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MINNOVA INC.

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SUBJECT: Samatosum: Regional Synopsis

A. Assumptions and Nomenclature

The following discussion assumes: (1) that the Tshinikin limestone is correlative with Cambrian limestone north of Vavenby, and (2) that Rea, Sam and Homestake mineralization is Devonian in age. There is a significant body of evidence for both of these assumptions. The correlation and age of the Tshinikin is not based solely on the fossil find near Vavenby; that find merely confirmed previous regional correlations. The Tshinikin is typical of thick lower Cambrian carbonates all along the North American margin, such as the Badshot in the Kootenay arc. The sequence containing the Tshinikin (EBG of Schiarriza and Preto, 1987) is similar to the Downey succession of Barkerville Terrane (the northerly extension of the Eagle Bay), with the overlying Bralco limestone correlative to the Tshinikin (Struik, 1989). While not foolproof, these correlations provide a strong basis for the Cambrian age assumption.

Age of the three mineral deposits is based on zircon dating of the Homestake host volcanics on the east side of Adams Lake, similar lead isotope signatures of the three deposits, and Devono - Mississippian fossil ages for the hangingwall sediments at Rea.

Based on observations made during the mapping, the following nomenclature (after Schiarriza and Preto, 1987) can be applied to the map units: Rea hangingwall sediments = EBP; Rea mafics = EBF (possibly also including EBG); Sam sediments = EBFs; middle mafics = EBF; turbidite wedge = EBP; Sam mafics = EBG.

B. Stratigraphy

The units are described here in order of ease of discussion, rather than in stratigraphic or structural sequence.

1. EBG

(a) Lithologies - EBG (Eagle Bay green) includes all rocks in the hangingwall of Samatosum, up to the quartzites in the upper tributaries of Haggard Creek (northeast of Johnson Lake). The package includes greenschist facies mafic metavolcanics, ribbon chert, argillite, phyllite, and pure to argillaceous limestones. Several considerations support the treatment of this thick section as a single stratigraphic entity:
(1) similarity of mafic volcanics throughout the section,
(2) occurrence of primary carbonate lenses within the mafics throughout,
(3) distribution of sedimentary and volcanic facies.

Mafic volcanics include a variety of rock types, some of which are recognizable as pillowed flows and flow breccias, fine tuffs (generally intensely foliated), lapilli tuffs, and tuff breccias. Diabase sills occur locally. In many areas, the deformational fabric obscures primary lithologies, and strong flattening strain is evident even in recognizable pillowed flows. EBG metavolcanics are distinctive in their calcareous nature and widespread black chlorite spotting on foliation surfaces. Identical looking rocks occur throughout the thick section below the Tshinikin, and above

the Tshinikin to the northeast side of Johnson Lake.

Selected samples from a variety of stratigraphic levels within the package have a consistent geochemical signature, confirming the visual similarity. Trace element geochemistry is consistent with an intraplate (alkalic) ocean island setting. Alteration causes a shift in alkali - silica ratios toward a subalkaline signature.

A distinctive epidote - quartz alteration facies is seen in a few places, widely scattered within the stratigraphy: on the northeast side of the tailings pond (above a cherty marker unit and below the Tshinikin), on the Victory property (below the cherty marker unit), and on the south side of South Barriere Lake (above the Tshinikin). This alteration is probably due to seafloor hydrothermal metasomatism.

Primary carbonate is diagnostic of EBG mafics. The carbonate component ranges from scattered pockets and small lenses, to isolated beds less than a metre thick, to lenses up to 200 metres thick. The thick lenses are scattered in the upper part of the section below the Tshinikin, but occur above the Tshinikin as well (e.g., north of Johnson Lake).

Noncalcareous metasediments also occur throughout the section, and are lithologically distinct from Sam and Rea sediments. Lithologies include argillite, ribbon chert with phyllite partings, unaltered muscovite-chlorite phyllite (i.e., not the sericite phyllite found at Sam), finely interbedded argillite and metatuff, chloritic tuffaceous phyllite, and pebble conglomerate. The phyllitic foliation is characteristic, and unlike the slaty cleavage developed in the Sam and Rea sediments. The pebble conglomerate exhibits intense flattening strain not seen in the coarse Rea and Sam clastics.

The sediments and mafic volcanics exhibit complex facies changes. A thick sedimentary section underlying the tailings pond thins out dramatically north of Johnson Creek on the Victory property, and south toward Twin Mountain. The southeast side of Twin Mountain contains no sediments (other than thin carbonate lenses), and abundant coarse fragmentals, and appears to be a volcanic centre. This grades laterally to the northwest (Victory) into a basinal setting characterized by intercalated argillaceous and calcareous sediments, cherts, fine tuffs and pillow basalts. North and east of South Barriere Lake the Tshinikin is absent and the upper section is dominated by argillaceous limestone and phyllite.

(b) Syndepositional faults - Dramatic changes in thickness of sedimentary units is suggestive of syndepositional faulting. East trending faults appear to control both rapid thickness changes in the tailings pond sediments, and volcanic - sediment facies changes across Johnson Creek. Appearance of a thick sediment unit below the Tshinikin on the east side of Samatosum Creek is evidence of another fault controlled basin. The abrupt disappearance of the Tshinikin between South and East Barriere Lakes is probably also due to fault control of reef/basin topography. Many of these faults, including the Johnson Creek and Samatosum Creek faults, have undergone renewed movement in the Tertiary and therefore now extend into the Devonian package.

2. EBP

(a) Rea hangingwall - EBP includes marginal basin turbidites and associated felsic volcanics of Late Devonian to Mississippian age. This association is found not only in the stratigraphic hangingwall (structural footwall) of Rea, but also in the Birk Creek area and within the lower Fennell. The lower Fennell has a coeval offshore facies, containing less siliciclastic sediment and significant

ribbon chert; zircon dating of a QFP near Sprague Creek gave a Devonian age.

The base of EBP at Rea is generally faulted, but EBP occurs locally on both sides of the fault. In places, therefore, it lies in stratigraphic contact with the sequence hosting Rea exhalative mineralization. The latter is locally capped by a thin, lensy, fine mafic to intermediate volcaniclastic - argillite unit (e.g., above the L100 lens). The base of EBP at Rea is a quartz - rich grit unit, which is overlain by (and laterally grades into) well bedded slate-siltsone turbidites. The latter are diagnostic of EBP. They are also typical of Devono-Mississippian turbidites from the Yukon to Nevada (e.g., Earn Group), the product of a continental - scale late Devonian extensional event.

The tubidite unit is structurally underlain by a thick felsic volcanic package (EBPv), which is underlain in part by more turbidites (e.g., along the mine road). The latter are probably structurally interleaved with mafic volcanics above the Homestake deposit (based on Dave Heberlein's mapping). Both felsic volcanic - turbidite contacts may be structural, but similar ages and widespread spatial association of the two units suggests that they are part of the same stratigraphic sequence.

(b) Turbidite wedge - A very thin, elongate belt of turbidites occurs on the northeast side of the Rea - Sam sequence: the turbidite "wedge". Symmetrical sequences on both sides of the wedge (in places), hinge zones near the core of the wedge, and facing reversals indicate that the wedge is a syncline. Facing reversals and bedding-cleavage relationships demonstrate that smaller scale parasitic folds are common. Consistent facing in some sections suggests that locally shearing may have removed one of the major fold limbs. Underlying the turbidites on both fold limbs are similar bands of cherty exhalite and pyritic sedimentary breccias.

Correlation of the distinctive turbidites in the syncline and in the Rea hangingwall is the simplest stratigraphic assumption. It is supported by the presence of exhalites stratigraphically beneath the turbidites in both cases.

3. EBF

(a) Correlations - The volcanic sequence hosting the Rea lenses contains a distinctive feldspathic lapilli tuff, which is regionally correlated with EBF (Eagle Bay feldspar) on the basis of lithology and the Devonian age of Rea mineralization. (EBF is undated, but regionally lies between the Middle Devonian Homestake schist - EBA - and Devono-Mississippian EBP). This interpretation, coupled with correlation of the turbidite wedge and Rea hangingwall sediments, and interpretation of the wedge as a syncline, implies that the Sam sediments (actually a mixed sedimentary - volcanic sequence) are EBF as well. The change from a volcanic - dominated sequence hosting Rea to a coeval sediment - dominated sequence beneath the turbidite wedge is therefore a structurally telescoped basinal facies change.

Correlative volcanics include the feldspathic lapilli tuffs and tuff breccias underlying EBP turbidites northwest of the Sinmax - Johnson Creek junction, and possibly some of the mafic units above the Homestake cliffs. The volcanic - turbidite succession north of the creek junction is right way up and faces northeast, opposite to the Rea succession. This implies that the EBPv felsics core a broad, overturned, although structurally dismembered syncline. The Homestake schist (EBA) does not occur on the upper (overturned) limb, due to non-deposition (i.e., EBF was deposited directly on EBG), and/or structural complications.

(b) Rea mafics - The feldspathic Rea mafics are exposed in the area of the Rea adit and trenches, and above the L97 lens. Toward the stratigraphic top of this section (especially below the L100 lens) they are strongly altered to sericite - quartz - pyrite, and riddled with deformed cherty quartz veins, which are texturally very similar to overlying cherty exhalites.

Geochemistry of the least altered of these rocks (chlorite - dolomite) is strikingly similar to the EBG metavolcanics. Both plot as intraplate alkali basalts on trace element discrimination diagrams, and as alkaline to subalkaline on the alkali - silica plot. Higher Zr in the Rea mafics may be due to continent - derived detrital zircons. The Rea mafics have a significantly higher MgO/CaO ratio, but this could be explained by footwall alteration as well as by primary composition.

The Rea mafic sequence contains EBG - like calcareous mafic metavolcanics structurally above the feldspathic mafics. These locally have a black chlorite spotted texture typical of EBG. A small exposure north of the mine road contains both units; the contact is obscured by overburden. According to Keith Glover, there is little possibility of a structural contact between the two units. This suggests that if these rocks are EBG, the Rea mafic sequence contains a preserved overturned unconformity between Cambrian (?) and Devonian rocks.

(c) 266 zone - Detailed work by Keith Glover on 266 zone core clarified the nature of the "dol seds" and the structural relationship between the "middle mafics/dol seds", overlying exhalites and the turbidite wedge. His interpretation is fundamental to the correlations presented here. To summarize briefly: the "dol seds" are fine volcaniclastics, locally with interstitial argillite, similar to rocks at the top of the Rea mafics; they occur on both limbs of the fold cored by the argillite

wedge; they are stratigraphically overlain and locally underlain by cherty exhalite and sedimentary chert breccias, with discontinuous massive sulphide pods; they pinch out to the southeast (toward Sam) into mainly argillaceous and cherty sediments. According to Bob Freisen, texturally distinguishable dolomitic mafic volcaniclastics extend southeast to about 100W in the mine area.

The sediments stratigraphically beneath the turbidite wedge are significantly different from EBP. The differences include: a higher component of chert (much of which appears to be exhalative), and widespread sedimentary and tectonic breccias with chert and sulphide fragments. These features are characteristic of a tectonically active basin with significant hydrothermal activity, whereas typical EBP lithologies suggest quiet accumulation of distal turbidites.

C. Structure

1. General - The Sam - Rea sequence is a narrow, highly deformed fold and thrust belt beneath a regional - scale thrust (the Haggard Creek fault of Schiarrizza and Preto). The style of deformation within the belt is attributable to proximity to this structure, as well as to the competency difference between the fine grained, well bedded sediments which dominate in this belt, and the thick, structurally overlying mafics and underlying felsic volcanics and intrusives.

According to Esso - Homestake mapping compiled by Dave Heberlein, the deformed belt pinches out rapidly to the southeast from Sam, with the Sam sediments disappearing within 1.5 kilometres. The Rea horizon continues well past Homestake Creek, but by Homestake Creek (2.5 km southeast of Sam) only 200 metres or so separates the EBP felsics and EBG. I interpret this pinchout

as a structural feature caused by convergence of the thrust at the base of EBG ("Haggard Creek fault") and a thrust separating the Rea hangingwall sediments and EBP felsics.

The Haggard Creek fault, as seen locally in outcrop and in drill sections, dips steeper than S1, and in plan view diverges from S1 and F1 fold axes by a small angle. It gradually cuts out the Sam-Rea sequence to the southeast, putting EBG almost directly on EBP felsics southeast of Homestake Creek, with only a narrow intervening sliver of "Rea horizon".

2. Phases of Deformation - The southeast trending planar penetrative fabric evident throughout the area is considered to be S1. It is possible that an earlier phase of deformation affected EBG, but no unequivocal pre - F1 fold closures were found. S1 is axial planar to tight to isoclinal folds and dips moderately to the northeast. First phase folds and cleavage - bedding intersections plunge variably depending on later folding (and possibly faulting). Minor folds are parasitic to large - scale, tight to isoclinal folds which in the Sam - Rea belt have wavelengths on the order of 100 - 200 metres.

According to Oliver (1988) the L98 lens at Rea is deformed by isoclinal folds with amplitudes up to 15 metres. These were not observed in surface mapping, but evidence of similar scale folding was provided by alternating bands of intensely altered and less altered metavolcanics across strike.

Large scale F1 folds have not been identified in EBG on the west side of Adams Lake. On the Adams Plateau, the presence of a quartzite marker unit in a thick mixed sediment package enabled identification of a regional scale syncline - anticline pair (Nikwikwaia Syncline) by government geologists.

A second phase crenulation cleavage is superimposed on S1 in finer sediments and is coaxial with phase one within about 15 degrees. As such it is probably a continuation of a single prolonged southwest verging deformational event. Phase 2 crenulations commonly plunge in the opposite direction to phase one cleavage - bedding intersections.

A third phase of deformation has produced east trending kink and chevron folds with a locally developed fine, steeply dipping axial plane cleavage. These folds are especially common in schistose mafic tuffs in the Twin Mountain area. They may be parasitic to major easterly trending folds. The long section of the argillite wedge shows an undulating base indicating open folds with a wavelength of 250(?) metres.

G.L. Dickie (Minequest) describes east trending second phase folds on the Adams Plateau which appear to be correlative with what I am calling F3. He also describes a later stage of regional scale north trending folding which has not produced a penetrative cleavage. Similar folds have not been mapped on the west side of Adams Lake.

D. Mineralization

Three mineralizing episodes can be recognized in the belt. A fourth, earlier episode is represented by the Homestake deposit, which is not discussed further here. These can be clearly distinguished only away from the pit area, as at Sam intense vein related alteration and structural complications make it difficult to disentangle phases of mineralization.

(1) Synsedimentary exhalite deposition is represented by the correlative Rea and Sam horizons and associated cherty breccias and pyritic (± quartz - sericite) alteration. This is the last,

hydrothermal phase of Devonian mafic volcanism, preceding more quiescent basinal conditions represented by EBP. Proximal exhalite at Rea is underlain by intensely sericitized volcanics, while more distal exhalites to the northeast (266 zone) were deposited in sediment - rich part of the basin, with little or no footwall alteration. Sulphide is characterized by As - Au - base metal mineralization; a late phase of bedded barite locally caps the sequence at Rea.

Pyritization (MUT) identified in the pit area as preceding vein related sericitization may belong (partly?) to this phase. Other candidates for early mineralization at Sam are: (1) the feeder type, breccia hosted, disseminated to semi-massive low Ag mineralization in RG 85; and (2) the isoclinally folded barite zone, with its Rea-like sulphur isotepe signature (C. Godwin).

The unusual, high arsenic geochemistry of the Rea lenses is probably a function of its tectonic setting. Its alkalic host rocks were superimposed on and lateral to an arc (Homestake) in an incipient rift setting, with mineralization probably occurring during the major Late Devonian extensional event. This event was accompanied by unusual styles of mineralization, such as carbonatite related rare earths (e.g. Aley carbonatite) and U-F rich replacement/exhalite (Rexspar). Rea is therefore not a typical arc-related VMS, nor is it related to a typical spreading centre in oceanic crust.

(2) Distinct from this phase are the Sam quartz veins with massive Ag-Sb - rich polymetallic sulphides and intense sericitic alteration zones. These clearly crosscut EBP turbidites in the pit and therefore postdate both exhalative activity and the onset of turbidite deposition, according to the correlations discussed above. This relationship, and the different geochemistry of Sam and Rea argue that the two phases are genetically unrelated.

If so, the similarity of Sam and Rea lead isotope signatures suggests either: (a) Sam galena (but not necessarily tetrahedrite) is remobilized from earlier exhalative mineralization, or (b) the two episodes occurred within the same time frame according to the resolution of lead isotopes (at best, ± 50 Ma). In any case, the lead shows that the two deposits have the same upper crustal lead source.

The theory that the two episodes of mineralization are temporally and genetically distinct does not mean that they are therefore unrelated. In particular, the vein fluids could have accessed structures developed during exhalite deposition.

The heat source for fluids which deposited the veins represents a further conundrum. One possibility is the granitic paragneisses which intrude Homestake rocks regionally, and which have a Late Devonian age by uranium-lead dating.

(3) The hangingwall mafics are cut by quartz-carbonate-base metal± barite veins and related sericite-carbonate alteration zones of the "Twin Mountain shear zone". This is a broad, diffuse zone of sheared and altered rocks which has been traced for 8 kilometres, trending roughly parallel to regional foliation. Large, relatively barren quartz-carbonate veins in the pit belong to this phase. Lead isotopes indicate a younger age than Rea/Sam, possibly coeval with early regional deformation (Late Triassic-early Jurassic?).