XIII.—*Dolomitic Limestones. (Abstract.)* By J. G. GOODCHILD,
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DOLOMITIC LIMESTONES may have been formed in any one of many different ways. Some of these were noticed in detail. Amongst those of *primary* origin were (1) the various modes of precipitation connected with the deposition of strata of lacustrine origin formed in closed bodies of inland water where supply is balanced by evaporation. The materials are derived (amongst other sources) from the decomposition of the ferro-magnesian silicates. (2) Precipitation consequent upon (a) the dessication of lagoons, or other temporary inlets of sea water; or (b) upon the mingling of various solutions. (3) Deposition direct from percolating solutions derived from the decomposition of basic igneous rocks situated at higher levels. Much of this is deposited as pearl spar in veins or other fissures, but occasionally masses of more importance are formed in this way. (4) Calcareo-magnesian matters exuded in consequence of the alteration of rock-forming silicates undergoing plutonic metamorphism, are, again, another source of certain dolomites of limited horizontal extent. (5) Some dolomitic limestones may, possibly, have originated directly through the secretion of small quantities of carbonate of magnesia, along with carbonate of lime, by various organic agencies.

Dolomites of *secondary* origin have nearly all arisen through the addition of magnesian salts—usually the carbonate—to limestones already existing as such. In some cases, as in that of The Magnesian Limestone, the rock may have been of lagoon origin, and therefore partly a magnesian precipitate, to begin with, and have subsequently received a further addition of magnesian matter through the copious downward percolations coming from the chief repository of such salts, the marls and sandstones of the “Upper New Red.” In the great majority of cases dolomites of secondary origin have originated through the alteration and the partial replacement of calcareous matter—originally free from magnesian salts—through the downward percolation of solutions containing magnesia in one or other of its forms originally deposited in connection with other rocks at a higher level. In a few cases this higher-lying source of magnesian solutions is an igneous rock of basic composition undergoing weathering. But in the great majority of cases, the direct source of the magnesian matter is one or other of the

Red Rocks—New Red, Old Red, or any other mass of strata formed in close bodies of inland water. (Even in such cases, of course, the original source of the material is traceable to the decomposition of the ferro-magnesian silicates.) As a good example of the kind of alteration referred to may be cited the limestones of the Carboniferous rocks, where they are yet, or have formerly been, covered by the New Red. From the Red Rocks referred to, magnesian solutions (always accompanied by ferruginous salts) have percolated downward into the rock beneath, staining the sandstones, and even the shales, and at the same time altering the limestones in some cases to an extraordinary extent. The solutions find their way downward along any divisional plane—joints, bedding planes, faults, &c.; and thence, extending into, and partly replacing, the calcareous matter adjoining, they convert this into friable, granular dolomite. The diminution in bulk consequent upon the addition of carbonate of magnesia to carbonate of lime brings about a general contraction of the part of the rock affected, whereby the texture of the rock is altered from compact to loose, while joints and other divisional planes are stretched wider open; and, more important still, geodes, drusy cavities, and a general cellular structure, are set up in the parts of the rock within the influence of the solutions that cause the contraction. It is this factor that has had much to do with the rearrangement of the Magnesian Limestone itself. The super-addition of magnesian matter to a limestone already partly magnesian in origin has brought about a diminution in bulk; and this, taking place while the constituents of the rock were comparatively free to change positions amongst themselves, has led to the formation of botryoidal structure, such as that seen in the Sunderland cliffs; or to the development of the equally-remarkable cellular structure seen at so many other localities.

Reasoning back from effects to causes, one may infer from the presence of the above-noticed alteration structures in the limestone, &c., of the Carboniferous rocks, that the staining and alteration of the shales and sandstones, and the dolomitization of the limestones, point to the former extension of the New Red Rocks over the rocks so affected. The writer mentioned, when this paper was read, that large areas of the Carboniferous rocks of the Basin of the Forth exhibit these features characteristic of infiltration from the New Red. This is especially the case with the Carboniferous rocks of the Dalkeith coal field. The sandstones and the shales are irregularly stained, while the limestones, with equal irregularity, are more or less dolomitized. From this the writer would draw the conclusion that the New Red Rocks have formerly covered those parts (and the areas

adjoining), and that their final disappearance there has taken place within geological times quite recent; if, indeed, remnants, concealed beneath the drift, do not exist even yet.

As the New Red Rocks bear the same geological relation to the Jurassic Rocks that the Upper Old Red does to the Carboniferous, it would follow from this conclusion that the writer believes that the Jurassic Rocks, also, formerly extended over the Lothian area, and the south of Scotland generally.

In conclusion, the writer pointed out that the replacement of calcareous matter by dolomite was one of the first steps towards the complete replacement of the calcareous matter by *haematite*, which, like the magnesian matter itself, was imported into the rock affected by means of downward percolations from the New Red. Both the iron and the magnesia being thus derived primarily from the decomposition of ferro-magnesian silicates, the concentration of the solution by evaporation in closed bodies of inland water, their location for a time in the lacustrine sedimentary rocks, and their final transference, through downward filtration, led to their present lodgment in the calcareous rocks below.

Some reference was also made to the dolomitization consequent upon volcanic and other action.