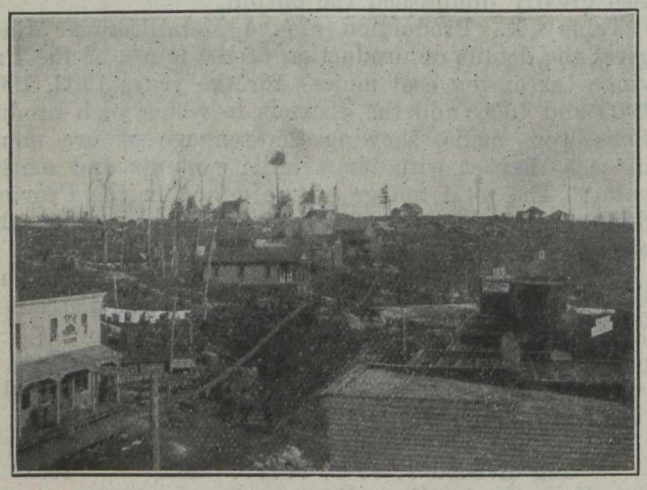
conditions, when atmospheric waters were not present, and the other under surface conditions, when atmospheric waters were present."

Again, "I believe that the extremely rich upper silver belt, so characteristic of the district, is unquestionably the result of two concentrations, the latter of which is accomplished through the agency of atmospheric waters."

Thus two distinct periods of time are here clearly



designated for the deposition of the silver ores, namely, an earlier one under deep-seated conditions away from the presence of atmospheric influences, and a later one under surface conditions, though both of these segregrations are secondary as compared to the prior segregration of the cobalt and nickel ores.

Dr. Van Hise also agrees with Professor Miller and others that the post-Huronian diabase which is known to underlie large areas within the district is the original source of the ore, and also that this diabase has the form of a horizontal sill or laccolith, rather than of a series of huge dikes or batholitic masses which spread out and increase in size as they descend, and that it rose through fissures or vents in the older rocks of Keewatin, Laurentian or Huronian age, until it reached and was stopped by some more resistant layer, through which it was unable to penetrate, and so was forced to spread out horizontally beneath it.

Professor Miller has also shown, in a paper published in the first number of this JOURNAL, that the mineral-bearing veins "appear to have been formed when the cooling of the diabase was taking place. On cooling, the diabase would contract, producing fissures, not only in its own mass, but also in the rocks with which it was in contact, or which lay adjacent to it."

It will be interesting to consider some of the effects on the form and richness of the mineral-bearing veins of the Cobalt district which would seem to follow as natural and logical results from the conditions outlined above. If the conclusions here reached do not harmonize with the conditions that may be found to occur in the mines by the managers and superintendents who are operating them, any corrections and emendations will be gladly welcomed.

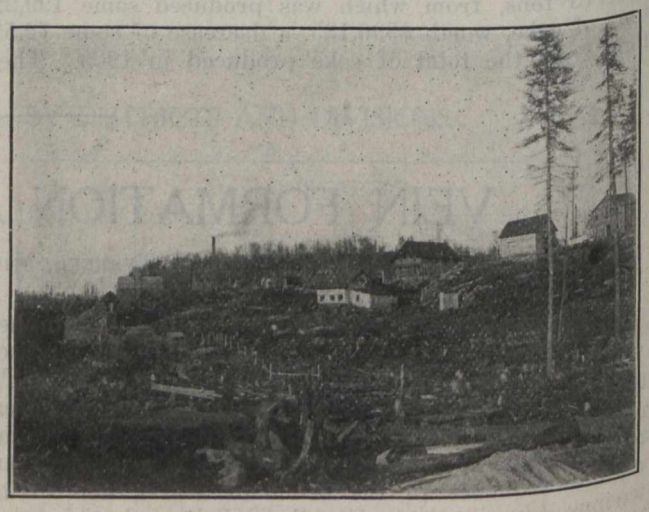
At the time when the laccolith was being formed the molten diabase, after rising for a certain distance through the older and already consolidated rocks, would seem to have met a more resistant layer which obliged it to spread out horizontally along planes of weakness in these rocks and form extensive flat-lying sheets. By the injection of this fluid sheet or lens the superincumbent rock was raised to a certain extent.

The liquid diabase was, of course, very hot, and the heat from it was communicated to the rocks above and below it, and these in their turn would expand with the increase in temperature, but on account of difference in texture and composition the heat would be absorbed differently by different bands, and the expansion would consequently be unequal, so that joints, fissures and shearing planes would be formed.

After the intrusion of the diabase had ceased, it would gradually begin to cool and harden. As it cooled it would contract, and fissures would form in the parts that had consolidated, but while there was any portion of the mass still fluid these fissures would probably be filled from the fluid interior. The fissures occupied by the present veins were therefore formed subsequent to the solidification of the whole mass.

After the mass had solidified, as it and the adjoining rocks gradually cooled they would necessarily contract, the contraction amounting to about 9 inches in 1,000 linear feet for every decrease of 100 degrees centigrade in temperature. This contraction would cause the formation of many irregular fissures normal to the plane of heating and cooling, or in this instance approximately vertical. The fissure would be widest and most extensive either in the diabase itself, or in the surrounding rock wherever this was in immediate contact with the diabase, where the heat had been most intense, and where the subsequent cooling and consequent shrinkage was also greatest.

The rock above the laccolith, extending from it to the surface of the earth, would lose its heat and cool comparatively quickly, and on this account it is hardly probable that it became very hot to any great distance from the diabase. Therefore the cracks and fissures wards more or less at right angles to it, would all be short and very shallow. They would, of course, be that were formed by contraction on cooling in the thin heated layer near the diabase, and that extended out-



widest close to the diabase where the heat and subsequent decrease in temperature had been greatest, and would quickly contract and disappear altogether at a short distance from it. If mineral-bearing solutions in ascending from the heated interior of the earth reached this zone, the fissures were probably filled by such minerals as are known to have been deposited first throughout the district, such as calcite, smaltite, cobaltite, niccolite, etc., but the silver ores, which are