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FIELD TRIP B2

MINERAL DEPOSITS OF THE SOUTHERN CANADIAN CORDILLERA

May 18 - 23, 1990

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A.S. Legun

District Geology Section
British Columbia Geological Survey
Ministry of Energy, Mines & Petroleum Resources

STOP 3

GEOLOGY OF THE SAMATOSUM DEPOSIT

by

R.G. Friesen
Chief Geologist, Samatosum Division
Minnova Inc.

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GEOLOGY OF THE SAMATOSUM DEPOSIT

Introduction

The Samatosum Mine is a 70:30 Minnova Inc./Rea Gold Corporation joint venture, located about 60 kilometres north of Kamloops B.C. Access is via a 35 kilometre secondary road eastward from Louis Creek, which lies on Highway 5 about 3 kilometres south of the logging/farming town of Barriere (pop. 1200). In terms of payable metal values, Samatosum is a silver, gold, zinc, copper, lead, and antimony mine.

The property lies on the northern slope of Samatosum Mountain, ranging in elevation from 1100 to 1500 meters above sea level.

Minnova first acquired the Samatosum property from Rea Gold Corporation back in 1983 on the strength of newly discovered gold and base metal mineralization, and favourable alteration and stratigraphy. However, this "Discovery Zone" (or Rea Gold Zone) as it is now referred, proved to be uneconomic and in 1985, Minnova renegotiated their agreement which effectively returned the Discovery Zone back to Rea Gold in exchange for a 70% interest in the remainder of the property. The following year, Minnova discovered the Samatosum Deposit nearby and by the end of 1987, diamond drilling had established an undiluted mineral inventory totalling 634,984 tonnes grading 1.2% copper, 3.6% zinc, 1.7% lead, 1035 g/t silver and 1.9 g/t gold.

During 1988, a feasibility study determined the deposit could be mined economically by open pit methods, despite an unusually high 25 : 1 waste to ore stripping ratio. The milling rate was set at 422 tonnes per calendar day to produce three separate concentrates of combined copper-silver, lead, and zinc. A Stage 1 Environmental Impact Assessment was filed with the British Columbia Mine Development Review Committee in June, 1988 and was conditionally accepted 3 months later; followed immediately by construction startup.

Mine stripping began in March, 1989. Ore production and milling began in May, 1989; one month ahead of schedule.

Total cost of the project construction and startup phase was $31.0 million, or $1.2 million under budget.

Mining Operations

The current development plan includes two phases of open pit mining: Phase 1 to take 193,000 tonnes of diluted ore until June, 1990; and Phase 2, to take 308,000 tonnes until January, 1993. A

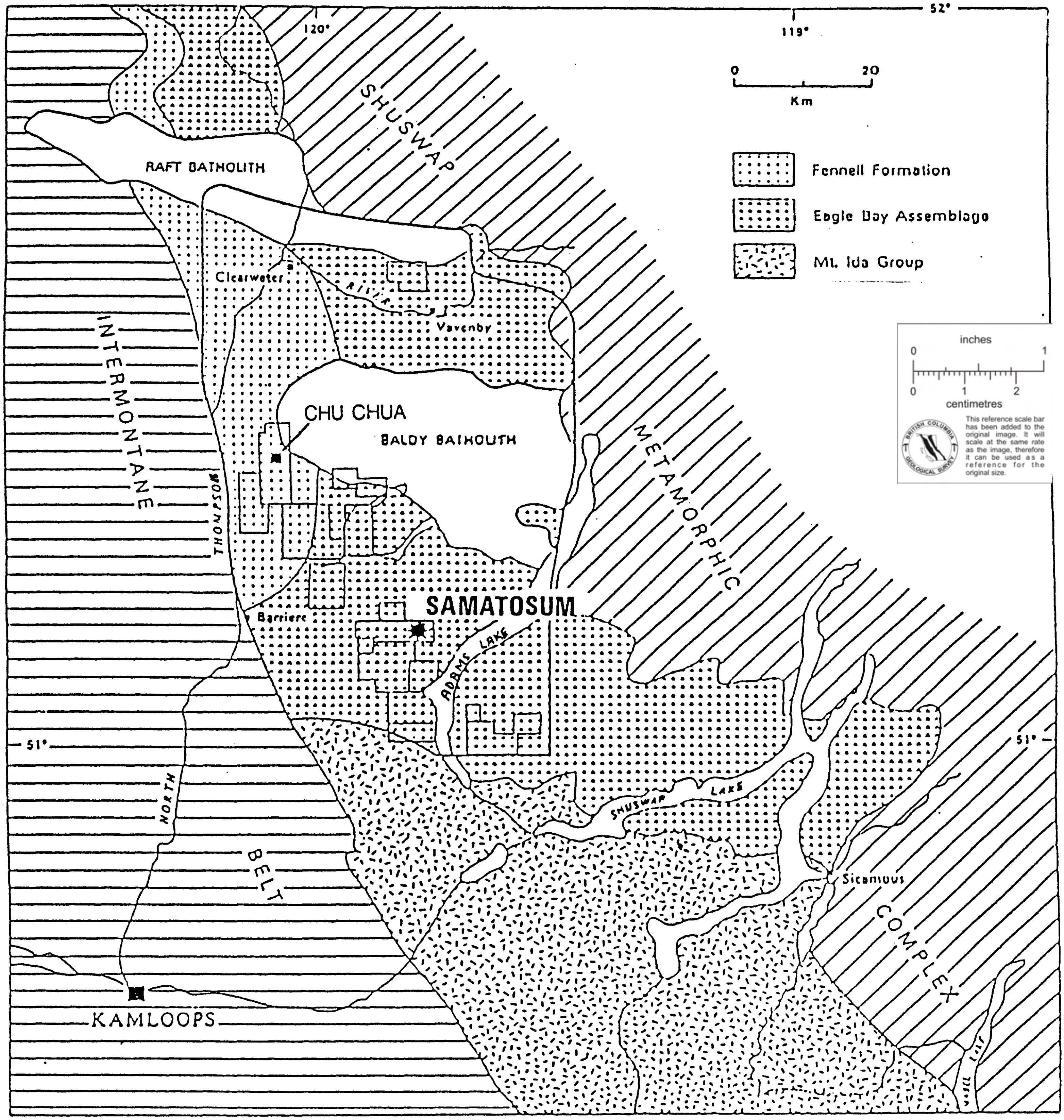
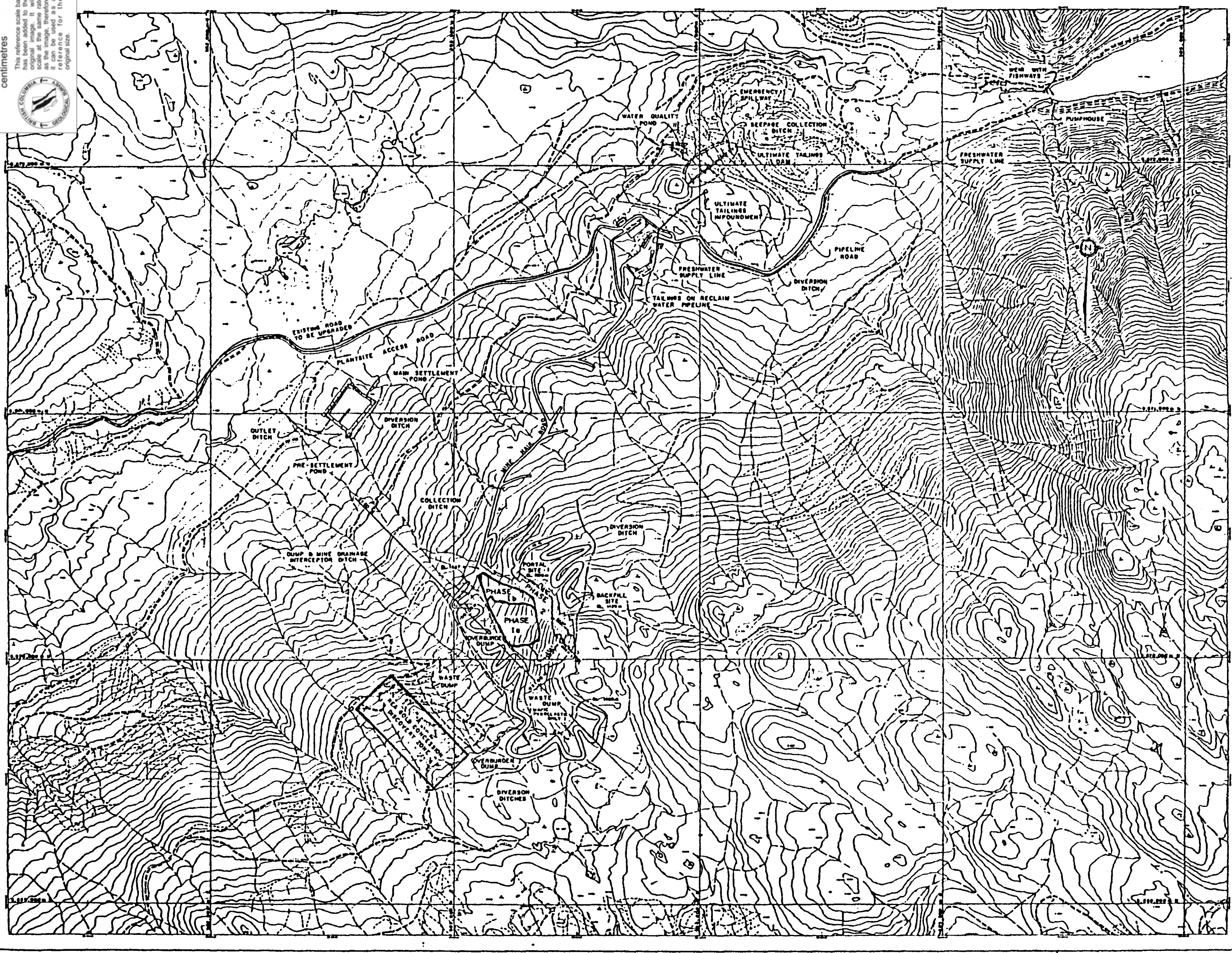


Figure 3. Geologic setting of the Adams Plateau – Clearwater – Vavenby area, modified after Okulitch and Cameron (1976). Not shown are Tertia volcanics and numerous granitic plutons of Mesozoic and Paleozoic age. Potentially correlative rocks north of the Raft batholith are included within tl agle Bay Assemblage. From: Schiarizza, P. and Preto, V. A. (1987). Geology of the Adams Plateau - Clearwater - venby Area, B. C. Ministry of Energy, Mines & Petroleum Resources Bulletin 1987-2.



MINNOVA INC. - SAMATOSUM J.V.

PROJECT DEVELOPMENT PLAN

third phase of probable underground mining will extract the final 273,000 tonnes to the end of the projected mine life in early 1995.

Waste mining (Zone 1 rock) is carried out on 10 meter benches on the hangingwall side of the ore zone (Zone 2 rock). Ore is mined in 2.5 meter phases within each 10 meter interval. All drilling, sampling, and digging in the ore zone is under the constant in-pit supervision of Minnova geology/engineering personnel.

Ore is trucked 1.5 kilometres to the mill site and stockpiled for storage and blending prior to milling. No ore is free dumped into the mill grizzly as metallurgical complications arise when the mill feed lead : copper ratio exceeds 2 : 1 (the lead will then preferentially report to the copper concentrate).

Year to date mill head grades are averaging 1.99% copper, 2.83% lead, 5.37% zinc, 1872 g/t silver, and approximately 3.5 g/t gold and 0.85% antimony.

Regional Geology

The Samatosum Deposit is located in the Adams Plateau district, in structurally complex metasedimentary and metavolcanic rocks of the Palaeozoic Eagle Bay Formation. Detailed mapping by Schiarizza and Preto has described a complex deformational history involving multiple stages of thrust faulting and folding during the Jura-Cretaceous produced strongly foliated and overturned rocks trending northwest and dipping northeast. These Palaeozoic rocks are intruded by mid-Cretaceous granodiorite and quartz monzonite (such as the Baldy Batholith about 30 kilometres to the north of the Samatosum property), and early Tertiary quartz-feldspar porphyry, basalt, and lamprophyre dykes. These are all locally overlain by Miocene plateau lavas--now represented in the area by occasional erosional remnants.

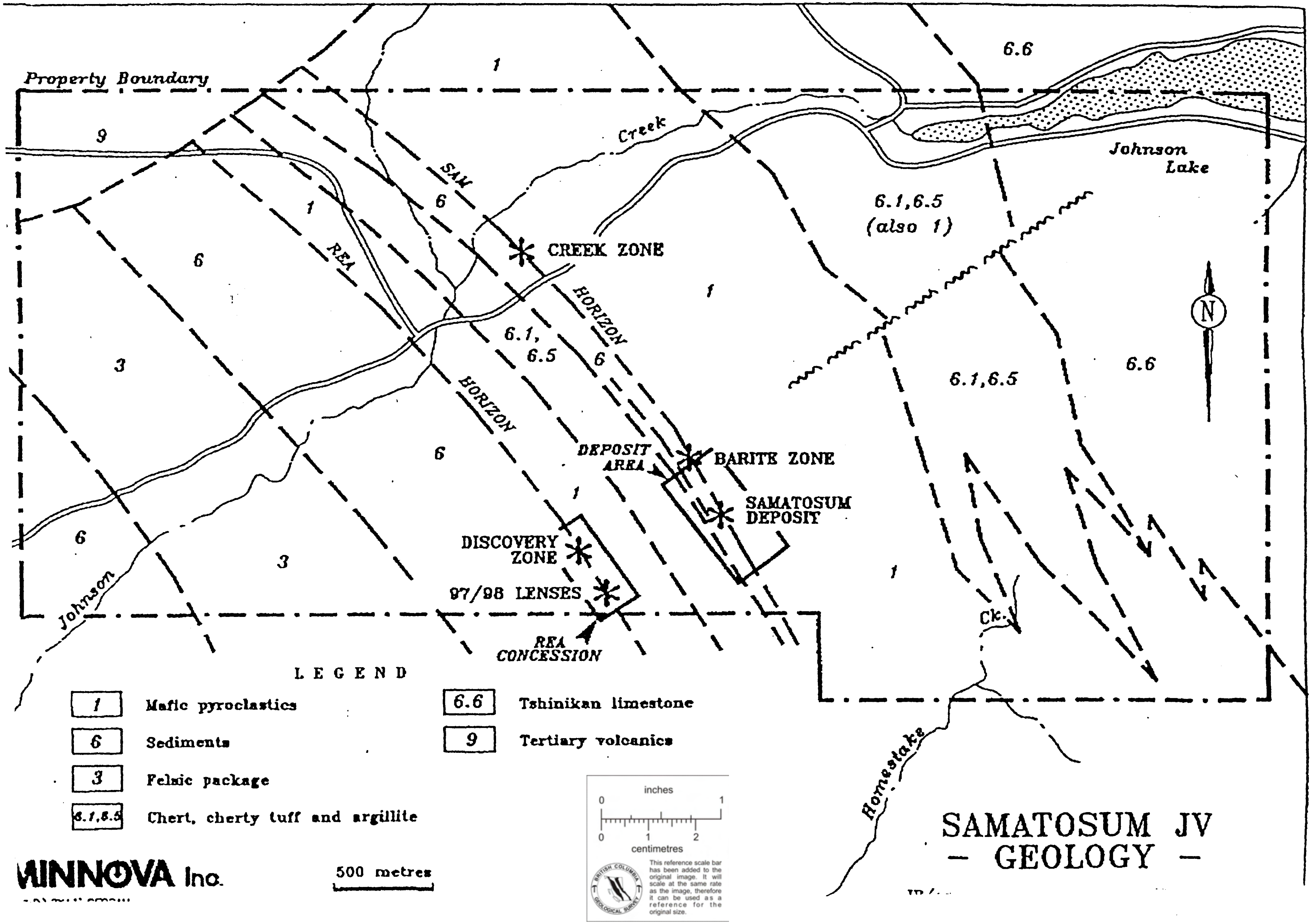
Property Geology

The deposit area can be divided into six principle northwest trending, northeast dipping units. From northeast to southwest these are:

The Tshinikan Limestone which forms steep, massive landforms dominating the area;

Mixed sediments consisting of interbedded cherts and argillites;

Mafic volcanics;



Property Boundary
Creek
Johnson Lake
SAM
REA
HORIZON
HORIZON
CREEK ZONE
BARITE ZONE
DEPOSIT AREA
SAMATOSUM DEPOSIT
DISCOVERY ZONE
97/98 LENSES
REA CONCESSION
Johnson
Ck.
Homestake
N
9
1
6
3
6.6
6.1,6.5 (also 1)
6.1, 6.5
6.1,6.5
LEGEND
1 Mafic pyroclastics
6 Sediments
3 Felsic package
6.1,6.5 Chert, cherty tuff and argillite
6.6 Tshinikan limestone
9 Tertiary volcanics
MINNOVA Inc.
500 metres
inches
0 1
0 1 2
centimetres
This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.
BRITISH COLUMBIA GEOLOGICAL SURVEY
SAMATOSUM JV
– GEOLOGY –

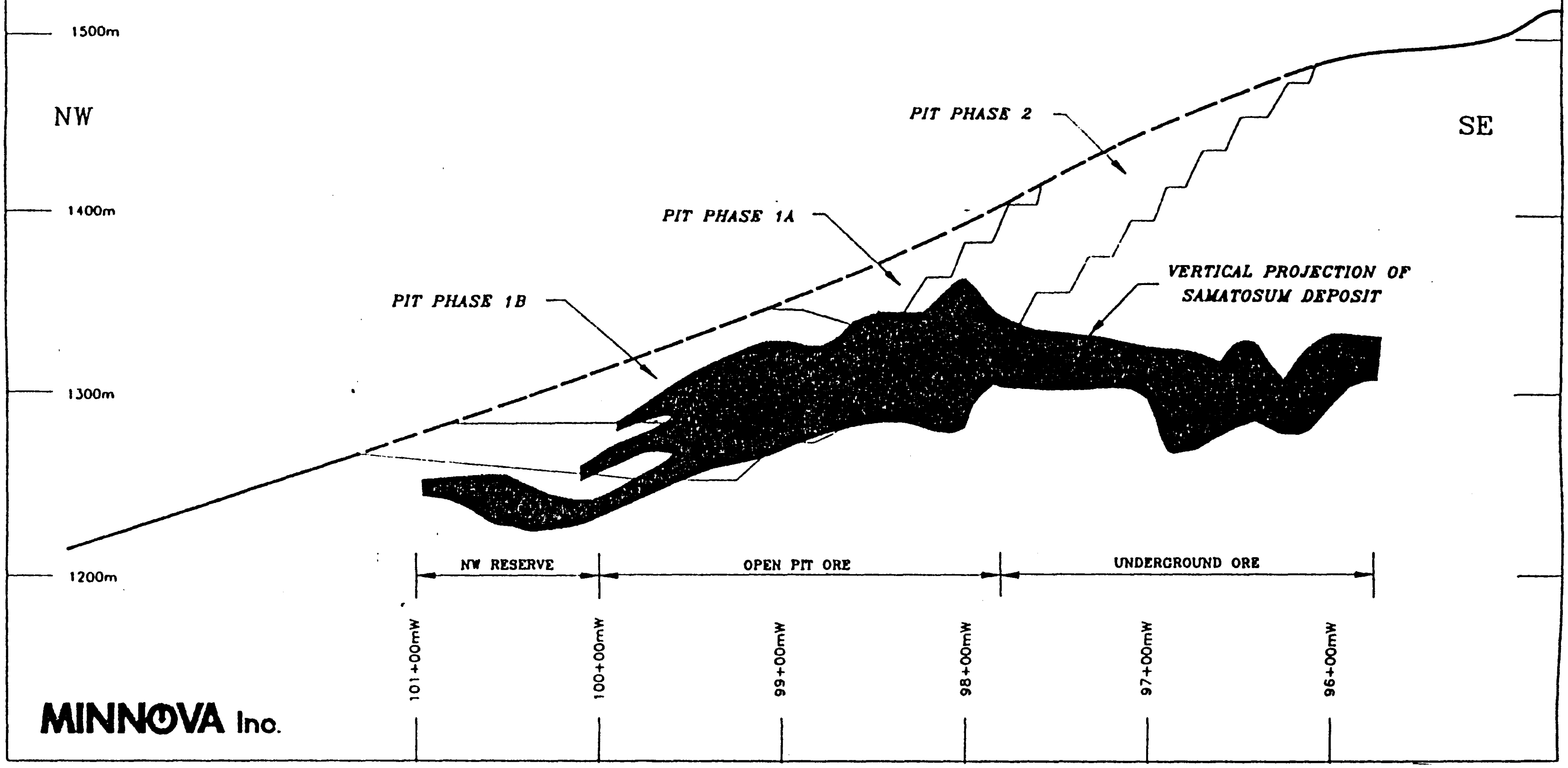
SAMATOSUM JOINT VENTURE

VERTICAL LONGITUDINAL PROJECTION OF OREBODY SUPERIMPOSED ON LINE 6+50mN THROUGH OPEN PIT

(LOOKING NORTH EAST)

BF/sg

JANUARY 1989



And then what is collectively called the "Mine Series" of rocks--i.e., a zone of more mixed sediments and mafic volcanics, with minor felsic to intermediate volcanics, which form the host stratigraphy for both the Sam and Discovery Zone deposits;

Finally, a thick unit of argillites and wackes and a package of felsic rocks lie in the structural footwall of the Mine Series.

Even this far into the development of the Samatosum orebody, current attempts to interpret and discuss the structure and genesis of this unique deposit have been hampered by uncertainties surrounding the nature and timing of the complex structural and alteration history affecting the deposit. To this end, Minnova is maintaining an ongoing study of possible structural and alteration models by incorporating more drilling, property mapping, relogging old holes, petrographic and mineralographic studies, and age dating.

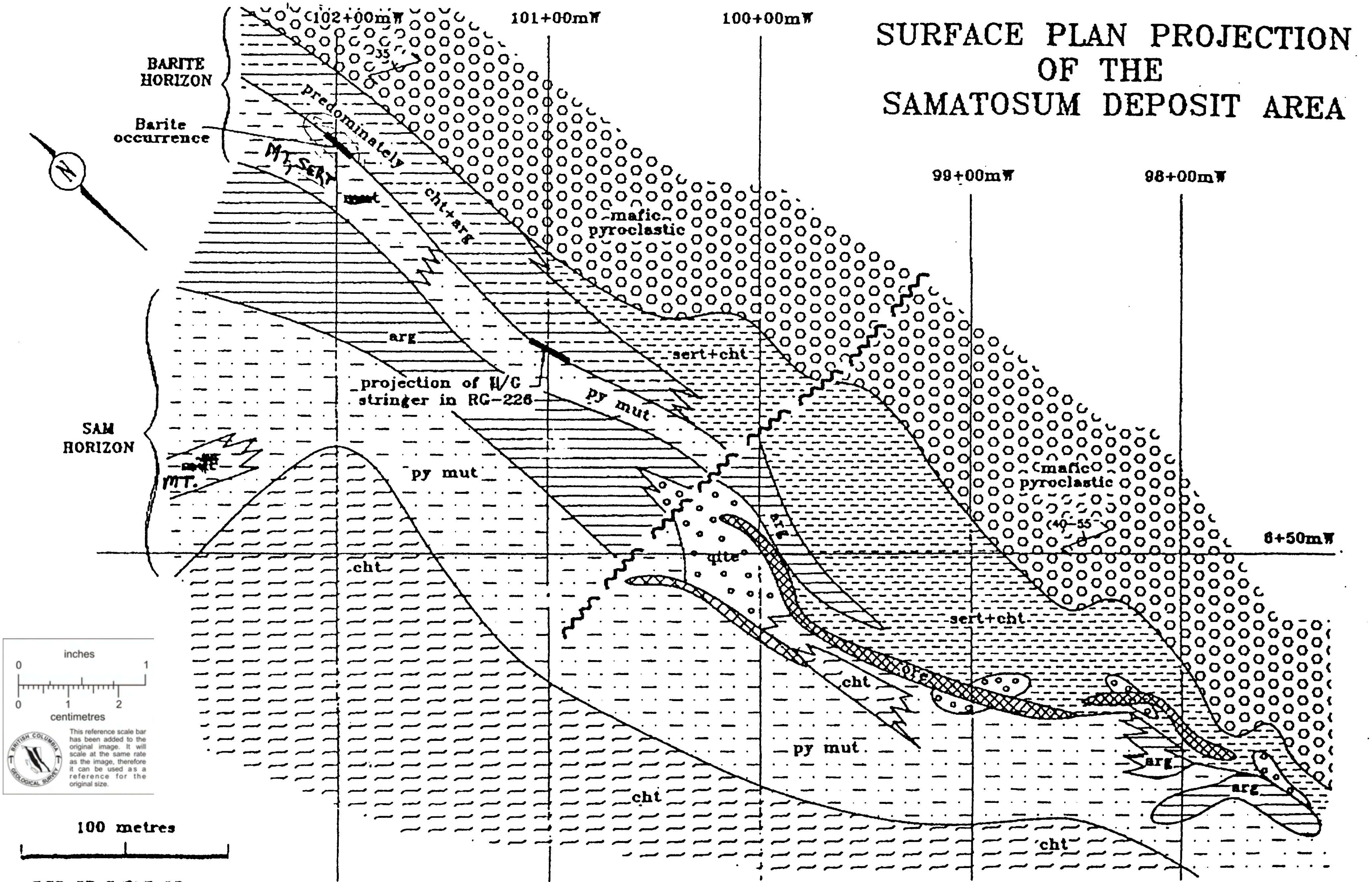
The generalized ore stratigraphy reveals the apparent stratabound nature of the orebody within the hangingwall portion of the heavily strained and highly altered Mine Series rocks. The orebody lies near the interface of altered mixed sediments and predominately altered argillites/wackes. Original terms such as "sericitic tuffs" for the mixed sediments; and "muddy tuffs" for the altered argillite/wackes are now largely out of favour as it is really alteration products we are seeing rather than original lithologies.

The mixed sedimentary unit (SERT) is characterized by a strong yellow to white sericitic content, interbedded with up to 30% cherty/quartz lenses. The altered argillites (MUT) are characterized by light silvery-grey muscovite and sericite. They may also often locally contain up to 60% very fine-grained pyrite and host low grade values of base and precious metals. Both units definitely represent altered lithologies; their protoliths are a topic of much in-house controversy, but probably were variations of an original argillite/wacke/tuff sequence.

Both the SERT and MUT lie structurally below a thick unit of chloritic mafic volcanics, which in the deposit area are most commonly tuffaceous to lapilli in texture; but with an occasional pillowed component.

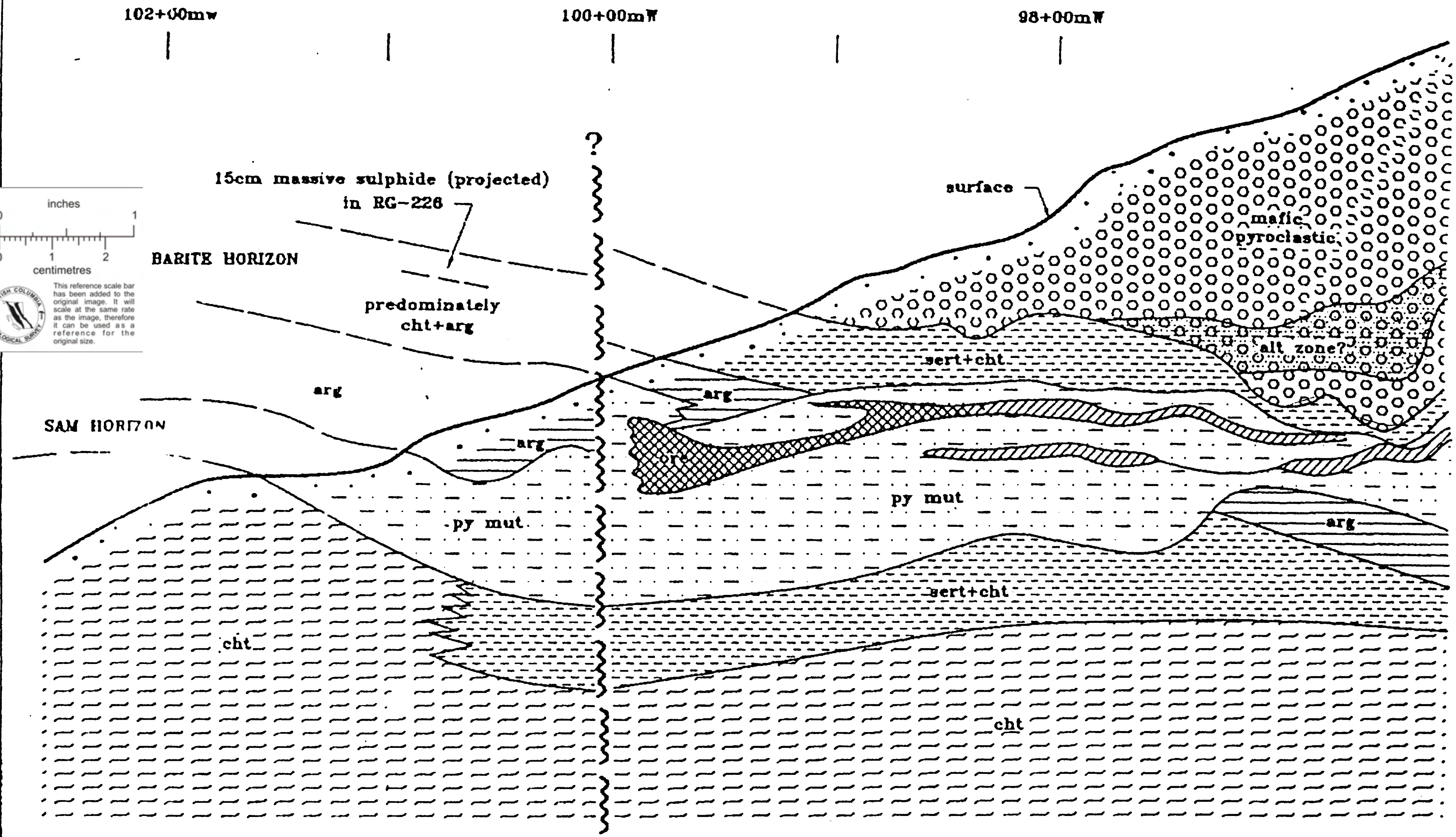
Both the Sam and original Discovery Zone 500 meters to the southwest are contained in a very similar stratigraphy: within a package of mixed sediments, argillites and their sericitic equivalents of SERT and MUT, and both are structurally overlain by mafic pyroclastics. Quite naturally, there is much speculation regarding their structural and genetic associations. There is a strong suggestion of repetition by folding and/or

SURFACE PLAN PROJECTION OF THE SAMATOSUM DEPOSIT AREA



MINNOVA Inc.

may 1988

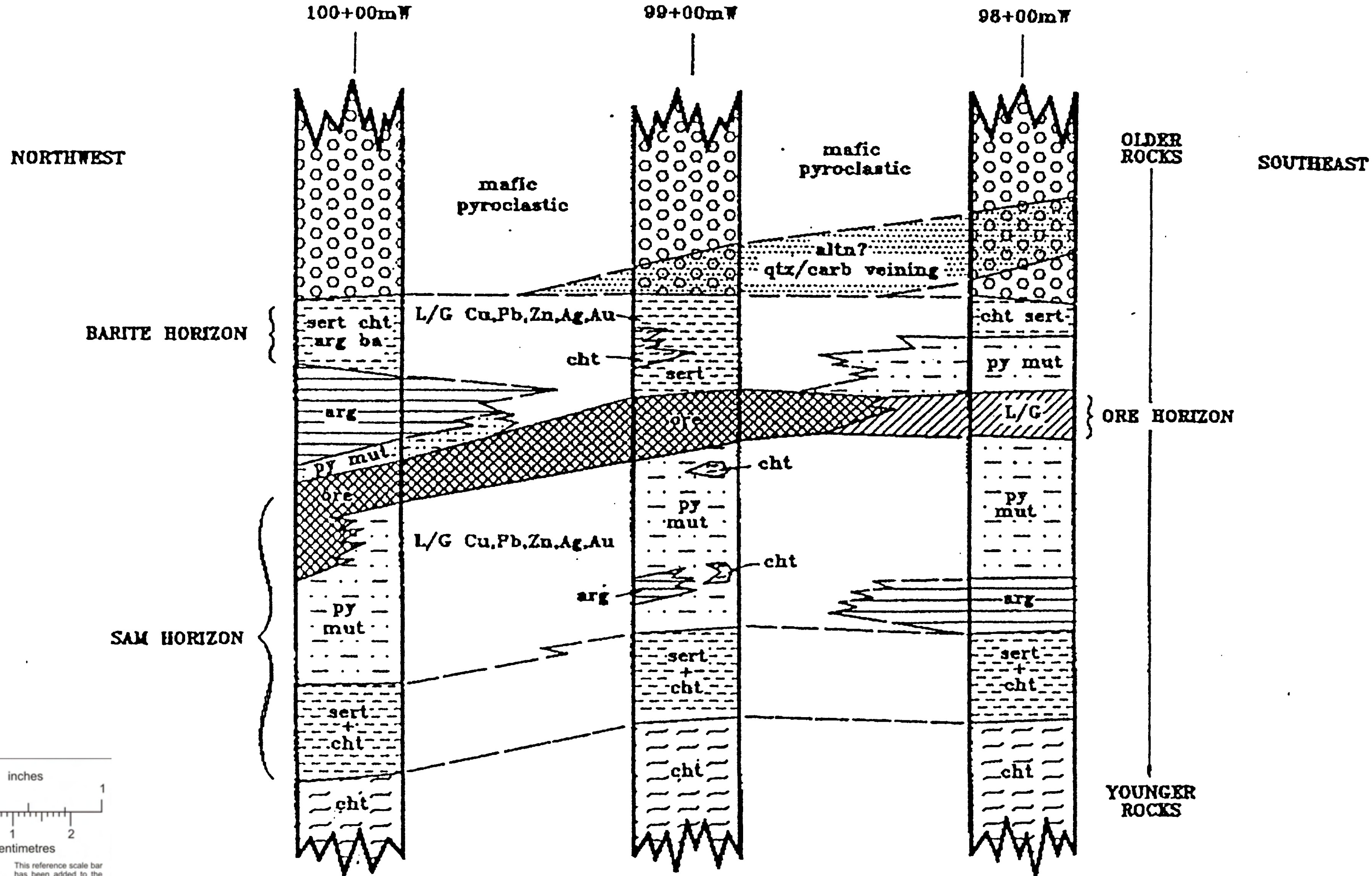


VERTICAL LONGITUDINAL SECTION
(LOOKING SW ALONG LINE 6+50mN)

MINNOVA Inc.

100 metres

MAY 1988



SCHEMATIC STRATIGRAPHIC COLUMN OF THE SAMATOSUM DEPOSIT AREA

(NOT TO SCALE)

WINNOVA Inc.

MAY 1988

faulting (which supports a long favoured theory of a thrust fault zone located between the deposits). Alternatively, but currently discounted, the two deposits may exist within similar stratigraphic cycles overprinted by a crosscutting alteration package.

MINERALIZATION AND ALTERATION

The Samatosum Deposit is an early, highly deformed quartz vein system containing massive to disseminated components of tetrahedrite, sphalerite, galena, and chalcopyrite hosted in structurally complex wallrocks. The upper portion of the orebody is tabular, averages about 5 meters in thickness, has a northwesterly strike length of about 500 meters and dips at an average of 30 degrees northeasterly for 100-150 meters. In the northern half of the deposit the tabular nature of the orebody gives way down-dip to an apparent synformal structure--which is currently interpreted to be caused by slicing and imbrication by local overturning and thrust faulting. The northern half of the orebody has a northwesterly plunge of about 20 degrees, whereas the southern half displays a very slight plunge to the southeast (phase 2 folding?).

Tetrahedrite is the most valuable mineral in the ore zone, followed by sphalerite, chalcopyrite, and galena. Samatosum tetrahedrite contains 36% copper, 25% sulphur, 23% antimony, 5% zinc, 4% silver, 3% arsenic, and 2% iron. It is important to note that whereas chalcopyrite, sphalerite and galena can be present in minor amounts in virtually any quartz vein occurrence throughout the property; tetrahedrite has so far been rarely found outside the immediate ore zone. Mineralogical relationships between the sulfide minerals still remain largely unstudied; however, assay data from thousands of production blasthole samples suggests their distribution is not all coincident. Tetrahedrite appears to be the most uniformly distributed, while the sphalerite, galena, and chalcopyrite often appear more erratically distributed in the northern end of the orebody as semi-massive to massive lenses within the quartz vein host; perhaps indicating more than one mineralizing episode.

The principle ore-related gangue minerals are: quartz (30%), dolomite (19%), and pyrite (11%).

Sericite and muscovite are by far the dominant alteration minerals in the Mine Series rocks and are thought to be a deformational product of the original ore-related alteration. All units from the lower portion of the mafics through the entire Mine Series stratigraphy are sericitic. Muscovite/sericite alteration fronts producing MUT commonly crosscut bedding and foliation, often leaving behind unaltered argillite/wacke remnants.

Other significant alteration in the deposit area includes: silicification or silica flooding of portions of wallrock surrounding the orebody (e.g. many original "quartzites" and black cherts are now believed to be silicified MUT and argillites);

dolomite--much more intense than previously believed, the bulk of which is probably a late-stage fault-related overprint; pyritization--as a replacement feature of lapilli in the mafic pyroclastics; and the green mica fuchsite, so far almost entirely restricted to a several meter thick occurrence associated with the argillites/MUT along the immediate sheared footwall portion of the ore zone.

Figure x. is a schematic structural portrayal of the Samatosum Deposit. The dominant feature in the mine area is considered to be southwesterly directed, overdeveloped Phase 1 folding originating during the regional metamorphic event in the Jura-Cretaceous. The overdeveloped nature of the folding has resulted in extreme deformation of the Mine Series rocks and probable transposition of the quartz vein ore; resulting from intraformational thrusting and shearing subparallel to the strike and dip of the primary fabric. The structural events produced the imbrication effect mentioned earlier and can best be seen in the pit area by their effects on the orebody and surrounding highly incompetent wallrocks:

> Boudinage in areas containing units of contrasting competency; e.g. quartz veins in SERT.
>
> Clockwise rotation of rounded fragments of the more competent "cherty" units (up to 7 meters in diameter) within the sericitic mixed sediments in the hangingwall of the ore.
>
> The shearing out of the short limbs of the "Z"-shaped drag folds.
>
> Finally, the effects of this deformational event can be seen within the ore itself in the form of foliated galena surrounding brecciated sphalerite. Also, remobilized galena from the ore zone can often be found associated with minor crosscutting quartz veins for 1 - 2 meters into the wallrock.

The ore zone has also been cut by several northeast trending near-vertical cross faults; however displacements appear to be relatively minor.

Apart from minor cross-cutting quartz veins noted above, no known intrusives intersect the ore zone.

Discussion

Originally, and to this day, the Samatosum Deposit is thought by some to represent a volcanogenic massive sulphide deposit mainly because of certain stratigraphic relationships, alteration, possible small exhalite appearing semi-massive to massive subeconomic bodies of mineralization located by diamond drilling down-dip from the orebody, and proximity to the Discovery Zone which receives little argument over being classified as a VMS deposit. Lately however, with the added luxury of substantial fresh mine exposures, other interpretations are being considered:

- It could be a component of a veined stockwork system; perhaps associated with a VMS deposit. Certainly the widespread alteration supports this consideration; however, no certain associated VMS-type mineralization has been located, with the exception perhaps of the Rea Deposit 500 meters to the southwest.

  Or

  Plain and simply, it could also be an epigenetic base/precious metal quartz vein deposit with no apparent VMS association.

Despite an apparent large quantity of stratabound appearing massive sulfide component and extremely large volume of associated sericite and silica wallrock alteration, the evidence for Samatosum as an epigenetic deposit is more overwhelming with the fact there can be no disputing its quartz vein host. The stratabound effect could easily have been produced from transposition resulting from the high degree of strain and deformation affecting the deposit area.

Bob Friesen

Chief Geologist, Samatosum Division
20/4/90

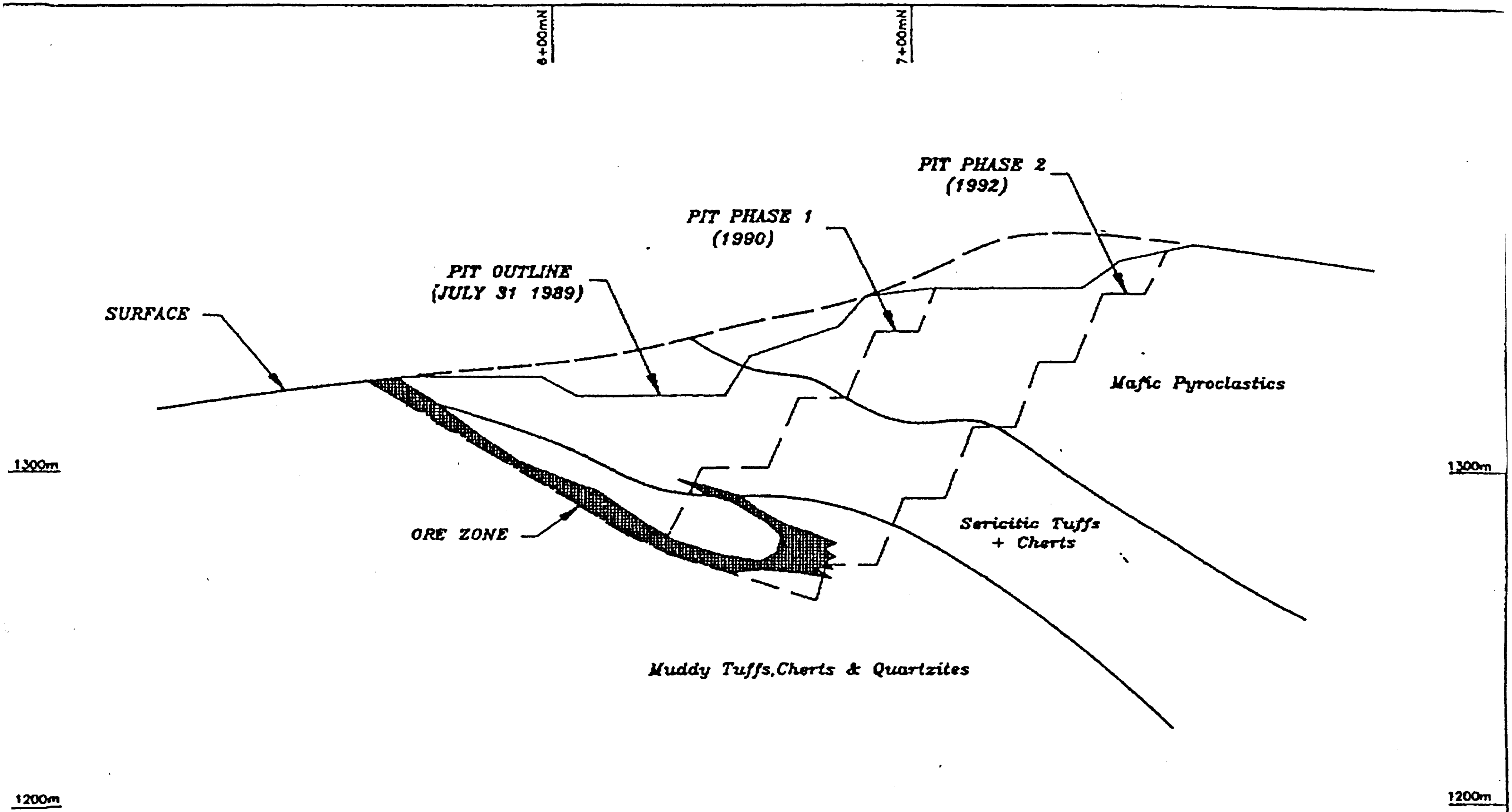


FIGURE "X"

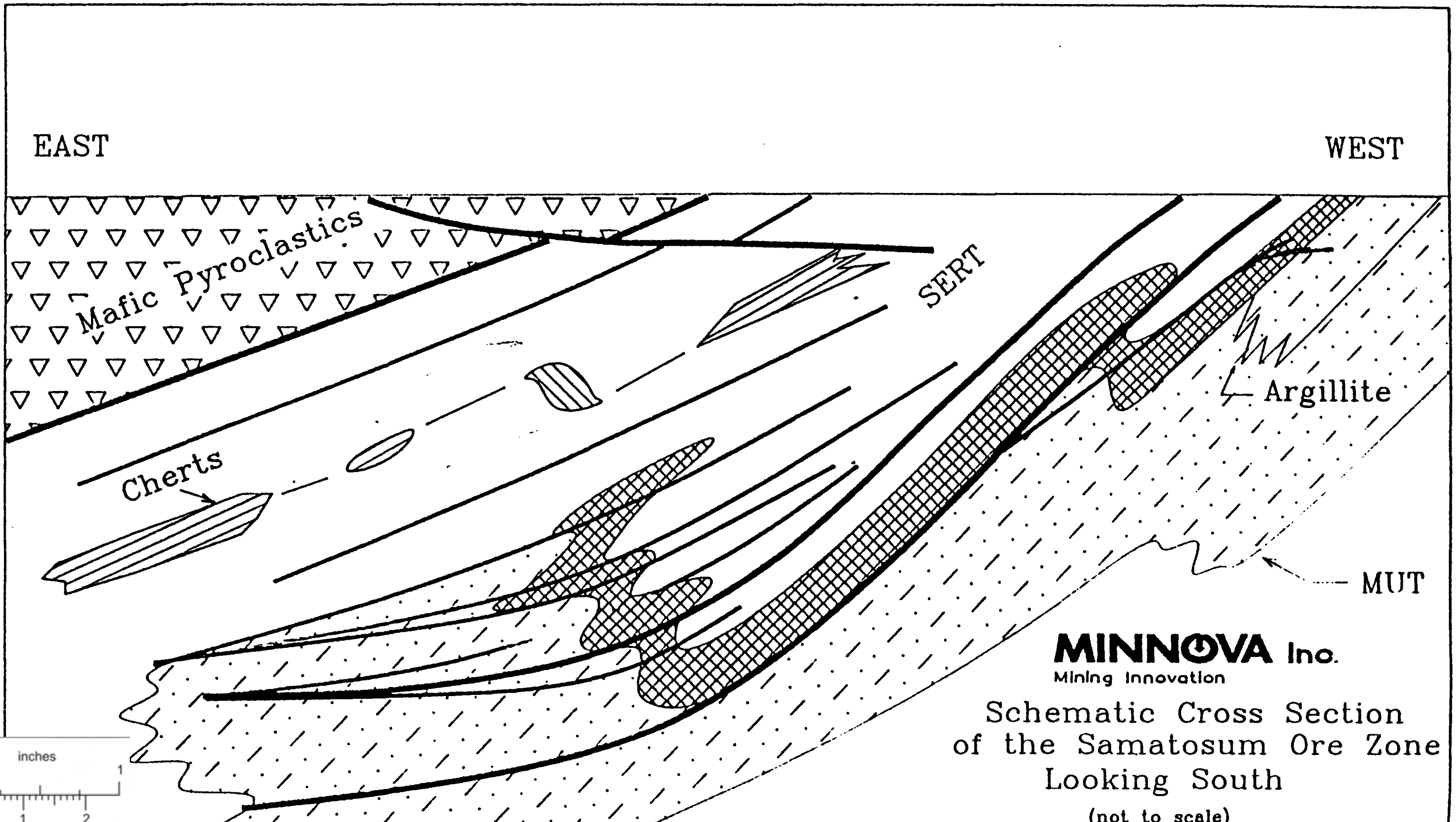
SAMATOSUM JOINT VENTURE

CROSS SECTION

LOOKING NORTH WEST ALONG LINE 99+00mW

BF/sg AUGUST 1989

MINNOVA Inc.



Schematic Cross Section
of the Samatosum Ore Zone
Looking South
(not to scale)