THE SAMATOSUM DEPOSIT

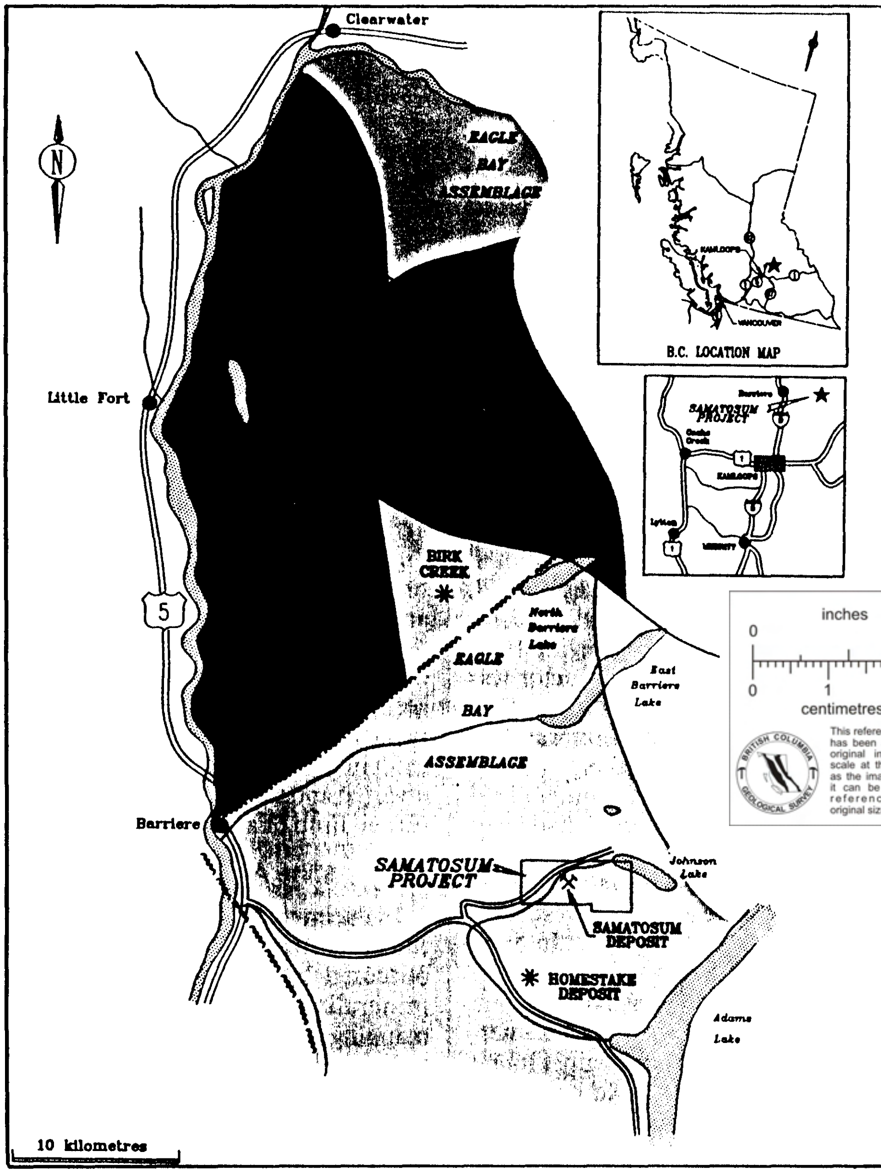
By Ian Pirie

Situated in the rolling Shuswap Highlands, 60 km northeast of Kamloops in south-central British Columbia (right), the Samatosum deposit is becoming the first of what Minnova Inc. believes will be a number of mines in this under-explored region. Discovered in 1986, it is under development, with production scheduled for the third quarter of 1989. Current reserves are an undiluted 634,984 tonnes grading 1,035 g silver per tonne, 1.9 g gold per tonne, 1.2% copper, 3.6% zinc and 1.7% lead.

The area between Barriere (on the North Thompson River) and Adams Lake (30 km to the east) has long been recognized by prospectors and geologists as a likely hunting ground for mineral deposits. The Homestake barite/sulphide deposit was found in 1893, numerous small stratiform massive sulphide deposits were found in the Birk Creek area in the 1920s and, in 1978, a massive sulphide deposit containing at least two million tonnes of 1%-2% copper was discovered on Chu Chua Mountain. Still, none of these ever resulted in significant production, and many thought of the area as consisting of teasers and red herrings without substance.

However, the continual improvement in access by local logging companies assisted prospectors as they continued to search the area. In the summer of 1983, Al Hilton and Roy Nicholls of Kamloops, B. C., noted a red color in the soil of a recent clearcut. They borrowed a nearby dozer to do a little digging and found massive sulphides over a width of 10.5 ft. Assays of this material produced gold values in excess of one ounce per ton as well as significant silver, copper, lead and zinc values. This area became known as the Discovery zone.

This find caused a stir in the exploration community, and in a flurry of activity that followed, Rea Gold Corp. picked up the property and optioned it to Corporation Falconbridge Copper (now Minnova Inc.).



SAMATOSUM PROJECT

Minnova Inc.

Early exploration was not encouraging as the first seven drill holes, in the immediate area of the discovery, failed to intersect significant sulphides. The eighth hole hit 2.5 m of barite and 0.5 m of massive sulphides, but this was 300 m farther up the hill and not connected to the Discovery zone. It was the only significant intersection of the first 20 holes.

Drilling continued and, after 18 months, two small but fairly high-grade massive sulphide pods (one of which has associated massive barite) were outlined. However, there was a metallurgical problem. The gold is very fine-grained and held in arsenopyrite. At about this time, Rea Gold assumed control of a small concession area surrounding the known mineralization and Minnova received the right to earn an increased interest in the rest of the property. (Rea Gold has continued to explore the concession. Their most recent published estimate of the mineralization is 169,000 tons of 0.27 oz gold per ton or 154,000 tonnes of 9.3 g gold per tonne.)

Up to this point, Minnova's drilling on the property had been restricted to a small area and had been target-specific. The original discovery was marked by a very strong gold/arsenic soil anomaly and responded well to very low frequency (VLF) methods. Drill holes had been targeted either on the known mineralized horizon or on nearby gold/arsenic and VLF anomalies. The new deal enabled Minnova to take a broader look at the claims.

Mapping in 1984 and 1985 produced a general understanding of property stratigraphy. In addition, horizontal-loop electro-magnetic (HEM) surveys defined several long strike-length stratiform conductors. One of these was known from drilling to be a graphitic argillite in the immediate hangingwall to the Discovery zone horizon.

Another conductor, about 600 m to the northeast, had no gold or arsenic anomalies associated with it, but it did have erratic, high values of lead, zinc and silver. Drill hole RG-37 hit 3.5 m of massive barite assaying 164 g silver per tonne. The conductor was clearly an argillite but, as at the Discovery zone, mineralization was very close to it in the sequence.

By early 1986, the new mineralized horizon (the "Silver zone") had been tested at 100- to 150-m intervals for more than 2.6 km. But there was a 400-m gap where access was restricted by steep and rocky terrain. In July, 1986, a drill pad was built on the rocky hillside; RG-64 was collared, and one metre of massive sulphides was intersected, grading 2,700 g silver per tonne (79 oz per ton), 3.8 g gold per tonne (0.11 oz per ton), 9.3% copper, 7.8% zinc and 6.9% lead. Samatosum had been discovered.

Regional Geology

The Samatosum deposit is in a structurally complex sequence of Palaeozoic metavolcanic and metasedimentary rocks named the Eagle Bay Assemblage (Figure 1). This assemblage, described by Schiarizza and Preto (1987), is on the western margin of the Omineca Crystalline Belt between high-grade metamorphic rocks of the Shuswap Metamorphic Complex to the east and rocks of the Intermontane Belt to the west. It consists of mafic to felsic pyroclastics interbedded with limestone, chert, greywacke, argillite and conglomerate, intruded by granodiorite and quartz-monzonite of the Cretaceous Baldy Batholith. It is locally overlain by Tertiary volcanics and sediments.

All pre-Cretaceous rocks have undergone several phases of deformation. This has resulted in several phases of folding, numerous faults and a strong penetrative foliation. Metamorphic grade is lower greenschist facies except for areas adjacent to the Shuswap Complex to the northeast, where amphibolite grade is reached.

The age of the Eagle Bay is poorly defined. It appears to range from Cambrian to Late Mississippian. As a result, parts may correlate with rocks of the Kootenay Arc in southeastern British Columbia and the Barkerville Terrane in the Barkerville/Cariboo River area. The age range of the assemblage strongly implies major unconformities and/or structural breaks.

The Samatosum deposit lies within a mixed volcanic/sedimentary sequence at or close to a significant break between a volcanic-dominated and a sediment-dominated depositional environment. Although sediments form the structural footwall and volcanics the structural hangingwall to the mineralized horizon, structural evidence indicates the sequence is inverted and the deposit is on an overturned limb of a recumbent syncline.

Mine Area Geology

In the immediate area of the deposit the protolith of the host rock is often obscured by intense alteration and mineralization. However, detailed mapping and core logging are starting to produce an understanding of the depositional environment.

The deposit is on the overturned limb of a major syncline. The oldest stratigraphic units are the structurally highest. The stratigraphic sequence consists of pyroclastics, epiclastics and sediments, all altered to varying degrees.

Pyroclastic rocks are mafic in composition and typically contain matrix-supported, subangular to subrounded blocks up to 15 cm in diameter. These blocks are the same composition as the matrix. Locally they appear vesicular and quite stretched. Basaltic flows are rare in the sequence and unknown in the vicinity of the deposit. However, fragment-poor tuffs are common and become the predominant rock type toward the stratigraphic top of the pyroclastic unit. Quartz-carbonate veins are common and locally contain small amounts of galena, sphalerite and, more rarely, chalcopyrite.

Hydrothermal alteration is generally restricted to a stratiform band at the top of, and as much as 30 m down into, the basalts. It consists almost entirely of sericite with minor amounts of carbonate. To date, no crosscutting, pipe-like alteration feature has been recognized at Samatosum. The altered rocks contain up to 20% pyrite while unaltered rocks rarely contain more than 1%.

In places, the top of the mafic sequence is marked by a gradation through sericitic tuff to "muddy tuff," but usually there is an intervening chert unit. The chert is a well-layered silica gel with laminae of sericitic tuff, argillite and, occasionally, sulphide. It shows evidence of both primary slumping and tectonic folding and brecciation. The rapid changes in thickness of the chert are believed due to pooling within fault-controlled topographic lows on the ocean floor.

The field term "muddy tuff" was established early in the exploration of the property and has been retained despite being a misnomer. It refers to a unit of uncertain parentage which, in drill core, appears as a homogeneous, muddy grey-colored, nondescript rock. Subsequent drilling away from mineralization has revealed it to be a predominantly epiclastic to sedimentary unit with a minor tuffaceous component. Wackes, argillites, cherts, mafic tuffs and debris flows comprised of small (less than 2 cm) fragments of every rock type in the area have been homogenized by sea floor hydrothermal activity to form muddy tuff. Alteration mineralogy has not been studied in detail, but is believed to include sericite, chlorite and clay minerals.

Muddy tuff is strongly mineralized. Much of this mineralization is syngenetic to diagenetic pyrite which commonly occurs in cencentrations of 20%-30%, although there are locally zones of 80%-plus.

True sediments occur as one thin (10-m) band within the muddy tuff in the immediate area of the deposit. The band becomes considerably thicker along strike to the northwest. It is predominantly a bedded wacke, with muds and silts forming interbeds a few millimetres to several metres thick. Graphitic argillite constitutes a small portion of the sediment volumetrically but is significant because it provides marker horizons which can be traced by geophysics across the large areas of thick overburden. Quartzose grit, which grades into a fine quartz pebble conglomerate, locally provides a good marker for drill hole correlation.

Strong sericitic alteration makes sediments difficult to distinguish from tuffs. Under these conditions, the sediments may contain 20% or more pyrite. Mineralization is usually restricted to thin pyritic argillite beds.

Mineralization

The Samatosum deposit consists of 634,984 tonnes of ore consisting of tetrahedrite, sphalerite, galena and chalcopyrite within a much larger tonnage of dominantly pyritic material. Minor minerals identified include electrum, bournonite, gersdorffite, chalcocite, arsenopyrite and covellite. Virtually all the silver is in tetrahedrite, while the gold occurs as electrum.

Non-ore sulphides contain some sphalerite, galena and chalcopyrite but only minor tetrahedrite. Several holes intersected semi-massive to massive, bedded and brecciated sulphide sections up to 11 m thick, which contain 2% to 3% zinc and 1% copper but with low precious metals contents. In other places, several tens of metres of muddy tuff may be present with 20%-40% pyrite and only parts-per-million levels of zinc, copper and silver.

Ore grade sulphides take one or more of the following forms:

- Massive sulphide bands, generally associated with strongly brecciated bull quartz. The sulphides can be massive tetrahedrite, sphalerite, galena or chalcopyrite or almost any combination of them.
- Pyritic "muddy tuff" cut by zones of silica flooding and fine quartz veinlets containing tetrahedrite and sphalerite.
- Finely disseminated tetrahedrite with or without minor sphalerite in units of high primary permeability and porosity such as quartzose wackes.

Massive sulphide ore is prevalent in the near surface parts of the orebody. Where tetrahedrite is the dominant sulphide, assays of up to 35,000 g silver per tonne (3.5% or 1,000 oz per ton) and 35 g gold per tonne (one ounce per ton) have been returned.

More commonly, silver grades are in the 3,000-g-per-tonne range and gold values 3-4 g per tonne.

Ore associated with silica flooding occurs mainly in deeper parts of the orebody. Tetrahedrite invariably rims sphalerite in 1-5-mm-thick silica veinlets within wider zones of silica enrichment. Typical values are 250 to 1,000 g silver per tonne.

Finely disseminated ore is less common and provides only a small part of the overall tonnage. It is also easy to overlook. In quartzose wackes, it takes the form of finely disseminated tetrahedrite specks fractions of a millimetre in diameter. In some of the more permeable muddy tuff units, it is accompanied by strong sericitization. Subsequent deformation produces a micaceous schist with a silvery color which masks the fine silvery grey specks of tetrahedrite.

The complete orebody is a flat, plunging zone 450 m long by 150 m wide with an average thickness of around 6 m. It is roughly lens-shaped with a thicker core tapering out on the extremities. No obvious metal zonation is present, with material on the flanks often having good grades over narrow widths. Ore margins are sharp, if somewhat irregular. Indeed, the cutoff grade of 250 g per tonne silver is only a factor where narrow, high-grade zones have to be diluted to a minimum mining width (2 m).

Metallogenesis

According to current evidence, the Samatosum deposit does not fit into any classic genetic model. New evidence from open pit mining should answer many of the outstanding questions. However, tentative metallogenic conclusions can be drawn at this time.

Overall, the deposit can be regarded as a traditional volcanogenic massive sulphide model formed on a hydrothermal system exhaling silica and metal-rich solutions into a submarine environment. Locally, the solutions are deposited directly on to the sea floor as massive sulphides or chert. More commonly, the pressure and temperature conditions in this particular basin were such that hydrothermal solutions precipitated out subsurface, altering and strongly mineralizing the host sediment. This produced the muddy tuff unit, in which the primary textures have been obliterated and sulphide content ranges from 1% or 2% to 100%. Chert exists where both sediment and tuffaceous material were silicified.

A second event explains why ore-grade sulphides form only a small part of the mineralized zone. Most sulphide produced by the system is not of economic grade. Semi-massive to massive sulphide sections containing zinc and lead values in the order of 2%-4% over thicknesses of up to 10 m are not uncommon, but if the sphalerite and galena are not accompanied by tetrahedrite, which is often the case, silver values are 30 to 40 g per tonne. Tetrahedrite, where it occurs, is associated with quartz veins and silica-flooded zones. These zones, although stratabound, crosscut lower-grade mineralization and must post-date it. At present, there is no information on the absolute ages.

Preliminary lead-isotope evidence suggests lead in veins is the same as lead in syngenetic sulphides and is Devonian in age. This is also the postulated age of the host rocks. It is unlikely there was any significant addition of lead either during periods of igneous intrusion (Cretaceous to Tertiary) or during tectonic upheaval (Jurassic to Cretaceous).

Because of this, at present it is believed the introduction of the tetrahedrite which carries most of the precious metals occurred shortly after the deposition of the original sulphides. It may have been a final pulse of the same hydrothermal episode. Subsequent deformation redistributed what was there into its present form.

REFERENCES:

Schiarizza, P. and Preto, V. A.; (1987) *Geology of the Adams Plateau/Clearwater/Vavenby Area;* B.C. Geological Survey, Paper 1987-2.

Ian Pirie is a senior exploration geologist with Minnova Inc. in Vancouver, B.C.

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