

pictures of such occurrences are highly instructive, since the complications are often so great that the most detailed description can convey no correct notion. Figs. 45 to 52, by reason of their small scale, do not give all the details contained in the originals from which they are taken. Figs. 45, 46, and 47 are from Weisenbach's famous book, and represent Freiberg occurrences. The rest are from Austrian publications. Figs. 48, 49, and 50 refer to Przibram, Figs. 51 and 52 to Joachimsthal. We have in Fig. 47 a specimen, so to speak, of the transition from a vein to a bedded deposit. But this is not the type called by the Germans "bed-vein" (*lagergang*), which is strictly a fissure-vein, the fissure of which coincides with the plane of stratification instead of crossing it. Sometimes it is a joint- or cleavage-plane (often confounded with the bedding) which the bed-vein occupies—a case of which has been found at Mitterberg, in Salzburg, and at the Ramelsberg, near Goslar.

In this category belong also the instances of a squeezing of strata near the vein, so that hanging- or foot-wall, or both, show for a certain distance a stratification parallel with the ore-deposit, and only beyond this zone does the normal stratification in a different plane appear. This case is best represented by Fig. 99, a sketch showing an east and west vein in a country of slate striking north and south. The occurrences at Rodna (Fig. 70) and Raibl (Fig. 69) furnish also some illustrations, though here it is chiefly barren fissures which traverse and bend the stratification.

The great number of ore-veins, as of ore-deposits in general, occur in eruptive rocks—a circumstance which doubtless indicates that their metallic contents have been derived, directly or indirectly, through these or other media, from the barysphere. The most productive ore-veins are wholly in such rocks, but others occur in stratified rocks traversed by eruptives. Comparatively few occur wholly in stratified rocks. In such cases large faults have unquestionably opened communication with the barysphere. To emphasize these relations, some illustrations will be made from well-known ore-vein districts comprising such occurrences,—

- (a.) In stratified rocks, entirely unconnected with eruptives;
- (b.) In the neighbourhood of eruptive masses, and partially enclosed therein;
- (c.) Wholly within large eruptive formations.

(a.) *Ore-veins in Stratified Rocks.*

Genuine ore-veins entirely unconnected with eruptive rocks are not easily to be found—especially in cases of important and well-studied districts. Clausthal, in the Hartz, still comes nearest to fulfilling these conditions. The Hartz Range is a mass of folded Palæozoic strata, which lifts itself in lenticular form above the North German plateau of mainly Mesozoic rocks. The strata comprising the Hartz generally strike at right-angles to the W.N.W. direction of the axis of the range, but most of the faults are approximately parallel to this axis, so that the terms "axial" and "cross" mean here the opposite of what they would mean in ranges the main axes of which coincide with the strike of the strata.

*Clausthal.*—The ore-veins of Clausthal are somewhat peculiar. There are zones of altered rocks, 65ft. to 262ft. wide and extending as far as about nine miles, in which the ore-bodies are somewhat irregularly distributed. These rock-zones are called vein-clay slates to distinguish them from the ordinary slates of the district; and recent careful investigations have shown that their composition practically corresponds with that of the latter. They are therefore, in fact, country-rock, altered for the most part mechanically, and only to a slight extent chemically. They are foliated; but the foliation rather parallels the planes of movement, being somewhat steep, while the strata of the surrounding region have generally but a slight dip. These zones may, therefore, be best conceived as the result of the friction of the great masses which have here been rubbed together.

In recent times, chiefly by A. von Groddeck, it had been actually proved that these zones represent great faults, along which either the foot-wall mass was moved S.W. downward, or the hanging-wall was lifted N.E. The vertical movement, measured at certain points, would be about 1,312ft.; but it is probable that the movement of one mass upon the other did not follow the true dip, and that the horizontal component was much greater than the vertical. The faulted portions of a kersantite vein discovered by Groddeck show that each southern mass was moved further west, or each northern mass further east.

The network in these zones of dislocation is also peculiar. As indicated in Fig. 37, lenticular masses have been isolated, after undergoing severally a movement in the direction of the axis of the Hartz Range; so that the whole zone of lenticular masses expresses the displacement which the solid crust has experienced. The structural significance of the zones is thus clearly disclosed as a means of communication with a deep region from which the mineral solutions ascended to deposit ores in the fissures of dislocation. An ore-vein is thus represented as the boundary of a displaced rock-mass, and so is brought into direct structural relation with the country-rock.

A glance at the geological map of the Hartz Mountains will show, however, that even this region is not free from eruptive rocks, for the stratified formations crossing the mountain axis are traversed by masses of granite, which have evidently played a part in the building-up of the range above the plateau. Moreover, according to the investigations of Dr. K. A. Lossen and others, contact-metamorphosis of the stratified rocks has proceeded from them. E. Kayser fixes the elevation of the granite between the end of the Carboniferous and the beginning of the Permian, and, since several of the faults extend into this rock, he thinks it cannot have been a factor in the fissure-formation. Lossen, on the other hand, is inclined to ascribe to the granite an active part in the formation of the ore-deposits, and to believe that these deposits were influenced by their position against the granite nucleus of the Hartz Mountains, which is said to lie steep on one side and more flat on the other beneath the sedimentary strata.

Accurate geological surveys of the Hartz have noted a large number of fault-fissures, some of which connect the two great ore-deposits of Clausthal and Andreasberg. Those which are called *ruscheln* resemble the dislocation-zones of Clausthal. They are fissures, up to 108ft. wide,