CORRESPONDENCE.

THE ORIGIN OF IGNEOUS ROCKS.

SIR,—As the result of field and petrological study of the igneous rocks of Caledonian age in the Newry Complex and in Argyllshire, combined with a comparative study of other areas, it is now possible to throw light on the origin of igneous rocks in orogenic regions. A brief summary of the conclusions, the full details of which will be published shortly, are as follows.

The parent magmas are ultrabasic and can frequently be shown to be represented by biotite-pyroxenite, hornblendite, and allied rocks. The ultrabasic magmas, which were rich in volatiles, rose by soaking and shouldering stress, and at the same time gave off emanations rich in alkalies. In consequence a zone of alkali enrichment preceded the advancing magma, and it can usually be demonstrated that soda travelled more rapidly and farther than potash. As the result of this alkali enrichment, the invaded sediments (including metamorphic varieties) are felspathized, quartz in particular being commonly converted to soda-potash felspar. To the felspathization of country rocks, together with an accompanying seeping in of ultrabasic magma, the rocks of batholithic intrusions are to be attributed.

By the combination of the two processes, felspathization and magmatic soaking, biotite-pyroxenite and allied ultrabasic magmas give rise, on invading aluminous sediments, to the series shonkinite–monzonite–syenite. The shonkinite consists of a small proportion of felspathized sediments and a high proportion of magma, whilst the syenite is in the main sediments enriched in alkalies. Monzonite represents a gradation between these two extremes. Hornblendite magma under similar circumstances gives rise to a parallel series appinite–diorite–plagioclasite. All gradations can be found between biotite-pyroxenite and hornblendite, and corresponding gradations are to be found between the two hybrid series to which they give rise. Kentallenite, in particular, is a connecting link between appinite and shonkinite, and is the result of the invasion of aluminous sediments by a magma representing biotite-hornblendite in composition.

These rocks, which frequently occur as marginal zones in "granite" batholiths and as xenoliths in the "granite", are developed in three different ways :—

1. By actual soaking of ultrabasic magma into country rocks which have already been enriched in alkalies by a vanguard of magmatic emanations. By this process the rock types mentioned above are developed in situ.

2. From magmas produced by the operation in depth of a process similar to that of case 1.

3. By the invasion of the ultrabasic rocks or magmas or their hybrid derivatives by a felspathic magma, such as plauenite, soda-syenite, or plagioclasite, each of which is attributed to enrichment of sediments in alkalies of ultrabasic origin. Augite-biotite-diorite, biotite-gabbro, and hornblende-gabbro may arise in this way by admixture of biotite-pyroxenite or hornblendite and plagioclasite.

When quartzite is invaded by biotite-pyroxenite or hornblendite magma, two immiscible magmas result. In the case of hornblendite the resulting magmas are appinite and soda-syenite, whilst in the case of biotite-pyroxenite and allied types the resulting magmas are shonkinite and syenite of Plauen type.

The acid rocks, which are generally dominant in batholiths, are formed in the following ways :—

1. Enrichment of siliceous sediments (including metamorphic derivatives) in alkalies of ultrabasic origin.

2. The soaking of one of the felspathic magmas, plagioclasite, syenite, or soda-syenite, into siliceous sediments or their metamorphic derivatives.

3. By the soaking of one of the hybrid types of intermediate composition into siliceous sedimentary or metamorphic rocks with an accompanying enrichment of the invaded rocks in alkalies.

These three processes may take place in situ, in which case the " granite " is usually porphyritic, or in depth. In either case there may be partial fusion of the sediments. The Newry Igneous Complex, for example, is margined by a zone of partial fusion at its eastern end.

The characteristic hypabyssal rocks of orogenic regions, which include the lamprophyres, porphyries, porphyrites, and aplites, are explained in a similar manner. Minette and kersantite are the hypabyssal representatives of shonkinite, kentallenite, and augite-biotite-diorite, whilst vogesite and spessartite correspond to the appinites. Many aplitic rocks represent siliceous sediments which were only partially fused and enriched in alkalies and, in consequence, they retain a granular hornfels texture.

This scheme of petrogenesis provides a common explanation for the igneous rocks of orogenic regions of all ages; explains the frequent association of rocks of Atlantic and Pacific type; and accounts for the vanished sediments in batholithic regions.

Doris L. Reynolds.

The Science Laboratories,
The University,
Durham.
28th July, 1934.