous, patchy and micritic. Holocene dolomites comprise units that, at most, are a meter or so thick, dolomite the mineral. Makes up less than 50% of the unit's mineralogy and forms in patches across areas that are no more than tens of kilometres wide. In contrast, most ancient dolomite entrains dolomite the mineral. That makes up more than 90% of the rock volume, is secondary, extensive and often sparry. It has overprinted whole limestone platforms as digenetic units that are typically some hundreds of meters thick and extend across areas that may be hundreds of kilometres wide. Possible reasons for the disparity between modern and ancient modes of occurrence are many, and related to dolomite's unique mineralogy and chemistry. The most important control on distribution is possibly kinetics; there has not been enough time in the Holocene to form extensive areas of secondary dolomite (Land 1985, 1998; Chai et al., 1995).The dolomitization potential of reflux brines has previously been evaluated with magnesium mass-balance calculations (Sears and Lucia, 1980; Simms, 1984; Montanez and Read, 1992; Shields and Brady, 1995). Mass balance studies generally ignore spatial variations in fluid flux, and the thermodynamic and kinetic controls on dolomitization are approximated by specification of a magnesium exchange efficiency (Whitaker et al., 2004) This results in a transport-limited system, whereas dolomitization may actually be strongly reaction rate limited, particularly at low temperatures, resulting in a dolomite body that strongly reflects geochemical controls (Wilson et al., 2001).The Tadipatri formation consist of dolomitic limestones and dolomites, often cherty, with intercalated purple shales and thin beds of chert. The dolomites are well bedded, with the individual) beds occasionally measuring up to a metre. The colour varies from white to grey, bluish grey, and when shaly, purple. On weathering the rock usually gives rise to a dark soil. The rock is compact and dense and has a sachha-roidal texture. The chert bands stand out in relief on the weathered surface in cherty dolomites. Occasionally, concretionary structures of chert resembling stromatolites consisting of alternating layers of chert and dolomite are seen in the area. The shales are typically purple in colour, hut may also be red. They are well bedded and compact, with increasing carbonate content; they pass into dolomites through calcareous shales and shaly dolomites.

2 STUDY AREA

The study area, Narpala Mandal of Anantapur district is present at the southwest part of the Rayalaseema region of Andhra Pradesh. The Anantapur district is located between 13 ° 40 'and 15 ° 15' north latitude and 76 ° 50 'and 78 ° 30' east longitude. The Area is total geographical area of 268.9 km2. Figure 1 represents the location map of the study area. The north, central and eastern parts of the Narpala are hilly terrain dotted with NW-SE trending hills and the remaining area is undulatory/rolling plain country. The maximum elevation is 585 m above msl, 1.5 km west of Jayyavaripalle while the minimum elevation is around 270 m above msl on the banks of Chitravati River. The Chitravati River drains the area in the south-eastern part and several third order streams drain the remaining area. Mid Penner south canal and a few tanks in the north-western part serve the irrigation and potable water needs of the area. Several ephemeral tanks serve the irrigation and potable water needs. Southern part of the area is drained by Pandam River and its tributaries which flow towards north and tributaries of Chitravathi River drains south eastern part of the area. A spring is situated on 100mcontour of a stream about three miles east of Chillavarapalle and Chelumpalle. The area is marked by NW-SE trending hills formed of Gulcheru quartzite in the south western side. The middle area comprising of Vempalle dolomites is also hillocks especially northwest of Chitravati River cut across the area.

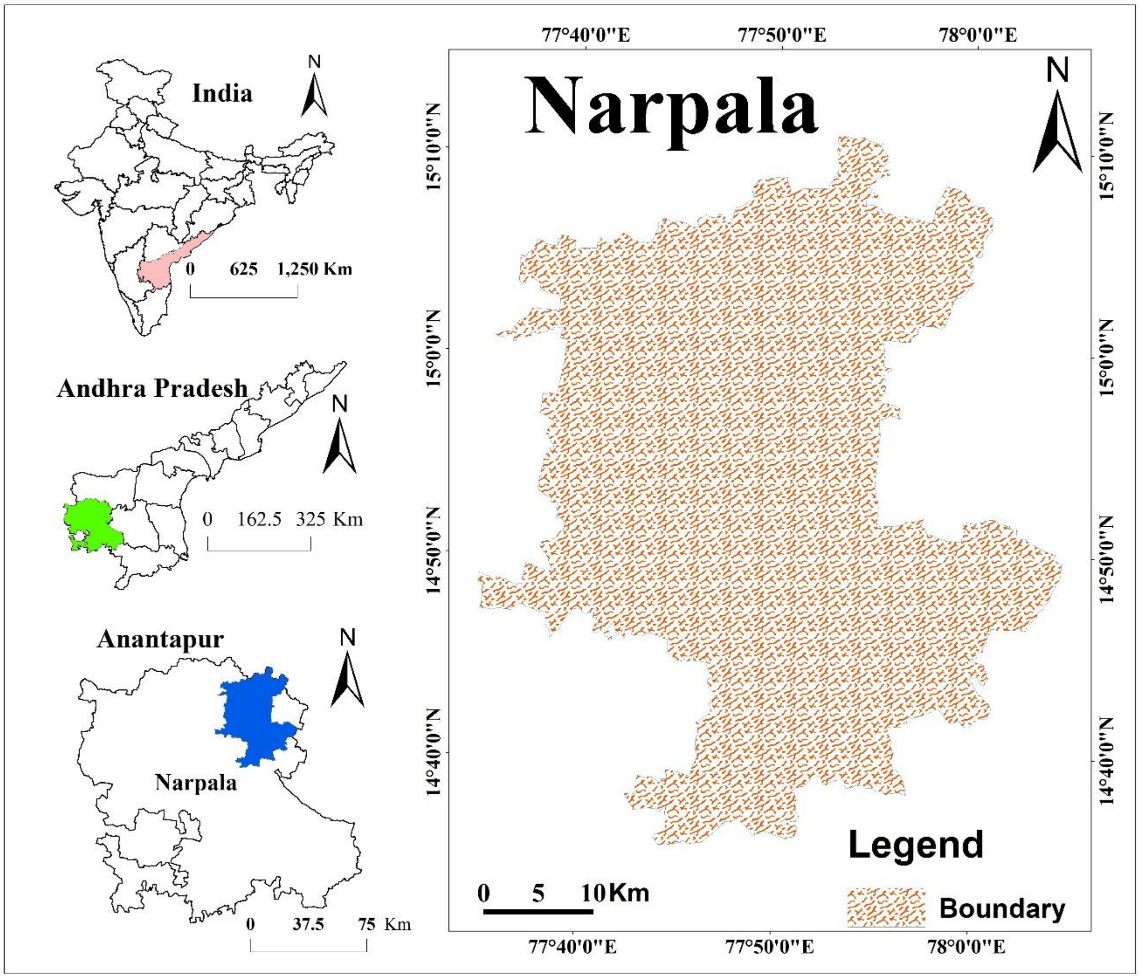

Figure 1 *Study area*

3 RESULTS AND DISCUSSION

3.1 ORGIN OF DOLOMITE

Most dolomite is thought to be secondary in origin and has been formed through the partial replacement of calcium by magnesium. Pettijohn (1957, p. 424) said: Dolomites are so commonly associated with salt and gypsum beds that high salinity and perhaps higher than normal temperatures promote dolomite formation. It may be that the waters of the basins that are partially isolated under conditions of aridity are enriched in magnesium by the continued inflow of normal sea water and by the precipitation of calcium carbonate and sulphate. in this manner favours the formation of dolomite. It even may be that dolomite itself is precipitated under these conditions and that some dolomite is indeed a primary rock. Dolomite closely resembles limestone, but close inspection shows many differences between them. Replacement of calcium in limestone by magnesium results in the recrystallization of the limestone to form dolomite. This replacement process, called dolomitization, generally tends to destroy the original or earlier texture and structure of the rock. For example, fossils once present commonly are destroyed, and ghostlike patterns remain to suggest their former existence. Complete recrystallization produces a rock in which many dolomite crystals are well outlined. In general, dolomite is more even grained and less fine grained than limestone. The weathered surface of dolomite commonly is mottled and shows the outlines of dolomite grains and generally shows the extent of dolomitization. Factors governing the kind of materials found in limestone also apply to dolomite.

3.2 GEOLOGIC FACTORS THAT AFFECT THE AVAILABILITY OF HIGH-CALCIUM LIMESTONE AND DOLOMITE:

As the chemical industries are the principal users of high-calcium limestone and dolomite, the exploration for these commodities requires that careful attention be paid to the quality as well as the quantity of the stone. A thorough knowledge of all aspects of exploring for high-calcium limestone and dolomite is essential because the margin of profit in selling these commodities generally is low and unforeseen cost may be disastrous to the success of the operation. Limestone and dolomite in many regions generally are no uniform, and the extent of no uniformity determines ultimate use. Exploratory drilling may be necessary in regions where there are no natural rock outcrops. Core drilling, based on geologic knowledge of the region, will provide samples for analysis and information useful for verifying predictions about thickness of overburden and usable rock. Non geologic factors, such as transportation facilities, fuel, markets, and population centres, commonly affect the establishment of a quarry or mine. Geologic factors therefore are not always the most important considerations.

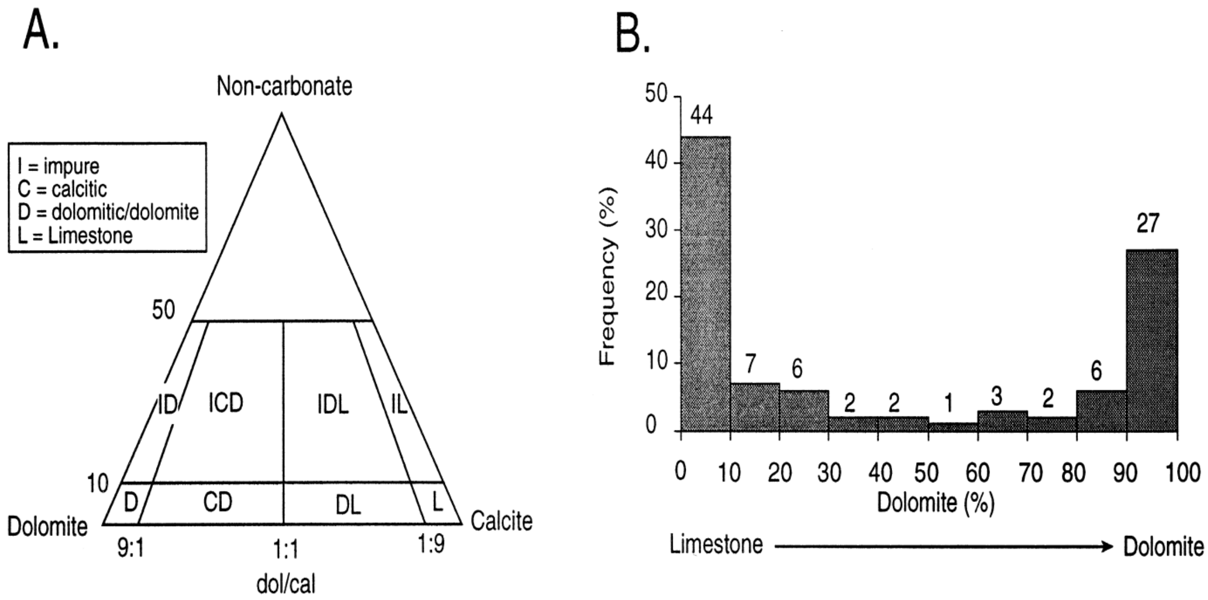

***Figure 2**. General carbonate classification according to mineralogy of components after Leighton and Pendexter, 1962. 2A. Computed percentages of calcite and dolomite for 1148 modal analyses of North American carbonates after Steidtmann, 1926; Blatt, 1992.*

Ancient carbonate rocks are mostly composed of two minerals; calcite or dolomite, with any non-carbonate phases usually dominated by ferruginous components or evaporates Fig. 2A. When a carbon-ate is dominated by calcite, it is called limestone, when it is dominated by dolomite the mineral. it is called dolomite the rock.. In North America, the term dolostone is sometimes used to describe such a rock. Carbonate rocks tend to be composed either mostly of calcite or mostly of dolomite Fig. 2B; Blatt, 1992.Whatever the conditions that favour dolomite or limestone formation the tendency is to form either one or the other end member, sub equal mixtures of calcite and dolomite in a carbonate rock are unusual. In a refinement of this analysis and using other unpublished work as well as their own data, Sperber et al. 1984.

3.3 DOLOMITIZATION

Ronchi et al. (2005) suggested that dolomitization processes happened in two stages (i) replacement and (ii) dolomite void space cementation, but Machel (2004) proposed that void space dolomite cementation should not be considered as dolomitization. Hence, only the first stage is numerically modelled here. Invasion of Mg rich, calcite and dolomite-under saturated near neutral (of pH ~7; following Consonni et al., (2010) dolomitization solution into a limestone domain will start dissolving limestone according to reaction

$$CaCO_3 + H^+ = Ca^{+2} + Hco_3$$

3.4 GEOLOGY SETTINGS:

The area exposes rocks of Kadiri Schist Belt (KSB) and Ramagiri Schist Belt (RSB) of Dharwar Super group of Archaean age, Peninsular Gneissic Complex (PGC-II) of

LITHOLOGY	FORMATION	GROUP / SUPER GROUP	AGE
Basic sills Dolomite Shale	Tadapatri Formation	Chitravati Group	Meso-Proterozoic
Quartzite with conglomerate	Pullivendla formation		
Dolomite with chert	Vempalle formation	Papaghni Group	
Conglomerate	Gulcheru formation		
Dolerite	Basic intrusive		Palaeo-Proterozoic
Quartz vein			
Coarse grained pink hornblendebiotite granite		Peninsular Gneissic Complex (PGC-II)	Archaean to Palaeo-Proterozoic
Grey biotite granite			
Grey hornblende biotite granite			
Grey hornblende – biotite granite gneiss			
Amphibolite	Ramagiri Schist Belt	Dharwar Supergroup	Archaean
Metabasalt	Kadiri Schist Belt		

Archaean to Palaeoproterozoic age and Cuddapah sediments of Meso-Proterozoic age. Dolerite and quartz Veins of Palaeo-Proterozoic age intrude the rocks of PGC-II. The lithological maps of the study area are shown in below

Meta Basalt:
This is the oldest rock exposed in the south eastern corner of the study area. It belongs to Kadiri Schist Belt of Dharwar Super group. It occurs as small enclaves within PGC. It is greenish grey to dark green, massive, pillowed, amygdular, and schistose rock with secondary calcite and quartz veins. It comprises hornblende/actinolite, chlorite, epidote and albite as essential minerals whereas sphene, magnetite and opaque's are the accessories.

Amphibolite:
The rock is medium to coarse grained, massive to foliated, dark green to green colour. It belongs to Ramgiri Schist Belt of Dharwar Super group and consists of hornblende and plagioclase. It is the most common rock type among older metamorphics. It occurs as very small enclaves within PGC and granitoids around Malyavantham village.

Grey hornblende-Biotite granite gneiss:
This litho unit forms the predominant rock type of the area covering most of the low-lying and plain areas. Grey hornblende-biotite granite gneiss is light grey in colour; medium to coarse grained and consists mainly of quartz, feldspar, hornblende and biotite. The rock is well foliated with a trend of NW-SE with moderate to steep westerly dips.

Grey hornblende biotite granite:
Grey hornblende- biotite granite occurs as small plutons. It is a coarse to medium grained, grey to light grey, holocystalline rock comprising quartz, orthoclase, microcline, hornblende and biotite with minor amounts of opaques. It is exposed near Bathlapalle.

Grey biotite granite:
It is grey, medium to coarse grained rock comprising quartz, potash feldspar, plagioclase, biotite + chlorite and opaques. Out crops are found near Bhimaraopeta, Kothapalle and Erraguntapalle.

Pink hornblende biotite granite:
The pink granite comes next only to the grey hornblende biotite granite gneiss in the order of abundance. It is medium to coarse grained, equigranular, occasionally porphyritic rock. It occurs as harpolithic plutons, tongues and apophyses of this rock are found within surrounding country rocks. At places it is very difficult to separate the grey and pink varieties. Coarse grained crystal of pink granite is a characteristic of this rock unit. Pink granite occupied as hillocks at central part of the toposheets. Pink hornblende biotite granite comprises of quartz, potash feldspar, perthite, plagioclase feldspar (andesite) and biotite.

Quartz vein:
Quartz veins intruding granites and gneisses extend often a few kilometers in length are seen around Gollapalle and Dugumati villages. These veins are grey/dark bluish grey and white in colour chiefly made up quartz, iron and sulphides.

Dolerite dykes:
Dolerite dykes of a few hundred of meters to a few kilometres length with variable widths (2-30 m) occur as linear ridges cutting across all the rock types. Mostly found towards the south eastern part of toposheet 57F/14.They are fine to medium grained, dark greyish green to black comprising plagioclase and pyroxene. Throughout the area dolerite intrusive were exposed as boulders.

Gulcheru Conglomerate:
Cuddapah sediments unconformably overlie the granites and gneisses. These sediments are classified into Papaghni and Chitravati groups. Papaghni Group is further sub-divided into lower Gulcheru and upper Vempalle formations. The lower Gulcheru is essentially made up of conglomerate and exposed near pulasasalanutala, Gugudu, Kuraganipalle. The matrix of the conglomerate was consists of hard compact grit stone. Sedimentary structures like current bedding and ripple marks are commonly observed.

Vempalle Dolomite:
Vempalle Formation conformably overlies the Gulcheru Formation and comprises dolomite, high grade limestone, reddish-purplish shale, chert and quartzite. TheVempalle Formation can be subdivided in to two zones, lower argillaceous and upper calcareous stromatolitic dolomite with cheat. Stromatolitic structure is commonly seen in dolomite near Ellutla, Jangamreddipalle. Oolitic structure also found in Vempalle dolomite near Pernapalle village.

Pullivendla quartzite:
Chitravati Group is divided into Pulivendla and Tadapatri Formations. The lower Pulivendla Formations disconformably overlies Vempalle Formation. It consists of ferruginous medium grained quartzite and conglomerate alternations. The conglomerate consists pebbles and cobbles of quartz, chert, jasper and quartzite. The quartzites range in composition from arkose to quartz asenite though sub-arkose. The major detrital mineral is quartz which is mostly unicrystalline in nature. These quartz grains are angular to sub-angular. Tadapatri Formation is basically an argillaceous unit compromising mainly shale. Basic flows/sills are seen intruding this formation.

Steatite:
Steatitisation of the Vempalle dolomites is more common in the present area close to the contact of the dolerite, preferably the upper contact. The steatite occurs in the form of bands usually alternating with unaltered massive dolomite or sometimes in the form of nodules within the dolomite. Only one or two bands of steatite occur in these areas and the workings are sustained by recovering mainly "white shale" bands which are found over the steatite bands and sometimes in between. The steatite is also often associated with serpentine or serpentinised dolomite, which usually occurs between the steatite bands and the dolerite sill, thereby suggesting that serpentinization perhaps proceeded steatitisation. This is also observed at Singanaguttapalle where a band of serpentinized dolomite comes between the dolerite sill and a zone of nodular steatite. In the main steatite area of Narpala little or no serpentine is noticed close to the dolerite contact. Due to intense steatitization here the serpentine was perhaps completely replaced by steatite. Thin serpentinized dolomite is also observed between the bands of steatite in the Narpala Mandal. In general, the steatite is a dense, compact rock with a parting parallel to the bedding in-some cases. Some of the bands show shaly appearance due to development of cleavage in folded areas. It is not uncommon to find massive dolomite

band in between two cleaved bands of steatite. In thin sections, the rock is seen to be composed of thin flakes of talc arranged in stellate fashion or without any orientation.

4. SRRUCTURE

The area forms part western margin of Proterozoic Cuddapah basin and late Archaean granite green stone terrain of eastern tectonic block of Dharwar Craton. One phase of deformation observed in grey hornblende-biotite granite gneiss. In the area deformation has been observed in the form of foliation. The foliation in gneisses trends towards NW-SE with sub-vertical dips towards west. The joints are seen along NNW-SSE, E-W, N-S, NE-SW and NW-SE trends at several places with either vertical or moderate to step towards north or west. The general strike in Cuddapah sediments is NNW-SSE with gentle easterly dips. The quartzites of Pulivendula Formation show ripple marks, planar cross bedding and mud cracks. The dolomites of Vempalle show stromatolites at many places. Oolitic structure also found in Vempalle dolomite near Pernapalle village.

Figure 4 *Stromatolitic dolomite east of jangamredipetta village*

Figure 5 *Dolomite showing oolitic structure near Narpala*

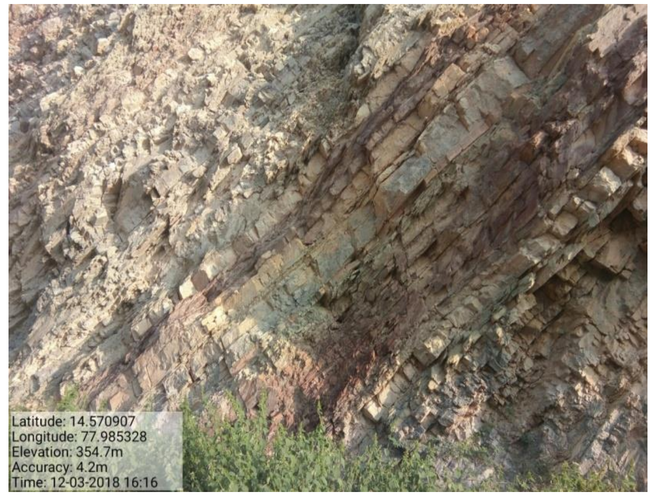

Figure 6 *Dolomitiation showing in near Narpala mandal*

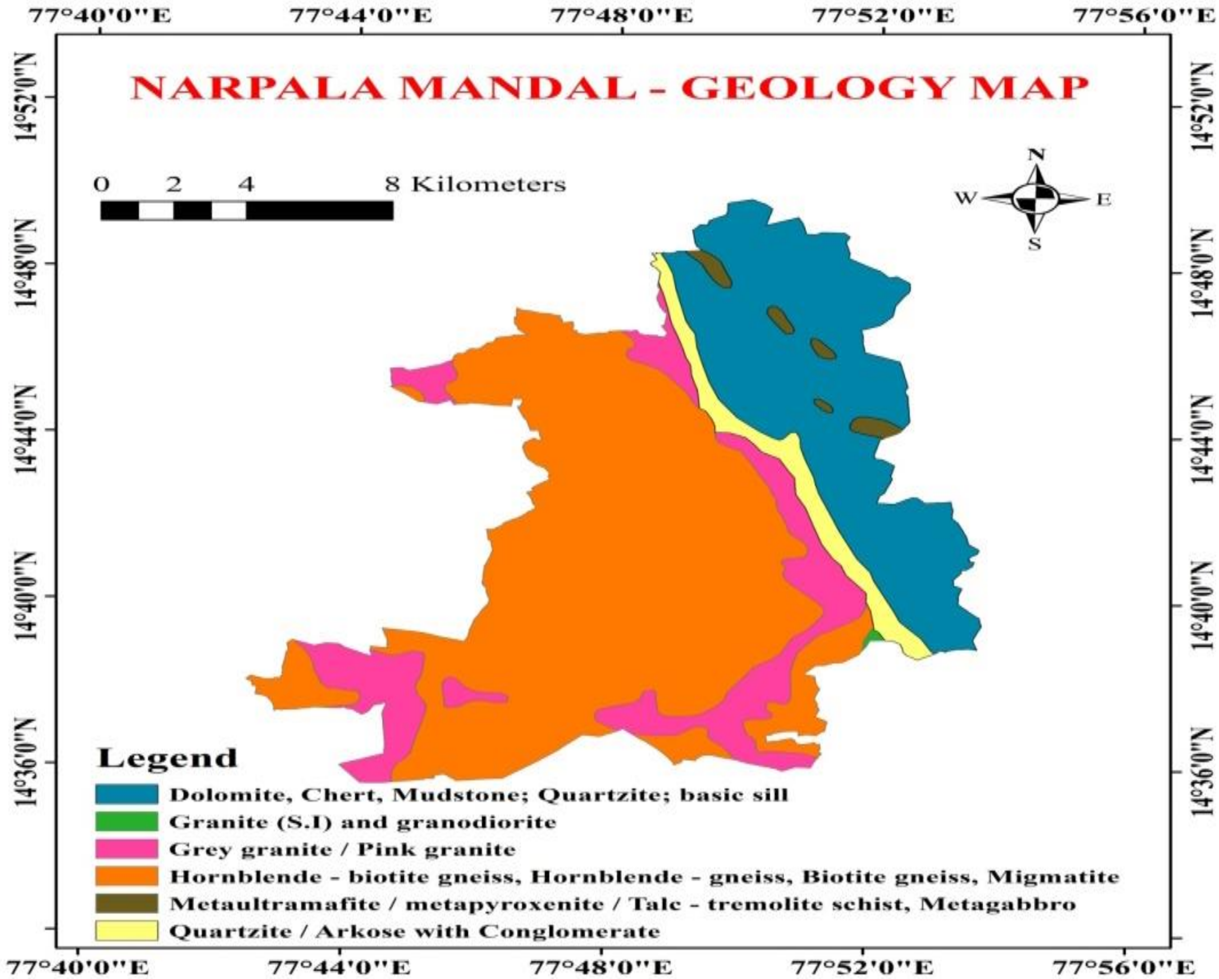

Figure 3 *Geology*

5 CONCLUSION:

The following are the main conclusions that may be drawn from the observations made during detailed mapping in the area:

i) The presence and continuity of the dolerite sill has been clearly established for the first time beyond Karnapudi up to the border of Anantapur Kurnool districts, though gaps do exist and the dolerite appears as detached lenses, its continuity is proved by the fact that it occupies almost the same strati graphical horizon with identical physical appearance and mineral assemblage.

ii) A zone of serpentinisation is observed on both the contacts of the dolerite sill followed by a zone of steatitisation,

iii) Along with serpentine, asbestos fibre development is seen near minor parts Gugudu area. Further investigation by trenching followed by test drilling is necessary to ascertain the intensity of the veins and workability.

iv) Steatitisation of the Vempalle dolomites close to the dolerite sill is a common feature in the area. North of the Penner River, the prospects for steatite are not high since only one or two bands are seen in the existing workings which are mostly worked for white shale.

v) Barytes mineralization in the form of veins and fissure fillings occur along the shear zones in the area. Mining for barytes is carried cut at present near Venkatampalle, but the other workings are abandoned. It is planned to carryout large-scale mapping and detailed investigation for barytes, including intensive search along the shear zones and faults traversing the Vempalle dolomites and Pulivendla quartzite's, especially along the contact zone of dolomite and quartzite. A programme of pitting and trenching and if feasible geophysical prospecting is necessary to assess the barytes deposits of the area.

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