THE GEOLOGY OF THE ARROWSMITH PENINSULA AND BLAIKLOCK ISLAND, GRAHAM LAND, ANTARCTICA

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Abstract. The Arrowsmith Peninsula and Blaiklock Island consist of a sequence of rocks belonging to the Antarctic Peninsula Volcanic Group intruded by plutons of the Andean Instrusive Suite. The volcanic rocks are principally basic lava flows and coarse-grained volcaniclastic sediments with minor fine-grained, bedded units. The plutonic suite ranges from gabbronorite to syenogranite, although monzogranite and granodiorite are most abundant. Both the volcanic and plutonic rocks are intruded by a complex series of dykes. The Arrowsmith Peninsula and Blaiklock Island are typical of the high-level rocks of the arc terrain found extensively on the western margin of the Antarctic Peninsula.

Introduction

The Arrowsmith Peninsula and Blaiklock Island lie between latitudes 67° 00′ and 67° 30′ south and longitudes 66° 30′ and 67° 30′ west, on the western side of the Antarctic Peninsula (Fig. 1). The area is a deeply dissected plateau, the remnants of which can be seen in Mount Rendu and the Boyle and Tyndall mountains, which reach over 2000 m in height (Fig. 2). Prior to the 1980–81 season, when the authors carried out extensive fieldwork, the area had been mapped at reconnaissance level only. The initial results of this work are combined with those of earlier workers to produce the first map (Fig. 3) and accompanying geological account of the area.

The nomenclature used for the plutonic rocks is based on the IUGS recommended classification of Streckeisen (1973), and modal data for 74 samples are given in Fig. 4. In the case of the volcanic rocks the widespread effects of alteration demand that reference be made to the chemistry as well as the mode (R. D. Hamer, unpublished data), and for that reason a combined classification scheme, based on the silica content (Cox and others, 1979), has been adopted for the 23 samples examined.

Previous Work

Goldring (1959) noted exposures of volcanic rock on the northwestern side of Lallemand Fjord, and Hoskins (1960) commented briefly on the geology of the Heim and Antevs glaciers area. More extensive work was carried out in the vicinity of Mount Rendu by Procter (1959), who established a broad stratigraphy of the area. He described an early sequence of unstratified volcanic rocks, and correlated them with the widespread exposures of volcanic rocks occurring throughout the Antarctic Peninsula, which are now referred to as the Antarctic Peninsula Volcanic Group, APVG (Thomson, 1982). These are intruded by a suite of plutonic rocks which he correlated with the Andean Intrusive Suite. Near-horizontal stratified volcanic rocks, apparently overlying many plutons at a high topographical level, were thought to be the youngest rocks in the area and were provisionally assigned a Tertiary age (Fig. 5). Abundant cross-cutting, predominantly basic dykes were observed throughout the whole area.

This stratigraphy was corroborated by later workers who mapped the Arrowsmith

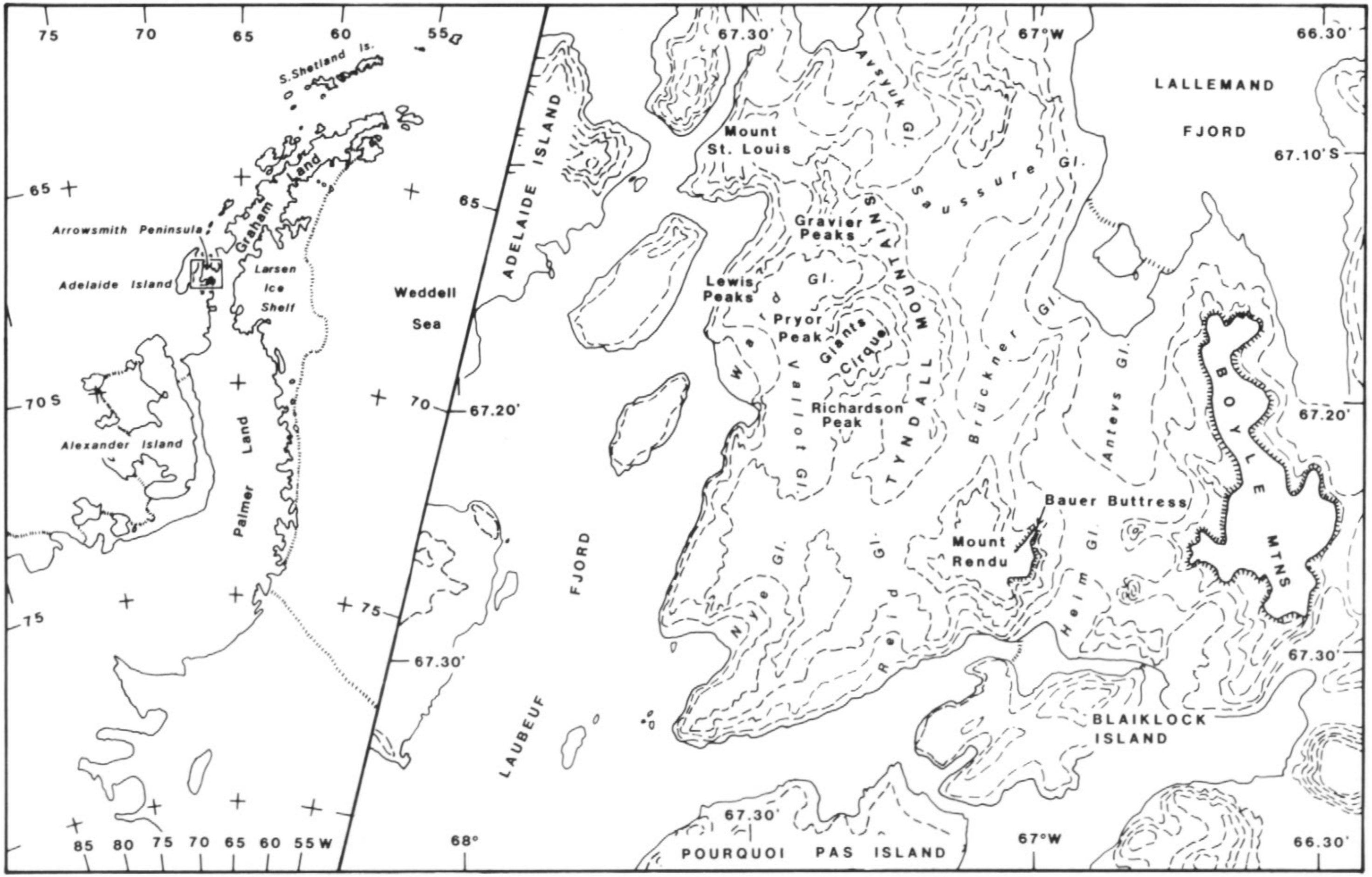

Fig. 1. Location map for the Arrowsmith Peninsula and Blaiklock Island. Formlines taken from an unpublished B.A.S. geological map, compiled by J. S. Harris.

Fig. 2. View looking north-east across the Vallot Glacier towards the Tyndall Mountains, with Gravier Peaks on the left (approximately 2000 m) and Richardson Peak right centre.

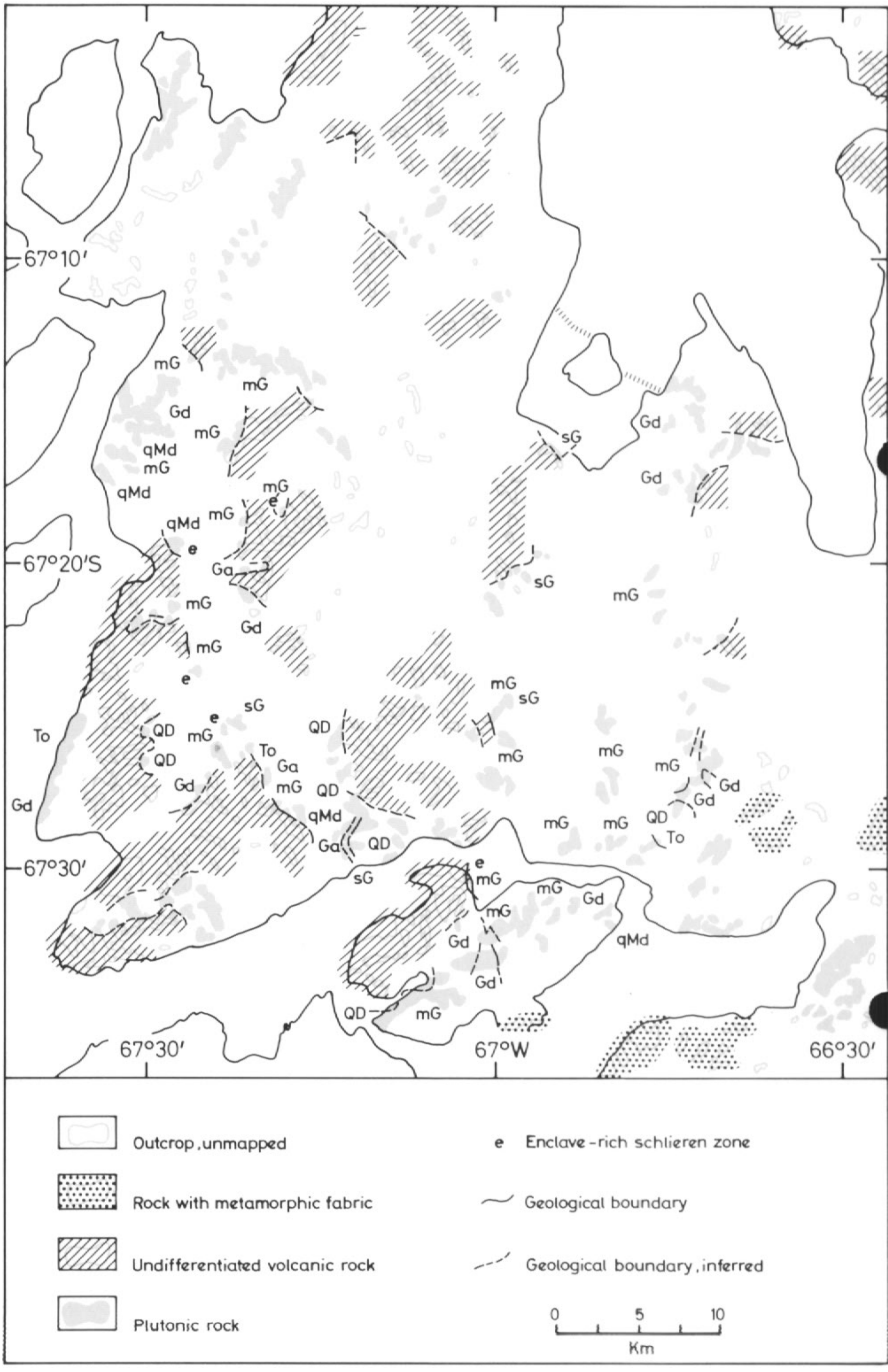

Fig. 3. Geological map of the Arrowsmith Peninsula and Blaiklock Island. Ga = gabbronorite; QD = quartz diorite; qMd = quartz monzodiorite; To = tonalite; Gd = granodiorite; mG = monzogranite; sG = syenogranite.

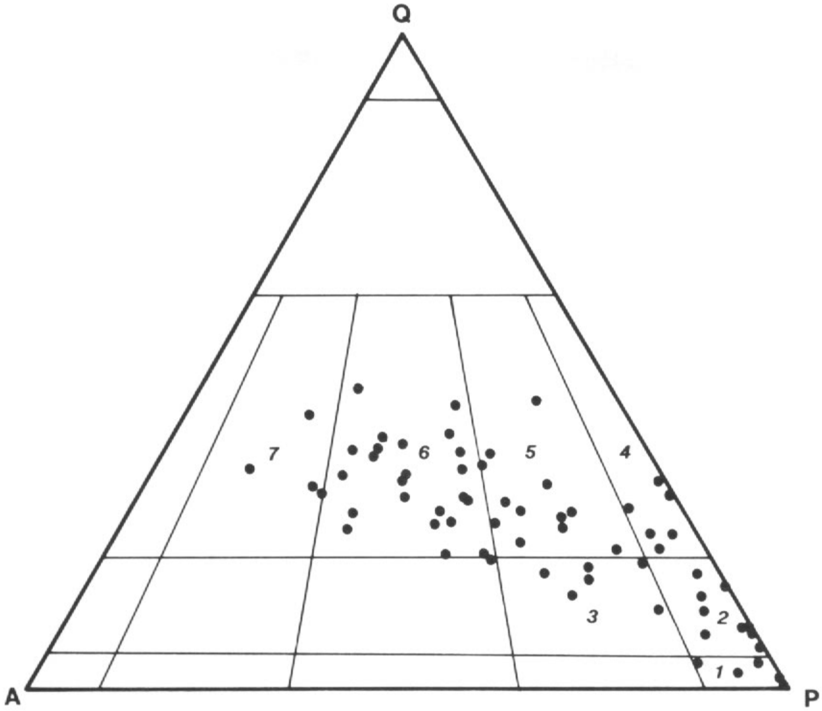

Fig. 4. Modal classification scheme for plutonic rocks of Arrowsmith Peninsula and Blaiklock Island. Field 1, gabbronorite; 2, quartz diorite; 3, quartz monzodiorite; 4, tonalite; 5, granodiorite; 6, monzogranite; 7, syenogranite. Q = quartz, A = alkali feldspar, P = plagioclase.

Fig. 5. View of Mount Rendu from hut on Blaiklock Island. Plutonic rocks form the lower outcrops with stratified volcanic rocks at higher levels. Approximate height of Mount Rendu is 2300 m.

Peninsula during short winter programmes (Culshaw, 1971; Davies, 1971; Hudson, 1972; Wyeth, 1972). Culshaw (1971) postulated that the gabbroic rocks may represent the earliest phase of magmatism. Since this reconnaissance mapping, however, only Hudson (unpublished data) attempted any detailed petrographical work, and no synopsis of the geology has been published.

Field Relations

A comprehensive study of the volcanic rocks is impeded by the high relief of the area. This frequently results in steep cliff-like exposures, sometimes overhung by seracs, where only the basal 50 m can be examined safely. In addition, field studies are hampered by the widespread intrusion of plutons, which often form the lower, more accessible parts of cliff sections.

Neither the base nor the top of the volcanic succession is seen in outcrop, but a minimum thickness of 400 m is recorded from the stratified volcanic rocks on the south-east side of Nye Glacier. Numerous contacts are observed between volcanic and plutonic rocks, and all indicate that the former are the older rock type. For example Mount Rendu displays stratified volcanic rocks at high topographical levels which are intruded by a variety of plutonic rocks, whereas at Bauer Buttress and along the western side of Heim Glacier large blocks are downfaulted into a monzogranite, and some outcrops consist of intimately mixed volcanic and plutonic rocks.

On the eastern side of Nye Glacier the volcanic rocks are intruded by granodiorite. Apophyses extend for approximately 50 m from the pluton and stratification in the volcanic rocks adjacent to the pluton is obliterated by recrystallization. Parallel to the dip of the contact is an inaccessible zone of enclaves, and Hudson (unpublished data) noted an indistinct foliation in the pluton. A distinctive contact between volcanic rocks and monzogranite is exposed on the south side of Giants Cirque, and is characterized by an enclave swarm. The enclaves are rectilinear to rounded, up to 10 m in length, and some are undoubtedly derived volcanic xenoliths. Similar enclave swarms are observed in other outcrops in the area, particularly in northwestern Blaiklock Island (Figs. 6 and 7).

Despite abundant exposure, pluton–pluton contacts are rare, although those seen do confirm the consensus that the more basic rocks are older than the acidic ones (e.g. Wyeth, 1972). A gabbronorite–tonalite contact exposed on the western side of Reid Glacier displays a distinctive schlieren zone. Dark-coloured enclaves and mafic schlieren are highly abundant, and appear to have been derived from the plastic deformation and break-up of the gabbro (Fig. 8). Enclaves of fine-grained gabbro are also seen in a quartz monzodiorite host at Lewis Peaks. The enclaves are up to 50 cm across, rounded, and occur over a wide (20 m) zone within the host. There is often a narrow (1–5 cm) reaction zone around the enclaves, but their origin is enigmatic, although disruption of a synplutonic dyke is plausible. The quartz diorite forming the eastern side of Reid Glacier is intruded by a syenogranite, which has brecciated the quartz diorite at the contact and recrystallized it over a distance of approximately 50 m.

Layering is present in only one outcrop of gabbronorite on the eastern side of Reid Glacier; layers are generally < 5 cm thick, laterally discontinuous and defined by grain-size differences. They are observed best on weathered surfaces. The layering dips at approximately 40° to the east, but its indistinct and discontinuous nature makes accurate measurement difficult.

Cross-cutting basic dykes are a distinctive feature of many outcrops. Their density varies considerably from one outcrop to another, although Culshaw (1971) estimated

Fig. 6. Contact between monzogranite and volcanic rocks on northern Blaiklock Island. Note two zones of rectilinear enclaves parallel to contact (arrowed).

Fig. 7. Detail of rectilinear enclaves from the lower zone of Fig. 6. Sub-parallel orientation of the enclaves is a characteristic feature of many monzogranite–volcanic contacts in the area. Cliff height approximately 20 m.

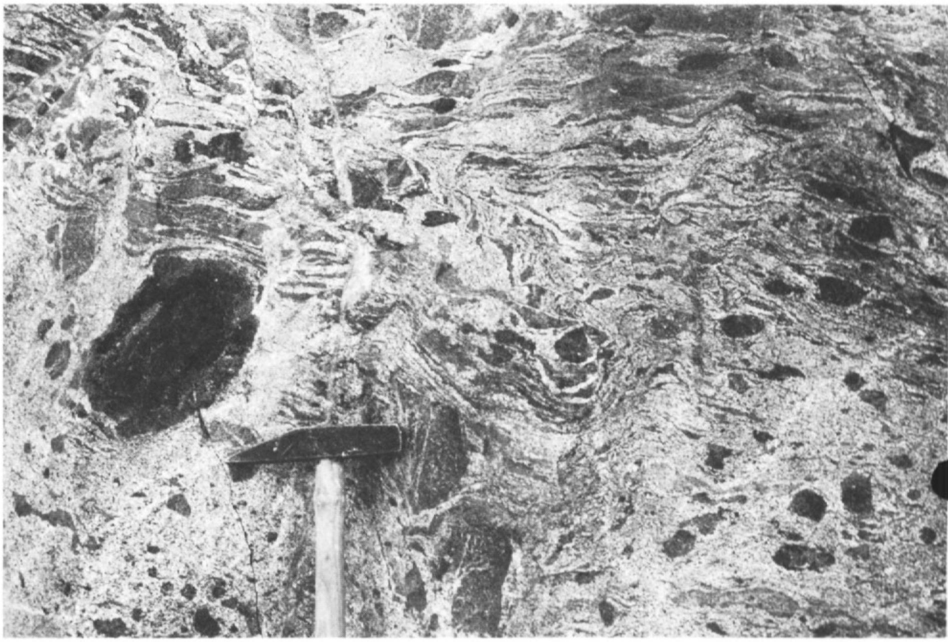

Fig. 8. Schlieren zone at contact between gabbronorite and tonalite, from the west side of Reid Glacier. Note mechanical break-up of large rounded enclave of gabbronorite (left), and intimate mixing of material. Hammer head approximately 25 cm long.

15–20% by volume as a maximum at one outcrop of granite. Early descriptions differentiated two sets of dykes – an initial set of mixed lithology, which cuts the APVG but which is cut by the plutons, and a later set of basic dykes which cuts all rock types. Goldring (1959) termed these dyke sets 'pre-Andean' and 'post-Andean', and this terminology was adopted by subsequent workers (e.g. Davies, 1971).

Volcanic Rocks

Approximately one-third of the exposed rocks on the Arrowsmith Peninsula and the western third of Blaiklock Island are volcanic rocks. They include mainly basic lava flows and minor intrusions, together with less abundant acidic pyroclastic material and volcaniclastic sedimentary rocks. Those sequences consisting predominantly of lava flows are more massive in outcrop than those containing interbedded pyroclastic and volcaniclastic material. From a distance, colour variation resulting from weathering and alteration defines a crude stratification in the volcaniclastic rocks. These rocks never constitute more than 40% of the sequence but estimates of the relative volumes of individual flow units cannot be made.

The age of the volcanic rocks is poorly constrained. Fragments of silicified fossil wood occur in volcaniclastic sedimentary rocks on the north-west side of Mount Rendu, but diagnostic fossils are lacking and the general state of alteration precludes whole-rock radiometric dating. At Bauer Buttress, however, a monzogranite with a poorly constrained age of 169 ± 21 Ma (see below) intrudes volcanic rocks. This suggests that part of the volcanic succession may be early Jurassic or older in age.

A limited number of sections have been examined, including those of western

Fig. 9. Stratified volcanic succession at Pryor Peak. Cliff height is approximately 300 m.

Blaiklock Island, Nye Glacier (Hudson, unpublished data) and the north-western slopes of Mount Rendu (Fig. 3). In some instances a guide to the rock types occurring at higher topographic levels has been obtained from scree material at the base of cliff sections (e.g. Pryor Peak, Fig. 9). All the volcanic rocks show signs of post-eruptive alteration, although it is nowhere ubiquitous. In some instances alteration has resulted in the complete replacement of all primary mineral phases by a secondary assemblage comprising quartz, chlorite, albite, hematite, sericite, calcite, sphene, actinolite, epidote and prehnite. The effects of alteration are most marked in the more permeable parts of the succession, e.g. vesicular and/or brecciated lava flows. This is manifested by the widespread development of epidote both as a replacement to mafic and plagioclase phenocrysts and in veins and vesicles.

In general, the lava flows and minor intrusions are petrographically similar. In the field they may be distinguished by the presence or absence of upper chilled zones or brecciated flow tops, but poorly exposed contacts often hinder identification. However, brecciation appears to be less common in the minor intrusions.

The lava flows are dominated by basalts and basaltic andesites, andesites being comparatively rare. The majority of these rocks are highly porphyritic, and comprise up to 35% phenocrysts by mode, but some of the basaltic rocks contain $< 10\%$ phenocrysts. The phenocrysts are often aggregated and the commonest assemblage includes olivine, clinopyroxene, orthopyroxene, plagioclase and opaque ore. Olivine is susceptible to alteration and is difficult to distinguish from pseudomorphs after orthopyroxene. Rare primary amphibole has been recorded in one andesite from the Nye Glacier. In the basic rocks, mafic phenocrysts occur in similar proportions to plagioclase, but in the andesites plagioclase, usually showing oscillatory zoning, is the most abundant phenocryst. The groundmass comprises fine-grained intergrowths of plagioclase, pyroxene and opaque ore, and interstitial chlorite probably represents devitrified glassy material. Trachytic textures are common in the lava flows, whereas intersertal and intergranular textures occur in the minor intrusions. Groundmass pigeonite has been identified in two basalts from the north-west side of Mount Rendu.

Minor rhyodacitic to rhyolitic pyroclastic rocks include crystal-lithic tuffs, ash-flow tuffs, agglomerates, volcanic breccias and lapilli tuffs. The breccias and agglomerates contain angular fragments up to 60 cm across and are usually highly altered. Individual beds typically display marked lateral variations in thickness and grain size. The tuffaceous rocks comprise a cryptocrystalline matrix which encloses broken crystal debris, chiefly partly resorbed quartz and feldspar, together with volcanic rock fragments.

Volcaniclastic sedimentary sequences, up to 10 m thick, are commonly associated with the tuffaceous rocks (Hudson, unpublished data). They show abundant evidence for reworking under aqueous conditions with channelling, grading and cross-stratification. On Mount Rendu reworked basic tuffs contain clasts of unaltered clinopyroxene, suggesting that these rocks are highly immature. Non-volcanic clasts have not been recorded. Scree cones on the south side of Ward Glacier contain numerous examples of unwelded and welded glassy rhyolitic tuff, which suggests that these rock types may form an important part of the inaccessible succession on Pryor Peak (Fig. 9).

Plutonic Rocks

Plutonic rocks occur abundantly in the lower slopes of many exposures, but may reach 2000 m in altitude in the north, e.g. Gravier Peaks and Mount St Louis (Fig. 1). They vary from gabbronorite to syenogranite, although monzogranite (adamellite) and granodiorite are predominant.

Many samples show varying degrees of alteration, the principal results of which are the frequent presence of secondary amphibole, the alteration of biotite to chlorite, granular sphene, epidote and occasionally prehnite, and the sericitization or saussuritization of plagioclase. In addition, amphibole and biotite may appear as secondary minerals replacing pyroxene, and sphene may rim Fe-oxide. Secondary amphibole is typically fibrous and actinolitic in composition, whereas secondary biotite commonly has very little body colour and is antipathetic to chlorite.

Gabbronorite occurs extensively only in the Reid Glacier and Richardson Peak areas, although many microgranular enclaves in other plutons are gabbroic in composition. Some outcrops show gradation between gabbronorite and quartz diorite, both of which may have an orthocumulate texture. Outcrops of quartz monzodiorite are typically heterogeneous, often with large ($\leqslant$ 1 m) angular to rounded enclaves of gabbroic material. The host rock often shows variable grain size, and the enclaves may be rimmed by a narrow (1–2 cm) band of coarser-grained material. Tonalite and granodiorite are typically leucocratic, and many outcrops contain abundant small ($\leqslant$ 50 cm) rounded enclaves, some of which may show reaction with the host. Monzogranite crops out extensively and granophyric texture is a very common feature of many samples. Two distinct varieties can be distinguished on petrographical grounds.

(i) Granophyre which contains only biotite and occasional amphibole as the mafic phases, both of which are usually considerably altered. These granophyres form large plutons, and probably represent simultaneous crystallization of quartz and alkali feldspar in a highly acidic magma (Barker, 1970). The subsequent generation of aqueous fluid leads almost inevitably to alteration of the mafic phases.

(ii) Granophyre in which biotite and amphibole are not the only mafic phase; pyroxene in particular may occur. These granophyres tend to form isolated outcrops spatially related to the margins or contacts of intrusions with more basic material. Therefore they may represent rapidly cooled marginal facies where assimilation and hybridization may have occurred.

Syenogranite is typically found in outcrops of restricted extent and commonly appears gradational towards monzogranite. One sample from the Reid–Nye glacier junction, however, is exceptional in both hand specimen and thin section. It contains pseudomorphs after olivine, plus orthopyroxene, clinopyroxene, amphibole, biotite and chlorite. Such an assemblage cannot be considered as being in equilibrium with a syenogranite, and this rock may have formed through hybridization.

Pyroxene is found commonly only in the more basic rocks, and orthopyroxene is particularly susceptible to alteration. Clinopyroxene may subophitically enclose plagioclase in gabbronorite, but progressively becomes less abundant in more acidic rock types and is frequently sieve-textured, with an epitaxial overgrowth of amphibole. Olivine has not been observed in any specimens examined, but pseudomorphs may record its former presence.

Plagioclase composition ranges from labradorite (up to An_{65}) in the basic rocks to oligoclase (An_{30}) in syenogranite. Zoning is rare in gabbronorite and syenogranite, but appears commonly in intermediate rocks, and is generally of a continuous nature. Discontinuous (oscillatory) zoning is present in some tonalite and granodiorite samples, and patchy zoning (Vance, 1965) is characteristic of many quartz monzodiorite specimens.

Amphibole is found in only one gabbronorite as a primary mineral, attains great modal abundance in the intermediate rocks, and is rare in syenogranite. It is commonly subhedral or anhedral, rimming clinopyroxene, and may show simple twinning. In some tonalite and granodiorite samples it commonly has embayed margins or skeletal cores filled with biotite, and some crystals have a marked 'bleached' appearance.

Biotite is also most abundant in the intermediate rock types, and is ubiquitous in granodiorite and monzogranite, commonly forming subhedral to anhedral crystals associated with amphibole.

Quartz often has sutured subgrain boundaries, with undulatory or strain extinction. Minor consertal texture may be present in some granodiorites. Alkali feldspar is cryptoperthitic in the more basic rocks, but is commonly microcline vein or patch microperthite in the more acidic rocks.

Fe-oxide is a ubiquitous accessory phase in all but the most acidic rocks, and apatite and zircon are also very common. Allanite is frequently found in granodiorite and monzogranite, where it occurs as discontinuously zoned crystals ($\leqslant 1.5$ mm) with a characteristic dark brown core and light yellowish rim, and may show simple twinning and epidote overgrowth. It also occurs as poikilitic crystals intergrown with late-stage granophyre.

Dykes

The 'pre-Andean' dykes vary from basalt to porphyritic andesite, are usually very fine-grained, < 1 m thick and may be feeders for sills and lavas within the APVG sequence. They appear to have no consistent trend. The 'post-Andean' dykes are mainly porphyritic and non-porphyritic dolerites, with less common quartz-feldspar porphyries. Attempts to define an intrusive sequence have met with little success (cf. Hoskins, 1960 and Culshaw, 1971). At several localities the thickness and orientation of the dykes varies considerably, although a north–south trend is common. The dip varies from vertical to < 50°. Some dykes are composite, and some basic dykes have lobate margins and inclusions of host pluton that appear consistent with a synplutonic nature.

Discussion

Early workers based their stratigraphy of the area on the assumption that the unstratified volcanic rocks were late Jurassic in age. These were intruded by plutons of the Andean Intrusive Suite that were themselves overlain by younger stratified volcanic rocks. There is, however, no evidence to support the existence of a post-plutonic episode of volcanism. At all the localities where volcanic and plutonic rocks are juxtaposed, and including those at high topographical level on Mount Rendu, the latter intrude the former. There also appears to be no justification for the subdivision of the volcanic rocks into an older 'massive' unit and a younger 'stratified' unit.

Previous correlations of Arrowsmith Peninsula and Blaiklock Island volcanic rocks with nearby successions (e.g. Adelaide Island) were based solely on lithological similarity. Recent investigations on Adelaide Island have shown that the volcanic sequence there ranges from at least late Jurassic to late Cretaceous/early Tertiary (Thomson, 1972; Jefferson, 1980). The present writers consider that, in the absence of diagnostic fossils or more thorough radiometric dating, detailed correlations should not be attempted, and the Arrowsmith Peninsula and Blaiklock Island successions be regarded simply as an undifferentiated volcanic unit within the Antarctic Peninsula Mesozoic–Tertiary arc terrain.

Whole-rock Rb–Sr radiometric determinations have been made on some of the plutonic rocks with limited success (A. B. Moyes, unpublished data). The age of the monzogranite pluton which crops out extensively in Heim Glacier and subsidiary glaciers is approximately 100 ± 8 Ma, with an initial $^{87}Sr/^{86}Sr$ ratio of 0.7060. This is a characteristic of plutonism during the early Cretaceous (Pankhurst, 1982). Samples from the western side of Heim Glacier indicate an age of 169 ± 21 Ma with an initial $^{87}Sr/^{86}Sr$ ratio of 0.7072, although a true isochron was not obtained. Although this may indicate an early to mid-Jurassic age, it does not provide conclusive evidence for the early plutonism so frequently found on the east coast of Graham Land (Pankhurst, 1982).

Many of the plutonic rocks are heterogeneous in outcrop. For example, the schlieren-rich contact zone between a gabbro and tonalite (Fig. 8) indicates very plastic deformation and considerable interaction between the two rock types. Similarly, the monzogranite which dominates exposures in the Vallot and Ward glaciers varies towards granodiorite and quartz monzodiorite at some outcrops. The latter rock type is very heterogeneous, and it is possible that hybridization of the monzogranite has taken place through assimilation of more basic material. The frequent occurrence of patchy zoned plagioclase crystals in these rocks may indicate rapid supercooling caused by magma mixing (Hibbard, 1981).

At least part of the hybridization process may be associated with the intrusion mechanism. Although some contacts are very sharp and steeply cross-cutting, a characteristic feature of many monzogranite–volcanic contacts is the presence of a microgranular enclave swarm. The enclaves are, at least in part, derived volcanic xenoliths, and indicate that stoping may have been important as an intrusive mechanism. Hybridization through assimilation of these xenoliths, in addition to the disruption of synplutonic dykes, may account for much of the local heterogeneity within the plutons. However, the origin of many enclaves is more ambiguous. It is possible that they represent disrupted 'slabs' of a chilled marginal facies of the pluton.

Contact metamorphic effects are rarely observed in the volcanic rocks. A common effect is extensive secondary alteration of both pluton and volcanic envelope, characterized by chloritization of the mafic minerals, and saussuritization/sericitization of plagioclase and epidotization. The frequent occurrence of such alteration in the plutonic rocks indicates that it may be an integral part of the intrusive process (Tulloch, 1979), although it would be difficult to distinguish such a process from a later, low-grade metamorphic overprint. The high concentrations of epidote in the volcanic rocks suggests that Ca mobility has occurred, probably linked to hydrothermal circulation of pore fluids around the rising magma bodies. The commonest alteration mineral assemblage in both the plutonic and volcanic rocks is characteristic of very low-grade metamorphism, and is compatible with the upper part of the prehnite–pumpellyite facies at < 3 kb and 300–350°C (Winkler, 1979). However, the occasional presence of secondary biotite replacing chlorite and rare grossular-andradite garnet replacing prehnite in some plutonic rocks reflects higher temperatures (> 350°C, Liou and others, 1983) associated with later intrusive phases.

No direct link between the volcanic rocks and the plutonic rocks has been adequately demonstrated. However, from studies elsewhere on the Antarctic Peninsula (Saunders and others, 1980) there is considerable chemical evidence that they are consanguineous, and that the plutonic rocks have intruded their extrusive equivalents. This is a typical feature of essentially similar rocks from the Andes of Peru (Cobbing and Pitcher, 1972).

Regional Implications

The Arrowsmith Peninsula, together with Adelaide Island to the west, forms one of the most extensive and accessible areas of exposure on the trenchward side of the Antarctic Peninsula magmatic arc. It comprises a partially unroofed calc-alkaline plutonic complex which intrudes volcanic rocks of the arc terrain. This association of calc-alkaline plutonic rocks intruding predominantly basic volcanic sequences has been widely reported in the west coast archipelago of Graham Land (Dewar, 1970; West, 1974; Smellie and others, in press) and western Palmer Land (Smith, 1977).

Inland of the Arrowsmith Peninsula, across a marked topographic depression, the geology changes significantly. Over the central axis of southern Graham Land outcrops of volcanic rocks are rare or lacking and plutonic rocks, often showing intense deformation, together with isolated slices of metamorphic basement, dominate the geology (Stubbs, 1968; Hamer and Moyes, 1982; Pankhurst, 1983). Similar exposures occur throughout north-east and central Palmer Land (Fraser and Grimley, 1972; Singleton, 1980) although basement rocks are less easily recognized (Meneilly, 1983). Farther east, on the Weddell Sea flanks of Graham Land, less extensive areas of acidic volcanic rocks intruded by plutons are found (Marsh, 1968).

These observations support the concept that the central axis of the Antarctic Peninsula comprises a horst-like block, or series of blocks, exposing lower structural levels relative to the flanks, where higher-level contacts with volcanic sequences are preserved (Saunders and Tarney, 1982). This block faulting probably relates to the extensional tectonic regime which became established over the peninsula during the final stages of subduction. At the extreme northern tip of the peninsula this extension led to the formation of a narrow marginal basin in Bransfield Strait as the South Shetland Islands separated from Trinity Peninsula (Barker, 1982).

Farther south, recent radio-echo sounding between Alexander Island and Palmer

Land across George VI Sound shows a similar structure, although here extension merely led to incipient rifting (Crabtree and others, in press) and relocation of the arc in central Alexander Island during mid-Tertiary times. The sub-ice topography of western Palmer Land bears a close similarity to that of the western Graham Land archipelago. Significantly the main scarp defining the western edge of the Palmer Land horst occurs nearly 80 km inland from George VI Sound (Crabtree and others, in press) and is potentially equivalent to the major structure defining the eastern margin of the Arrowsmith Peninsula. This continuity is further supported by the existence of a linear magnetic anomaly extending northwards throughout western Palmer Land, across Marguerite Bay, Adelaide Island, the Arrowsmith Peninsula and into the Biscoe Islands (S. W. Garrett, personal communication).

Thus on the Arrowsmith Peninsula and Adelaide Island, high-level plutonic rocks and associated extrusives are preserved due to marginal down-faulting in response to extension. This terrain forms a continuation of that exposed father south in western Palmer Land, and together these represent higher structural levels of the magmatic arc than those now exposed over the central area of the Antarctic Peninsula.

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