A COMPARISON OF THE RYDAL AND HARTLEY EXOGENOUS CONTACT-ZONES.

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(One Text-figure.)

[Read 24th June, 1936.]

Introduction.

In dealing with the exogenous contact-zone at Hartley (Joplin, 1935) it was pointed out that the Upper Devonian (Lambian) Series at Hartley could probably be correlated with rocks of similar age at Rydal. Thus, in discussing the incipient metamorphism at Hartley, it was assumed that the original sediments were similar to well-defined types at Rydal.

It may now be shown that this assumption was correct, as there is a very close parallelism between the hornfelses of both aureoles.

It is not proposed to describe the Rydal aureole exhaustively, but merely to place on record certain similarities with the exogenous contact-zone at Hartley. Possibly, if further field studies were undertaken and further material examined microscopically, other assemblages might be revealed; but as Rydal lies only about 10 miles from Hartley, as the sedimentary series is similar and as the Rydal granite represents only another part of the great Hartley–Bathurst bathylith, it seems unlikely that any very notable dissimilarities will be found. The writer feels confident that further study of the Rydal aureole would reveal other assemblages that have been described from Hartley.

The Primary Hornfelses of Hartley and Rydal.

Sixteen primary hornfels types were recognized in the Hartley aureole and eleven of these have been discovered at Rydal, as well as one assemblage which has not been met with at Hartley.

The hornfelses were collected along the Bowenfels Road on the south-eastern side of Cox's River Bridge and in the old and new railway cuttings north of Sodwalls. As the Rydal types are exactly similar to those of Hartley, it is not proposed to repeat detailed descriptions of the assemblages, but a comparison of the two aureoles is made in the following table, from which it will be seen that, as at Hartley, the Rydal aureole is characterized by a "wet" medium-grade metamorphism.

Primary Assemblage.	Hartley.	Rydal.
1. Andalusite-cordierite-biotite	+	+
2. Andalusite-biotite-orthoclase	+	–
3. Cordierite-quartz	+	+
4. Cordierite-plagioclase	+	+
5. Plagioclase-biotite	+	+
6. Amphibole-plagioclase-biotite	+	+
7. Amphibole-diopside-plagioclase-biotite	+	+
8. Amphibole-diopside-plagioclase	+	+
9. Amphibole-plagioclase	–	+
10. Diopside-plagioclase	+	+
11. Plagioclase-diopside-epidote	+	+
12. Plagioclase-diopside-wollastonite	+	–
13. Diopside-grossular-wollastonite	+	–
14. Vesuvianite-diopside	+	–
15. Wollastonite-diopside	+	–
16. Sandstone Hornfels	+	+
17. Grit	+	+

The Absence of Certain Primary Assemblages at Rydal.

Reference to the above table will show that the andalusite-biotite-orthoclase assemblage has not been met with at Rydal. Only one example of this type was recorded at Hartley; this was found as a boulder and has never been met with *in situ*. It is, therefore, not a prominent type, and it is not surprising that it has not been discovered at Rydal, especially in view of the fact that the study of this aureole is incomplete.

Again it will be noted that no assemblages containing wollastonite occur at Rydal. In dealing with the Hartley aureole it was pointed out that such assemblages were developed only at short distances from the contact. At Rydal, so far as the present writer is aware, the calcareous beds (*Spirifer*-bearing quartzites) do not outcrop closer than 800 yards from the contact, and the rocks contain quartz and calcite, which Eskola (1922) has shown to be a low-temperature assemblage.

Finally, the vesuvianite hornfels appears to be absent from Rydal, but in the Hartley aureole this was recorded from a single locality and it might be found at Rydal if more detailed work were carried out.

Metasomatism.

As at Hartley, greisenization, or the development of white mica, is common in the sandstone hornfelses and in the cordierite- and andalusite-bearing assemblages at Rydal.

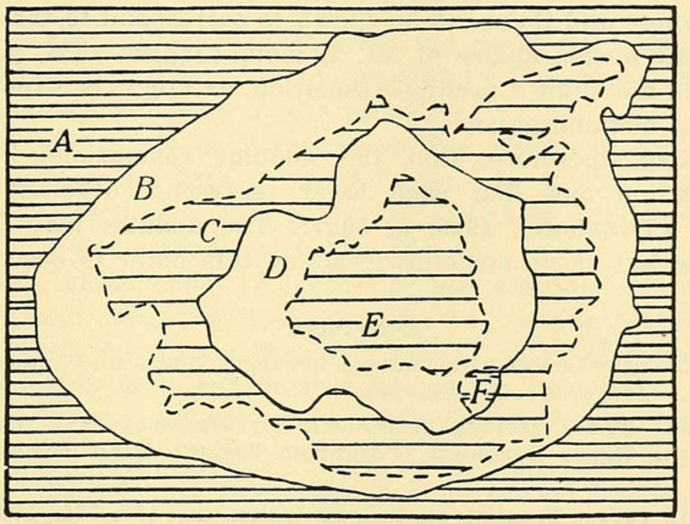
The development of andradite, prehnite, scapolite, etc., which was noted in many parts of the Hartley aureole, appears to be absent at Rydal, and this may be explained again by the fact that the more calcareous types do not occur very close to the contact.

Zoned Calcareous Nodules near Sodwalls.

A "purple-hornfels" with light calcareous patches occurs at the junction of the old and new railway lines on the Rydal side of Sodwalls at a distance of about 600 yards from the contact. The patches may be scattered through the body of the rock, but they are often concentrated on certain horizons and, though sometimes irregular in shape, are usually flattened ellipsoids. They vary in size from half an inch to about two inches in length, and show a rude zoning.

Examined microscopically, the well-defined zones are seen to consist of different mineral assemblages, and the less-defined ones are due to the relative abundance of a certain mineral in a given assemblage (see Text-fig. 1).

The "purple-hornfels" (Joplin, 1935) which encloses the calcareous bodies consists for the most part of biotite, quartz, and plagioclase, but a little amphibole is usually present and this becomes more abundant, together with calcite, in the immediate vicinity of the calcareous body.



Text-fig. 1.

A.—Biotite-plagioclase-amphibole-quartz assemblage.
B.—Plagioclase-amphibole-quartz-sphene assemblage with plagioclase > amphibole.
C.—Amphibole-plagioclase-sphene assemblage with a little quartz and amphibole > plagioclase.
D.—Plagioclase-amphibole-sphene assemblage with plagioclase > amphibole.
E.—Amphibole-calcite-sphene assemblage.
F.—Amphibole-sphene-iron ore.

The separate nodules show a good deal of variation in the order of the different zones, but consist mainly of the amphibole assemblages listed in the above table. Diopside may or may not be present.

Text-figure 1 is a diagram of one such nodule, and a critical examination of this indicates that the centre is richer in lime, and that this gradually decreases outwards, that magnesia attains local abundance in certain zones but is present throughout, that alumina is absent in the centre but occurs in the outer zones where silica also becomes prominent. The last oxide, in the form of quartz, is something of an anomaly, as it has been found in large irregular grains with calcite and amphibole in the centres of some of the nodules.

The junction between the biotite-bearing and biotite-free assemblages is very sharply defined and, as may be seen by reference to Text-figure 1, another well-marked junction occurs between an amphibole-rich and an amphibole-poor plagioclase-amphibole-sphene zone.

The origin of these bodies is somewhat obscure. Ward (1912) and Waterhouse (1916) have described calcareous patches and veins in shaly rocks in Tasmania, and they postulate addition from the magma; but the mode of occurrence, the frequent concentration of the nodules on a definite horizon, and the zoning make it difficult to explain the origin of the Rydal bodies in this way.

Twenhofel (1926) states that calcareous concretions are very common in claystones, and it seems likely that the nodules were concretions in the original tuffaceous silt which is now represented by the "purple-hornfels".

As regards the zoning, two alternative explanations suggest themselves, either that there was reaction between the concretion and the enclosing rock during metamorphism, or that the original concretion was laminated concentrically.

It is unlikely that much diffusion would take place at such a distance from the contact and, moreover, sharply defined beds of calcareous and purple hornfelses occur elsewhere and these can be shown to correspond to the *Spirifer*-bearing quartzites and soft purple shales of Mt. Lambie (Joplin, 1935, p. 19). Furthermore, the zones do not show a gradual transition, as might be expected if diffusion took place during metamorphism.

It seems likely, therefore, that the nodular concretions had an original concentric lamination and that each layer represents different admixtures of calcite and clay (Twenhofel, 1926, p. 503). The nodules may have been built up around fossils, but as no structure remains this point is obscure.

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