NEPHELINE AND MELILITE ROCKS FROM SHANNON TIER.

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We received recently from the Mines Department some specimens of rocks from the Shannon district, where they had been looked upon as indicating the possible occurrence of tin and gold. Mr. George Allison, of Hunterston, kindly supplemented these, and outlined for us their geological occurrence on that estate, and from his descriptions we are able to indicate broadly the features of the locality. The Shannon Tier forms there a high plateau of mesozoic dolerite which rises a thousand feet above the Permo-Carboniferous country at its base. On the slope below the Tier are small rounded or conical hills of a dark grey, slightly bluish, basaltic rock: and at the base of or beneath the flanks of these is a strange-looking coarse zeolitic rock called locally "tourmaline-rock." This is as much as can be stated at present respecting the geology of this rather remote place. The presence of gold is said to have been established in the tourmaline-rock, but an assay by the Government Analyst did not confirm this.

The locality gives us three varieties of eruptive rock, viz., the Mesozoic dolerite, the so-called tourmaline-rock, and the bluish basalt. We may here anticipate by diagnosing the pseudo-tourmaline rock as nephelinite, and the basalt as melilite-basalt. The geological age of these rocks, so far as can be hazarded without examination on the spot, is probably Permo-Carboniferous for the nepheline and melilite rocks. The dolerite is considered to belong to the close of the Mesozoic era.

Dolerite.—This varies in degrees of coarseness, but is the typical ophitic dolerite which occupies the summits of the Central Tiers, and of numerous mountains in every part of the island. It is a holocrystalline plagioclase-augite rock, structurally diabasic, and sometimes, where the augite is chloritised, merging into diabase. The well-formed prisms of labradorite felspar, sometimes long and slender, sometimes stout and short, are cemented together

by the augite mineral ; and these two elements have combined to form a non-vitreous massive rock of essentially the same mineralogical constitution as gabbro and basalt, but as regards grain and structure, intermediate between the two. If we could follow this rock to its deep-seated roots in the earth's crust, where the pressure was greater and the process of crystallisation correspondingly slower, we should probably find it existing there as coarsely crystalline gabbro. On the other hand, we must not regard its present surface as in any way its original one. Much of it, as well as all the overlying rock, has been removed by denudation. Admitting its intrusive nature, there are two theories of its occurrence which press their claims for acceptance. Seeing that its internal structure agrees closely with that of diabasic sills, has it spread laterally from fissures covering up underlying rocks, and leaving an exposed surface now owing to the removal of the overlying strata ? On this hypothesis, the dolerite on the tiers and the mountain tops is only a capping, and shafts sunk through it would pierce the stratified sediments below. The level contours of the sidimentary beds abutting on the sides or faces of the Tiers, and simulating infraposition, have suggested this explanation, but we have had no demonstration by any actual trial. The enormous thickness of the dolerite is greater than that of any sills known to us.

The second hypothesis is that what we see represents the massive intra-telluric part of an immense body of eruptive rock, which, as a whole, never reached the surface, but which everywhere thrust out lateral dykes, parts of which we can still trace in the coal measures. Either explanation is surrounded with difficulties, which extended observation alone can solve. This doleritic rock is a product of the gabbroid magma; but we now proceed to notice an entirely different class of rocks, those which have issued from what Rosenbusch calls a theralitic eruptive magma. Deep-seated rocks give the key to the relationships of the volcanic ones. Hence in modern petrology the latter are referred to or compared with their plutonic representatives. Theralite is a plutonic nepheline + lime soda felspar (occasionally potash felspar) rock, the deep-seated parent of nepheline and melilite basalts.

Nephelinite.—This is a nepheline-augite rock. A brief examination serves to show that the long black prisms which form such a striking feature are not tourmaline but augite. The interstices between the prisms are occupied

by light brown and yellowish nepheline, which has often decomposed and originated snow-white radiated aggregates of the Zeolite natrolite. The proportions of augite and nepheline vary greatly. Sometimes the augite is extremely abundant, otherwise more sparingly distributed.

The mineral constitution of the rock may be stated as follows :—

Essential minerals	=	Nepheline, augite.
Accessory minerals	=	Olivine, sanidine, apatite, melanite-garnet, magnetite.
Secondary minerals	=	Natrolite, serpentine.

Microscopical characters.—The structure is holocrystalline, hypidiomorphic. No groundmass is present. Nepheline, generally, forms about one-half of the entire rock, sometimes more. It gives large sections bounded by rectangular contours, margined with iron oxide, and sometimes penetrated by augite. Its substance is mostly converted into radiating natrolite : some patches, however, remain water-clear. The clear nepheline encloses slender rods of apatite, as well as other needles, which, from their oblique extinction, we surmise to be augite. The natrolite gives beautiful fan-shaped aggregates, polarising in grey, low yellow, and orange colours. The nepheline crystals are often cut up by rectangular cracks.

The augite is in large prisms of green to violet tints, sometimes showing both colours in the same crystal. Its maximum extinction angle measured from the fissure lines is 45°. It encloses prisms of apatite. A prominent element of the rock is apatite in long transversely-jointed rods and prisms, some of which are large enough to be visible to the unaided eye. Olivine is an infrequent accessory. It has crystalline contours, the usual rough-looking surface with irregular cracks, and is associated with some serpentinous material. Some orthoclase felspar is also present in small quantity. Its transparency indicates the sanidine variety.

No one who has seen the familiar slides of the nephelinite (or nepheline-dolerite as it has been called), of Katzenbuckel in the Odenwald, can fail to recognise the same type in slices of this Hunterston rock. The latter is the same rock reproduced in the Southern Hemisphere. The specific gravity of an average specimen was ascertained to be 2·66.

Melilite-Basalt.—Associated with the nephelinite is the basaltic rock of the small conical hills referred to above. This is dark grey compact basalt, with porphyritic olivine

and sometimes porphyritic augite. It has a sp. gr. of 3·15, and dissolves to a large extent in HCl. Microscopically, it is seen to consist of crystals and grains of olivine in a groundmass of crystals of melilite, accompanied by perofskite or picotite. It contains no felspar, neither do we detect nepheline. Nepheline, however, occurs in rocks in such a form as often to be only recognisable by chemical methods, and hence it would perhaps be unsafe to assert its total absence here. The melitite is the most interesting element, as we believe it has not been recorded previously in Australasia. It seems to occur only in one generation, and in thin section yields two forms—the prismatic vertical and the transverse section of the prism. The boundaries of the prism are imperfect, showing crenulated contours, and the elongated sections show a peculiar mid-rib or median line, often beaded, sometimes repeated as several vertical lines when the crystal is broad enough. According to Dana,* the peg structure of melilite, which consists of parallel peg-like inclusions passing from the base inwards, is not always easily seen. We have not seen it in the Hunterston rock, nor in our slices of melilite basalt from the Capo di Bove, near Rome, and from the Hochbohl, Württemberg. The transverse sections of the mineral in our rock have the grey interference colour of felspar, from which, however, they can easily be distinguished by their crenulate contours and isotropism in basal sections. They are mostly, but not always, water-clear, while the longitudinal sections show a prevalent granulation of the substance of the mineral. There is none of the blue interference colour, which is sometimes seen, for instance in the Hochbohl rock. Dana regards melilite as crystallising in lieu of plagioclase, but Rosenbusch† mentions the fact that while augite and melilite exist in the rock in varying proportions, their sum remains constant, and that consequently melilite takes the place of the augite, and not of felspar. He correlates melilite-basalt with the trachydolerite-limburgite series. Short prismatic and granular microlites are abundant; these are probably augite; nevertheless, the structure is holocrystalline. There are numerous minute octrahedra and grains of a highly refractive dark or imperfectly-translucent mineral, which may be spinel or perofskite. In one section we have observed a yellow garnet.

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* A Text-book of Mineralogy, E. S. Dana, 1898, p. 427.

† Elemente der Gesteinslehre, H. Rosenbusch, 1898, p. 359.

We have noticed an extremely fine grained variety in which augite is dominant in the porphyritic form as well as granular. This would appear to be an intermediate or aberrant form tending towards the nepheline melilite basalts.

The families of nephelinite, nepheline-basalt, and melilite-basalt are separated by Rosenbusch decisively from ordinary basalts, with which, he says, they have no sort of relation. He groups the three first-named families genetically together, bound to each other by ties of geological valency and association, and forming an integral volcanic or effusive formation, which (with the trachydolerites, tephrites, leucite rocks, limburgites, and augitites) belongs to theralitic magmas.*

We may here add that we have not yet detected nepheline in any of the other Tasmanian basalts. The crystals formerly attributed to nepheline in the Tertiary olivine-basalts of Northern Tasmania have always seemed to us to be so invariably associated with longitudinal sections of apatite as to make it probable that they were the hexagonal transverse sections of the same mineral. A similar confusion seems to have occurred with respect to the Tertiary basalt of Phillip Island, Bass Straits. In a letter recently received from Prof. G. H. R. Ulrich, of Dunedin, he informs us that the late Mr. Cosmo Newberry, not long before his death, analysed the so-called nepheline of that rock and found it to be apatite. One would, however, expect nepheline-basalts to be associated with nephelinite, and it is highly probable that the Shannon district will still be found to yield those lavas.

Viewed from a mining point, these peculiar basaltic rocks do not offer anything particularly encouraging. As they are unique in Tasmania, there is little use in comparing them with mineral-bearing rocks in other parts of the island. The few localities in the world where such rocks are known to occur are not noteworthy as mining ones. The rocks are altogether incongruous with the notion of tin ore occurring in them ; and though gold is not intrinsically an impossible metal, distributed in excessively small quantities as in some other eruptive rocks, such as the Port Cygnet phonolitic trachytes for instance, yet payable gold is, so far as we are aware, entirely unrecorded from this family of stone.

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* *Ibid.* p. 352.