COPPER DEPOSITS AT RUBY CREEK

MR-028-02

For the past seven years Bear Creek Mining Company has been engaged in the exploration of an interesting copper deposit at Ruby Creek in northwest Alaska. The deposit is of interest by virtue of its unusual geologic character and the technical problems posed by the remote and arctic location.

Ruby Creek is 13 miles north of the village of Kobuk on the Kobuk River. The River flows west and empties into Kotzebue Sound, north of the Seward Peninsula. It is roughly 150 miles east of the town of Kotzebue; 150 miles west of Bettles; and 300 miles northwest of Fairbanks. Access is by air from Bettles or Kotzebue - which are on the main airlines from Fairbanks. Heavy equipment and fuels are barged up the River from Kotzebue.

The copper deposits at Ruby Creek were discovered in 1901 by gold seekers. After a brief flury of activity the prospect lay dormant until Rhinehart Berg, for all practical purposes, rediscovered it in 1948. It should forever be to Berg's credit that in the long years following he stuck with it and after much hard work stripped and exposed the best of the near surface mineralization. In 1956 Russ Chadwick examined the prospect for Bear Creek; we optioned the property on the basis of Chadwick's recommendation and in 1957 began drilling.

Because of the relative scarcity of outcrop in the area, our knowledge of the deposit has been derived primarily from drilling results. As it turned out, the best mineralization yet known was completely blind. Most of the holes were drilled BX wire-line and core recovery was excellent - especially so in the mineralization. Deviation of the holes was great enough to be a problem; they were surveyed with Sperry-Sun single-shot apparatus. Holes in the valley gravel were drilled and cased to bedrock with a churn drill.

Ruby Creek is in a Paleozoic orthogeosynclinal terrane just north of the Cretaceous Koyukuk Basin. The metamorphic grade of the Paleozoic sediments is variable but generally is low. Structure is not complex and the grain of the country runs east-west. Basic sills and dikes and a few granitic bodies are present. The nearest known granitic intrusive is 25 miles northeast of the deposit. The rocks in the immediate vicinity of Ruby Creek are low in the greenschist facies but feldspathic gneiss is exposed in a canyon 7 miles to the east.

The deposits at Ruby Creek occur in a reef complex within carbonate rocks of upper Devonian age - presumably post Skajit limestone. The carbonates conformably overlie a muscovite - chlorite - quartz phyllite. This varies from an argillite to a schist and generally is carbonaceous. The carbonates are overlain, also conformably, by an interbedded sequence of chloritic argillites and meta-basalt. All of these are, to the south, unconformably overlain by clastic Cretaceous sediments of the Basin. Sill-like bodies of serpentinite are common at and near the unconformity. The Paleozoic, and to a lesser extent, the Cretaceous rocks form a large east-west doubly plunging anticlinal fold. This structure is somewhat modified by faulting but is more so by cross folding. The deposit is on the north flank of the main fold about 3 miles from the trace of the axial plane.

There are at least 2500 feet of Devonian carbonates at Ruby Creek. A great variety of lithologic types, including argillaceous sediments, are present. The assemblage constitutes a typical multiple patch-reef complex (if there is such a thing).

The reefs are both biohermal and biostromal and may pass from one type to the other. Most contain a large proportion of fragmented reef material and they are often bordered by extensive aprons of debris. Algal material and corals are the chief reef builders. The fauna is very similar to that of the Devonian reefs of Alberta.

All of the reef material, including the surrounding debris, is now dolomite. The weight of evidence is overwhelmingly in favor of a penecontemporaneous origin. The presence of dolomite reef detritus in calcareous near-reef sediments suggests that this dolomitization must have been very early.

In and near the reefs, facies changes are frequent and often quite abrupt. These lateral variations along with vertical repetitions, variations in thickness, and the effects of diagenesis and mineralization have made correlation a formidable task. Largely through the efforts of Riz Bigelow we are now able to find our way around in this mess.

Most of the carbonates are fine-grained, particularly the dolomites. Delicate organic structures have been preserved - even in mineralization. Most of the original sedimentary features are still recognizable to the practiced eye. Carbonate veinlets of many ages are abundant. Veins in limestone are nearly always calcite and veins in dolomite generally consist of dolomite. We attribute little significance to these - even though they usually contain sulfides when in mineralized rock. It appears that little material has been added but sulfides, though the deposit does represent a major concentration of sulfur, iron, and copper.

But for one major fault just inside the mineralized area, the structural setting is relatively simple. Dips vary from 20 to 45 degrees to the north but anomalous attitudes are often observed in the vicinity of steep facies boundaries. These are attributed to initial dips and to the results of penecontemporaneous deformation such as differential compaction and slumping. The reef complex in itself makes an antiform. No doubt the area was structurally active in Devonian time and possibly the location of the reef complex was structurally controlled.

In their gross geometry the Ruby Creek deposits are stratiform; the greatest dimensions are in the plane of the bedding. They exhibit a sometimes remarkable conformity to original sedimentary features. A close relation exists between both the character and degree of mineralization and the lithology.

Within the more extensive low-grade mineralization are higher-grade runs - which constitute our orebodies. These are recognizable as geologic entities and the distribution of copper values within them meet the statistical tests for randomness.

The mineralogy has been the subject of a doctorial thesis at Harvard by Donald Runnells. I cite his work as authority for some of what follows. The chief primary sulfides are: pyrite, chalcopyrite, bornite, chalcocite, sphalerite, tennantite, and p pyrrhotite. Present in minor amounts are galena, germanite, carrollite, and marcasite. There are no credits other than copper in the ore. Occasional specimens of the better-grade ore exhibit radioactivity of up to 6X background. The mineral responsible has not yet been identified.

The effects of supergene alteration are not quantitatively important. Runnells finds the principal supergene sulfides to be: djurleite, covellite, digenite, and sooty chalcocite. Djurleite approximates chalcocite in composition and can be distinguished from it only by powder X-ray methods. The digenite is formed early in the alteration of bornite. Limonite is abundant and lesser amounts of the basic copper carbonates and cuprite, native copper, and an arsenate are present.

In places, primary sulfides completely replace the host rock. More commonly they occupy - with some replacement - discontinuities in the host. In the carbonates they appear as an interstitial filling between carbonate grains, they rim sedimentary clasts, line stylolitic surfaces, and fill minute fractures. Organic structures are often partially replaced. In the argillaceous sediments, sulfides appear as conformable seams and as disseminations along the bedding.

Pyrite is by far the most abundant sulfide, usually comprising not less than 10 or 20 volume percent of the sulfides in any given specimen. Its distribution bears no relation to ore. Often the pyrite exhibits the concentric banded textures suggestive of deposition from the colloidal state. Framboidal pyrite is common in the argillaceous sediments and not uncommon in the carbonates.

Chalcopyrite is the most abundant copper sulfide but, much of the ore contains a high proportion of bornite and steely chalcocite.

The textural relations of the sulfides shed little light on the sequence of mineralization; but clearly, most of the pyrite is early. Chalcocite appears to be later than bornite but the textures may also be interpreted as being a result of exsolution.

Runnells recognizes a vertical zonal pattern which we do not. But there is a suggestion of zoning in plan. Ideally, the sequence proceeding outward is 1) bornite & chalcocite, 2) bornite & chalcopyrite, and 3) chalcopyrite & tennantite. Several centers are involved and the actual situation is somewhat confused. Sphalerite is ubiquitous but tends to occur in greatest concentrations in areas peripheral to the strongest copper mineralization. Pyrrhotite is rare in the ore and is abundant only where the host rock is sideritic.

Barite and fluorite occur with calcite in post-copper veins. Granules and granular aggregates of anthraxolite are fairly common within the carbonate host rocks. But show no apparent relation to thesulfide mineralization.

Wallrock alteration is not much in evidence. There has been no silication - except, perhaps, to form cymrite: a barium-aluminum-silicate. Siderite is abundant in several distinct st stratigraphic positions. The field evidence suggests it to be an original sedimentary unit (a facies); while the laboratory evidence suggests it to be a product of solution alteration.

It is premature to comment on the commercial possibilities of the deposit. But a typical operation for an enterprise of this type would assume room and pillar open stoping from inclined haul roads using trackless diesel equipment. The milling would be straightforward and ~~would be~~ done near the shaft collar. Concentrates would have to be trucked 15 miles to the Kobuk and stored for shipment during the annual shipping season. Because of ice, this season is limited to 3½ months in the summer, and, needless to say, transportation would loom large in the cost schedules.

NORMAN LUTZ
12/7/63

N.W.M.A. CONVENTION