Chapter 4
Minor Intrusions

Classification and Distribution

Hatch *et al* (1972) recommended the use of names such as rhyolite and basalt as a non-genetic system for both minor intrusions and volcanics. Le Maitre (1989) made recommendations on the classification of volcanic rocks using these names, and these divisions are used in this survey (Figure 5). Allen & Stephens (1971) recorded feldspar and quartz porphyry (sic) dyke swarms in north Lantau (Lamma porphyry and D'Aguilar porphyry). These are mapped as feldsparphyric and quartzphyric rhyolite. Although none are shown on their map of the island, Allen & Stephens (1971) also recorded basic dykes, mapped in the prek-ent survey as either lamprophyre or basalt.

The minor intrusions occur as dykes varying in width from a few centimetres to 100 metres. The dykes are best exposed in coastal sections, but can often be traced across the island for as much as 700 m. The dominant dykes are of quartzphyric rhyolite, with minor occurrences of feldsparphyric rhyolite, aplite, pegmatite, lamprophyre and basalt. Quartz veins form widely distributed small-scale features. The rhyolite dykes are closely related to Mesozoic granite emplacement, whereas the basalt and lamprophyre are either late-stage Mesozoic syn-plutonic dykes or formed in a Tertiary extensional phase.

Quartzphyric Rhyolite

Distribution and Lithology

Quartzphyric rhyolite is characterized by an aphanitic groundmass containing scattered small quartz megacrysts (Plate 5). The rock is pale grey when fresh and is commonly fractured. The margins of the narrow dykes are often flow-banded (Plate 6), and may be darker and finer than the main body of the dyke.

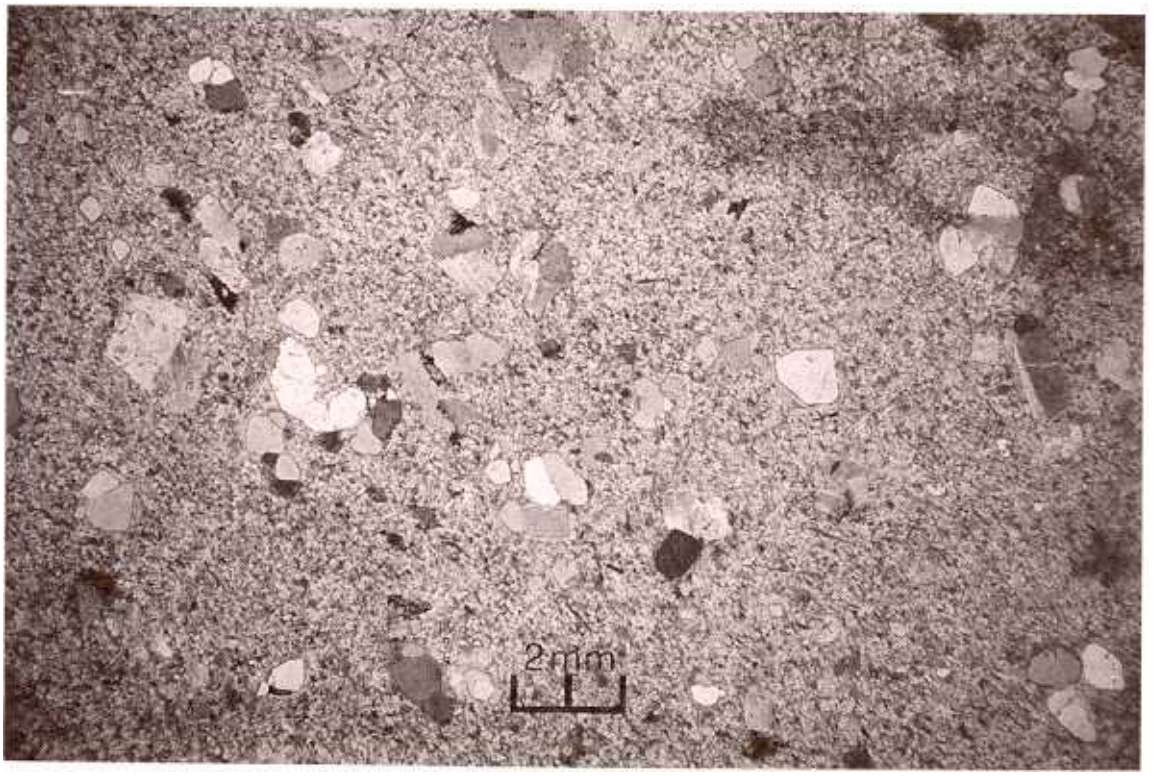

Plate 5 - Thin Section of Quartzphyric Rhyolite (HK9040) from East Chek Lap Kok (1180 1897); XPL x 7

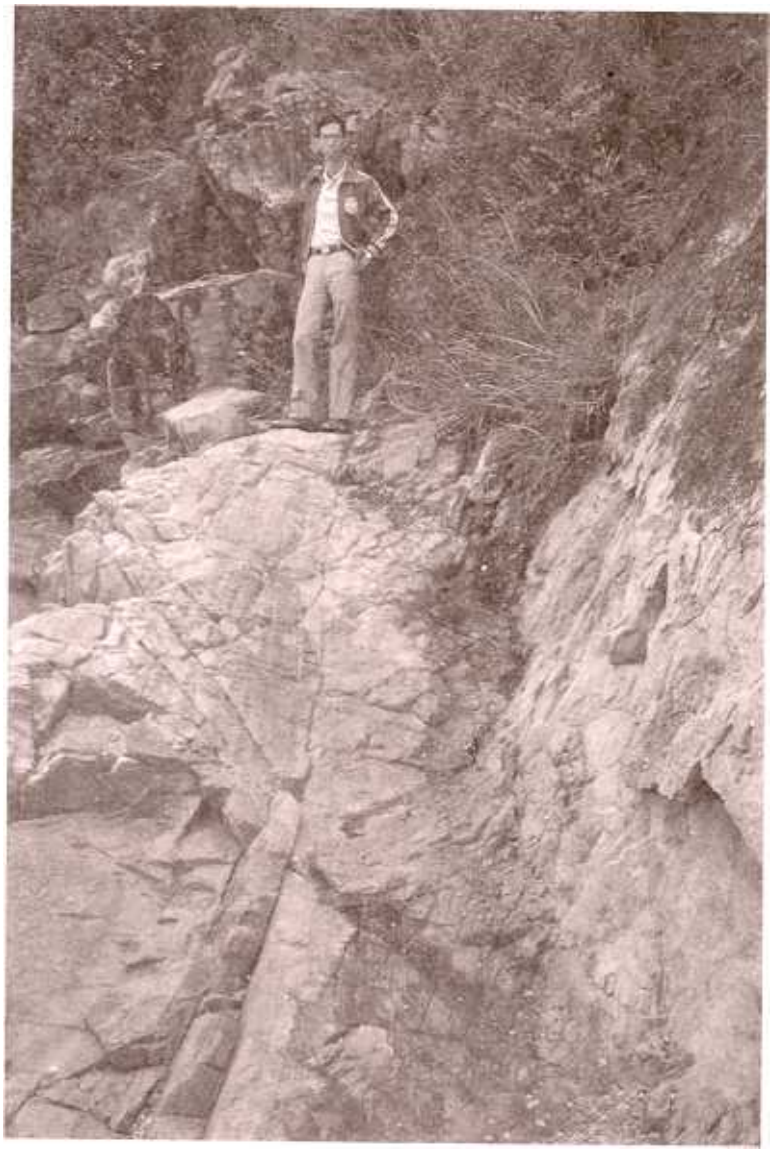

Plate 6 - Northeast-trending Flow-banded Quartzphyric Rhyolite Dyke, Pak Sha Tsui (1104 1690)

Quartzphyric rhyolite outcrops as northeast- and eastnortheast-trending dykes, cutting the granite. They do not occur in the northern part of the island, and are a prominent feature of the peninsula south of Ha Law Wan. They are part of the dyke swarm that dominates north Lantau, and their emplacement is probably related at least in part to the eastnortheast-trending North Lantau Fault. This fault lies south of the island, and it appears that dyke emplacement decreases to the north with increasing distance from the fault.

Details

Southern Peninsula. On the coast south of Ha Law Wan, a dyke of grey quartzphyric rhyolite trends northeast. The dyke has an irregular contact with the granite country rock, and is flow-banded near the contact. The centre of the dyke, which is around 10 m wide, is slightly coarser, with the appearance of fine-grained granite. This microgranite core, a mix of very fine and fine grain sizes, also contains abundant small megacrysts.

At Pak Sha Tsui (110 169), there are extensive exposures of quartzphyric rhyolite, with several slivers of granite country rock adjacent to flow-banded margins. These exposures probably form part of a multiple dyke swarm up to 150 m wide. Most contacts with the granite are very irregular.

South of Kwo Lo Wan, the same quartzphyric rhyolite dyke that is seen at Pak Sha Tsui can be seen exposed on the coast. The dyke is cut by lamprophyre (Plate 7) (1156 1827), and has flow-banded margins against the older granite country rock.

Plate 7 - Lamprophyre Dyke with Spheroidal Weathering, Cutting Flow-banded Quartzphyric Rhyolite Dyke Intruded into Megacrystic Fine-grained Granite, South of Kwo Lo Wan (1156 1827)

East Chek Lap Kok. On the hills and coast to the east of Fu Tau Shan are exposures of quartzphyric rhyolite dykes in swarms up to 100 metres wide. The dykes have prominent quartz megacrysts up to 3 mm exposed on the surface. Contacts with the megacrystic fine-grained granite country rock are irregular. The individual dykes, trending eastnortheast, are as little as 3 to 5 m wide, but can be up to 30 m. A typical sample of the dyke (HK9040, 1180 1897) is grey and porcellanous, with pinkish feldspar megacrysts up to 3 mm and quartz dominantly 0.5 to 2 mm.

West Chek Lap Kok. Exposures of quartzphyric rhyolite to the west of the Sham Wan-Fu Tei Wan Fault are rare. One occurrence about 500 metres southeast of the test embankment (1069 1840) is of light greenish grey rhyolite containing megacrysts of quartz and feldspar up to 3 mm; the feldspar megacrysts are subordinate and the groundmass is very fine-grained. The intrusive margins with the adjacent granite are sharp. Within the dyke, parallel to the margins, is abundant quartz veining.

A similar dyke exposed 200 m to the south (1077 1818) is cut by quartz veins and has a lamprophyre dyke and silicified granite on one margin. This same dyke can be traced eastnortheast, and is probably intersected in borehole L27/3427A (11069 18226) near the fault.

Petrography

In thin section, the quartzphyric rhyolite typically contains many small megacrysts set in a very fine-grained groundmass (Plate 5) (HK9040, 1180 1897). The quartz megacrysts are euhedral to subhedral, slightly embayed, and 0.5 to 1 mm across. Sample HK9233 (1069 1840) has a similar texture and contains microperthitic alkali feldspar with Carlsbad twinning up to 1.5 mm, and plagioclase feldspar of oligoclase composition can be up to 2 mm. There are scarce crystals of muscovite, biotite and an opaque mineral around 0.2 to 0.5 mm. The groundmass is devitrified glass with secondary sericite and a texture of around 0.02 to 0.05 mm. Other samples of quartzphyric rhyolite also show evidence of devitrification, with radiating quartz needles and granophyric texture also present as reaction haloes to megacrysts.

Age Relations

Elsewhere in the Territory, the quartzphyric rhyolite dykes cut all the Mesozoic intrusive and extrusive rocks. On Chek Lap Kok they cut the major granite intrusion, but no clear relationship with the feldsparphyric rhyolite was seen. However, as the quartzphyric rhyolite dykes cut the fine-grained granite of the

Chek Lap Kok Granite, and the feldsparphyric dykes do not, it is probable that the former are the younger of the two. The rhyolite is cut by quartz veins and by much younger lamprophyre dykes.

The dykes formed as the late stage in a high-level intrusion, together with feldsparphyric rhyolite and quartz veins. They are controlled by eastnortheast-trending major structures that were extensional at the time of emplacement.

Feldsparphyric Rhyolite

Distribution and Lithology

Dykes of feldsparphyric rhyolite are characterized by abundant large megacrysts of feldspar up to 12 mm long set in an aphanitic groundmass. Megacrysts of quartz and biotite are also present, but are not as visually dominant as the feldspar crystals.

Feldsparphyric rhyolite dykes are scarce and texturally close to the quartzphyric rhyolite. This contrasts with dykes in north Lantau, where they are dominant and distinct, with feldspar megacrysts commonly over 25 mm. All the feldsparphyric rhyolite dykes occur in the south, mostly in the southern peninsula.

Details

Southern Peninsula. Feldsparphyric rhyolite is exposed in coastal sections to the south of Kwo Lo Wan. Two small dykes, 0.5 and 3 m wide, have feldspars only up to 3 mm. Similar dykes closer to the quartzphyric rhyolite dyke swarm have small but prominent feldspars. Abundant boulders of feldsparphyric

Plate 8 - Pegmatite Pod up to 6 m across in Megacrystic Fine-grained Granite near the Northern Tip of Chek Lap Kok (1242 2031)

rhyolite with larger megacrysts, around 20 mm, are seen on the beach south of Ha Law Wan. Corestones of the same rock are an obvious feature of the adjacent hillside.

Petrography

One sample of feldsparphyric rhyolite from north of Ha Law Wan was sectioned (HK9234, 1103 1764). The rock has subhedral embayed quartz crystals up to 5 mm and smaller feldspar (up to 3 mm) set in a very fine-grained groundmass.

Age Relations

The feldsparphyric rhyolite dykes appear to be older than the more abundant quartzphyric rhyolite dykes, as they have not been seen cutting the younger fine-grained granite of the Chek Lap Kok Granite. They follow the same trends and are similarly cut by younger lamprophyre dykes. They may therefore be part of the same structurally controlled, high-level granitic intrusion that in its later stages produced rhyolite dykes, quartz veins and localized hydrothermal alteration.

Aplite

Small impersistent dykes of aplite are occasionally found in the granite, occurring in a number of places around the coast, often in small groups. The dykes are leucocratic, with a markedly equigranular grain size of around 0.5 mm. They can be from 25 mm to 5 m wide, but are commonly around 0.25 m. The aplite and granite are closely linked in age and genesis.

Pegmatite

Pegmatite or very coarse-grained granite, with crystals over 20 mm across, is rare, and generally occurs as pods or lenses too small to be separately shown (Plate 8). An irregular, roughly east-west trending pegmatite patch is exposed west of Fu Tei Wan (1075 1824).

Pegmatite is only found in the granite, and is intimately associated with the host rock. This is coeval with the formation of the granite, and is the result of hydrothermal emanations late in the cooling of the pluton.

Plate 9 - Quartz Vein in Weathered Granite South of Cheung Sha Lan, Forming a Partially Overturned Mosaic-like Sheet, East of the Test Embankment (1101 1930)

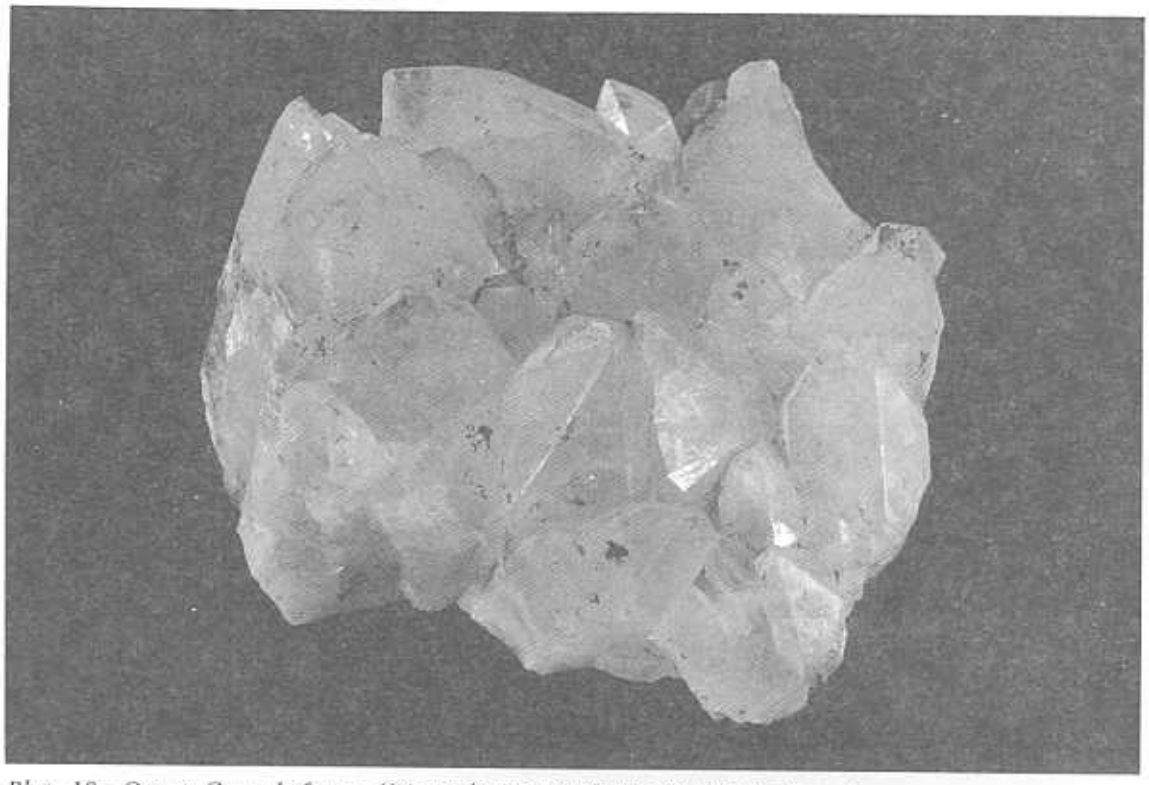

Plate 10 - Quartz Crystals from a Vein in the Borrow for the Test Embankment

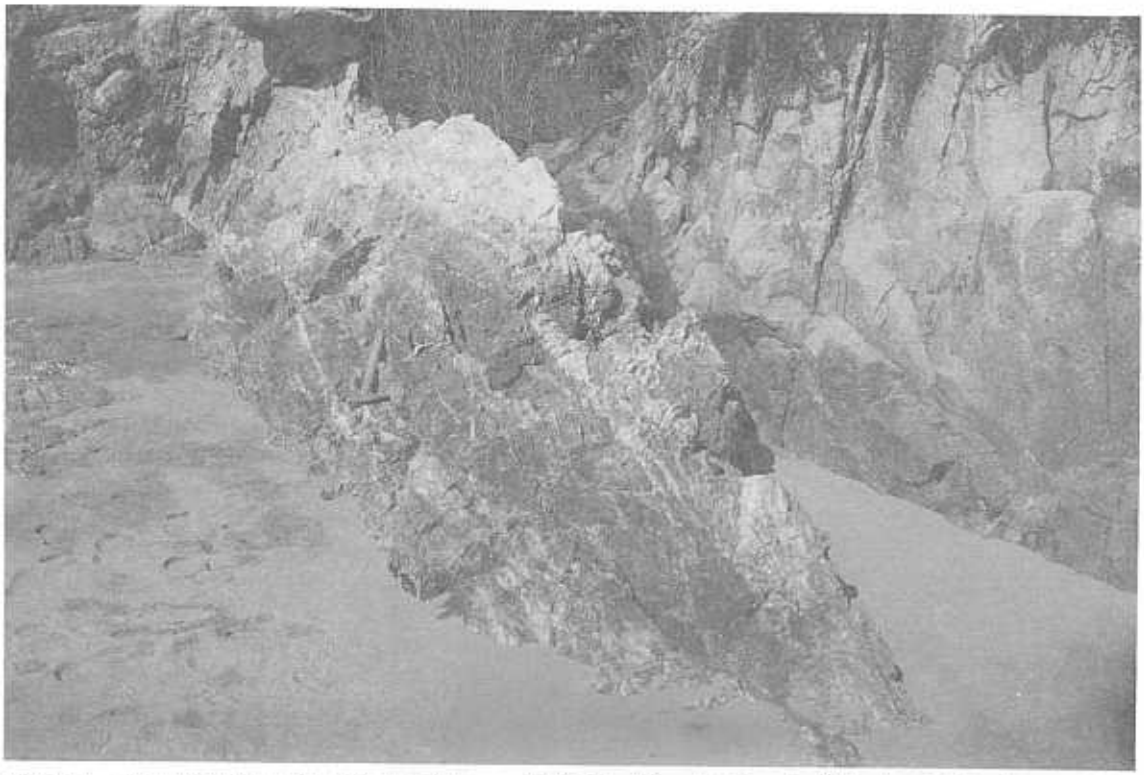

Plate 11 - Northerly Trending Quartz Veins and Silicified Granite South of the Test Embankment (1072 1835)

Quartz veins

Quartz veins are widely distributed throughout the island, mostly trending east to eastnortheast, cutting the granite country rock and most of the minor intrusions. They are generally narrow, ranging from stringers a few mm wide to veins up to 0.3 m wide. Quartz veins are especially common in and around the area of kaolinization in the granite east of the test embankment. The quartz veins are commonly seen as upstanding ribs in the deeply weathered granite. The thin veins tend to separate along cracks on joint faces to produce a mosaic-like sheet of quartz (Plate 9). Soil creep bends and displaces this sheet to form a trail of debris downslope of the vein.

Petrographically, the veins are almost always composed of massive, white crystalline quartz. Only rarely do euhedral crystals form (Plate 10), although crystal aggregates up to 0.2 m across have been found, with individual crystals up to 45 mm across (HK9555, 1091 1912).

As well as discrete veins, there are places where the granite country rock has been silicified. To the south of the test embankment, in a coastal exposure, (1072 1835) (Plate 11) the fine-grained granite country rock has been finely veined and silicified in a zone at least 1 m wide trending southsoutheast.

Basalt and Lamprophyre

Distribution and Lithology

Basic dykes are widespread in the granite and rhyolite dykes, but all are relatively thin and impersistent. The dykes are mostly basalt in composition, although they are all strongly altered. In the field, basalt

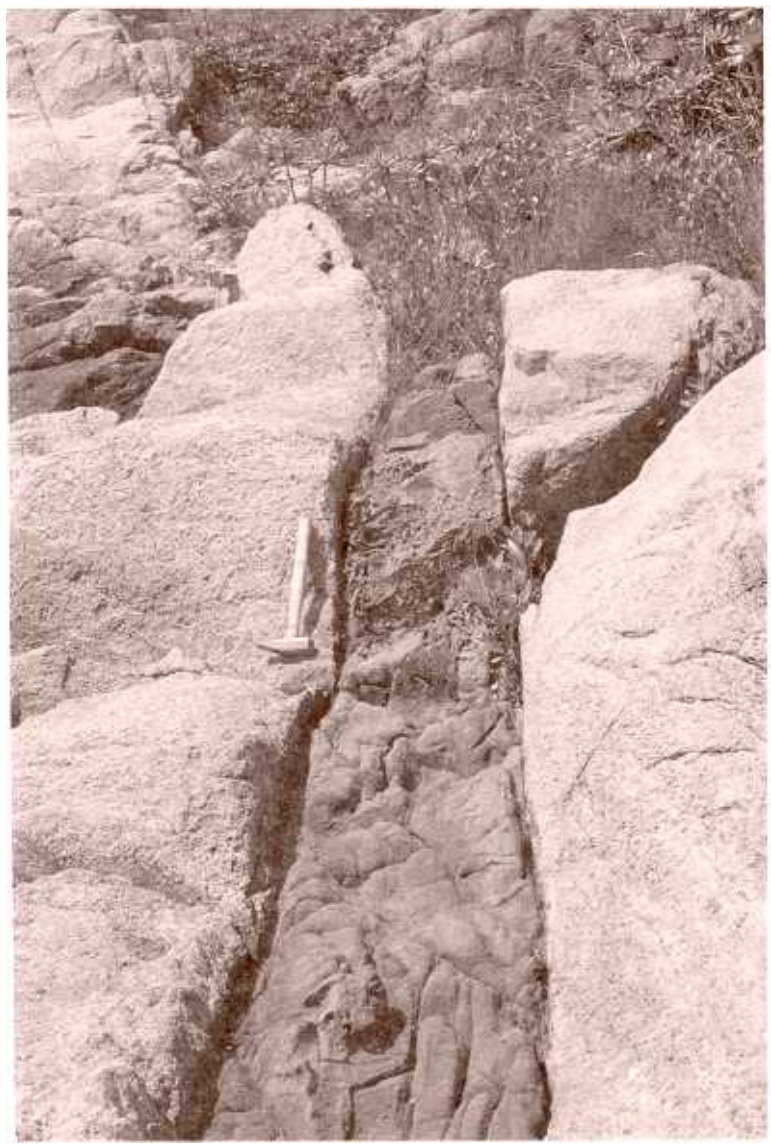

Plate 12 - Lamprophyre Dyke Trending East in Megacrystic Fine-grained Granite at Fui Yiu Wan (1203 1964)

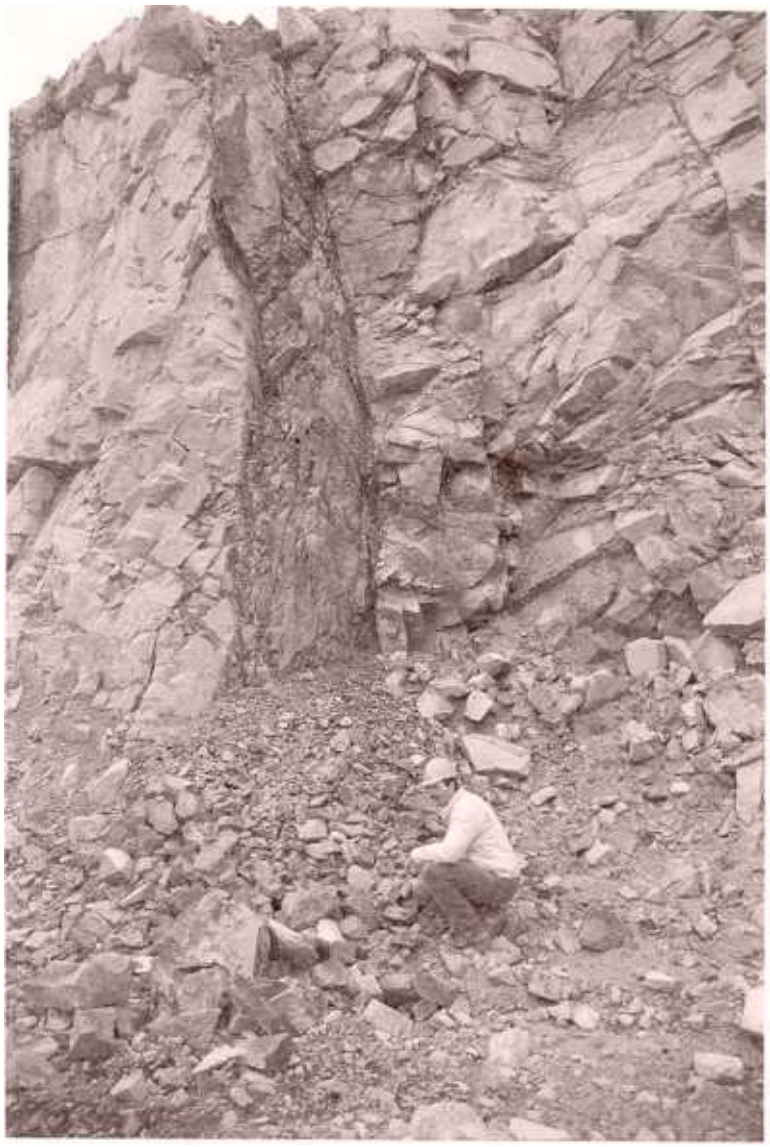

Plate 13 - Basalt Dyke in the Borrow for the Test Embankment (1066 1904)

dykes have a low magnetic susceptibility because of the alteration, while the fresher lamprophyres have a high magnetic mineral content. A chemical analysis of a lamprophyre is given in Appendix 2.

Details

Southern Peninsula. There are many small basalt dykes cutting granite and rhyolite dyke country rock on the northeastern end of the peninsula. Plate 7 shows spheroidal weathering in a basalt dyke about 2.5 m wide trending southsoutheast (1156 1827). This dyke clearly cuts both the megacrystic fine-grained granite country rock, and a flow-banded quartzphyric rhyolite dyke that intrudes the granite. About 100 m to the north is a swarm of basalt dykes cutting the granite (1151 1738). These basalts are dark greenish grey with a carious weathered surface. They are mafic-rich, with altered feldspar megacrysts, and range from 50 mm to 1.5 m in width. They cut not only the granite, but also an easterly trending feldsparphyric rhyolite dyke.

Fui Yiu Wan. A basalt and a lamprophyre dyke are to be found on the north coast of Fui Yiu Wan, trending east to eastsoutheast (Plate 13, 1203 1964). The dykes are dark greenish grey with a finely carious surface, and both are about 0.5 m wide. The lamprophyre follows the dominant joint trend in the area.

Fu Tei Wan. Two basalt dykes cutting fine-grained granite west of Fu Tei Wan are themselves cut by a small fault (1083 1814). The basalt is deeply weathered and foliated, and displaced sinistrally southsoutheast by about 0.3 m (Plate 14). The dykes are about 0.3 m wide, and also cut an aplite dyke in the granite.

Plate 14 - Foliated Basalt Dyke Cutting Fine-grained Granite, Sinistrally Displaced 0.3 m by a Northeast-trending Fault near Fu Tei Wan (1083 1814)

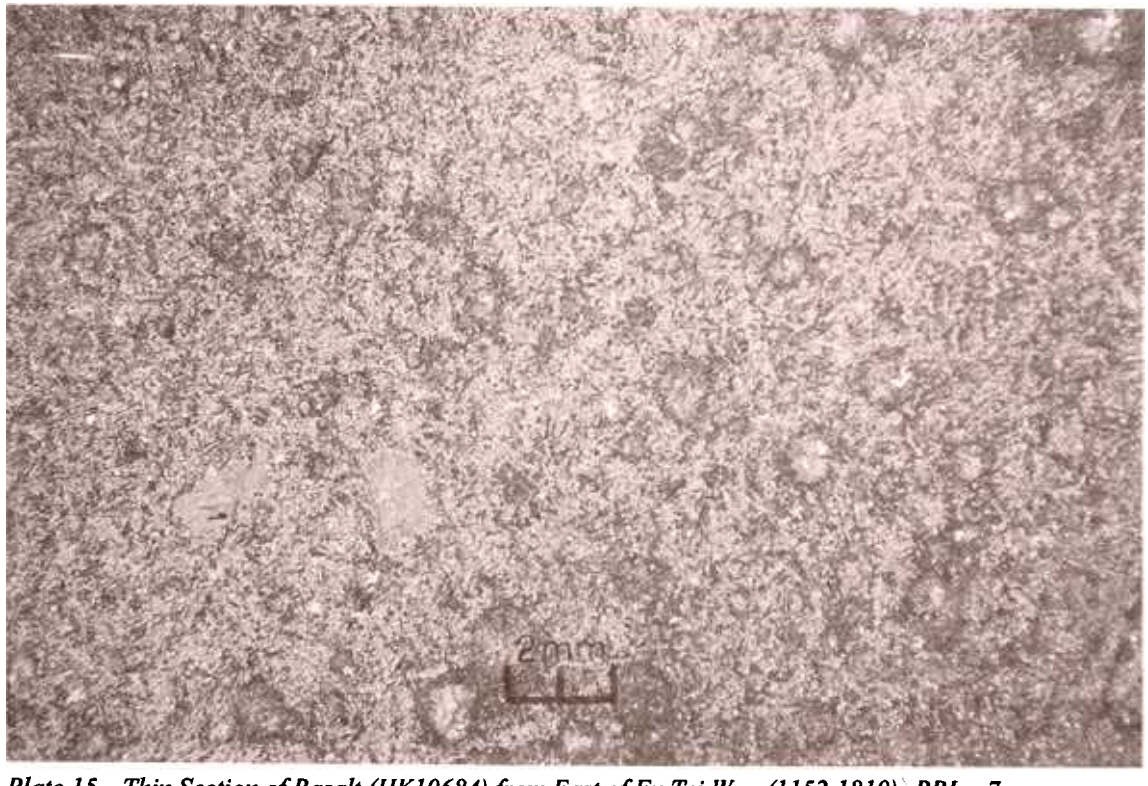

Plate 15 - Thin Section of Basalt (HK10684) from East of Fu Tei Wan (1152 1810); PPL x 7

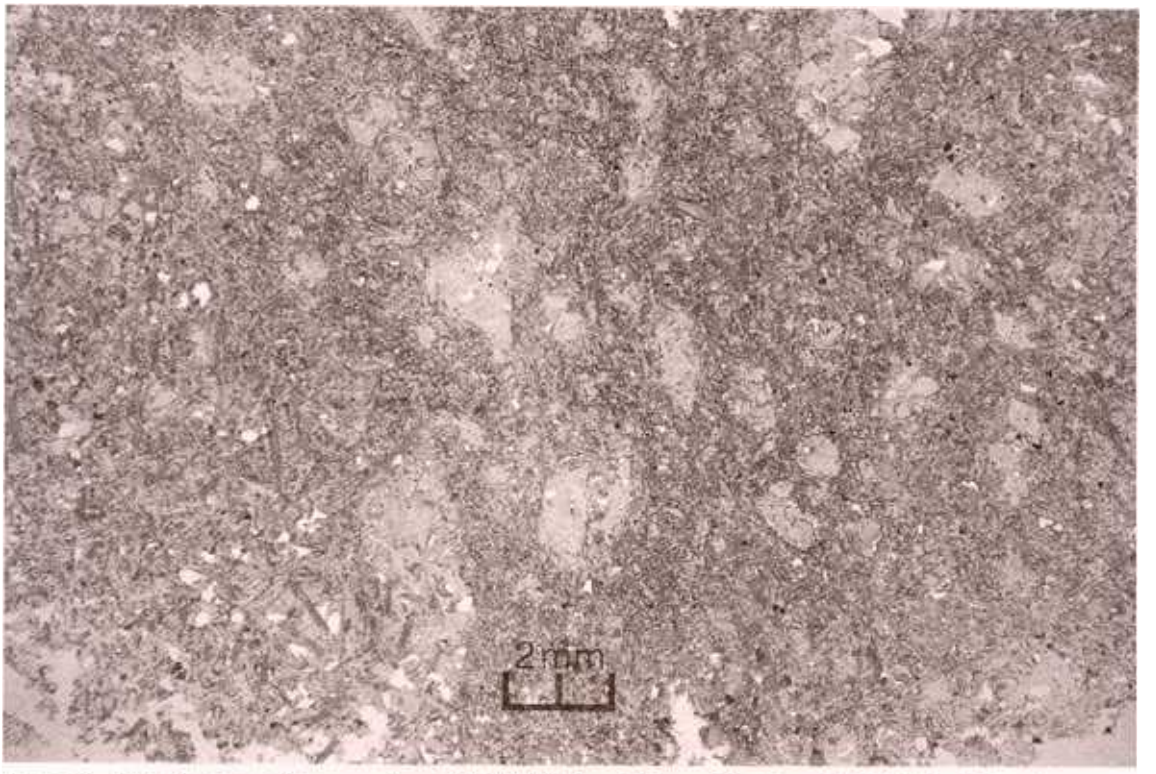

Plate 16 - Thin Section of Lamprophyre (HK10859) from Cheung Sha Lan (1117 1986); PPL x 7

Petrography

The basaltic dykes are typically both very fine-grained and altered, but one sample (HK10684, 1152 1810) (Plate 15) has a slightly coarser groundmass grain size of 0.3 to 0.5 mm. This microgabbro has a well-defined sub-ophitic texture of sericitized plagioclase and pyroxene, and includes phenocrysts of sericitized plagioclase up to 2 mm long.

A typical finer grained sample of basalt (HK9237, 1156 1827) from the peninsula south of Kwo Lo Wan is a dark green, very fine-grained rock speckled with mafic phenocrysts. In thin section, the phenocrysts are composed of secondary chlorite and calcite. The groundmass contains abundant hornblende, with plagioclase and epidote.

Lamprophyre dykes in hand specimens can display prominent dark green mafic phenocrysts, and overall are mafic-rich relative to the basaltic dykes. In thin section (HK10859, 1117 1986) (Plate 16) the rock contains abundant augite and hornblende crystals, with some plagioclase, mostly less than 1 mm long. Chlorite replacement of lath-like mafics is common, and there are no feldspar phenocrysts. The composition of the lamprophyre is probably vogesite.

Age Relations

The basalt dykes were thought to be of Tertiary age by Allen & Stephens (1971). They are seen cutting the granite country rock, but are themselves cut by small northwest-trending faults. The lamprophyre dykes also cut the country rock of rhyolite dykes and granite, and are thought to be of a similar age to the basalt dykes. However, at one locality north of the test embankment (1051 1920) the lamprophyre is cut by a quartz vein about 0.25 m wide, implying that the lamprophyre is closer in age to the granite (Late Jurassic-Early Cretaceous).

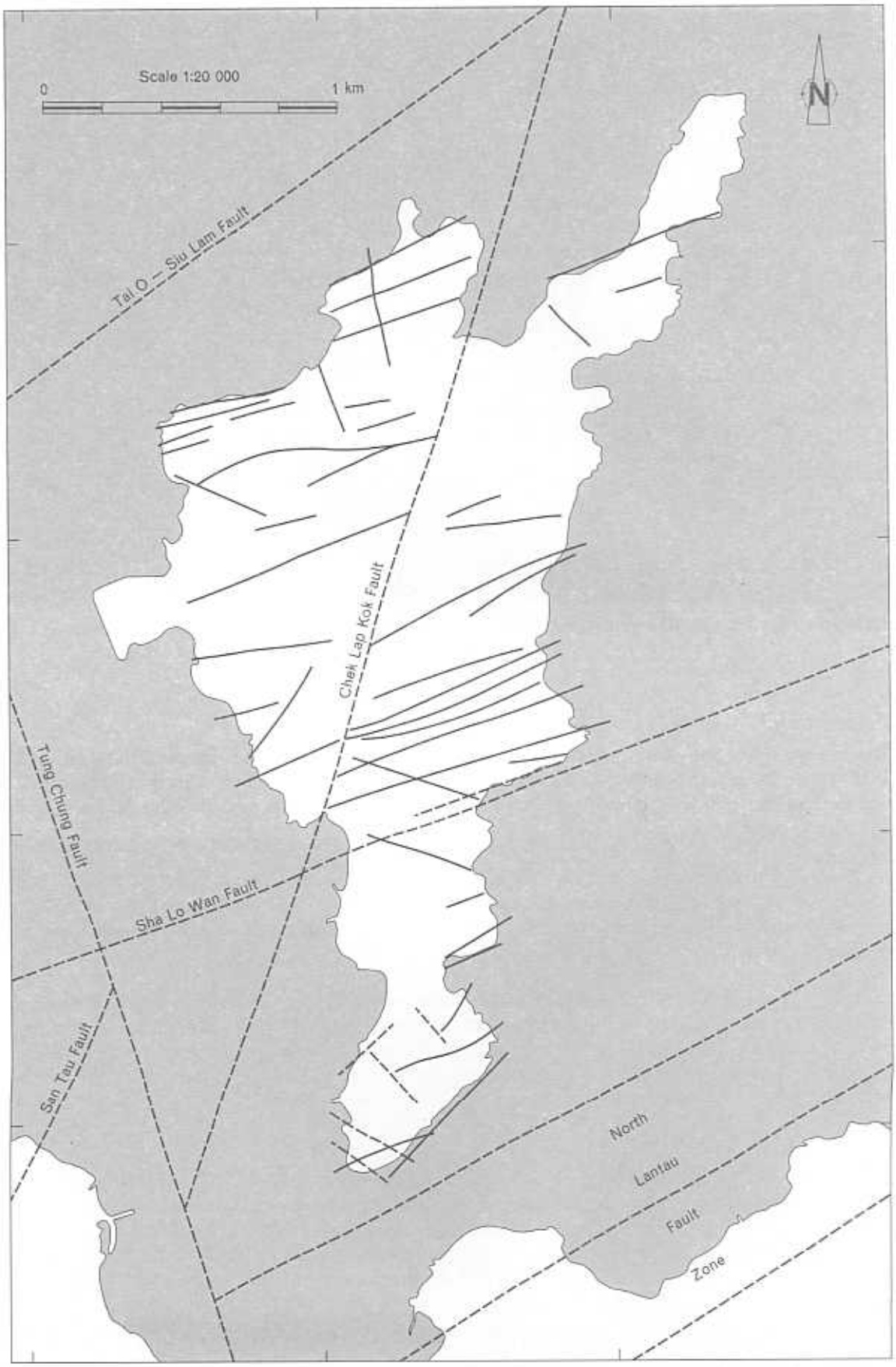

Figure 6 - Principal Structural Features in and around Chek Lap Kok: Faults (Broken Lines); Photolineaments and Major Dykes (Solid Lines)