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SHEEP CREEK CAMP.

A brief report on the geology of the camp and the completeness of geological knowledge as it effects development.

Following the early regional work of Daly and Leroy the first detailed study of the camp was made by Walker. Later, about 1938, D.C. Sharpstone and E.N. Pennebaker mapped the surface of the Reno holdings on a scale of 300 feet to the inch; somewhat later Beaton mapped the Gold Belt surface on 200 feet to the inch and J.R. Johnston mapped part of the Kootenay Belle holdings on 100 feet to the inch.

Most of the company geologists also worked underground, although they appear to have done little detailed mapping, but worked more towards the preparation of type sections. C.C. Starr, for Reno, prepared a number of detailed level maps. R.A. McGuire of Sheep Creek published a paper in which was embodied all the then existing information, regardless of authorship, and drew heavily on Sharpstone's sections. Sharpstone's concept of the structure is considered standard in the camp, by operators and consultants alike.

Walker's section on Reno mountain shows Quartzite Range quartzite folded into a tightly compressed anticline, above

which is approximately 3,500 feet of Reno formation, including quartzite, argillites and limestone. There is indicated a subsidiary anticline on the west limb of this main anticline, in rocks of the Pend d' Oreille series. The Pend d' Oreille is not represented in the main anticline, but shows in a syncline to the east.

The Sheep Creek concept of the geology terms the Quartzite Range formation the Motherlode quartzite, and subdivides the upper part to include the Nugget formation, of about 200 feet of argillites overlain by 500 to 1000 feet of Nugget quartzite. The Reno formation is considered to be about 500 feet thick, consisting of a lower argillite-quartzite member and an upper quartzite member. The Reno as so defined contains no limestone whatever and little if any of the biotitic argillites so common in the Pend d'Oreille. The Pend d'Oreille contains limestone, schist, argillite, and a few bands of quartzite in its lower part of about 1000 feet.

Structurally, the Sheep Creek concept of the geology differs from that of Walker in that a well defined subsidiary anticline is recognized west of the main anticline. This subsidiary or western anticline exposes an 800 to 1500 foot width of Reno formation between Sheep Creek and Reno Mountain and, in the basin of Sheep Creek, the Reno is eroded to expose the underlying Nugget quartzite. Between the western and eastern anticline there is a tight syncline of Pend d'Oreille, from 300 to 1000 feet wide. This structure has been mapped by the geologists of the camp from ½ mile south of Sheep Creek to Hidden Creek on the north.

The existence of the western anticline is clearly indicated in the various mine workings, particularly as in Gold Belt and Sheep Creek mines the ore is restricted to Nugget quartzite beneath the arch of overlying Reno argillites and quartzites; in the Reno mine, now inaccessible, the situation is reversed and ore occurs in strongly drag-folded Reno above the Nugget quartzite, according to detailed mapping by Sharpstone. The anticline can readily be seen in No. 3 level at Sheep Creek and Gold Belt workings follow the axis in several cases. The arched Nugget quartzites are exposed on the hillside north of Sheep Creek, topped by less symmetrically folded Reno.

The syncline of Pend d'Oreille rocks is less regular, and the point of curvature cannot be detected owing to some crumpling and the failure of the soft rocks to form an arch at the apex of the fold. In the No. 6 level crosscut on the Kootenay Belle the Pend d'Oreille schistose and calcareous rocks are relatively uncontorted and there is an almost exact repetition of banded limestones against characteristic Reno grits on both sides of the supposed syncline. This is the best proof of a fold seen by the writer.

That the intervening rib of schistose and limy rocks is synclinal is strongly inferred if not proved by the fact that Nugget quartzites on Waldie and Reno Mountains are cross-bedded with the west side definitely up, pointing to an anticline to the east and syncline to the west.

There appears to be no direct proof of the existence of the larger or eastern anticline, beyond the fact of repetition of similar appearing rocks. Where crossed on Waldie, Yellowstone, and Reno ridges no sign of major anticlinal folding was seen, although there is local contortion of beds. The succession on the east side of the main quartzite (Motherlode) is not precisely the same as on the west, although it is similar. Cross-bedding at several horizons in the western two-thirds of the quartzite shows the west side to be up but, although a little cross-bedding was found in the east third of the quartzite it was inconclusive. Where best exposed on the north side of Waldie Creek the supposed Pend d'Oreille is strongly plicated and for this reason difficult to compare with that on the west.

Several bands of chloritic material in the quartzite, the most prominent of which is 50 feet thick, were seen in all three sections east of the centre of the band. There is no repetition of these bands such as would be produced by a major anticline. On Waldie ridge, about 2,000 feet east of the peak, there is a band of 400 feet of argillites in the quartzites. This band does not persist more than a mile to the north in spite of the fact that it can be clearly seen crossing two ridges and an intervening valley nearly 1,000 feet deep.

The writer does not doubt that an anticline exists, but the foregoing makes him feel that the structure is not symmetrical and that there may be infolds— as of the 400 feet of argillites. With a southerly plunge demonstrated in the camp this infold on Waldie ridge would not necessarily show on Yellowstone or Reno ridges.

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The main features of the structure, as set forth above, appear to be correct from the writer's own observations both on surface and underground.

The importance of structure in the localization of ore is great. With the exception of Reno, the many ore bodies in the camp are almost entirely restricted to the Nugget quartzite, either in the crest of the western anticline or the west limb of the eastern anticline. A little ore has come from the overlying Reno but that formation has not yet been fully explored. The Motherlode vein has been followed into the Motherlode quartzite and has produced ore therein, but exploration on other veins in that rock is small in amount.

The veins belong to a set of steeply dipping fractures which strike about N 65° E and which are seen from one end of the camp to the other. Not all of these fractures are mineralized so far as known, but neither are the vein fractures continuously mineralized. These fractures are seen in the Motherlode quartzite as well as in the Nugget and, so far as seen in a brief survey, equally well developed. A second set of vertical fractures, or joints is normal to the strata.

The major concept of the structure is understood and followed by all operators, but the details are not known. The only complete mine section worked out is that of Sharpstone on the Reno vein, where the ore is localized in drag-folded Reno quartzites and argillites. This is an important point, because

the ore seems perhaps localized there because the Reno has been stiffened and rendered more competent as a unit by the folding. Other workers, namely Johnston and Schmidt, believe that in Kootenay Belle and Gold Belt drag folds in Nugget quartzites have exacted a localizing influence, a point I had not the opportunity to check. Certainly the Reno formation throughout most of the camp remains virtually unexplored, and the internal structure is not known. Detailed study of the western anticline would establish its form and nature, and would help greatly in exploration. The study should help to solve many baffling problems, chief of which is: what are the localizing factors in the position of ore shoots?

There is as yet, to my mind, no proof that ore bodies are solely localized in the general hooded section of the western anticline and in a given vertical range in the western limb of the eastern anticline. The men of the camp believe that the several veins bottom owing to the presence of underlying granite, but there is no proof that this is so any more than that there may be a second horizon of ore bodies beneath a general barren zone. A structural study should go a long way to prove this point, and might, if successful, bring in hitherto unknown or unsuspected ore-bodies.

There is a possibility of another, satellitic anticline on the west, indicated on Walker's section and suggested by my own observations. If so, and the quartzites are not buried too deeply, there is a chance for an entirely new section of ground

~~of ground~~, some 6 miles in length. If the eastern anticline is complex, as vaguely indicated, then certain parts or horizons should repay prospecting, since fractures of the ore-bearing set are widespread. The base of the Pend d'Oreille syncline is not known, but could perhaps be determined approximately by a close structural study.

Current practice in the Sheep Creek Mine is to follow all fractures of the ore-bearing set, as encountered and regardless of presence of mineral. This work has been a large part of the 12,000 feet of development a year in normal times. The precise relation of the veins to the wall rocks has not been understood, and much difficulty has been encountered. It is a fact that the vein fractures persist, but are productive chiefly in the heavier bedded quartzites, but there are exceptions to this rule, and the fractures locally pass into bedding planes and become dissipated on both dip and strike, only to appear somewhere else. If the structural relations of the veins and their typical behaviour in various structural elements could be worked out, a great deal of time and money could be saved.

It is not known whether the ore bodies of the camp are due entirely to the existence of a set of north-east fractures which, in suitable situations, are receptive of ore, or whether there is some other major factor of control. The aplite dyke which traverses the camp from end to end, either in two strands or in single widths up to 100 feet, has been credited by some with a controlling influence. Another major feature is the Queen fault, dipping eastward at 45 degrees and seen underground only in the southern part of the camp. This fault clearly displaces the veins.

In my estimation a close study of Sheep Creek camp by the Department is very much worth while. The work would be appreciated by the operators, both Gold Belt and Sheep Creek. Henry Doelle was keen, and all of his staff would be glad to have many points cleared up.

The work would entail mapping of the surface from the granite on Lost Creek to Hidden Creek, a length of 7 to 8 miles and across a width of about three miles. Much mapping has already been done between Waldie and Hidden Creeks and would simply have to be checked. Mapping should be done on a scale of 500 feet to the inch for the entire job, in order to locate contacts and structures sufficiently accurately to be of direct benefit to exploration. Some of the mapping should be on a larger scale in order to be able to correlate surface with underground geology.

Studies of all veins should be made, a long and tedious job, but necessary for the understanding of the localization of ore. Mapping of many of the workings is comparatively easy, but in some parts is slow and difficult. Accurate sections should be prepared at frequent intervals.

Plane table mapping can be employed, and should be, on much of the ground but parts are so steep and in others the geology seems so simple that plane table coverage of the entire area is not warranted. The preparation of a topographic base is necessary; parts can be made by plane table but overall instrumental control is necessary. In my opinion the work could be done by photo-topographic methods, i.e. by horizontal photographs and triangulation.

A liberal use of signal stations would benefit the geological mapping both to provide ties for compass work and for plane table orientation.

Topographic mapping could be done in a season, but only by a competent topographer. Geological work would take two full seasons, and it might be considered worth while to spend even more time than that.

For the work to be done well and efficiently it should be the sole concern of the geologist until the job is finished. It is a laborious job involving a great deal of paper work, and the geologist must get to know the camp thoroughly and all the problems of mining as well as geology. He cannot work efficiently and to good advantage if he must do other jobs concurrently. A reasonably comfortable headquarters must be set up with good facilities for drafting and office work.

The work might best be done with one good assistant the first year, one who could act as a senior assistant the second year with semi-independent duties.

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