BRITISH ANTARCTIC SURVEY SCIENTIFIC REPORTS

No. 36. D. C. GOLDRING. The Geology of the Loubet Coast, Graham Land. 1962. 50 pp. 18*s*. 0*d*.

BECAUSE of its position on the west coast of the Graham Land peninsula, the Loubet Coast is geologically important. It lies between the well-known north Graham Land and Marguerite Bay areas, which have already been described in some detail in this series of reports. The petrology of the Loubet Coast, the many small island groups in Crystal Sound (between the mainland and the Biscoe Islands), and the islands in Hanusse Bay is described in this report.

Metamorphic schists and gneisses of the Basement Complex, which so far have only been known from central and southern Marguerite Bay, occur as inclusions in later tonalites and granodiorites. It seems that some of these rock types are similar to those described from Marguerite Bay, but there are a few variants. Representatives of the early Palaeozoic volcanic and hypabyssal rocks are also present as screens in the same acid plutonic rocks.

Although many varieties of pre-Jurassic intrusive and plutonic rocks have been described as inclusions from the Upper Jurassic Volcanic Group of Graham Land, their origin has remained partially obscure. Coarse-grained early Palaeozoic granites with distinctive characteristics have been investigated *in situ* at Black Thumb and the Debenham Islands in Marguerite Bay, and now a complete suite of acid intrusive rocks, which are highly sheared and characteristically foliated, has been discovered at Orford Cliff on the east coast of Lallemand Fjord. The Orford Cliff Suite, which has also been assigned to an early Palaeozoic age, is described in detail, and apparently forms the acid end of a much larger suite of intrusive rocks.

Much of the Loubet Coast comprises a thick succession (at least 5,000–6,000 ft.) of lavas and pyroclastic rocks of the Upper Jurassic Volcanic Group, which is intruded by batholiths of the Andean Intrusive Suite. The base of the volcanic rocks has not been observed in this area but their relation to the Andean intrusives is clearly seen in many places, especially in the mountains of the coastal hinterland. Although the majority of the volcanic rocks are andesitic in composition, there is a range from basalt to rhyolite. This is in strong contrast to the east coast of Graham Land in the same latitude where the more acid volcanic rocks predominate. Basic dykes, which are related to the lavas and pyroclastics in time, are widespread and intrude the early Palaeozoic Orford Cliff Suite. In common with the Upper Jurassic volcanic rocks of other parts of Graham Land, those of the Loubet Coast have suffered hydrothermal alteration which is associated with the proximity of the Andean intrusions.

On the Loubet Coast the Andean Intrusive Suite exhibits its full basic to acid range. Among the basic rocks there are interesting troctolites and norites, and gabbros showing orbicular structures. The intermediate and acid types (quartz-diorites, granodiorites and granites) possess the same characteristic features found elsewhere in Graham Land. At one locality an alkali-granite containing aegirine-augite and riebeckite has been found *in situ*; this is in many respects similar to the alkali-granite recorded as erratics from Booth Island to the north.

Basaltic and doleritic dykes, which are certainly post-Andean and possibly mid-Tertiary in age, are common throughout this whole area.

This comprehensive account of the Loubet Coast is an important contribution to the knowledge of the petrology of Graham Land, and only when adjacent areas have been investigated in more detail will the full significance of these observations be appreciated.

No. 37. M. A. SHERET. Analysis of Auroral Observations, Halley Bay, 1959. 1963. 33 pp. 15*s*. 0*d*.

HALLEY BAY is situated close to the zone of maximum auroral frequency at the only easily accessible point where the zone crosses the Antarctic coastline. Auroral observations were

begun by the Royal Society I.G.Y. Antarctic Expedition in 1956 and have been maintained by the British Antarctic Survey since 1960.

In this report special study is made of the relationship between auroral activity and the simultaneously recorded pattern of geomagnetic disturbance. Individual auroral displays are considered together with their corresponding magnetograms. A close resemblance between these auroral-magnetic patterns and those from similar northern latitudes is demonstrated. Examples of the magnetic effect of quiet arcs are given and particular attention is paid to the variability of this effect throughout the night. A few special occurrences, such as a distinctive east–west undulating motion and the phenomenon of repetition, are also considered at some length.

Although the conclusions are based on the observations from a single station it is considered that the analysis has established a recurrent pattern observable in most auroral displays. The sequence is: quiet arcs in the south until about midnight; then a discontinuity with rapid undulations along the arc or moderately intense rayed bands; an advance northward and the beginning of flaming, overhead activity and the break-up into diffuse forms; finally, the re-formation of the arc and recession southward. Examples show that the geomagnetic elements H and V change from small increasing bays to decreasing ones at the same time as the discontinuity in the auroral display. There are also large bays coincident with flaming and overhead activity. The magnetic disturbance pattern is explained by atmospheric electric currents to the south of the station in the geomagnetic east–west direction, easterly in the evening and westerly in the morning. Meridian currents would explain the less regular behaviour of the element D.

The data support previous investigations which have demonstrated a close spatial association between quiet arcs and the atmospheric electric currents which displace the magnetic elements from their mean values. However, these currents show a reversal of the sign of disturbance even when the same auroral form is present. It seems that this has not previously been emphasized.

The undulating activity is a very distinctive motion. It usually occurs when a quiet arc develops rays and the undulations move to east or west, or in both directions at once. It has been shown that movements of auroral features with a large east–west component produce a magnetic effect which may be explained in terms of a net transport of negative charge in the direction of movement. The undulating activity has all the characteristics of a mixture of opposing movements and it seems significant that it occurs frequently near the time of reversal of the sign of the magnetic disturbance.

In more intense displays the basic patterns of auroral and magnetic activity are not followed so strictly, but the main phase of activity still takes place in the morning and is characterized by a large decreasing displacement of the element H.

It was observed that the flaming motion does not consist simply of regular movements of "waves of light upwards one after another in the direction of the magnetic zenith" (*Photographic Atlas of Auroral Forms*). The whole motion is irregular and often nearly obscured by other active motions.

The Halley Bay observations during 1956–59 show that the position of the quiet-arc zone moved to higher latitudes during years of sunspot maximum. This movement is consistent with a direct geometrical relationship between the quiet-arc zone and the position of the "horns" of the Van Allen zones of radiation.

The observations at Halley Bay are being continued and this report is the first of a series which is expected to appear in the *British Antarctic Survey Scientific Reports*.

No. 39. D. J. BLUNDELL. Palaeomagnetic Investigations in the Falkland Islands Dependencies. 1962. 24 pp. 9*s*. 0*d*.

THIS report gives an account of an investigation of the magnetic properties of the igneous rocks of the Graham Land region. It explains that when any igneous rock cools and solidifies during its formation a permanent magnetism is acquired in the direction of the prevailing

magnetic field. This magnetism is often retained even up to the present day, and measurement of its direction indicates the direction of the past magnetic field. In this way it is possible to work out the configuration of the Earth's magnetic field for various times in the past. Local disturbances and the effects of demagnetization occurring during the time since the rock was formed tend to scatter the direction of magnetization, so many orientated samples have to be measured and their average is taken to be the past field direction. The report describes how this procedure was followed for the mid-Tertiary, Andean, Jurassic and Palaeozoic rocks of the region and how the various precautions and tests of magnetic stability were applied. The mid-Tertiary and Andean rocks were found to be magnetized in one of two directions, either in the direction of the present field (making allowance for the secular variation) or in exactly the reverse direction. This reversed magnetism has been found before in many other parts of the world. It could be due to some special magnetic property of the rock but it is more probably the result of reversals of the Earth's magnetic field. The directions of magnetism of the Jurassic and older rocks were found to be widely scattered and no amount of laboratory examination could reveal a consistent pattern of results. The magnetism was rather weak and in general tended towards the direction taken up by the nearest Andean rocks. The Jurassic and older rocks must have been so heated during the intrusion of the Andean batholiths which constitute the bulk of Graham Land that all their magnetism was destroyed. No locality has yet been discovered in which the Jurassic volcanic rocks have been sufficiently undisturbed by the Andean intrusion to yield a worthwhile result; it would be extremely valuable if one could be found.

The report concludes by emphasizing the usefulness of this kind of study in determining the past histories of the continents. If the configuration of the Earth's magnetic field in the past is assumed to be the same as it is now, then from the direction of magnetism of a rock at a certain locality the latitude of that locality when the rock formed can be deduced directly. It seems that Graham Land has remained in its present position at least since the beginning of the Tertiary, when the Andean rocks were intruded. The evidence of a warmer climate at that time, as inferred from the abundant temperate to subtropical fauna and flora preserved in late Cretaceous to mid-Tertiary sediments, and the subsequent deterioration to the present-day polar conditions at the beginning of the Pleistocene, must point to a world-wide climatic change rather than to a drift of Graham Land towards the South Pole.

No. 43. A. K. HOSKINS. The Basement Complex of Neny Fjord, Graham Land. 1963. 49 pp. 19*s*. 0*d*.

THE Basement Complex, which is known to occur only in the Marguerite Bay area of Graham Land, was first described petrologically in *Falkland Islands Dependencies Survey Scientific Report* No. 11. In this report it was pointed out that, of the eleven metamorphic rock types described, only five are true members of the Basement Complex, and the others are in fact hybrids. It was also made clear that certain aspects of the metamorphic history and petrology of the Basement Complex required detailed reinvestigation, especially in the type area of Neny Fjord.

As a result of the new investigation in the Neny Fjord area, the Basement Complex rocks have been subdivided into *three* major groups: banded biotite-gneisses, dioritic gneisses and granite-gneisses. The oldest group—the banded biotite-gneisses—is considered to be regionally metamorphosed sediments which were later intruded by dioritic gneisses and granite-gneisses. In this area there are numerous phases of dioritic gneiss and granite-gneiss occurring as isolated outcrops; these have been successfully correlated by the use of metamorphic criteria. Prior to a phase of metamorphism which reached the almandine-amphibolite facies, the granite-gneisses were intruded by basic dykes now represented by metadolerites and strings of schistose plagioclase-amphibolite inclusions. Potash metasomatism was also associated with the metamorphism. Subsequent to metamorphism the Basement Complex was intruded by another set of basic dykes along the joints in the granite-gneisses.

A further phase of metamorphism, of albite-epidote-amphibolite facies, gave rise to the present complicated situation in the Basement Complex rocks.

The Basement Complex rocks of Neny Fjord have a north-west to south-east foliation dipping gently westward in the south but in the north it is vertical. There is ample field evidence that the western part of Neny Fjord is dominated by dioritic gneisses, whereas the eastern part comprises mainly banded biotite-gneisses. This area is broken up by block-faulting associated with the emplacement of the Andean Intrusive Suite and the north-east to south-west trending faults displace the Basement Complex zones of intrusion.

Although the stratigraphical relations within the Basement Complex are now known in the Neny Fjord area, the exact age of these rocks is still in doubt—perhaps they are late Precambrian or even early Cambrian in age, but K/A dating is needed to provide absolute dating.