CHAPTER - II  

FLOWS AROUND SAGAR

2.1 The lava flows and their description

The flows around Sagar are mainly simple, consisting of single flow units, in contrast to the compound flows of western India (Walker, 1971). There are both Aa and Pahoehoe flows, though at times it is difficult to judge. Columnar joints are common but not prominent. Vesicles are abundant and show difference in size and shape with different flows.

The author has studied the geology and distribution of the flows in an area of nearly 500 sq. kms. and it was possible to identify at least twelve flows around Sagar. The flows differ in their physical characters namely, colour, hardness, granularity, the way they break apart and the mode of weathering. Most of these flows show spheroidal weathering. The size of boulders released due to weathering is an identifying characteristic, which is different from one flow to the other. Secondary minerals like zeolites and calcite are common in the weathered part of some of the flows. Tops of the flows are often "decorated" with geodes and various silica minerals. Some of the flows have a lateritic cap which is ferruginous.
FIG. 5 The Deccan trap lava flows as penetrated by borings around Sagar.

Lameta bed = Upper Cretaceous
Vindhyan Sandstone = Pre-Cambrian
The water-works Hill at Sagar (the site for Bore-hole 1) exposing the higher flows. The encircled area is shown in the next photograph on a magnified scale.

A road section exposing the contact between the weathered top of flow 6 and flow 7 at the Water-works hill.
A Conical Deccan Trap outcrop near the site for Bore-hole 2. An Intertrappean limestone bed (dotted lines) separating Flow 5 and Flow 6. A close-up of this contact is shown below.

The main Intertrappean horizon, separating Flow 5 and 6 at the Conical Hill, near the site for Bore-hole 2.
The 1856' Hill, the site for Bore-hole 2, at Sidgaon, 7 km. from Sagar on the Sagar-Jabalpur Road. Flow 5 and 6 are separated by a limestone horizon, abundant in aragonite nodules.

A massive exposure of Flow 2 near the site for Bore-hole 3 exhibiting prominent vertical joints.
The thickness of basal flow varies greatly from place to place as it must have been controlled by the pre-Deccan trap topography and also by the direction of flow. No ultrabasic nodules have been observed or reported so far, but caught-up fragments of Vindhyan Sandstone-quartzite are present.

2.2 **Samples of the present study**

The samples for the present study were obtained from three boreholes (Fig. 5) which together penetrated the entire thickness of the Deccan lava pile in the area. These boreholes were drilled by Geological Survey of India during the years 1972-73.

The first borehole, BH1, has encountered six flows with an intertrappean limestone horizon, and the second borehole, BH2, has penetrated four flows, two of which are also present in BH1. There are two sedimentary beds in the flow sequence; a limestone bed which coincides with the one present in BH1, the other a chocolate coloured clay bed at a lower level. A third bore-hole BH3 has cored two lower flows. BH1 and BH2 rest on the Vindhyan sandstone quartzite while BH3 rests on Lameta beds. A composite stratigraphic column of the flow sequence has been constructed from all three borehole data to get the entire picture (Fig. 5). The correlation
**A BRIEF PETROLOGIC DESCRIPTION OF THE TIN FLOWS**

<table>
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<tr>
<th>Matres</th>
<th>1</th>
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<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
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</table>

Fine grained, greyish black, groundmass extremely fine under microscope, abundant iron ore and greenish black chlorophaeite. Microphenocrysts of plagioclase only.

Texture in general hyalopilitic

Very similar to the flow above

Greyish brown, medium to coarse grained. Greenish chlorophaeite abundant in hand specimens. Texture commonly intergranular. This flow is relatively altered compared to the rest

Brownish-grey in colour with brown chlorophaeite. Microphenocrysts of plagioclase very common. Sub-ophitic texture, has well formed iron ore and ilmenite crystals.

Medium to fine grained, jet black in colour. Intersertal texture. Olivine present

Extremely fine grained, jet black in colour, breaks with sharp edges. Groundmass very fine, phenocrysts rare. Abundant chlorophaeite and iron ores

Coarse grained, brownish grey with rough surface. Partly altered, abundant greenish chlorophaeite. Phenocrysts of plagioclase only. Ground mass equigranular.

Similar to flow above. Intersertal texture, well formed magnetite and ilmenite crystals.

Medium grained, black, breaks with even surface. Shows microphenocrysts of plagioclase and pyroxene. Sub-ophitic texture, grains of olivine present, frequent yellow chlorophaeite.

Jet black, hard, breaks with irregular surface. Porphyritic texture. Phenocrysts of plagioclase only.

Ground mass very fine containing laths of plagioclase, sub-hedral pyroxene grains and skeletal crystals of iron ore and yellowish chlorophaeite.

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**FIG. 5** A composite stratigraphic column of the basaltic sequence constructed from the three bore-holes.

- Cherty lime-stone
- Chocolate red clay
- Lameta beds—Sandstone and limestones
of the individual flows is mainly based on comparable reduced levels. From Fig. 6 it is seen that there are two sedimentary horizons in the flow sequence dividing them into three separate groups. As would be seen later one of the breaks also corresponds to a chemical break. Flows 1, 2, 3 and 4 hereafter shall be referred to as Lower flows and flows 5, X, 6, 7, 8 and 9 as Higher flows. One of the flows is marked as X because it is present only in BH 1 but absent in BH 2. The numbers 1-9 are in ascending stratigraphic sequence. The individual thickness of the flows is shown in Table 2.2.

**Table - 2.2**

<table>
<thead>
<tr>
<th>Flow No.</th>
<th>Bore Hole No.</th>
<th>Thickness (in Metres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>BH 1</td>
<td>10.37</td>
</tr>
<tr>
<td>8</td>
<td>BH 1</td>
<td>24.0</td>
</tr>
<tr>
<td>7</td>
<td>BH 1</td>
<td>19.0</td>
</tr>
<tr>
<td>*6</td>
<td>BH 1</td>
<td>17.90</td>
</tr>
<tr>
<td>X</td>
<td>BH 1</td>
<td>12.0</td>
</tr>
<tr>
<td>5</td>
<td>BH 2</td>
<td>28.0</td>
</tr>
<tr>
<td>4</td>
<td>BH 2</td>
<td>29.0</td>
</tr>
<tr>
<td>3</td>
<td>BH 2</td>
<td>08.00</td>
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<tr>
<td>2</td>
<td>BH 3</td>
<td>19.50</td>
</tr>
<tr>
<td>1</td>
<td>BH 3</td>
<td>08.00</td>
</tr>
</tbody>
</table>

*Average from BH 1 and BH 2.*
2.3 Petrography

The ten lava flows studied are more or less similar in their petrographic characters and belong to either of the two types;

(i) Fine-grained, equigranular basalt
(ii) Fine to medium-grained, microporphyritic, basalt.

Basal flow (Flow 1) and the flow 6 are the ones that can be described as micro-porphyritic. All the rest are equigranular with interstitial to intergranular texture. Sub-ophitic texture is not uncommon in some of the sections. The principal constituents are plagioclase (An55-63) and brownish non-pleochroic augite (2V: 45-53°). Iron ores and glass are the accessory constituents. Among the sub-porphyritic types, phenocrysts are mainly plagioclase; the average size being 2 to 4 mm. The grain size of the flows is not very helpful in distinguishing one flow from the other due to irregular intraflow variation.

Olivine is very rare, an occasional crystal can be seen only in Flows 2 and X.

2.3.1 Description of individual minerals:

Plagioclase:

Plagioclase (labradorite) is always the most abundant constituent. It occurs as idiomorphic to
Photomicrograph of Flow 9 (x 24).

Clusters of plagioclase and pyroxenes microphenocrysts in a groundmass of plagioclase laths, pyroxene, opaques and glass.

Photomicrograph of Flow 6 (x 24).

Intergranular flow 6, showing sub-ophitic texture; pyroxenes partly enveloping plagioclase, granular opaques and brown glass.
Photomicrograph of Flow X (x 24).

Clusters of labradorite and augite microphenocrysts in a groundmass of labradorite laths, augite, opaques and glass.

Photomicrograph of Flow 5, (x 24).

Extremely fine-grained, Flow 5; plagioclase laths, pyroxenes, opaques and glass in an intergranular relationship.
Photomicrograph of Flow 2 ( x 24 ).

Microphenocrysts of augite and labradorite in a groundmass composed of labradorite, augite, brown glass and granular iron-ores.

Photomicrograph of Flow 1 ( x 24 ).

Porphyritic Flow 1, with clusters of plagioclase phenocrysts in an interstitial groundmass of pyroxene, plagioclase and brown glass.
### TABLE - 2.3

**Average Anorthite Content of Plagioclases and 2V's of Pyroxenes**

<table>
<thead>
<tr>
<th>Flow No.</th>
<th>Phynocryst An%</th>
<th>Groundmass An%</th>
<th>Average An%</th>
<th>2V (Optical axial angle) of Pyroxenes</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>60.4</td>
<td>59.5</td>
<td>59.96</td>
<td>44°</td>
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<tr>
<td>8</td>
<td>62.5</td>
<td>58.3</td>
<td>60.65</td>
<td>53°</td>
</tr>
<tr>
<td>7</td>
<td>59.1</td>
<td>55.2</td>
<td>57.15</td>
<td>49°</td>
</tr>
<tr>
<td>6</td>
<td>67.3</td>
<td>62</td>
<td>64.9</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>69.5</td>
<td>61.4</td>
<td>65.45</td>
<td>44°</td>
</tr>
<tr>
<td>5</td>
<td>69.0</td>
<td>60.2</td>
<td>64.6</td>
<td>50°</td>
</tr>
<tr>
<td>4</td>
<td>64.6</td>
<td>62</td>
<td>63.3</td>
<td>48°</td>
</tr>
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<td>52°</td>
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<td>1</td>
<td>64</td>
<td>56</td>
<td>60</td>
<td>48°</td>
</tr>
</tbody>
</table>
subidiomorphic laths and is present both as micro-
phenocrysts and in the ground-mass. Twinning of the
plagioclases on the albite law is more common; carlsbad
and complex twins are rare. Zoned phenocrysts have a
rim of An$_{48}$ and core of An$_{65}$.

**Pyroxenes:**

Pyroxenes are pale-brown, non-pleochroic augites
and show sub-ophitic or intergranular relationship with
the plagioclases. Unlike plagioclases, the pyroxenes do
not occur as microphenocrysts or phenocrysts but more
commonly occurs as granules filling the interspaces between
the plagioclases. 2V for the microphenocrysts and so also
for the augites present in the ground mass varies from 43
to 53°.

Barth (1931) described the presence of pigeonite
from the Deccan basalts of Rajahmundry area. Naidu (1960)
also reported the presence of pigeonite as phenocrysts
in the Deccan basalts of Chandwara, Bombay and Mysore.
Detailed work of West (1952), however, established that
the sub-calcic augite is the most common variety while
pigeonite is rare. Latter workers (Poldervaart, 1953;
Sharma, 1963 and Subba Rao, 1964) confirmed this
observation from their study of basalts of Bombay, Pavagharh
and Girnar areas. The present study shows that sub-calcic
augite is the most common pyroxene in basalts of Sagar
while pigeonite is absent.
Table 2.3 gives the anorthite, content of the plagioclases (Measurement of 2V of pyroxenes in the ten flows is in progress).

**Plagioclase-pyroxene ratios:**

Plagioclase to pyroxene ratio is not very meaningful for the identification of different flows as could be seen from table, given below:

<table>
<thead>
<tr>
<th>FLOW NO.</th>
<th>PYROXENE</th>
<th>PLAGIOCLASE</th>
<th>Pg/Px</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>45</td>
<td>45</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>33</td>
<td>43</td>
<td>1.3</td>
</tr>
<tr>
<td>1</td>
<td>37</td>
<td>44</td>
<td>1.2</td>
</tr>
</tbody>
</table>

Table 2.3 gives the optical properties of plagioclases and pyroxenes of the ten flows.

**Opaque minerals:**

The chief opaque minerals are magnetite and titanomagnetite occurring as rectangular crystals, plates, elongated bars and also in irregular patches. Ilmenite also occurs as small crystals and plates.

**Glass:**

Glass is present in all flows in varying amounts. When fresh it is colourless or pale brown. Some of the glass has been altered to palagonite and chlorophaeite. The tops and bottoms of the flows are always more glassy than the middle horizons.
Mode:

Systematic modal analysis could not be undertaken because of the fine-grained nature of the basalts.

The range of modal variation is as follows:

- Plagioclase: 40 - 60%
- Pyroxene: 25 - 40%
- Iron ore: 6 - 14%
- Glass: 3 - 10%

Brief petrographic description of samples used for chemical analyses is to be found in Appendix I.