CHAPTER IX

MINOR ACID INTRUSIVES

DISTRIBUTION

A few minor acid intrusives, including microgranite, pitchstone and porphyritic felsite have been observed in the general area of this igneous complex. They constitute about 1 percent of the total acidic rocks in the area. The rock types can be grouped as follows.

1. MICROGRANITE

(a) A tongue shaped body of microgranite occurs with a northeasterly trend within the basalt, and appears to emerge from the Modhpur-Ghumli-Abapara felsite in the eastern part of Ghumli area. It has a length of about 450 yards (411 metres) and a width of about 100 yards (91.5 metres).

(b) A minor subcircular patch of microgranite occurs to the north of Jambu talao. It has a diameter of about 250 yards (228.6 metres) and is enclosed by the finer granophyre of Modhpur area, and shows a transitional contact.

(c) Minor dykes of microgranite, have been located across the Minsar river valley, at about $\frac{1}{2}$ mile (0.8 km) and $1\frac{1}{2}$ miles (2.4 km) north-northwest of Wansajalia village. These dykes cut across the basaltic country. The nearest one to Wansajalia, trends N 60° W, and has a tongue shaped projection in the direction of N 26° E; its length and width are of about 100 feet (30.5 metres) and 5 feet (1.5 metres) respectively. At about 400 yards (365 metres) further north, another minor dyke with its trend N 50° E and width of about 10 feet (3 metres) has been traced.
2. **PITCHSTONE**

   (a) Pitchstone dykes are associated with the felsite plug of Gandiwala Nes, where they form two main zones in an en echelon pattern. The rock is black and devitrified. Devitrification forms "leopard rock" with glassy black spots in between devitrified white areas.

   (b) Pitchstone dykes trending N 40° E have also been traced within the basaltic stoped block of Khambiyara-Talara talao areas. These minor dykes are very thin and are hardly 20 yards (18 metres) wide.

3. **PORPHYRITIC FELSITE**

   An arcuate dyke of porphyritic felsite has a width of about 50 yards (45 metres) and a length of about 1 mile (1.6 km) and indicates that its centre lies towards the south. It has been located within the basaltic rocks at \( \frac{1}{2} \) mile (0.8 km) northwest of Katkola Railway Station. This dyke is linked with the acidic rocks of Alech hills; it has a steeply dipping flow structure indicating a rhyolitic character. Steep inward dip of flow structure suggests that this arcuate body of dyke is a cone sheet.

**MODE OF OCCURRENCE**

Microgranite, felsite and pitchstone may be formed at different conditions of crystallisation from the same acidic magma. Their occurrences within the basaltic rocks of Khambiyara-Talara talao, Katkola and Wansjalia areas, show clear evidences for the intrusive nature of the acid magma into the Deccan Trap basalt flows. The acid dykes e.g., microgranite in Wansjalia, pitchstone in Khambiyara-Talara talao and porphyritic felsite in Katkola areas have contact effects like silicification, strongly developed sheet like joints and metamorphism within the invaded basalts.
PETROGRAPHY

1. MICROGRANITES

Sp. No. SC/22.10.70: From Ghumli area.

In hand specimen it is fine grained, granular and appears to have a saccharoidal texture. The rock has dirty white colour with black patches and composed of quartz, feldspar and mafics. Fine grained xenolithic patches of smaller sizes, with a concentration of mafics, have been observed.

Microscopically, the rock shows a hypidiomorphic granular texture (Fig. 49), formed by euhedral plagioclase, interstitial and coarse subhedral patches of alkali feldspar and subhedral to anhedral quartz grains. Other minerals include clinopyroxene, brown hornblende, biotite, profuse iron ores and traces of zircon.

(Alkali feldspar is abundant as interstitial subhedral grains and stained with dusty inclusions. Plagioclase occurs in the form of euhedral tabular grains, and shows distinct twinning and an outer alkali feldspar rim. Quartz is abundant as coarse anhedral grains, which are interlocked with feldspar and pyroxene.

Clinopyroxene is colourless and occurs as irregular and prismatic grains with $Z \cdot c = 30^\circ$, $2V_z = 53.5^\circ$ and $N_y = 1.703 \pm 0.006$ and it is augitic in composition, $Ca_{43} Mg_{31.5} Fe_{25.5}$.

Brown hornblende and biotite subpoikilitically replaces clinopyroxene. Brown hornblende has distinct pleochroism in the scheme of $X = $ pale yellow, $Y = $ yellowish brown and $Z = $ faint greenish brown and with $Z \cdot c = 28^\circ$, while the biotite grains have a strong pleochroism in the scheme of $X = $ pale yellow and $Z = $ orange red.

Iron ores occur profusely in granular forms. Euhedral zircon grains have also been traced.
Sp. No. 8B/22.10.70: From Ghumli area.

Megascopically, the rock has the same character as the previous specimen but it is comparatively coarse and devoid of any xenolithic patches.

Microscopically, the rock is composed of alkali feldspar, quartz, plagioclase, clinopyroxene, probable fayalite pseudomorph, iron ores and zircon. The granophyric intergrowths of quartz and alkali feldspar along with hypidiomorphic granular texture are seen in the present section (Fig. 50).

Plagioclase is common as phenocrysts which have rim formed by micrographic intergrowths.

Alkali feldspar grains are common, and occur as granophyric intergrowth with quartz. Quartz also occurs as discrete grains.

Clinopyroxene is common in the form of shorter prisms, and is strongly pleochroic with X = light green, Y = brownish yellow, Z = bright green, Z/C = 38° and 2V = 54°, Ny = 1.715 ± 0.005 and ferro-augitic in composition, Ca44 Mg23 Fe3.

Fayalite grains, pseudomorphed by iddingsite show a lemon yellow colour. It also shows limonite along cracks. Iddingsite also replaces clinopyroxene in patches. Fayalitic olivine shows 2V = 54°, indicating hortonitic (Fe80) which is comparable to hortonitic olivine occurring in granophyric of Skye (Hatch, Wells and Wells, 1961, p. 268).

Iron ores occur frequently as subhedral to anhedral grains. Large grain of zircon are also common.

Sp. No. 10/24.2.71: From Jambu talao area.

In hand specimen, it is fine grained, felsitic to granular, light blue in colour and composed of a quartz-feldspathic groundmass with phenocrysts of feldspar and mafics.
Fig. 49. Photomicrograph showing microgranitic texture formed by anhedral quartz grains (white), subhedral to euhedral alkali feldspar (stained, grey) and iron ores (black). Crossed nicols, x 82.

Fig. 50. Photomicrograph showing granophyric intergrowths (right hand side) grading towards microgranitic texture (left hand side). Crossed nicols, x 82.
Microscopically, the rock is fine grained and has granophytic intergrowths grading to microgranitic texture. It is composed of quartz, alkali feldspar, plagioclase and iron ores.

Quartz occurs both in the form of coarse xenomorphic grains and as intergrowth with alkali feldspar. Alkali feldspar grains occur abundantly in the forms of numerous xenomorphic independent grains and also as intergrowth with quartz. Plagioclase phenocrysts are common in the form of tabular grains, marginally zoned to alkali feldspar and rimmed by granophytic intergrowth. Clear plagioclase grains may show alteration along the margins, presumably because of potash content.

Clinopyroxene grains occur as euhedral phenocrysts and also as a constituent of the groundmass. They show distinct pleochroism from clear bright green to greenish brown (olive green) and $Z\alpha c = 50^\circ$, $2V_g = 59^\circ$ and $N_g = 1.727 \pm 0.003$ indicating that it is a hedenbergite, with Ca$_{47.5}$ Mg$_{7.5}$ Fe$_{45}$.

Grains of iron ore are common in the interstitial spaces and also as inclusions within clinopyroxene.

2. PITCHSTONE

Sp. No. 9/13.2 : From the easternmost pitchstone dyke within Gandiwala Nes felsite plug.

It is dark grey coloured, nonporphyritic rock with peculiar sheeted joints and conchoidal fractures.

The thin section shows that the rock is composed of a fine-grained felsitic mass which possibly formed by devitrification of volcanic glass. Numerous needle-shaped pyroxene microlites are present and they are clotted together in association with granular iron ores. The microlites have both regular parallel and irregular haphazard patterns. The rock is a devitrified pitchstone.
Under the ore microscope, the most common iron ore minerals in the rock include titanomagnetite in medium to fine dot-like grains, and have a range of sizes rather than several distinct generations. The grains are mostly subhedral to euhedral (octahedral) in forms, and occur interstitially. A few slightly coarser grains have poikilitic intergrowths with the silicates. Some elongated grains are titanomagnetite which are maghemitised, leaving out irregular unaltered patches. Titanomagnetite grains, at places, form clusters. Some fine grains occur either as inclusions, or along the borders of silicates. Ilmenite rarely occurs forming a secondary intergrowth with titanomagnetite. A few dotted specks of chalcopyrite have been found. In an included fragment (possibly a caught up felsite fragment) a few elongated ilmenite and martitized titanomagnetite grains have been recorded.

*Sp. No. 13/13.2:* From the east-west trending pitchstone dyke in the same Gandiwala Nes felsite plug.

It is fine grained, non-porphyritic and dark grey in colour, with a few distinguishable grains of iron ores and mafics.

Microscopically, the rock is felsitic and composed of very fine intergrowths of alkali feldspar and quartz. Free quartz grains of coarse sizes are common. Pyroxene occurs as very fine granules in association with dusty iron ores forming longulites or in the form of fine needles (microlites) arranged mostly in a parallel to a few of haphazard pattern (Fig. 51). Other minerals in the submiarolitic spaces of the groundmass include iron ores, quartz and aegirine-augite (weakly pleochroic in the scheme of $X =$ green, $Z =$ yellowish green, $Y =$ pale yellowish green and $X \Lambda C = 30^\circ$).

Subspherulitic radiating structure with submicroscopic intergrowth of alkali feldspar and quartz in fibers and radial pattern (Fig. 52) have been traced in the groundmass.
Fig. 51. Photomicrograph showing pyroxene as very fine granules in association with dusty iron ores in the form of longulites, arranged mostly in a parallel to a haphazard manner. Ordinary light, x 82.

Fig. 52. Photomicrograph showing fine fibres of alkali feldspar-quartz intergrowth arranged in a radial pattern within the groundmass. Crossed nicols, x 23.
Felsitic texture is possibly derived from glass by devitrification. It is a very fine grained granular intergrowth of quartz and alkali feldspar that gives a felted appearance under crossed nicols.

The rock is identified as felsitic pitchstone.

**Sp. No. 5A/18.10.70 : From Khambiyara-Talara talao areas.**

Megascopically, the rock is dark pitch grey in colour and aphanitic in texture. The constituent minerals are too fine to be identified megascopically.

Microscopically, it has a felted appearance, and is composed of very fine grained intergrowths of alkali feldspar and quartz and fine disseminated iron ores. Undevitrified glass is also common.

The chemical analysis in Table 24, shows that the pitchstone is a dacite and its very low normative quartz content shows that this rock approaches towards monzonitic composition.

3. **PORPHYRITIC FELSITE**

**Sp. No. 9/21.2 : From Katkola area.**

In hand specimen, it is light brown coloured, fine grained and porphyritic with phenocrysts of feldspar in a felsitic groundmass. Fine miarolitic cavities are visible.

Microscopically, the rock is fine grained and porphyritic with phenocrysts of plagioclase in a felsitic groundmass.

Plagioclase phenocrysts are common in the form of euhedral tabular grains, clotted at places, twinned according to albite and Carlsbad laws and show inclusions of epidote and iron ores.

The groundmass is felsitic, with fine intergrowths of quartz and alkali feldspar. Very fine laths of plagioclase of both twinned and untwinned
types are common in the groundmass. Other constituents of the groundmass include epidote, clinopyroxene and iron ores; epidote is common as anhedral grains; iron ores occur in the forms of subhedral prisms and needles; clinopyroxene is common as needle-shaped and skeletal grains, green in colour with feeble pleochroism and mostly replaced by iron ores.


Megascopically, it is a fine grained, brown coloured and highly altered rock and consists of phenocrysts of feldspar in a felsitic groundmass.

Microscopically, the rock is fine grained, porphyritic with phenocrysts of plagioclase within a felsitic groundmass.

Plagioclase phenocrysts are common, in the form of euhedral tabular grains, which are untwinned, with corroded edges, and contain inclusions of chlorite and stilpnomelane both of which are alteration product from clinopyroxene. Stilpnomelane is deep brown in colour and strongly pleochroic in the scheme: X = green, Z = deep brown.

The groundmass is fine grained and composed of fine intergrowths of quartz and alkali feldspar, and poorly developed spherulites. Iron ores in association with chlorite occur as the groundmass constituents. Coarse and anhedral grains of quartz are also common.

Sp. No. 2/21 : From Katkola area

It is greenish grey to brown in colour, fine grained and porphyritic with phenocrysts of feldspar in a fine grained groundmass. Feldspar phenocrysts are tabular to lath-shaped.

The thin section shows that the rock is porphyritic with phenocrysts of plagioclase in a felsitic groundmass.
Plagioclase phenocrysts are common in the form of tabular to lath-shaped grains, which are untwinned, clotted, and contain alteration patches of chlorite and calcite. Chlorite also occurs in association with subhedral to anhedral grains of iron ores and rare subhedral grains of biotite.

The groundmass is composed of fine intergrowths of quartz and alkali feldspar, fine and untwinned plagioclase laths, patches of chlorite, fine granular sphene, longulites formed of iron ores and a few comparatively coarse anhedral quartz grains. Chlorite is possibly an alteration product from clinopyroxene.

**MODAL DATA**

The modal compositions (volume percent) of the constituent minerals in the microgranite are in Table 23.

**TABLE 23**

<table>
<thead>
<tr>
<th>Slide No.</th>
<th>Quartz</th>
<th>Alkali feldspar</th>
<th>Plagioclase</th>
<th>Clinopyroxene</th>
<th>Amphibole</th>
<th>Biotite</th>
<th>Iron ores</th>
<th>Accessories</th>
</tr>
</thead>
<tbody>
<tr>
<td>86/22.10.70</td>
<td>34.0</td>
<td>45.3</td>
<td>11.1</td>
<td>1.8</td>
<td>1.8</td>
<td>1.1</td>
<td>4.8</td>
<td>0.1</td>
</tr>
<tr>
<td>83/22.10.70</td>
<td>29.8</td>
<td>61.7</td>
<td>1.2</td>
<td>4.2</td>
<td>Nil</td>
<td>Nil</td>
<td>3.0</td>
<td>0.1</td>
</tr>
</tbody>
</table>

The modal data of microgranite shows that it is similar to those of the coarse and fine granophyres, as described in the preceding chapters.

**CHEMICAL DATA**

The chemical analyses and norms (C.I.P.W.) of pitchstone and fayalite-bearing microgranite collected from Talara talao and Ghumli areas is shown in the Table 24.
TABLE 24

Chemical Analyses and Norm of Pitchstone and Fayalite Bearing Microgranite

(1) Pitchstone from Talara talao area

Sp. No. 54/18.10.70

<table>
<thead>
<tr>
<th>Chemical Analysis</th>
<th>Normative C.I.P.W.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂ = 53.56</td>
<td>Quartz = 13.14</td>
</tr>
<tr>
<td>Al₂O₃ = 12.69</td>
<td>Orthoclase = 7.78</td>
</tr>
<tr>
<td>TiO₂ = 1.25</td>
<td>Albite = 14.67</td>
</tr>
<tr>
<td>Fe₂O₃ = 5.30</td>
<td>Anorthite = 23.07</td>
</tr>
<tr>
<td>FeO = 7.31</td>
<td>Diopside = 12.79</td>
</tr>
<tr>
<td>MnO = 0.06</td>
<td>Enstatite = 10.30</td>
</tr>
<tr>
<td>CaO = 8.14</td>
<td>Hypersthene = 5.02</td>
</tr>
<tr>
<td>MgO = 4.11</td>
<td>Magnetite = 7.66</td>
</tr>
<tr>
<td>Na₂O = 1.77</td>
<td>Ilmenite = 2.43</td>
</tr>
<tr>
<td>K₂O = 1.29</td>
<td>Apatite = 0.67</td>
</tr>
<tr>
<td>P₂O₅ = 0.343</td>
<td></td>
</tr>
<tr>
<td>H₂O⁺ = 0.36</td>
<td></td>
</tr>
<tr>
<td>H₂O⁻ = 3.48</td>
<td></td>
</tr>
<tr>
<td></td>
<td>99.663</td>
</tr>
</tbody>
</table>

(2) Fayalite bearing Microgranite from Gumli area

<table>
<thead>
<tr>
<th>Chemical Analysis</th>
<th>Normative C.I.P.W.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂ = 62.52</td>
<td>Quartz = 20.70</td>
</tr>
<tr>
<td>Al₂O₃ = 11.03</td>
<td>Orthoclase = 16.12</td>
</tr>
<tr>
<td>TiO₂ = 0.89</td>
<td>Albite = 29.34</td>
</tr>
<tr>
<td>Fe₂O₃ = 4.84</td>
<td>Anorthite = 6.39</td>
</tr>
<tr>
<td>FeO = 8.15</td>
<td>Diopside = 15.79</td>
</tr>
<tr>
<td>MnO = 0.08</td>
<td>Enstatite = 0.05</td>
</tr>
<tr>
<td>CaO = 5.20</td>
<td>Ferrosilite = 1.65</td>
</tr>
<tr>
<td>MgO = 0.10</td>
<td>Magnetite = 7.03</td>
</tr>
<tr>
<td>Na₂O = 3.43</td>
<td>Ilmenite = 1.67</td>
</tr>
<tr>
<td>K₂O = 2.72</td>
<td>Apatite = 0.67</td>
</tr>
<tr>
<td>P₂O₅ = 0.282</td>
<td></td>
</tr>
<tr>
<td>H₂O⁺ = 0.26</td>
<td></td>
</tr>
<tr>
<td>H₂O⁻ = 0.48</td>
<td></td>
</tr>
<tr>
<td></td>
<td>99.96</td>
</tr>
</tbody>
</table>

Analyst: B. P. Gupta
The following observations can be made from these chemical analyses:

1. The normative proportions of quartz, orthoclase and (albite + anorthite) have been recalculated to 100, as 22.4, 13.3, 64.3 and 31.3, 24.2, 44.5 respectively for pitchstone and fayalite-bearing acid rock and which show them to be granodioritic in composition.

2. The normative values of quartz, orthoclase and albite, recalculated to 100, for pitchstone and fayalite-bearing acid rock, as 36.9, 21.9, 41.2 and 31.3, 24.2, 44.5 respectively have shown their positions near the minima of experimental granite-water system; which is consistent with their undoubted igneous origin.

3. The differentiation indices have been calculated for pitchstone and fayalite-bearing rock as 58.66 and 72.55 respectively which may indicate them to be intermediate and felsic differentiates, respectively.

4. The oxidation ratios for pitchstone and fayalite-bearing rocks have been calculated as 39.50 and 34.77 respectively, which may be correlated with the presence of fayalite and ferroaugite in the mineral assemblage.

5. The molecular proportions of total soda and potash is less than that of alumina for both the pitchstone and fayalite-bearing acid rock, and hence they may be considered as metaaluminous.

6. In the pitchstone, the lime and magnesia content is comparatively high than that in fayalite-bearing acid rock. The low magnesia content of fayalite-bearing acid rock is also reflected in their ferroaugite- and fayalite-bearing assemblages.

7. The soda and potash proportions are comparatively less in the pitchstone than in the fayalite-bearing acid rock; and in each case, the weight percentages of soda slightly exceed those of potash.
PETROGRAPHIC SIGNIFICANCE

As referred to earlier, minor dykes of microgranite, porphyritic felsite and pitchstone occurring in the present area, may be formed from the same acidic magma, but at different conditions of crystallisation. The mineralogical similarities of these minor intrusives with those of granophyres and felsites forming the major intrusives of the area suggest a common acidic magma as their source. The intrusive nature of these minor acid rocks into the major intrusives of the area, indicates that the acid igneous emplacement at the Barda complex took place at different phases.

Pitchstone is devitrified glass with a very low water content (analysed specimen shows $H_2O^+ = 0.36$). Subspherulitic patches and microcrystalline quartz and alkali feldspar are products of devitrification from a highly supercooled glassy rock which invaded the major acid intrusives.

Crystallisation of microgranitic rocks favour the conditions lying in between felsites and granophyres. At an intermediate degree of supercooling in between, that of felsites and granophyres, the microgranitic or aplitic rocks with or without subordinate granophyric units develop. The low water content (analysed specimen shows $H_2O^+ = 0.24$) in the microgranite also appears to have influenced the formation of the microgranitic texture.