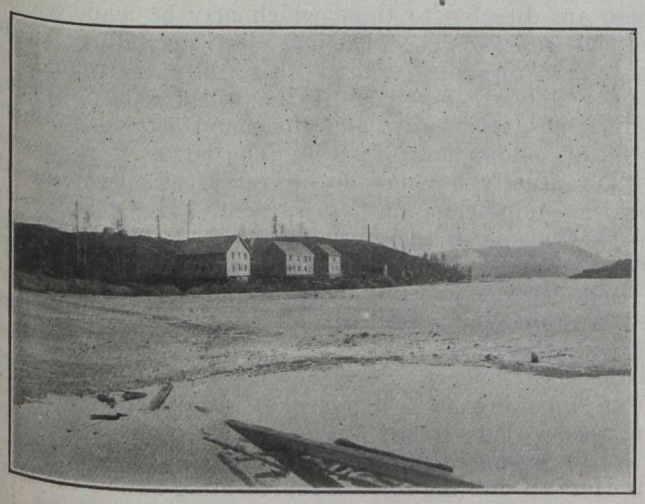
here the products of a later segregation, would probably be absent.

The rocks that underlay the diabase, whether Keewatin greenstone, Laurentian granite or Huronian conglomerate, would be heated by it like the rocks above it, but as the cooling took place largely by radiation of heat from the surface of the earth, and as the laccolith now lay between these underlying rocks and the surface, the cooling would progress exceedingly slowly, in fact it would not begin at all until the laccolith itself had cooled to the temperature of the rock below it. Then this lower rock would begin to cool and shrink, and as the shrinking continued numerous fissures would be formed, which in the aggregate would certainly be widest and most extensive close to the contact with the overlying diabase, and would pinch out and disappear as they descended, or as they went farther and farther from the diabase.

To what depth the rock was affected by the heat from the diabase and by its subsequent cooling is not known, but it will be a matter of great interest to determine, as the fissures occupied by the veins may be expected to extend to that depth.

As clearly shown by Dr. Van Hise, the fissures so



formed in this zone of shrinkage were first filled by calcite and ores of cobalt and nickel by precipitation or deposition from solutions that had risen from deep-seated sources during the later stages of the diabase eruption, and had circulated outwards through cracks and crevices as far as the influence of the diabase intrusion had reached. These minerals now make up very much the largest part of the contents of the veins, so that the veins were formed almost to their present size, and the walls were almost as far apart as they are now, and consequently the adjoining rock had cooled almost to its present temperature, while this early stage of ore deposition was in progress.

As an accompaniment to the very last stages of the diabase instrusion, silver-bearing solutions rose from deep-seated sources along the igneous vents and spread through and under the mushroom-shaped laccolith along the fissures and veins as these widened slightly with the final cooling and shrinking of the rock, the process being continued until all the channels for the passage of the rising waters were choked.

The veins thus fill V-shaped fissures which extend downwards unknown distances below the bottom of the laccolith, or the former position of the laccolith, and in the aggregate become narrower as they go down.

In applying this rule, however, it should be observed that any individual fissure may be only a part of a complex imbricated series, so that while one may contract, another to one side or the other of it may widen to an almost corresponding degree. The rapid pinching out of one vein in depth should not, therefore, lead to the belief that the bottom of the zone of shrinkage had been reached, but should rather lead to exploration for other so-called "blind veins" in the vicinity.

After the veins had thus been formed by segregation from waters of magmatic, or at all events of deep-seated origin, there was a very long period of time during which the earth's surface was here subjected to the influence of atmospheric agencies, and was gradually eroded away. Much of the rock which originally covered the diabase laccolith was thus removed, and doubtless large blocks of the diabase itself were also worn away, uncovering the rocks which underlay it over areas of unknown extent. At the same time many veins holding ores of cobalt and silver were cut into, and exposed to meteoric influences, so that the oxygenated surface waters percolated downwards into them, and leached the silver from their decomposed uppermost portions, redepositing it a little lower down near the zone of groundwater. This process went on continuously as the surface was gradually removed, and the level of groundwater was lowered, and in this way an abnormally rich zone was constantly present in the veins a short distance below the surface. This is the later "secondary enrichment" spoken of by Dr. Van Hise.

As the long period of denudation was drawing to a close, during which erosion, solution and concentration had been almost constantly at work, the Glacial period set in. A vast sheet of snow and ice then moved southward across the country, and cleaned off and swept away the decomposed rock that for long previous ages had everywhere formed the uppermost layer of the surface of the land, and left the greatly enriched parts of some of the veins either exposed to view, or merely covered by a thin layer of boulder clay.

In summing up the evidence, more especially in regard to the veins in the conglomerate and other rocks beneath the diabase, it would thus appear:—

That these cobalt and silver veins were formed in V-shaped fissures which taper from above downwards;

That though they were formed by mineral-bearing waters which rose from deep-seated sources, and were associated with the latest stages of the eruption of diabase, having probably risen through the same vents with it, these waters spread out laterally through cracks and openings in the mushroom-shaped top of the laccolith of diabase, and descended into the fissures in the rocks beneath it;

That thus the veins were originally formed by deposition from waters which locally descended from above, rather than ascended from below, as in most normal veins;

And finally that the veins were superficially enriched at a later period by atmospheric waters descending through portions of the veins which have since been eroded away.