CHAPTER 10

SUMMARY AND CONCLUSION
SUMMARY AND CONCLUSION

The entire work of the thesis has been summarized and the following conclusions have been drawn based on the detailed study.

The perusal of the entire documents has led to the following conclusions.

The entire work has been carried out using satellite data IRS, 1D, P6 data. The spectral signatures of various units namely Dark Grey Limestone, Light Grey Limestone, Pink Limestone and the Flaggy units have been clearly demarcated in the image.

In the Yanakandla Block that is the subject area, mainly Pink Limestone and Light Grey Limestone are exposed at the outcrop level.

The satellite product has been interpreted both for geology and structure. The details of the said topics have also been brought to light very clearly. These have been verified in the field and corrected.

The limestone under discussions is the Light Grey Limestone. The general sequence of the limestone as observed in the other mines is as follows.

- Dark Grey Limestone
- Light Grey Limestone
- Pink Limestone
- Pink Shale
The limestone deposit belongs to the Narji Limestone of the Kumool Group. It is middle massive that is compact and breaks with conchoidal fracture. The sequence is as follows.

The geological units in the Yanakandla Block as observed in the field are Pink Shale followed by Green Limestone over lained by Pink Limestone and again followed by Light Grey Limestone. The Green Limestone has Intra Formational Conglomerate. This reflects the fluctuation of the basin during sedimentation.

The Pink Limestone has thin partings of Green Limestone. It has also the presence of intra formational conglomerate. The Pink color indicates oxidizing conditions and shallow water condition of deposition.

Mud cracks and ripple marks are noticed. These features point to shallow water conditions of the deposit. The Light Grey Limestone exhibits ribbed weathering, slightly resembling elephant skin type of weathering.

Geomorphologically the entire area that includes adjacent area of Yanakandla Block has well developed Mesa structures, capped by Panyam Quartzite, a younger unit than the Narji Limestone. The subject area has broad cuesta like feature.

Structurally the entire area as seen in the satellite frame exhibit sub-horizontal nature of bedding. But the, areas located outside the Yanakandla block reflecting open synforms and double plunging synforms. Yanakandla Block that is subject area forms a part of a broad synform with axial trace trending WNE-ESE. Within the Yanakandla block, there are minor antiforms that are very local and the
axial trace is ENE-WSW and NW-SE. There are no faults. But, there is a lineament trending ENE-WSW outside the Yanakandla Block area. This, when traced westward becomes a fault and is seen as a prominent lineament in the imagery. A spring is also noticed on the lineament outside the Yanakandla Block.

There are number of joints of different magnitude. These are bedding joints, strike joints, oblique joints etc. Majority of the joints are all open. The width of the opening varies from 20cm – 30cm. But they run for longer a distance that is more than half a km. The open joints are filled with soil creep. The depth of the soil creep is very shallow (0.2-0.5 m).

The limestone deposit of the Yanakandla has been studied in detail as indicated in the number of chapters of the thesis. The deposit of Yanakandla unlike other deposits of the Narji is on a slope of a mound and slightly involved in tectonism. In fact this has been a challenging one in exploration and in planning the mine development (The later one has not been dealt with in the thesis).

Exploration has been done by (1). Topographic Surveying, (2) Geological Mapping, (3) Surface and Sub-Surface sampling.

Topographic survey was conducted on 1:2000 scale with 1m contour interval. The bench mark has been taken from the adjacent canal of M.I. Department.

The grids of 200 m on N-S and E-W lines are drawn.
Geological mapping was first done on the image and the topobase has been transferred on to it. The lithological contacts were marked using tape and compass and following the grid intersection points and other survey stations.

Structural data has been incorporated by adopting standard structural details.

The cross sections have been drawn reflecting the surface geology and drilled bore hole details. These are drawn at 200 m interval along the section lines that is, along the dip direction.

Surface samples have been collected using the section lines. The sample interval has been taken as 50 m. In all 140 surface samples have been collected in the Yanakandla Block.

The planning of drilling is mainly based on the following points.
(1). The lithological units exposed are micritic limestone.
(2). The rocks are devoid of any major structural disturbances that may complicate the mining and correlation of beds.

Exploration is followed following the field guidelines of the "United Nations Frame Work Classification" (UNFC).

For proved mineral reserve that is for Yanakandla Block, it is taken as 200 x 200 m interval. The UNFC code is 111 (EFG).

In all 19 core bore holes and 19 DTH bore holes have been drilled. Each core bore hole alternates with a DTH bore hole.
The industrial parameters of the limestone are

LSF (0.66-1.2) - 1.16
SM (1.2-4.0) - 7.56
AM (1.7-2.4) - 3.01
IM (>0.65) - 2.21

The values given in the parenthesis are the standard ones. The values in red color are that of the limestone of Yanakandla Block.

The above information indicates that SM and AM are not agreement with the specification. This will be rectified in the raw mix and by using low ash content coals.

The cut-off (end use) grade is considered as 79% of CaCO₃. It indicates that CaO is 44.24 %. This satisfies the specification stipulated by NCB, where CaO is taken as 44-52 %.

Marginal grade is considered as 75 % to 79% of TCO₃. In the Yanakandla Block this is nil. The sub-marginal grade is taken as 63 % to 74.99 % of TCO₃. In the Yanakandla Block this is minimal. Thus, in the Yanakandla Block only end use grade is available and the rest is rejects only, where TCO₃ is < 63 %.

The percentage of core loss in Yanakandla Block is about 13.12 %. Core recovery is 86.88 %. It is considered as reasonably good recovery.

The sub-surface sampling for core bore holes is taken as on 1m and for DTH as 1.5m.
In the core bore holes the thickness of the Grey Limestone grades from 1.90m to 26.33m (avg -10.32m). The thickness of Pink Limestone ranges from 2.68m - 9.40m (avg - 6.17m).

In DTH drilling, no core comes out. The rock comes out in the form of chips. The length of the rod is 1.5 m and the sample is considered as the sample length.

In the DTH bore holes, the thickness of Light Grey Limestone ranges from 4.0m - 19.0m (avg -10.62). The Pink Limestone varies from 2.50m - 8.0m (avg - 6.55).

There is no over burden in the subject area.

Core logging has been followed as per the standard style of logging as shown below.

1. Borehole No: S7W5
2. Type: coring: Vertical
3. Location: X Section: A-A’
5. Collar R.L (m):250.21

<table>
<thead>
<tr>
<th>Run(m)</th>
<th>Length</th>
<th>Core length</th>
<th>Recovery</th>
<th>Lithology</th>
<th>Structural features</th>
<th>Remarks</th>
</tr>
</thead>
</table>

Core has been split using core splitter and one half is powdered to 100 mesh and the other half is preserved for future reference.
The perusal of the chemical data has indicated the following information.

(1). Surface samples – TCO₃ 90.85 % to 41.48 %

(2). Primary samples – CORE

<table>
<thead>
<tr>
<th></th>
<th>Max</th>
<th>Min</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td>13.62</td>
<td>10.86</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>1.62</td>
<td>0.32</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>2.72</td>
<td>0.14</td>
</tr>
<tr>
<td>CaO</td>
<td>47.66</td>
<td>37.57</td>
</tr>
<tr>
<td>MgO</td>
<td>2.04</td>
<td>0.60</td>
</tr>
<tr>
<td>LOI</td>
<td>36.88</td>
<td>28.93</td>
</tr>
</tbody>
</table>

(3). Primary samples – DTH

<table>
<thead>
<tr>
<th></th>
<th>Max</th>
<th>Min</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td>14.64</td>
<td>13.86</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>2.33</td>
<td>0.31</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>3.3</td>
<td>0.35</td>
</tr>
<tr>
<td>CaO</td>
<td>46.44</td>
<td>37.01</td>
</tr>
<tr>
<td>MgO</td>
<td>1.61</td>
<td>0.4</td>
</tr>
<tr>
<td>LOI</td>
<td>36.64</td>
<td>26.29</td>
</tr>
</tbody>
</table>
Eleven Radicals:

SiO₂, Fe₂O₃, Al₂O₃, CaO, MgO, LOI, Na₂O, K₂O, Cl, SO₃ and P₂O₅.

The values are given in tabular form (Table: 10.1) in the adjacent page.
### Table 10.1: Chemical Analysis of Compounded Samples

#### Core Sample Analysis Reports - Yanakandla

<table>
<thead>
<tr>
<th>S.NO</th>
<th>Limestone</th>
<th>T.C.</th>
<th>LOI</th>
<th>SiO₂</th>
<th>Al₂O₃</th>
<th>Fe₂O₃</th>
<th>CaO</th>
<th>MgO</th>
<th>LSF</th>
<th>Na₂O</th>
<th>K₂O</th>
<th>Cl</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>light grey</td>
<td>82.88</td>
<td>36.17</td>
<td>13.62</td>
<td>1.24</td>
<td>0.54</td>
<td>46.44</td>
<td>0.92</td>
<td>1.16</td>
<td>0.17</td>
<td>0.02</td>
<td>0.06</td>
<td>0.06</td>
</tr>
<tr>
<td>2</td>
<td>pink</td>
<td>73.40</td>
<td>32.37</td>
<td>22.62</td>
<td>1.45</td>
<td>0.40</td>
<td>49.21</td>
<td>1.42</td>
<td>0.62</td>
<td>0.15</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>total</td>
<td></td>
<td>78.90</td>
<td>34.11</td>
<td>18.40</td>
<td>1.47</td>
<td>0.43</td>
<td>43.62</td>
<td>0.20</td>
<td>0.82</td>
<td>0.18</td>
<td>0.04</td>
<td>0.05</td>
<td>0.06</td>
</tr>
</tbody>
</table>

#### DTH Sample Analysis Reports - Yanakandla

<table>
<thead>
<tr>
<th>S.NO</th>
<th>Limestone</th>
<th>T.C.</th>
<th>LOI</th>
<th>SiO₂</th>
<th>Al₂O₃</th>
<th>Fe₂O₃</th>
<th>CaO</th>
<th>MgO</th>
<th>LSF</th>
<th>Na₂O</th>
<th>K₂O</th>
<th>Cl</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>light grey</td>
<td>81.42</td>
<td>36.03</td>
<td>14.64</td>
<td>1.38</td>
<td>0.42</td>
<td>45.59</td>
<td>0.6</td>
<td>1.06</td>
<td>0.16</td>
<td>0.02</td>
<td>0.05</td>
<td>0.08</td>
</tr>
<tr>
<td>2</td>
<td>pink</td>
<td>71.74</td>
<td>31.62</td>
<td>23.64</td>
<td>1.84</td>
<td>0.96</td>
<td>39.93</td>
<td>0.61</td>
<td>0.58</td>
<td>0.17</td>
<td>0.05</td>
<td>0.05</td>
<td>0.06</td>
</tr>
<tr>
<td>total</td>
<td></td>
<td>76.43</td>
<td>33.84</td>
<td>18.98</td>
<td>1.65</td>
<td>0.55</td>
<td>42.48</td>
<td>1.21</td>
<td>0.77</td>
<td>0.17</td>
<td>0.03</td>
<td>0.05</td>
<td>0.07</td>
</tr>
</tbody>
</table>
The chemical composition of limestone for cement manufacture shall be such that it gives in combination with an argillaceous component and other corrective materials, if need be, a raw mix of appropriate composition. The specifications for different types of cement are different and no rigorous standard specification can be followed.

The NCB has suggested the following broad specifications of the Run – of Mine cement grade limestone.

Oxide Acceptable range for manufacture of ordinary Components Portland cement
Cao% 44 – 52
MgO% 3 – 5 (Max)
\( \text{SiO}_2 \) 
\( \text{Al}_2\text{O}_3 \) 
\( \text{Fe}_2\text{O}_3 \)
\( \text{K}_2\text{O} + \text{Na}_2\text{O} \) < 0.5
\( \text{P}_2\text{O}_5 \%) < 0.5
Cl% < 0.05
SO\(_2\) < 0.6

To satisfy the LSF and SM of the raw mix

Considering the said specification, the Light Grey Limestone and the very little of top portion of the Pink Limestone of the Yanakandla Block are of cement grade. The portions that are marginal to the specification in respect of CaO, can be sweetened with calc-tuffa and can be brought under the framework of specification. Furthermore, Indian Bureau of Mines stipulated the following threshold values for the limestone.
Cao  ----------------------------  35% (Min)
MgO  ----------------------------  04% (Max)
SiO₂  ----------------------------  8% (Max)
Alkalis  ----------------------------  0.5% (Max)

Limestone or shaly limestone having CaO less than 35%, MgO more than 4% and SiO₂ more than 18% can be considered as rejects.

In respect of reserves the following parameters have been followed.

Parameters for Reserve Calculations: - The main parameters required for the estimation of reserves are.

(1). Geometry or shape or morphology of the limestone body in respect of areal extent and thickness.
(2). Grade in terms of CaO% and SiO₂% expressed as weighted average that together determines the utility of the limestone.
(3). Recovery of the limestone and
(4). Bulk density of the insitu limestone.

Geometry – It is a "plenemensurate body" meaning that such bodies can be fully measured and sampled at an early stage in the exploration. Such bodies will have well defined top and bottom.

Grade – is within the specification of cement grade.
Recovery is considered as very good (86.88 %).
Bulk density is taken as 2.5 tonnes/ m³

The cross sectional method of reserves calculation has been followed and this was cross checked by Arithemetic means method. There was an agreement between these two.
ESTIMATION OF RESERVES (PROVED) BY ARITHMETIC MEAN METHOD:

1. The area that is considered after deducting the land constraints =
   \[ 26 \times 40,000 \text{m}^2 = 1,040,000 \text{m}^2 \]

2. The Thickness is taken as an average of the total thickness
   of the end-use grade = 13m

3. Volume = 1040000 m\(^2\) \times 13 = 13,520,000 m^3

4. Reserves = 13,520,000 m\(^3\) \times 2.5 = 33,800,000 Tonnes
   or 3.38 Million Tonnes

ESTIMATION OF RESERVES (PROVED) BY CROSS SECTIONAL METHOD:

TOTAL RESERVE (ROM) = 3,120,914.5

Life of the mine is given below.

Minable Proved Reserves = 27.44 million tonnes

\[ \frac{27.44 \text{ million tonnes}}{3 \text{ million tonnes per annum}} = 9.15 \text{ Years} \]

Environment is prime concern of all the people, especially of the people who are involved in mining.

Environment means surroundings or conditions that influence development.

The environment act 1986 in India defines environment to include water, air, land and their inter relationship that exists between the above said and the human beings and other living being organisms.
The base line information in respect of Environmental studies include:


All the above said are within the norms of environmental specification.

In the cement plant, noise pollution will arise from coal mill, Kiln/Raw mill, Cement mill, Packing section, Generator room, etc. Higher noise levels will be near the active mining areas. Noise control measures like provision of acoustic dampers in foundation, encasing of noise generating equipment, effective preventive maintenance system, provision of antivibratory measures, etc, the noise levels will be controlled effectively.

Only a few machines have more Noise than the standard. To reduce this, the following techniques are adopted.

1. Lubrication, Maintenance and Speed rating.
2. Green belt will be developed.
3. Controlled Blasts.
4. Ear protection and.
5. Design of Equipment.

Reclamation in the Yanakandla Block can be taken up after the life of Yanakandla Block.
Afforestation controls the pollution, especially dust pollution. It is planned to have neem and tamarind trees for afforestation as their survival rate is high.

Socio-economics of the area will be as follows.

There will be direct employment to nearly 200 persons. In fact quite a few of them are already absorbed. Further, good number of people will get ancillary jobs in transport, casual labour for various works. In addition, the living condition will be improved through integrated rural development programmes, provision of essential facilities like education, health care, drinking water and all other well conceived beneficial social welfare activities.

In respect EMP Stabilization and vegetation of dumps, Measures to control erosion/ sedimentation of water course, Treatment and disposal of water from mine, Measures for minimizing adverse effects on water regime, Protective measures for ground vibrations / air blast caused by blasting, Measures for protecting historical monument and for rehabilitation of human settlements likely to be disturbed due to mining activity, Socio-economic benefits arising out of mining.

These will be taken care and details are given in the chapter on environmental management plan.

Implementation and monitoring of any programme needs a competent and dedicated team. Hence, the monitoring of schedules will be done by the following team.
GM PROJECTS

ENVIRONMENTAL ENGINEER

CHEMIST

HORTICULTURIST

LAB ASSISTANTS

FIELD ASSISTANTS

The said team will monitor the Environmental Scheme that is detailed below.

<table>
<thead>
<tr>
<th>S.No</th>
<th>Description of Parameters</th>
<th>Schedule and Duration of Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ambient air quality</td>
<td>Samples for 24 hours continuously</td>
</tr>
<tr>
<td></td>
<td>a). In and around plant for SO₂, NOₓ, CO, RPM &amp; SPM.</td>
<td>will be collected twice a week for one</td>
</tr>
<tr>
<td></td>
<td>b). Stack monitoring for SPM, RPM, SO₂, NOₓ, &amp; CO.</td>
<td>month during each season for the</td>
</tr>
<tr>
<td></td>
<td>c). Work zone for air quality monitoring for SPM, RPM, SO₂, NOₓ, &amp; CO.</td>
<td>year as per norms of APSPCB.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Once in a fortnight or as per the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>prevailing norms of APSPCB.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Once in a month or as prevailing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>norms of APSPCB.</td>
</tr>
<tr>
<td>2</td>
<td>Water quality of bore wells inside the plant premises and in water bodies around the plant</td>
<td>Quarterly or as per norms of APSPCB for various parameters as required by APSPCB, for physical, chemical and bacteriological system</td>
</tr>
<tr>
<td>3</td>
<td>Ambient noise levels inside the plant premises and nearby villages</td>
<td>Once in a month as per the norms of APSPCB</td>
</tr>
<tr>
<td>4</td>
<td>Occupational health check-up</td>
<td>Once in a year</td>
</tr>
<tr>
<td>5</td>
<td>Inventory of fauna and flora</td>
<td>Once in a year on all the green belts created and once in 5 years in the study area</td>
</tr>
<tr>
<td>6</td>
<td>Socio - economic system</td>
<td>Once in 5 years through physical survey for detecting any adverse variation and prompt correctives.</td>
</tr>
<tr>
<td>7</td>
<td>Ground vibration studies</td>
<td>After one year from the commencement of mining activity.</td>
</tr>
</tbody>
</table>

The entire work on environment will be done in a systematic way.

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Thus the entire work "GEOLOGY, EXPLORATION AND ENVIRONMENTAL ASPECTS OF THE LIMESTONE MINING AROUND YANAKANDLA VILLAGE OF BANAGANAPALLE MANDAL, KURNOOL DISTRICT, ANDHRA PRADESH, INDIA, USING REMOTE SENSING DATA AND GIS" was done using the modern trends and techniques. The challenging work was done in a systematic way as reflected in the compendium.