

there are many large specimens of the ore, some of which, having been polished, show this structure plainly. Pictures of some of them have also been published by Kjerulf.

In this connection, the primitive ore-bearing character of the *fahlbänder* (so often cited by geologists as primary ore-beds, which enrich the veins by which they are crossed) is entirely denied. It has been proved that the ores of the Modum fahlbands are connected with the malakolite and the augite-rock which intrudes in "lineal" form between the steep strata of quartz-schists. Figs. 94 and 95 are intended to show the appearance of these deposits, formerly deemed to be beds. The former represents a specimen from the Kongens Mine at Roras, and the latter a part of the specimen illustrated by Kjerulf, from the Mug Mine at Trondhjem. In the former, the subsequent entrance of the ore is at once recognised. The latter appears as if the crystallization of the minerals had taken place after the ore-impregnation.

Of course, the political boundary does not divide the nature of the ore-deposits of the Scandinavian kingdoms. Those of Sweden are often the continuations of the Norwegian. The crystalline rocks are here peculiarly developed, and have also been peculiarly named by the Swedish petrographers. In the Swedish granulite, for instance, one would scarcely recognise its Continental namesake. These rocks are not in general so coarsely crystalline that their constituent minerals can be distinguished with the naked eye. The so-called eurites are still finely crystalline, and the *hällfrinta* is almost amorphous, consisting only of the ground-mass of the massive rocks. The beds and mass-deposits of the crystalline rocks are often, like many of the Norwegian deposits, associated with talcose and chloritic slates. Sometimes limestone is also present, as at Falun, Tunaberg, &c., where the ores lie on the limestone contacts. The ores of some of the deposits suffer in depth a remarkable change. Thus the mass of copper-pyrites at Falun has diminished in depth; but, on the other hand, gold-bearing quartz-veins appear in the midst of the pyritic body, and have yielded in recent years considerable amounts of gold.

*Ammeberg.*—There is here one of the most interesting deposits—namely, the zinc-blende mine of Ammeberg, belonging to the Vieille Montagne Company, which has personally been examined by me.

In a winding line, chiefly east to west, and about two miles in length, occur steeply-dipping beds of zinc-blende in granulite, or gneiss resembling granulite. At certain points they show very beautiful close folds. At first glance they seem to be genuine intercalated beds of the same age as the rock. The ores, however, do not continue along the whole line, but form separate lenses, up to 49ft. thick, which show a distinct stratification, consisting in layers of fine-grained to amorphous material resembling *hällfrinta*, alternating with the coarser granulite. Fig. 96 is a polished specimen, which exhibits clearly the secondary ore-invasion. The original bedding is here indicated by a series of light and dark dense *hällfrinta* layers; and these are broken through by masses of coarsely crystalline rock and of ore. The entrance of the ore into the coarsely crystalline layers seems to have been attended by an enlargement of their volume, which resulted in their breaking through the dense layers.

The same explanation is required for some parts of the bed, in which, between the plane surfaces of two fine-grained, barren strata, ore occurs in highly folded and contorted layers. This folding is due by no means to an exterior mechanical energy, but to interior chemical forces.

Some of the blende layers carry a considerable admixture of galena, as, for instance, the two ore-layers shown in Fig. 97, separated by a fine-grained, yellow to brown, barren stratum of eurite. The whole mass is traversed by fine fissures perpendicular to the bedding, which are filled with leaf-silver, looking like tinfoil. A replacement with ore of the original rock-constituents is here beyond question.

This Ammerberg deposit, then, although so distinctly bedded, is by no means of primitive origin; and still less can such an origin be supposed for the others, which occur as lenses of the greatest variety of filling, enclosed in the crystalline schists. If mica may be replaced with zinc-blende, magnetite, &c., such a change will, of course, be confined to certain portions of the rock, immediately within range of its cause; and these portions, as distinguished from the rest of the country-rock, are to be considered mineral deposits.

Some of the ore-deposits of the Alps have a certain similarity to those of Scandinavia, for instance, Prettau, in the Ahrn Valley, in Tyrol; Brenthal, near Mühlbach, in Salzburg; and Schneeberg, near Sterzing, in Tyrol.

*Prettau in Tyrol.*—There is here a very ancient copper-mining industry, which was overwhelmed in 1878 by a great disaster, and will not soon recover—viz., the settlement at the smelting-works was buried by an avalanche so deep in *débris* that it has been necessary to sink shafts nearly 65ft. deep and mine out the stock of manufactured copper and other objects of value.

The crystalline schists, which here strike east and west, and dip steeply south, contain impregnations of copper- and iron-pyrites, very short horizontally, but considerably prolonged on the dip. The deposit has been opened to a vertical depth of 1,640ft., representing 1,968ft. on the dip, so that the horizontal projection, or distance between the top and bottom, is only 1,088ft. Figs. 56 and 57 are a vertical section and plan. Figs. 54 and 55 are sketches from the roof and side of the Ottilie gallery, where the chlorite-slate and pyrites present highly complicated forms, somewhat like the structure observed in the Transylvania rock-salt. It may be explained, in my opinion, either by an interior increase of volume or by a distortion of the chlorite slate in the steep westward-pitching line indicated by the ore-deposit. It is extremely difficult to form a correct conception of this deposit.

It is remarkable that the pyrites-mine of Brenthal, near Mühlbach, shows an entirely similar structure and form of ore-bodies, and almost the same westward pitch upon the east-to-west plane of the stratification. It looks as if dynamic movements connected with the mountain had played a leading part in thus determining the same pitch for the ore-bodies of deposits on opposite sides of the Central Alps.