rock, thus forming great cavities and caverns. Now the Old Red Sandstone is rich in iron. In fact its reddish color is due to oxide of iron, just as the red color of the blood is due to iron. When, therefore, either by grinding glacier or raging torrent, denudation of the sandstone rocks took place, the oxide in the finely divided particles of sand was dissolved by the vegetable acids into carbonate of protoxide of iron. As this solution of iron floated along in the drift it was acted upon by the oxygenated atmosphere, iridescent films would appear on the surface of the flood, indicating that the protoxide had been transformed into peroxide of iron. These insoluble films of iron oxide being of higher

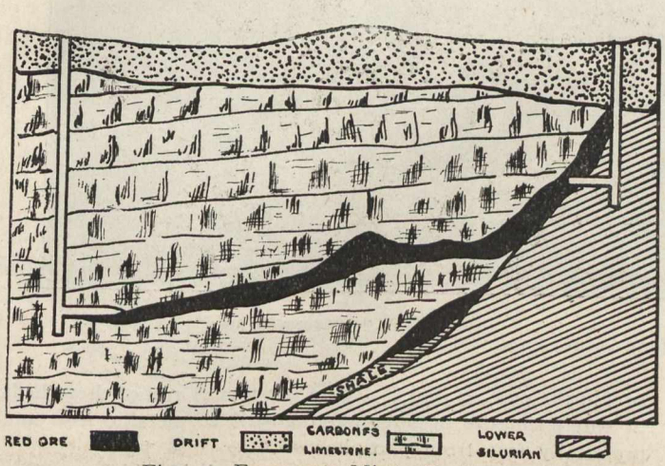

Fig. 2.—Egremont Mine, England.

specific gravity than the rest of the drifting material, and becoming heavy masses by the addition of new particles, sank to the bottom, filling up the cavities and deep fissures, and gradually solidified into solid beds of red haematite iron ore as illustrated in Fig. 2.

To a like origin may be traced the formation of the famous bed of haematite ore in the Chapin Mine, near Iron Mountain, Michigan, U. S. A. (Fig. 3.)

This is the greatest deep mine deposit of ore being worked in the world to-day, and was opened in 1880. It consists of four lenticular deposits 2,500 feet long, 130 feet wide, depth unknown. The ore contains 63% of metallic iron, 0.07% phosphorus.

Phosphorus.

Mention of the phosphoric contents of the Chapin Mine ore opens the way for an explanation of the reason why the extensive beds of carbonate iron ores which abound in the Eston hills of Yorkshire, England, and in the broad seams running from New Jersey, through Pennsylvania, down to Alabama in the United States, contain as high as 2.75% of phosphorus; while the 1,000,000,000 tons of haematite iron ores buried in the Mesabi range, and Lake Superior district, U S. A., are practically free from this mortal enemy of the steelmaker.

Popularly stated, there are three periods in geological time:—(1) Silurian: age of Invertebrates; (2) Devonian: age of Vertebrate fishes; (3) Carboniferous: age of coal plants, vertebrate, amphibians and reptiles. It is a well established induction of science that the existence of phosphorus in iron ores is due to the remains of decayed fishes and animals. It is also a fact that the solid frame work of the invertebrate animals which existed in the Silurian period consisted of carbonate of lime; whereas the bony structure of the vertebrates, which existed in the later Devonian and Carboniferous periods, was made up of phosphate of lime. Now the high phosphorous ores of the Cleveland district of England, and Pennsylvania, U.S.A., are all found in beds of the Carboniferous age, in close proximity to the great coal measures, when fishes, amphibians and reptiles abounded; and it is from the decayed bones of these extinct vertebrates that the excessive phosphorus is derived. On the other hand, the Lake Superior haematite ores, are all found in the levels of the Silurian age when vertebrates did not exist; only shells or mollusks, corals, crinoids, trilobites and other invertebrates; and as already stated. The solid frame work of these creatures consisted not of phosphate but carbonate of lime, hence the comparative freedom of these iron ores from phosphorus.

Modern Ore Making.

If proof is needed of the foregoing theory of the origin of iron ores, the reader can have actual demonstration before his eyes in Canada to-day. About midway between Montreal and Quebec in the valley of the St. Maurice, where the river flows from the north into the St. Lawrence, is Lac à la Tortue (Turtle Lake), a body of water four miles long, by one and one-quarter miles in average width, situated in the middle of a swampy morass. The environing land consists largely of sand, doubtless carried down from the archæan rocks in the vicinage, by the erosive and grinding action of glaciers.

Standing on the western shore, the traveler gazes in imagination upon a primeval scene. Innumerable streams and rivulets may be seen winding and percolating their way down to the lake, through the sand rich in oxide of iron. These running waters are laden with the decaying vegetable matter which grows rank in the marshy lands; carrying with it quantities of the sand, saturated with iron oxide. The organic acids evolved by the decomposition of the vegetable stuff dissolve the oxide of iron, which is carried to the lake. But as it floats down, this solution of protoxide of iron is acted upon by the atmospheric air, oxidation takes places, and a remarkable phenomenon is perceived. Patches of iridescent film appear on the surface of the lake, looking like petroleum with its rainbow colors, indicating that the soluble protoxide has been transformed into insoluble sesquioxide of iron. The reason this peroxide film appears in patches, is due to concentrationary action; the particles aggregate themselves into batches, which sink to the bottom of the lake in the form of cakes ranging up to ten inches diameter or more; hence the term "cake ore."

This brown haematite lake ore contains 70% of metallic iron, and seems inexhaustible; for with the decay of each year's vegetation, new supplies of iron from the sands are deposited in the lake. These rich lake ores have been used in the St. Maurice Furnace at Radnor since 1752. In 1775 one of the lessees of the Radnor furnace, aided the American colonists, by casting shot and shell—made from the lake ores—to be used against Quebec.

Lac à la Tortue and a neighboring lake, are the only known instances of the kind on the American continent.

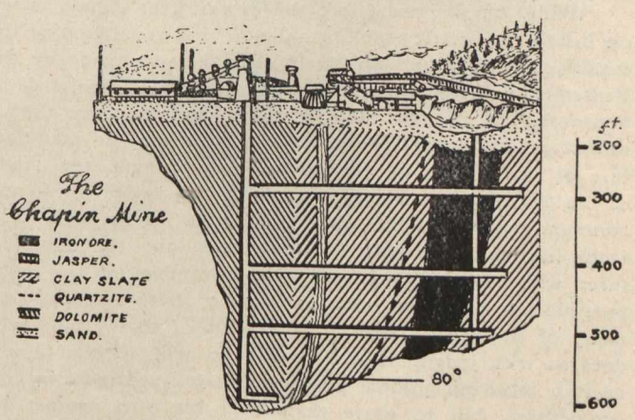

Fig. 3.—The Chapin Mine, U S. A.

Deep mine formations like those of the Chapin Mine and lake bottom deposits similar to that of Lac a la Tortue, are, however, mineralogical curiosities when compared with the magnificent surface deposits of the Mesabi range in Lake Superior country. We are almost bewildered with the marvellous prodigality of nature when we look upon awe inspiring scenes like that pictured in Fig. 4. Gazing upon this stupenduous work of man, we are impressed with the