*On the Geology of the Grassington Mines, near Skipton, in Yorkshire.**

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My occupation in the lead mines in the secondary district of North Wales, and in the north of England for many years, has necessarily enabled me to acquire some knowledge of the stratification of those districts, and to observe the effects which are produced on the mineral veins by the numerous changes, or alternations, and disruptions, of the strata which are presented.

The important changes in the position, size, and contents, of the veins, which are so clearly to be traced to those causes, have often led me to suppose that similar causes exist in Cornwall; though much less distinct than in those carboniferous districts, where the colour and mineral character of the alternating beds present such a clear development of the strata; and if such causes exist we may fairly presume that the effects are as important.

The lead mines, of which the model represents a part, are the property of His Grace the Duke of Devonshire, at Grassington, near Skipton, in the West Riding of Yorkshire.

In this kingdom lead mines are to be found in various strata, from the carboniferous series to the primitive rocks. The total annual produce of Great Britain is about 51,000 tons of pig lead. Of this quantity the primitive and transition series of rocks yield about 16,000 tons. The remainder is from veins in that division of the secondary rocks, known as the 'carboniferous formation,' and may be divided as follows:—Cumberland, Northumberland, Westmorland, and Durham, about 17,000 tons; Yorkshire, 6,000 tons; Derbyshire, 5,000 tons; North Wales, 7,000 tons; and a small quantity from Somersetshire and Ireland.

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* A model of the stratification accompanied this Paper.

In these districts the veins are found productive in particular strata; whilst in the alternating beds they are much contracted, and seldom, or never, found to contain lead, or any other ore. For example:—in Cumberland, Northumberland, Westmorland, and Durham, in a very limited depth, we have calcareous, argillaceous, and siliceous beds, alternating to the number of a hundred, or more. From these the annual produce is about 17,000 tons, about one-half of which is produced from veins in one particular bed called the great limestone, a stratum varying from 9 to 12 fathoms in thickness. More than two-thirds of the remainder is from other calcareous beds, leaving only about 2,500 tons to be produced from the veins while passing through the numerous argillaceous and siliceous beds.

The ore from the limestone yields a much higher per centage of lead, is found much more fusible, and makes a much better metal for white lead than those from the gritstone, or the primitive and transition rocks; and the ores from the latter series of rocks are generally richer for silver than those from either the grit or the limestone.

In Derbyshire, the total produce is from the limestone: the shale and grits above, and the toadstone or basaltic rock beneath, never having been found productive of lead ore.

In the carboniferous districts of North Wales, the produce is almost entirely confined to limestone-rocks, and such is the fact in some parts of Yorkshire. The Grassington district is, however, an exception to almost the general rule; for although the beds are found nearly in the same order as in those mines where the veins are only found productive in the limestone, nearly the whole of our produce is from the siliceous beds.

We are without evidence of the precise time when the Grassington mines were first worked; but there is abundant proof that some of the veins were discovered and worked at an early period of mining in this country, and there is little doubt but that they were conducted by parties from Derbyshire, which may be considered the first seat of lead mining in secondary districts.

These mines extend over a large tract of moor land. The veins are numerous; but, generally speaking, small and not very productive.

The strata are alternating beds of shale and gritstone to about the average depth of 40 fathoms from the surface. At this depth the limestone is met with, and continues to a further depth of 36 fathoms, where a bed of shale is found, the exact thickness of which has not yet been ascertained.

As the veins in this mineral field were found to be productive of lead ore in the gritstone, and it was evident from the stratification of the district, and the dip, or inclination of the beds, that the limestone was to be found at a very limited depth, the prevailing opinion amongst old and experienced miners was, that when the workings reached the limestone the produce of lead from this district would equal, if not exceed, that from any other district of a like extent. This might reasonably have been concluded from the numerous veins discovered, and the fact before stated,—that the beds in which the veins were found productive in other districts were yet to be explored in these mines. The numerous and expensive trials subsequently made in these beds have not borne out these opinions; for although the veins have generally been found wider and more regular in the limestone than in the grit, I believe I may say, with propriety, that the limestone has not yielded 2*s.* 6*d.* worth of ore for every 20*s.* expended on trials in it. We are, however, looking with some interest and expectation to a trial now going forward for exploring some of the most powerful veins below the bed of shale before alluded to.

Most of the veins in the Grassington district are what are termed *fault veins*, that is, a vertical throw or displacement of the strata has taken place, so as to cause the same beds to be found at different levels on different sides of a vein, similar to the effect produced by the *trap dykes*, or *faults*, in coal districts.

The subsidence, or depression of the strata, is generally on that side to which the vein lades, or underlays, and the underlay is invariably found to be greater in the argillaceous or shale beds, than in the grit or limestone.

A depression of a few feet, or two or three fathoms, is considered most favorable for lead or other ores. The displacement is, however, sometimes so great as to cause grit or limestone on one side of the vein to be opposed to argillaceous beds on the

other, and it is seldom that veins are found productive of ore when the beds are so circumstanced.

The general matrix of the veins is calcareous spar, fluor-spar, barytes, and occasionally calamine; and when the throw of the strata is to such an extent as to cause beds of a different mineral character to be opposed to each other, fragments of the containing rock form a considerable portion of the matrix.

I have selected that part of the Grassington mines which I consider presents the most interesting geological features to be represented by the model, because it includes two extensive *fault veins;* one of which was found very rich in places, although the throw of the strata is so great as to cause shale on one side to be opposed to grit on the other; the other vein is totally barren with the beds so circumstanced.

By a reference to the model, it will be evident to every practical man, that if these mines were sunk to a certain depth, and trials made in the shale, or limestone, a considerable sum of money might be expended without the least discovery of ore: at the same time the veins above or below such workings might be very rich. This fact must convince every one, that much attention to the stratification, and to the disruptions of the strata in secondary districts, is essential to the economical working of mines in such strata.

I have witnessed extensive disruptions in the Isle of Man, where the strata are analogous to those of many of the mining districts of Cornwall, and I have little doubt but that similar faults or displacements are numerous in Cornwall.

If the model, which I now present to this society, and the reading of this Paper, should be the means of drawing the attention of any of the highly-respectable and intelligent mine agents of Cornwall to a comparison of the stratification of their respective districts with those of which the model is a representation, I shall feel amply repaid for the time I have devoted to it.