No. 40
Green serpentinized marble tile. The white veins are of calcite.
Size (30 x 15) cm.
A. SURPENTINIZED MARBLE (Verd green marble):

a) Distribution and mode of occurrence:

The serpentinized marbles were originally impure limestone bands or lenses subsequently intruded by ultrabasic rocks in an ophiolite trough. They are intermixed with undersea originated extrusive rocks. Subsequently the black colour of the olivine and pyroxene, the green colour of serpentine, and the white patches and veins of calcite makes a beautiful mosaic pattern of typical verd green marble.

The commercial value of the verd green marble depends upon the maximum size of the block which are not shattered, fractured or otherwise damaged. If the rock is friable, jointed, fractured or crushed, it loses all commercial value. The three exposures of verd green marble in the Onkronglok river valley showed that the lenses below the massive olivine peridotite are physically compact even though they show migmatite-like flow structures. The third exposure on the side of the massive olivine peridotite, below layered olivine peridotite are highly fractured and covered by rock taluses thereby making it difficult to determine the commercial viabilities. Detail pitting, trenching and removal of the talus overburden can easily give one an idea about their commercial value.
b) **Physical characters:**

The rocks are brittle and tend to break along the foliation direction of the rock. It is comparatively easy to collect plate like rock pieces upto a size of (75x50) cm. width. Crude method of mining works by chisel, hammer and crowbar, one can not hope to exploit blocks of 1 sq. metre or above. The rocks when hammered, fractures along the calcite veins. The crude method of sampling done by us yield (50x50x20) cm. blocks, where from the maximum sized tiles could be cut is (22x15) cm. Thereby the recovery percentage is nearly 15. Systematic and technically correct method of exploitation may yield recovery percentage between 30 to 35 percent.

The hardness of the calcite is 3 and the serpentinite is 3.5 to 4. The magnetite grains present in some of them may give rise to a potential hazard in the polishing of the tiles as the magnetite grains tend to break and may scratch the polished surface.

c) **Industrial possibilities:**

Verd green marble has got great commercial value as high cost decorative material suitable to be used as flooring and wall-panelling matter, in the prestigious buildings and in architectural monuments. The pleasant colouring, colour pattern and fine gloss it takes, makes it a covetable decorative building material. Big panels of the stone can be used
as costly table tops and can be used as counter panels in prestigious buildings as banks, offices and luxury shopping centres.

The material which has been collected by us, and cut and polished in Jaipur was found to be much superior than those which are being sold in Delhi and Calcutta and are originated in Rajasthan and Gujrat.

d) Industrial potential:-

For a stone slabbing industry the primary requirements are—Raw material, Machineries, Electricity, Water, Skilled labour and Market.

Raw material:— Three exposures of verd green marble have been found in Onkronglok valley and only detail geological mapping, pitting, trenching and removal or overburdens can give the exact reserves of the rocks in the Khudengthabi area. However, as the availability of the commercial quality of the rocks has been proven in Manipur ophiolite belt, it is a sure bet that better and bigger deposits could be discovered within this belt.

Machineries:— The machineries required for a semiautomatic plant to manufacture polished wall and floor panels from the green marble and their price will be:
1. Block Slicing Machine  Rs. 4,25,000
2. Multi Cutter  1,20,000
3. Cross Cutter  90,000
4. Side Cutter  30,000
5. Polishing Line  4,00,000
6. Finishing Line  1,35,000
7. Edge Cutting Machine  35,000

Rs. 12,35,000

Stated price is as it was in April 1956, ex-factory, transport and local taxes are extra.

Function of the machineries:

Block Slicing Machine:— It is a medium sized, single blade diamond impregnated, circular saw, rock cutting machine used for sizing the quarried serpentine blocks to slabbable cubic or rectangular shape. The blade can be moved vertically and horizontally. The unsized rock blocks are placed on saw car controlled by variable speed motor. The blocks are 'fixed' with straw and plaster of paris. A stray jet of water is pumped on the cutting surface of the saw to keep it cool and act as lubricant.

Technical specification:

1. Main Motor Circular Saw  75 H.P.
2. Power for vertical up and down of cutter  2 H.P.
3. Power for side movement of cutter  1 H.P.
4. Monoblock for water supply  3 H.P.
5. D.C. drive for saw car  2 H.P.
6. Maximum size of cutter  60"
7. Maximum size of saw car  8'x4'
8. Rate of feeding of saw car  variable
9. Size of thickness of possible slab  36" to 6"
10. Electric control  Control centre
11. Floor area required for machine  30'x20'x12'
12. Weight of machine  11000 kg approx.

2. **Multi Cutter Machine**:- There are multiple, circular, parallel diamond impregnated blade used to cut a number of tiles at the same time. The coolant and lubricant is water. All operations are electrically controlled from control centre. The technical specification are—

1. Main motor  30 H.P.
2. No. of cutters  2 Nos.
3. Maximum size of cutter  24"
4. Size of saw car  6'x3'
5. Auxillary motors  3 Nos.
6. Water pump  1 H.P.
7. Overall dimension of M/C  12'x14'x10'
8. Total wt. of machine  3500 kg.
3. **Cross Cutting Machine:** This machine is used to cut the prepared strips or slabs crosswise to required length.

1. Maximum cutting width 300 mm.
2. Minimum cutting 75 mm.
3. Motor power 10 H.P.
4. Total installed power

4. **Side Cutter Machine:** This machine is used to remove the unevenness on the edges, and excess in size in the tiles to bring it to exact specified size.

Technical specification:

1. Main Motor 1 H.P.
2. Water pump 0.25 H.P.
3. Size of blade 250 mm.
4. Total installed power 2.0 H.P.

5. **Automatic polisher:** It is a conveyor driven automatic sizing, dressing and polishing machine equipped with seven polishing heads, having useful polishing width up to 375 mm. Each head is independent.

Technical specification:

1. Maximum working width 375 mm.
2. Maximum working thickness 25 mm.
3. Power of sizing head 15 H.P.
4. Power of polishing head
   7.5 H.P.
5. Dimension
   6300x1350x1500 mm.
6. Spend of conveyer
   Adjustable
7. Total installed power
   80 H.P.

6. **Complete Tile Finishing Line:** It is an automatic side polishing and levelling machine with 9 operating hands, of which 4 for chambering, 4 side polishing and one for grooving. The line is further attached with blower and buffing unit. This operation terminates the complete processing cycle for tile.

**Technical specifications:**

1. **No. of levelling units**
   4 Nos.
2. **No. of slide polishing units**
   2 Nos.
3. **No. of grooving unit**
   1 No.
4. **No. of drying unit**
   2 Nos.
5. **No. of buffing unit**
   1 No.
6. **Installed power**
   25 H.P.

**Electricity:** Electricity is not available in the Khudengthabi area until now and there is little chance that in a near future it will become available in regular supply in that area. It is recommended that the block should be mined in Khudengthabi area and transported to the nearby valley town either to Moreh or to Pallel. As Moreh is very near to.
the international border, it will be preferable to establish the rock slabbing industry in the town of Pallel.

**Water:** - Perrenial streams with sufficient water flow is available just near the exposures of the rock in the form of Onkronglok and Lokchaw river.

**Skilled labour:** - Skilled labour both for mining and for slabbing the rocks are not available not only in the Khudeng-thabi, but in the whole Manipur state. Skilled labour, technicians, engineers must be brought from other state of India, where such works are a traditional industry as in Gujrat, Rajasthan or Madhya Pradesh.

**Commercial viabilities:** - Our investigation has shown that the present market price (1986-87) of inferior quality verd green marble slabs and tiles in the metropolitan cities of Calcutta and Delhi in the retail sales counters are the following:

<table>
<thead>
<tr>
<th>Type</th>
<th>Size in cm.</th>
<th>Quality</th>
<th>Price in Rs/sq.m.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Delhi</td>
</tr>
<tr>
<td>Wall panelling</td>
<td>30x15x10</td>
<td>Mirror polished</td>
<td>300</td>
</tr>
<tr>
<td>Floor panelling</td>
<td>30x15x10</td>
<td>Mirror polished or drab polished</td>
<td>350</td>
</tr>
<tr>
<td>Big wall panels</td>
<td>200x75x20</td>
<td>-do-</td>
<td>650</td>
</tr>
</tbody>
</table>
As the Manipur verd green marble is far superior quality, a high price can be expected.

Possible industrial centre:— According to our opinion Pallel is the most suitable town for establishment of this industry as it is nearest to the rock occurrences, electricity in sufficient availability throughout 24 hours and population is low enough thereby making the total investment for land and building much lower than that of Imphal. Imphal gets the second preference as it is the capital of Manipur and financial advantages and marketing control will be superior in Imphal. Unskilled labour or potentially skilled labour which will be trained up are easily available both in Imphal and Pallel.

Transport:— The block should be mined out in Khudengthabi, transported by truck to Pallel and Imphal. Finished product should be transported to the market. Trucking is the only way by which these material should be transported and the nearest railhead is in Dimapur.

Marketing:— The nearest market for these luxury products are Gauhati and Tinsukia; Imphal and Dimapur being economically undeveloped to use such production in bulk quantity. When the industry is fully developed, markets in metropolitan cities such as Calcutta, Delhi and Bombay should be determined. Export potential for these stones, slabs and panels is enormous and should be studied in depth.
B. MADRAS BLACK STONE:

The Madras black stone or commonly known Black marble are nothing but slightly serpentinized massive olivine peridotite found in the Khudengthabi-Moreh region. It is technically possible to prepare black slabs and panels from these stones which have got good market in India and abroad. As the state of Tamil Nadu is already manufacturing the stone slabs and the Manipur black stones being not any way superior to the ultrabasic complexes of the Salem district, Tamil Nadu, at present we do not think that the Manipur black stone can stand in competition with Madras black stone from Tamil Nadu.

The Madras black stones of Tamil Nadu are coming from the massive ultrabasic intrusives, little disturbed by tectonic movements, whereas the ultramafics from the ophiolite belt greatly tend to get fracture due to tectonic movements and comparatively smaller blocks without any fracture and joints can be mined.

The massive peridotite collected by us cut into slabs showed a number of hollow fractures in it thereby making it unsuitable for commercial exploitations.