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Evaluation of limestones resources in parts of Palnad basin, Nalgonda district, Telangana

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ABSTRACT

Palnad Basin is the store house of limestone which is equivalent of Narji limestones of Kurnool basin. Krishna stream cut over the Palnad Basin generally is EW course and limestones uncovered on either side. Palnad Basin covers parts of Nalgonda district of Telangana and Krishna & Guntur districts of Andhra Pradesh. The Palnad limestones are lithologically similar to Narji limestones of Kurnool basin (Madhusudhan Rao, 1964). (Madhusudhan Rao, 1964). They are well exposed on either sides of Krishna River to the North of river Krishna in Nalgonda, to the South of river Krishna in Guntur district of Andhra Pradesh and to the East of river Krishna in Krishna district of Andhra Pradesh. Nalgonda district is located in the southern part of Telangana state in India and encompasses an area of roughly 14,240 square kilometres. The district has abundant natural resources, including limestone, and quartz. The geology of Nalgonda district is diversified, with rocks ranging in age from the Archean to the Quaternary. The district is separated into four major geological units: the Archean Gneissic Complex, the Proterozoic Cuddapah Supergroup, the Mesozoic Deccan Traps, and the Recent Alluvium. Limestones display considerable range in hue viz., purple, green, pale green, chocolate, buff, dark grey and light grey. The limestones are fine grained with shallow dips across the whole basin, but rolling dips are not unusual. Limestone resources evaluated in

Key words: *Palnad Basin, Limestones, Nalgonda, resource evaluation,*

Geology

The Cuddapah Basin has been the focus of considerable study since king (1872), who characterised the geology and structure of the different formations, Cuddapah formations and the later Kurnools are classified as Purana formations (Holland, 1904; Mahadevan, 1956). (Holland, 1904; Mahadevan, 1956). They comprise a unique stratigraphic block spanning an area of roughly 44,500 Sq.km. (Krishnan, 1953; 1960). (Krishnan, 1953; 1960). Kurnool formations exist as two physically separated different zones, viz., Kurnool proper and in the Palnad Tract, occupying portions of Suryapet, Nalgonda, Guntur and Krishna districts of Telangana and Andhra Pradesh states. Munn and Mahadevan (1932-38) discussed the geology of the current region in their study

on the possibilities of manufacturing Portland cement in the Palnad Basin. Mukherjee and Syed Kazim (1947) of erstwhile Hyderabad Geological Survey carried out geological mapping of the Palnad Basin and made an assessment of cement grade limestone's, which brought to the light for the first time the flux grade quality of limestone in the Palnad Basin in parts of Krishna district.

Heron, (1949) on the basis of field evidences estimated the thickness of limestones to be 6,400 metres followed by 2,438 metres shales, while Krishnan (1968) held the opinion that despite their thickness is substantial but not as much as indicated by Heron (1949). (1949). Sri Rama Rao (1954) argued that the limestones present in Palnad Basin are counterparts of the Kurnool system. Vaidyanathan (1962), Madhusudhan Rao (1963 & 1964), Setti & Rajurkar, (1964) and Krupanidhi (1967) carried out geological research in and around this region notably with regard to their age correlations. The quality and quantity of limestone grade and influence of mining industry studies were carried out by the Anil (1998) via his study effort.

The correlation of the various rock types met within the Palnad Basin has been a matter of controversy and subject of investigation for about a century (Rao T.M. 1963; Nageshwar Rao, 1964; Rao M.N. & Rao S.V.L.N., 1964; Sathyanarayana Rao, 1963; Vijayam B.E., 1975; Rao T.M., 1956; Ziauddin, 1963; and Dutt N.V.B.S., 1960). (Rao T.M. 1963; Nageshwar Rao, 1964; Rao M.N. & Rao S.V.L.N., 1964; Sathyanarayana Rao, 1963; Vijayam B.E., 1975; Rao T.M., 1956; Ziauddin, 1963; and Dutt N.V.B.S., 1960).

Preliminary investigations to locate the flux grade zones in parts of Palnad Basin in Krishna district was initiated in 1963 by Sri K.V.Krishna Murthy from Geological Survey of India and Sri S.R.Sarma from Department of Mines and Geology followed by continuation of investigations by the G.S.I. during 1964-67 and again detailed studies were carried from 1972 to 1974 by Sri C.J.V.R.Rao, D.S.S.Murthy, C.Nageshwar Rao, D.N.Setti, T.Madhusudhan Rao, M.R.Bhalla, S.H.Mehdi, and Sri V.Natarajan and S.Rajagopalan Nair from G.S.I. The researches by these personnel of Geological Survey of India were targeted at demarcating flux quality limestone existing in and around Jaggayyapeta for Visakhapatnam steel plant. Thereafter, comprehensive geological mapping of the Palnad Basin north of Krishna river was carried out by Sri A.Sekharan and Pandey B.P., (1978-79) with a view to understand the geology and structure of the Palnad Basin in Kodada, Miryalaguda and Huzurnagar districts. Prem Singh, Kundurkar V.S. and Narsing Rao A. of Indian Bureau of Mines (1986-87) carried out a Regional Mineral Development Study on limestone mines in Nalgonda district.

Madhusudhan Rao (1964) reported that the Narji limestone has thickness of roughly 120 to 160 metres in Kurnool, Cuddapah and Anantapur districts. Rao S.V.L.N. et.al (1964) concluded that the succession begins with a quartzite overlain by argillaceous flags, shales that are calcareous in the upper section ultimately grading into limestone (Narji), which has a great area and thickness and are non-dolomitized. Dutt believed that limestone in the northern half of the basin may reach a thickness about 300 metres. Comprehensive research on Limestone in portions of Nalgonda district for qualitative assessment of Limestone's up to a depth of 15m was appraised by Narsing Rao A. (1993).

In the Peninsular India there are number of Sedimentary bowls constitute Proterozoic arrangements to be specific, the Cuddapah and Kurnool's; they are scattered over a genuinely expansive territories in the southern parts of Peninsula. Cuddapah Basin contains tremendous heap of sedimentary arrangement having a place with the Upper Proterozoic Time. The Basin has two noteworthy frameworks of rocks in particular, the lower Cuddapah framework and the upper Kurnool framework, yet they are considered to have a place with various ages (Krishnan, 1964). (Krishnan, 1964). Every one of these advances is separated into four arrangements, with furthermore sub-divisions per arrangement (Nagaraja Rao et al, 1986). (Nagaraja Rao et al, 1986). The Cuddapah deposits are predominantly arenaceous and argillaceous with just subordinate limestones of dolomitic nature. The more youthful limestone arrangements of Kurnool framework are uncovered in two vast regions, one in the western piece of the Cuddapah Basin and the other in the north-eastern part is a few times refilled to in Indian Geology as Palnads (Krishnan, 1968).

(Krishnan, 1968). The Basin in which they are stored is likewise refilled to as Palnad Basin. The Krishna River, one of the real waterways in south India courses through the Palnad Tract.

The study area falls in survey of India topo sheet nos. 56P/5, 56 P/6, 56 P/9, 56, P/10, 56 P/13, 56 P/14, 65 D/1 and 65 D/2. The area is bounded by Latitudes 16° 37' 00" to16° 55' 00" and Longitudes 79° 26' 00" to 80° 05'00".

Geology of the investigated area

The limestone deposits under research are found on the north- eastern boundary of Cuddapah basin in Andhra Pradesh. The Cuddapah basin has crescentic form, with its concave side pointing towards east. The main portion of the crescent is occupied by the rocks of the Cuddapah system, while north-western and northern sections are overlain by the rocks of the Kurnool system. The whole basin is stretched across an area of 33,600 Sq.km. The northern segment of the Krishna. Guntur and Nalgonda districts composing Kurnool formations was originally explored by King (1872). (1872). Thereafter, Officers of the Geological Survey of India have carried out extensive study of Cuddapah and Kurnool systems in the Cuddapah basin. (Madhusudhan Rao, 1963; Sathyanarayana Rao. 1964: Jhanwar et al, 1964; Setti and Rajurkar, 1964; Narayanaswami, 1971).

The region located towards north of Krishna River in areas of Nalgonda district in which strata pertaining to the upper Proterozoic are visible. The region is encompassed by Wadapally, Irkigudem, Kothapalli, Advidevalapalli, Mudimanikyam. Neredcherla, Mahankaligudem, Mellacheruvu, Peddaveedu and Mattapally villages. During the Geological investigations the contacts of distinct lithological units were defined and representative samples were collected for laboratory analyses. Fig. 1.

Sedimentary rocks pertaining to Kurnool formation overlie the Archean granites and gneisses. The Kurnools Contain quartzites, shales and limestones. Their interdependence and line of succession has been established.

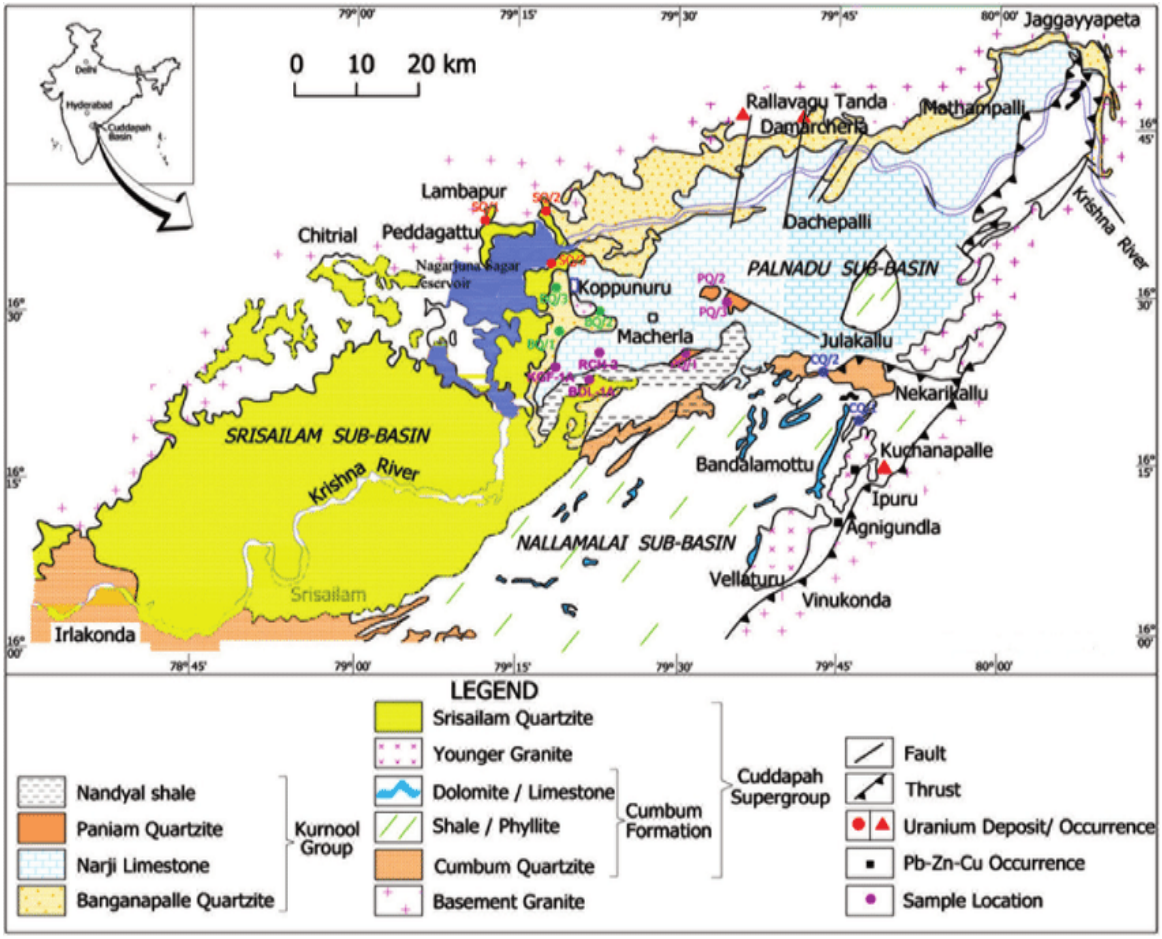

Fig.1. Generalised geological map of the Palnad basin (after GSI)

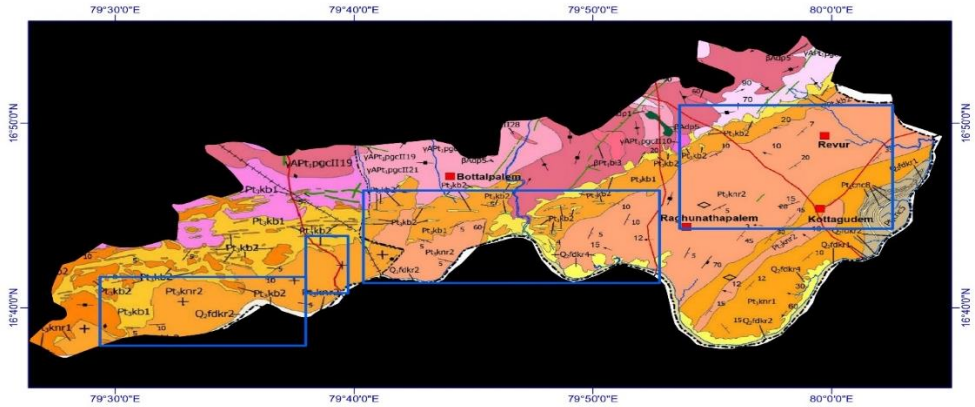

Fig.2. Geological map of the Palnad basin based on remote sensing data

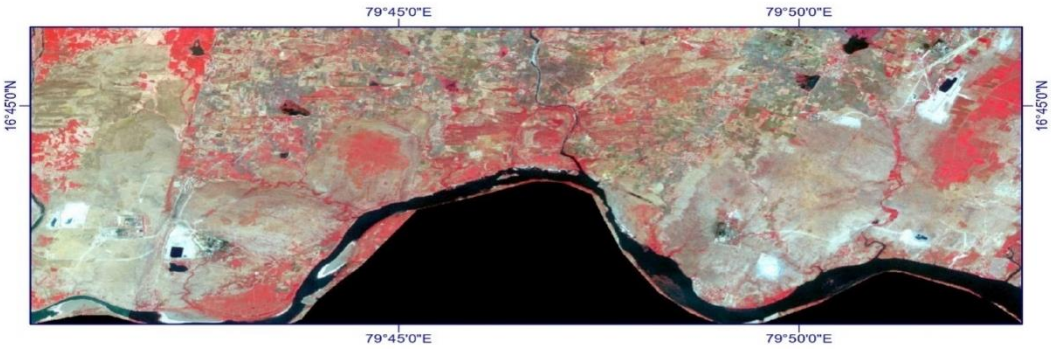

Fig.3. Satellite image of Mattapally

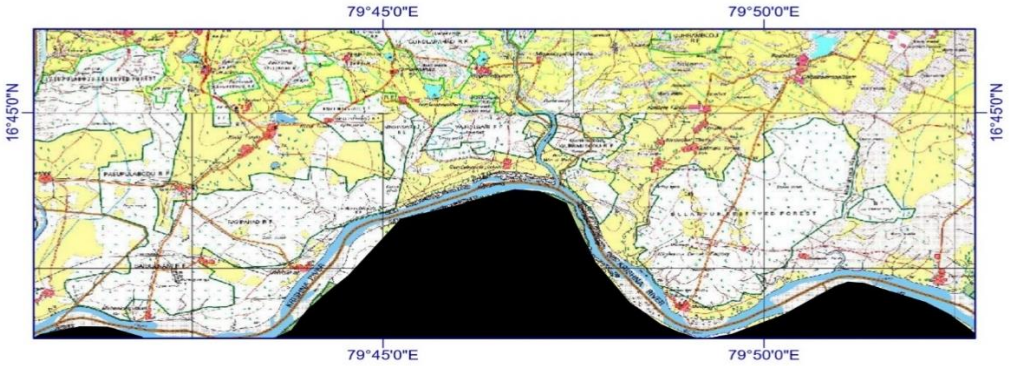

Fig. 4. Toposheet of the area under study

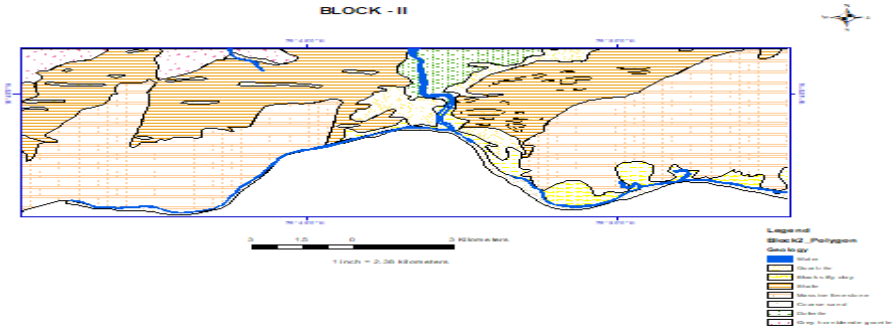

Fig. 5. Geological map of the study area as deduced from remote sensing data

Dharwars

The earliest rocks appearing as enclaves within the Peninsular gneissic Complex and are spread across the region and comprises of banded haematite quartzites and banded magnetite quartzites. Meta volcanics are characterised by amphibolites, hornblende, biotite schists and gneisses. Banded Haematite Quartzites and Banded Magnetite Quartzites exist as tiny bands and lenses inside the granites as enclaves and are of modest extent and are unmappeable units.

Table.1 Geological succession of the investigated area

	Soil	
KURNOOLS	Narji	Limestones Shales
	Banaganaplli Series	Quartzites
	----------Un-conformity----------	
ARCHEANS		Dolerite dykes quartz reefs Granites & Gneisses
		Older Metamorphics

Granitic Rocks

Granitic rocks are predominantly constituted of grey granites and infrequent occurrence of pink granite is also detected. Greater areas of the region is covered with grey granites. In certain situations, granites and gneisses exist and they swiftly grade in to one other in short distances. These grey granitic rocks appear exposed as outcrops in the shape of tiny dome like hills and sheets. They are medium to coarse grained. Rare occurrence of pink felspars is also seen in grey granites.

The microscopic analysis of thin slices indicates the presence of quartz. orthoclase, microcline, micro-perthite and plagioclase felspars whereas the ferro- magnesian minerals appear as minor minerals, consisting of hornblende, biotite. sericite and chlorite etc...

Quartz Veins

Many quartz veins exist discontinuously in Ragadapa, Bodupally, Anjanapally and Vardhapuram villages. Its length different from few metres to a maximum of 500 metres and breadth varies from few metres to a maximum of 40 metres. Quartz is white in hue. The white type is regarded higher in quality and it is sacchoiroidal in nature. This variant may be employed in ferro- silicon and in glass manufacturing.

Basic Dykes

Dykes of varied diameters exist with a maximum length of several kilometres in the northern portion. They are pre-Kurnool in age and located in the northern regions of the country, primarily limited to granitic terrain. Most of the dykes are going in ESE-WNW direction, few dykes move in N-S or NNE- SSW direction. Dykes are fine to coarse grained and are doleritic in composition.

Kurnools

Kurnool systems of rocks exposed in the vicinity are called as Palnads and the basin is known as Paland basin. The Kurnool formations are formed over an irregularly eroded granitic landscape. The Main trend of these sedimentary strata is ENE-WSW.

The diverse lithological units occurring in this include conglomerate, quartzites, purple shales and limestones. These strata are gradational and conformable, sitting on the granitic rocks.

Conglomerate

Basal conglomerate appears as minor exposures as un-mappeable unit in Ragadapa village. It is overlain by quartzites and shales. A tiny layer of conglomerate exists resting on granites at a distance of 1.5 km West of Ragadapa hamlet, consisting of angular to sub-angular pebbles of quartz, quartzites. The cementing substance is siliceous and ferrugenous in composition. Moreover, towards south of Ragadapa hamlet a tiny exposure of conglomerate has been found at the foot of a quartzite hill. Conglomerate beds are also documented by Geological Survey of India from Timmapur and Vardhapuram villages, wherein conglomerate comprises of quartz. quartzite, slate and chert as pebbles.

Quartzites

Quartzites is the earliest formation belonging to Kurnools in this region which rest un-conformably atop granites. They also occur as thin intercalations inside shales. West of Musi River quartzite is largely missing, however east of Musi till Vemuleru the basal quartzites are visible discontinuously. Thickness of these quartzites vary from a minimum of 2 metres to maximum of roughly 15 metres. It is noted that the quartzite occurring cast of Musi River is coarse grained. Quartzite is medium to coarse grained, sub-rounded and largely homogeneous in composition. They are white and brown in coloration. During weathering they develop reddish brown tint. ripples markings are seen at Raghunathapalem region. Quartzites generate tiny ridges owing to their superior resilience to weathering. Quartzites appearing as thin intercalations is extensively exposed in the Musi River area.

Shale

The quartzites are succeeded conformably by shales. Shales are dominant and inhabit low lying places owing to deterioration. At the east of Musi River,the quartzites are superseded conformably by shales. Shales are prevalent (Bugga Vagu) shales overlie on granites and these are overlain by quartzites, which shield them from weathering. Between Musi and Vemuleru shales exist over granites in most of the region, while East of Vemuleru their position is replaced by the quartzites fc., shales appear over quartzites. Thickness ranges from several metres to roughly 15 metres (Musi River segment). Shales are grey, green, yellow and purple in hue. The shales in contact with underlying limestones are generally purple in hue. The shales in their close contact with limestones become calcareous and include intercalations of calcareous material, which reveal progressive transition from shale to limestones.

Limestones

Shales are replaced conformably by massive limestone, exhibhiting an assortment of hues viz., purple, green, grey, buff etc. (Table No.2). Limestone is often huge and dense, breaks with conchoidal fracture. This unit is the most well developed in the Palnad basin and occupies a substantial percentage in the region of research. All the forms of limestones are present through however with a vast difference in the thickness. Agrillaceous partings are present in the basal beds. The argillaceous limestone is predominantly purple in colour and is overlain by dark grey limestone and in turn by buff/white tinted limestone. Between purple and dark grey limestones, a thin bed of light green limestone is discovered and it comprises a marker bed and is observed all around the basin. Limestones in general are level with moderate dips of 5° to 12° maximum. The worn surfaces have a smooth or slightly pitted look. Limestones surfaces reveal elephant skin weathering or ribbed character created owing to the movement of water.

Table.2 Limestone succession in the investigated area

Narji Limestones	-------	Light Grey Limestone Buff Siliceous Limestone Dark Grey Limestone Green Limestone Purple Limestone

Solution activity in the limestones is recognised by the existence of channels, fissures, pot holes etc., these are created around nallah streams owing to the action of water. Channels reach to a depth of around 3 m. Cavities detected along the joint planes are filled by clay material, occasionally extending up to a depth of 10 m maximum. The fills are typically of transportable kind and affect the quality in mechanised mining operations, wherein FeO and SiO, value will be greater in the R.O.M.

Structural Setting

The Palnad limestones cover the largest portion of the territory of Palnad tract of Guntur, Krishna and Nalgonda District. They have overall NE-SW and ENE- WSW tendency. They are normally horizontal, the dip being mainly SE and extremely slight, often about 5° and seldom above 12°. Rolling dips are visible at various spots along the canal sections. In majority of the sites the dips are horizontal. Since, the sediments are deposited over an unevenly eroded granitic foundation, the dips revealed by the shales and quartzites are basinal dips. The form of the outcrops demonstrates a structural homogenity with the tendencies of Archeans (i.e. N-S Dharwars) showing that the Archean basement has to some degree impacted the depositional pattern. There is no large scale folding and compression in this region nor there is any crustal shortening except on the eastern boundary of the basin, however in the type area of the Cuddapah basin, the Kurnools have exhibhited some movements in the form of folds. The disturbances are prominent near the eastern border but diminishing down progressively westwards. The Kurnools are discovered to be gently folded along N-S axis in the middle region and along N-W S-E axis in the south-west, where large scale tectonic disturbances are relatively significant. Absence of granitization in these Pre-Cambrian sediments is also a factor against their geo-synclinal character.

Limestones resources in Mattapally evaluated qualitatively and quantitatively for use in various industries. Though the area in under active exploitation of limestone resources for use in cement industry, systematic and scientific evaluation of limestone resources is still to done, hence the study area so chosen. Remote Sensing data has been made use of in evaluation of limestone resources.

Limestone analysis data of various limestone in the Mattapally block is as below :-

Radicals	Purple Limestone		Green Limestone			Dark Grey Limestone					Buff Limestone					Light Grey Limestone			
	WLPM	PSCL	WLPM	PSCL	PACL	WLPM	PSCL	PACL	MNCL	MNCL	WLPM	PSCL	PSCL	MNCL	MNCL	WLPM	PSCL	PACL	PACL
	-6	-6	-7	-7	-7	-8	-8	-5	-1	-4	-9	-10	-11	-2	-3	-10	-9	-6	-8
CaO	41.3	42.38	41.6	43.55	44.84	48.63	47.4	49.56	50.42	50.44	41.59	45.42	46.15	46.15	45	44.24	46	45.01	47.8
MgO	1.9	1.85	0.56	3.36	0.38	0.09	3.25	2.18	0.2	0.66	0.1	0.19	2.2	2.2	0.5	0.5	0.32	0.78	2.89
SiO2	18.5	17.36	21.38	11.77	16.57	12.28	8.6	6.67	8.7	8.73	22.69	16.97	13.1	13.1	17.5	7.2	14.4	7.5	9.46
Al2O3	2.6	2.6	2.13	1.5	0.4	1.34	0.66	0.1	0.82	0.14	1.5	0.14	1.75	1.75	0.15	0.2	1.2	0.68	0.1
Fe2O3	2.5	2.27	1.2	1.06	2.38	0.8	0.75	0.8	1.22	0.4	1.22	1.61	1.45	1.45	0.8	1.1	1.23	0.65	0.8
L.O.I	33.7	33.7	32.5	37.91	35.23	37.27	39.46	40.57	39.3	39.88	33.04	35.26	36.33	36.33	35.1		36.81	38.62	39
Acid Insolubles	20.62	21.62	24.38	14.29	18.35	13.44	10.63	7.53	10.08	9.53	23.56	18.43	16.05	16.05	18.93	15.73	17.51	10.09	10.55

Table. 3. Chemical analysis of various limestones in Mattaapally

Bore Hole No.	Depth In Meters		Lithology	Grade Cao
	From	To		
B.H. 1	0	2	Light Grey Limestone	34.5
	2	10	Dark Grey Limestone with calcite veins	48.7
B.H. 2	0	6	Light Grey Limestone	39
	6	14	Dark Grey Limestone	46.5
B.H. 3	0	13	Light Grey Limestone	42.5
	13	17	Dark Grey Limestone with calcite veins	50.1

MATTAPALLY

In Mattapally the general thickness is as follows:

Light Grey Limestone	6 m
Buff (siliceous) Limestone	about 6 meters
Dark Grey Limestone	about 12 meters

The thickness is as encountered in the boreholes.

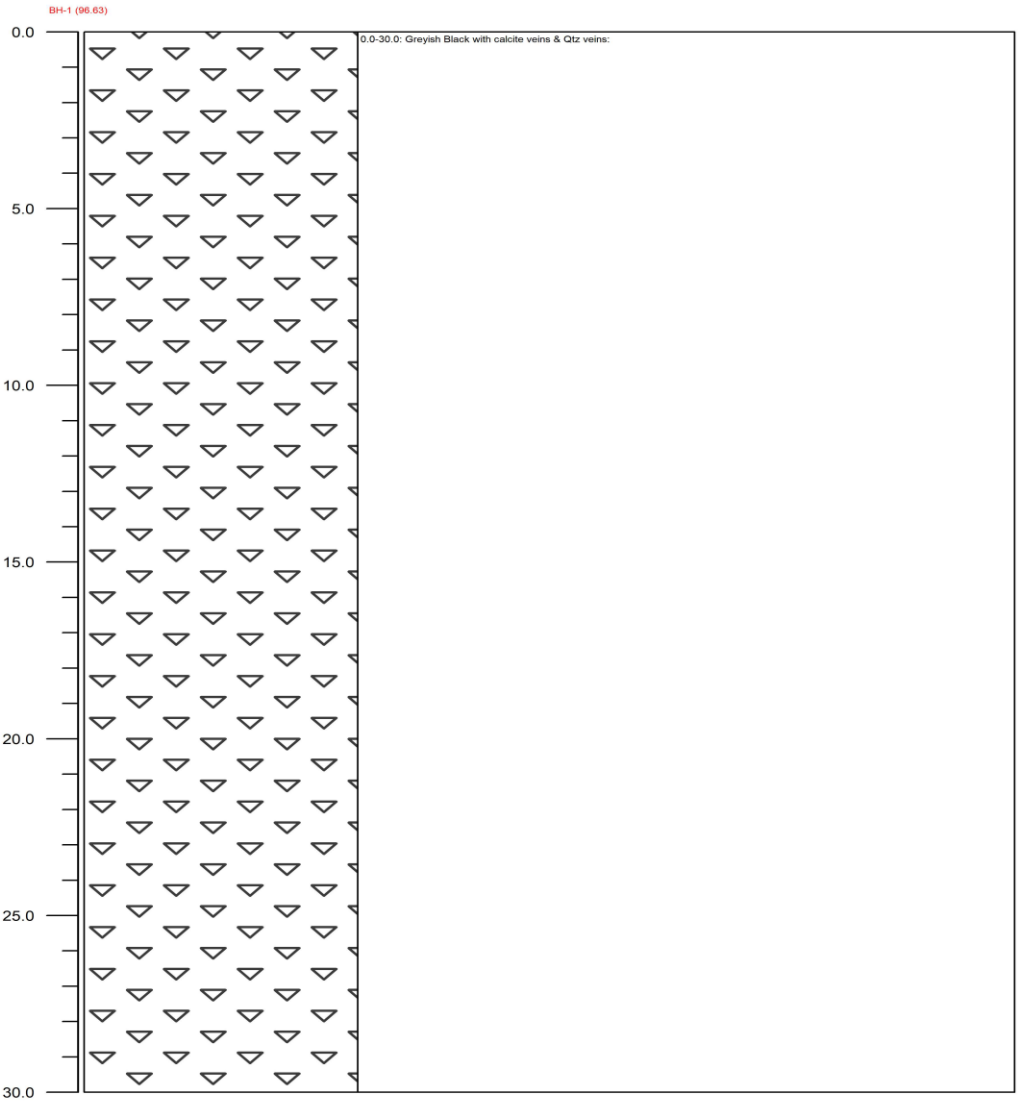

Fig. 6. Bore Hole log

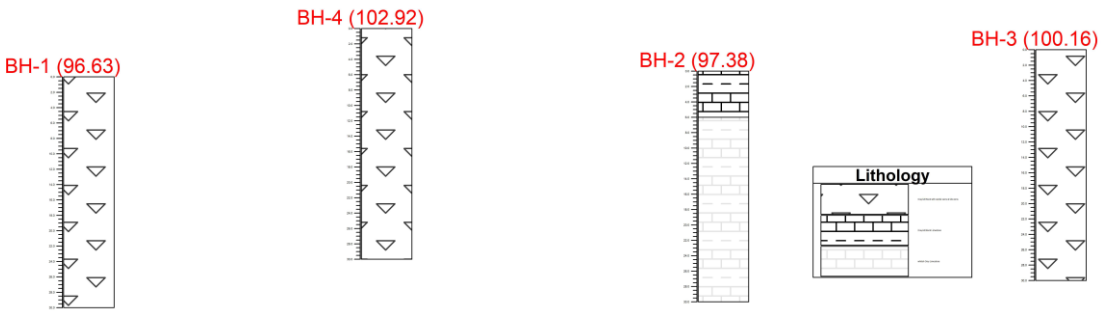

Fig. 7. Bore Holes Section Map

The thicknesses of the limestone ascertained in the field followed by geological cross sections, nallah cutting and the bore hole data obtained from the user industry in the area under study.

Purple limestone is flaky in the basal beds with a soft feel and bedded type, breaks along the bedding planes. Green limestone is thin bedded, fine grained and compact; purple and green limestones have a gradational contact, hence the purplish colour is seenin the basal beds. Dark Grey limestone is fine grained, compact and breaks with a conchoidal fracture .Buff coloured limestone is hard compact and has a substantial thickness in tne area (about 25m). The light grey limestone is exposed in small area and has a thickness of about 16 meters maximum.

The percentage of recovery was allocated to the distinct bands based on their respective changes in the quality and bulk density. For instance, a bulk density of 2.0 for green limestone buff limestone and light grey limestone and 2.2 for dark grey limestone was assigned A lower bulk density was attributed because there are shaly intercalations and existence of holes which fill considerable area inside the limestone bands.

Whilst most of the current workings are confined to a depth of around 10 m to 20 m the mineable width has been estimated to be 25m in case of these formations. However, the reserves are calculated limiting to a thickness of 20 metres only. The reserves are characterised as proven, likely and potential, depending on their quantitative and qualitative assessments.

The quantifiable factors taken into consideration for the purpose of calculating the stocks are (1) areal length (ii) thickness, (iii) Strike and dip of the formation, (iv) Variety of layering, especially intercalation of shales, presence of holes and clay infill along joint lines etc., The qualitative characteristics are (i) hue (ii) chemistry and mineralogical qualities.

The reserves were calculated using block technique. Recovering factor is assessed as 75% based on the study carried out throughout the task and also on the data collected from the working sites. The backups have been classified into confirmed, likely and prospective. Areas where mining operations provided three-dimensional information is designated as proved category; the extensions of areas around mines where from two-dimensional data is available for reserves estimation is designated as probable type then the geological extensions of these areas are designated as possible type.

Matapally block				
	Proved	Probable	Possible	Total
Dark grey	57	15	45	117
Green	7.5	4	5.13	16.6
Light grey	15.5	8.2	9	32.7
Buff	45	10	12	67

The study area has huge limestone resources to the tune of 233.33 Million Tonnes

Conclusions

The Palnad Basin of Nalgonda district in Telangana contains a wide range of limestone types that have important industrial and economic uses. These limestone deposits are a valuable natural resource and play a crucial role in the development of the region.

In the current research exploration data obtained from mines. Exploratory data by way of collecting bore-hole information from the mines in all the three blocks followed by collection of data in open-cast mines, pits and quarries has been used in integration of data in GIS and also in preparation of sections for overall assessment of limestone qualitatively and quantitatively.

In the current studies reserves have been evaluated based on the exploration data acquired from the mines. Bore-hole data has been obtained for analysing the depth persistence. Analysis of the limestone mines, pits and quarries in the study a region supplemented data as to the disposition of different limestones. The offered information has been utilised in drawing sections.

REFERENCES

1. Prem Singh, V.S. Kundurkar & A. Narsing Rao (1989) Regional Mineral Development Study of Limestone Mines in Nalgonda District, Andhra Pradesh
2. Madhusudhan Rao (1963) Pre-Cambrian Formations of south India. Journal Deccan Geological Mining Society Vol. III
3. Madhusudhan Rao (1964) Limestones and Dolomites in the Cuddapah Basin; Journal Indian Geoscience Association. Vol. IV.
4. King (1872) On the cuddapah and kurnool formations in the madras Presidency, Memoirs. Geological Survey of India
5. Holland (1904) Journal. Queen Victoria Memorial Fund, Vol. II
6. Munn and Mahadevan (1938) Enquiry into the possibility of making Portland cement. Jour. Hyd. Geol. Survey vol. III. Part-2.
7. Krishnan (1953) The Structure and Tectonic History of India. Memoirs. Geological Survey of India. Vol.81
8. Krishnan (1960) Geology of the India and Burma, Higgin-Bothams, Madras
9. Krishnan (1964) The Upper Proterozoic of South India; Journal Indian Geo-Science Association Vol. IV, PP 1-12.
10. Krishnan (1968) The Evolution of Indian Peninsula; Journal Indian Geoscience Association Vol. VII. pp. 1- 12.
11. Mjukherjee and Syed Kazim (1947) Geology of Huzurnagar and Suryapet Taluks· Jr Hyderabad Geological Survey 5(1) 173-180
12. Heron (1949) Synopsis of the Purana formations of Hyderabad, Journal Hyderabad Geological Survey Vol.5.
13. Sri Rama Rao (1954) The Geology of parts of Planad and Sattenapally taluks, Guntur district. Records Geological Survey of lndiaVol.83 pt.2.
14. Vaidyanathan (1962) Effect of uplift of Palnad on Drainage in southern part of Cuddapah Basin; Journal Geological Society of lndiaVol.3.
15. Setti & Rajurkar (1964) Correlation and structure of cuddapahs and Kurnools in the Palnad area Journal, Indian geoscience Association Vol. lV.
16. Krupanidhi (1967) Geological Survey of India. Progress report for 1967-68 (unpublished).
17. Anil Kasam (1998) Remote Sensing & Gis Applications in Evaluation of Limestone Resources in Parts of Palnad Basin in Guntur District, AP. (unpublished Ph.D. Thesis).

18. Rao M.N. & Rao S.V.L.N., (1964) Frame work of sedimentation on Cuddapah and Kurnool formations; Journal Indian Geo-Science Association. Vol. IV.
19. Sathyanarayana Rao (1963) Volcanic and other igneous rocks in the Cuddapah formations of Gani veldurthi area. Kurnool district. A.P. Journal Deccan Geological Mining Society Vol. II.
20. Vijayam B.E.& reddy P.H (1975) The stratigraphic correlation of Banganapalli group in the Palnad basin Jour. India. Aca. Of Geo.Sci.Vol.18.
21. Ziauddin (1963) Limestone deposit near Jaggayyapet area, Krishna district Andhra Pradesh Rec. Geol. Survey of India vol.93.
22. Dutt N.V.B.S. (1960) Mineral Resources of the ceded districts Andhra Pradesh Geol. Survey of India
23. Narsing Rao. A. & M.N.Reddy (1993) Resource Evaluation in relation to exploitation of limestone deposits of Palnad basin in parts of Nalgonda district, A.P. (unpublished Ph.D. Thesis 1993 Resource evaluation).

