but as forming part of a whole, so that it would be a blunder to have a concession for a single mineral.

We now pass to another question. As deposits are not independent of their position in space, neither are they so in their place in time. Since formation metalliferous deposits have undergone modifications and have not been able to remain in the state in which they were crystallized out in remote ages. These changes have been determined by their approximation towards the surface, and the effects of superficial action must be conceded to extend to a depth of several hundred yards. Fissure veins have a limit both in depth and in height, and if we find them cropping out at surface, it is because denudation has removed more or less of the crust and exposed them to-day. This exposure has induced reactions in the upper parts of lodes which have gradually transposed minerals to continually deeper portions of the veins.

There is everywhere a point beneath the surface where water is reached and below this horizon aqueous actions and movements are decelerated. The nature of the region above this hydrostatic level is entirely different, and throughout this space the surface waters, charged with oxygen, carbonic acid, etc., percolate, reacting on rocks and minerals, and issuing from the surface as springs. It is interesting to note the alterations which are produced in this upper portion, and to a certain distance also under the hydrostatic level, by the incessant circulation of superficial waters. The present was preceded by a higher surface, the vein extending up the interspace, and in which certain ores were placed in solution—for example, copper; this dissolved copper was partly washed away by the rains, but a portion was also precipitated in the vein at some distance beneath. This action continued to the gradual enrichment of the lower zone by cementation. At a varying depth under this zone the unaltered vein becomes, more or less, suddenly poorer. Gold lodes are affected in a similar manner, the lode above the unaltered zone assuming an abnormal productiveness, and the same for silver lodes. These phenomena entail important consequences, of which numerous instances could be cited; a prominent case will be sufficient. When ores are enclosed in calcareous strata these reactions attain a maximum of intensity; thus one is able to refer the development of calamine deposits to the phenomenon of cementation. They are the result of the transformation of blendes, and are not formed in depth. Similar action changes spathic iron to iron oxide, which is shown in iron cappings and in the extensive masses of hematite worked at Bilbao and other places. In the mines of Leadville galena has been converted into cerrusite, but this action is less frequent than for zinc and iron, since the compounds of lead are less soluble.

To sum up, in the presence of metalliferous deposits it is essential to attribute considerable significance to this vadose action; if the country is accidented and if the water level is at a great depth, as in the Andes and Mexico, such alterations may reach a depth of 900 to 1,200 feet. The study of these transformations is interesting from a theoretical point of view, as it affords an explanation of facts inadequately interpreted by the theory of lateral secretion. It is possible thus to construe the presence in these enrichments, formed at an epoch almost contemporaneous, of bones of modern animals which have been enclosed in them. The alterations of minerals much more ancient is confirmed by similar crystallizations of sulphides and oxides often produced in old and abandoned mines. When we are prospecting a new country, we are enabled to grasp some knowledge of its general tectonic character, and to form an opinion on the nature of the enclosed ores, and to determine in what direction operations should be undertaken.

ROSSLAND ORE DEPOSITS*

By O. E. LeRoy.

Rossland is situated about six miles west of Columbia River and five miles north of the International Boundary. The main avenue of the city is 3.410 feet above sea level. The city lies on the slopes of Red and Monte Christo mountains towards the head of Trail Creek. The immediate surrounding country is characterized by mountains with rounded peaks and gentle, flowing slopes. The city commands a view of Trail Creek Gulch, the Columbia Valley 2.000 feet below, the Selkirk Mountains to the east and the ranges in Northern Idaho and Washington to the south.

The first discovery near Rossland was made on the Dewdney trail in 1887, when the Lily May claim was staked. In 1890 the LeRoi, Centre Star, War Eagle, and other mines were staked on Red Mountain, and a small lot of ore was packed out in 1891 and shipped to an American smelter.

The total production from 1894 to 1912, inclusive, according to the Provincial Bureau of Mines, amounts to 4,105,358 tons, containing 1.995,589 ounces of gold, 3,381,421 ounces of silver and 86,608,170 pounds of copper. The gross value is placed at $55,100,259.

The principal mines at present are the LeRoi, War-Eagle, Centre Star group, owned and operated by the Consolidated Mining and Smelting Company, and the LeRoi No. 2 Company. The greatest depth reached is 2,200 feet below the surface outcrops, and all ore mined is shipped to Trail for treatment.

Ore Deposits.—There are two mineralized belts in the Rossland camp, known as the North and South belts, respectively. The North belt is by far the most important. All the rocks, except perhaps the later dikes, are more or less mineralized, but the larger ore bodies are confined mainly to the Carboniferous augite porphyrites and the monozonite, and lie along the northwest border of the large area of monzonite, and near or on the contact of the porphyrites and Mount Roberts formation with the monzonite, granodiorite or granite porphyry. The South belt is underlain mainly by the porphyrites and sediments of Carboniferous age.

In the North belt, the ore deposits occur (a) in fissure veins with or without replacement of the country rock; (b) as lodes in zones of fissuring or shearing, the ore minerals forming a network of veinlets impregnating or replacing in whole or in part the intervening masses of country rock; (c) in irregular impregnations in the country rock. The most important ore bodies found so far have occurred as indicated under (a) and (b). On the basis of mineral contents, the ores may be classified as follows:—

1. Massive pyrrhotite and chalcopyrite ores with some pyrite, occasionally a little arsenopyrite and more rarely magnetite and molybdenite. Galena and blende have been found in a couple of instances. Free gold occurs, but is rarely visible though the proportion runs from 10 to 50 per cent. of the total gold content.

2. Massive coarse grained pyrrhotite with but little copper and gold.

3. Pyrite and marcasite with arsenopyrite in veins with possibly some galena and blende. This type is

*Extracts from Guide Book, No. 9, prepared by the Geological Survey of Canada, for Twelfth Session International Geological Congress, August, 1913.