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B.C. Geoscience Research Grant Progress Report #1

Genesis of the Windy Craggy Deposit: a contribution to the understanding of massive sulfide formation in volcano-sedimentary environments

submitted by Jan M. Peter

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Introduction and Background:

This project has been funded at a level of $20,000CDN to conduct a detailed field and laboratory study of the Windy Craggy deposit, northwestern British Columbia. This report summarizes progress over the period May 2-July 25, 1988.

Last field season, Jan Peter was employed by Geddes Resources Ltd. as a geologist for a period of two months. Work last year involved exploration in the vicinity of the Windy Craggy Deposit, and concentrated in particular on the Tats mineral claims. However, about one week was spent mapping the surface geology of Windy Peak and its ridges. This provided a good sample suite of regional rock types as well as of the surface mineralization of the Windy Craggy deposit and the Tats showing.

This field season, Jan Peter commenced field investigations and sampling of the Windy Craggy deposit on May 2, 1988 as one of three on-site geologists.

Geddes has kindly provided access to all existing baseline geological data. As well, the company has allowed Jan to freely sample all drillcore from previously drilled holes (stored in Vancouver) as well as all holes currently being drilled (stored on site). Access to this information and the collection of these geological samples is vital to the successful completion of this project. The only stipulation by the company is that all reports, manuscripts, and material for oral presentations are first cleared with Mr. J. D. Little, President of Geddes Resources Ltd. in order to avoid any possibility of divulging proprietary or sensitive information.

Fieldwork:

Geddes Resources Ltd. is currently conducting a diamond drilling program from newly completed underground workings. This program commenced on March 18, 1988 and is expected to continue until Christmas of this year. Fieldwork so far this year has included extensive diamond drill core logging and sampling as well as two weeks of underground mapping of the North Drift.

In early August, one of the two drills will shut down while development in the North and South Drifts resumes. This will give the writer the opportunity to undertake an examination of core not logged personally and to sample core for specialized purposes. In addition, it is hoped to continue mapping and sampling on Windy Peak in the area of massive mineralization, and to perform limited regional sampling (e.g., the "felsic pillow lavas" east of Tats glacier).

Underground Mapping:

Jan has conducted two weeks of underground mapping to determine the geology and structure of the North Drift. Mapping was done on a scale of 1:250. None of the existing underground workings expose mineralization that is the target of current diamond drilling; however, the North Drift exposes geological relationships in the vicinity of the mineralization that could not easily be seen on surface due to the limited access afforded by the rugged topography. As well it provided much needed lateral exposure not available within the confined exposure provided by drillcore. This allowed more thorough sampling of certain geological units.

Underground Diamond Drillcore Logging:

Jan has examined, logged, and sampled well over 9000 feet of core.

Sample Collection:

An on-going sample collection program has been initiated. Hand specimen sized samples have been collected from underground and over 300 whole and sawn drillcore specimens have been collected. Drill core sampling is done while core is logged, wherever feasible. Whole core is taken if that particular interval of core is not to be assayed by Geddes. However, if that particular section is to be assayed, the core is sawn lengthwise and only about 1/3 to 1/2 is collected. A note is then left in the core box indicating that Jan has that particular section of core, should it be necessary to refer to that section of core again by on-site geologists.

To date, 56 sedimentary rock samples (including 15 mafic tuff, 31 argillite), 71 igneous rocks (including mafic, intermediate flows, and intermediate dikes), 43 sulfide samples, 47 exhalite samples, 3 vein samples, and 12 samples of possible organic matter and tourmaline have been collected. All samples are systematically catalogued, described, and entered into a database program on a portable Apple Macintosh computer on-site. Each samples is given an identifier, date collected, name of collector, type of analysis to be performed/reason for sampling, sample type and sub-type, description, number of any corresponding photographs, and any pertinent geochemical results. The database can search any or all of these categories simultaneously. This will facilitate the expedient retrieval of samples collected for special purposes.

Rock Types:

The host rocks of the Windy Craggy deposit are within the Middle Tats Complex, an Upper Triassic sequence of mixed graphitic shales and argillites, and intermediate to mafic pillowed and massive flows. A summary of rock types found in the immediate vicinity of the deposit is given below. Descriptions given are derived entirely from drill core and underground observations.

Volcanic Flows: Are invariably fine grained, range in color from medium grey to dark green. Predominantly they are massive to amygdaloidal. Amygdales are 1 to 5 mm diameter and filled with white calcite.

They contain microlites of plagioclase, are pervasively chloritized and are carbonatized in many places. They are undeformed to slightly foliated (rarely approaching a chlorite schist). Underground exposures of mafic volcanic pillow basalts are present; however, exposures of pristine pillows are rare. Usually, pillows are slightly to highly sheared.

Individual units vary from less than one meter to more than 80 meters in thickness and are laterally continuous over observed strike lengths of from 100 to 400 meters. In places, mafic flows appear to grade laterally into mafic tuffs.

Volcanic Tuffs:

Mafic volcanic tuffs are common in the vicinity of the deposit. They are predominantly dark green to green black in colour, fine to very fine grained, and laminated to indistinctly bedded to massive. Rarely, sedimentary structures such as graded bedding, convoluted bedding (soft sediment deformation), sulfide nodules, etc. are observed. These tuffs commonly contain an appreciable argillaceous and calcareous component, and in places appear to grade laterally into argillite.

They are mineralized in places and can contain appreciable sulfides (pyrrhotite, chalcopyrite) as disseminated fine grains, foliated bands or beds 1mm to >3 cm wide, and wisps.

Argillites :

Argillites are dominantly dark grey to black but can range to light grey to buff. They are dominantly fine to very fine grained, but minor thin, sandy lenses of beds are noted. These sand-sized grains of light limestone are invariably stretched. They range from non-calcareous to very calcareous (impure limestones) and frequently contain graphite along fracture and cleavage planes.

Sedimentary structures present within argillites include graded bedding and lamination, scours, pebble dents, and nodules. Nodular argillite is a locally important variant and consists of spherical to ellipsoid boudins of lighter grey calcareous siltstone. Occasional thin laminae and beds of very fine to coarse, euhedral cubes of pyrite and/or fine-grained pyrrhotite are observed.

Dikes:

several compositional types of dikes are present (listed in approximate order of decreasing abundance):

1) intermediate to mafic, fine grained
2) diorite, medium to coarse grained
3) gabbroic, green black, medium to coarse grained, generally with abundant felted hornblende phenocrysts in a calcite-chlorite-epidote matrix. All of these are limited in their extent and occurrence.
4) lamprophyre: contains medium to coarse grained biotite flakes in a finer grained groundmass This is extremely rare and of limited extent.

These dikes are invariably poorly to well foliated and thus predate folding and tectonism of the deposit.

Mineralization:

Several styles of sulfide mineralization exist.

Stringer Mineralization: Stockwork or stringer mineralization occurs within what appears to be the stratigraphic footwall to the deposit. Stringer mineralization apparently does not extend beyond the limits of the massive ore. In the sections drilled to date, stringer mineralization extends to about 100 meters beneath the deposit. However, in many places this material is slightly to moderately foliated and it is likely that this zone has been thinned and possibly separated at least partially from the overlying massive mineralization. This might explain the present structural position of the stringer zone near the nose or hinge area of the major synclinal fold within the deposit (see section on structure).

The most intensely altered material consists of angular fragments or clasts of very bleached, milky white, silicified host rock fragments 1-10 cm diameter veined by anastomosing <1mm to over 10 cm wide veinlets of fine grained massive sulfide. Angular fragments are completely silicified and resemble an aphanitic chert. Sulfides consist predominantly of pyrrhotite with minor chalcopyrite. Less intensely altered material consists of pervasively intensely chloritized wallrock fragments that are a medium to apple green color or of partly silicified fragments that have only a rind of silica.

Stringer mineralization is not confined to any one particular lithology, although it appears to be most common within mafic flows and tuffs. In several places, stringer mineralization occurs within well laminated to bedded argillites. This material contains well laminated clasts of silicified argillite which resemble chert. Clasts are veined by narrow sulfide veinlets which cross-cut and transcend laminations and bedding in places. However, it appears that the sulfides have preferentially replaced many laminae within individual fragments.

<u>Massive Sulfide</u>:

Gammon and Chandler (1986) have indicated that massive mineralization has a surface strike length of approximately 1800 meters. Drilling has indicated that the sulfide mass varies in thickness from about 70 to well over 150 meters. However, due to folding and deformation, this is probably not a true stratigraphic thickness.

Current indications are that the massive sulfide mass is mineralogically zoned from massive pyrrhotite nearest the footwall to massive pyrite overlying this. Minor magnetite occurs at the transition. It appears that this zonation is a primary feature and is not related to later metamorphic events. It is likely that this zonation has an appreciable lateral as well as vertical component.

Drilling so far this season has identified three main types of sulfide: 1) predominantly massive pyrrhotite (±chalcopyrite), 2) predominantly massive pyrite (±chalcopyrite), and 3) massive pyrrhotite and pyrite (±chalcopyrite). Massive mineralization commonly contains dark green chlorite along fractures. Chalcopyrite occurs as discontinuous wisps, streaks, and blebs often associated with diffuse patches of white calcite. In places, open space vein fillings of very fine layers of botryoidal calcite, ankerite, and pyrite occur within the sulfides.

There appears to be a great deal of textural variation within the sulfide mass. Among the different textures identified are: 1) massive, fine grained, 2) brecciated, with angular clasts of pyrite and/or pyrrhotite in a fine grained sulfide matrix, 3) foliated to gneissic, with discontinuous layers of chalcopyrite, pyrite, pyrrhotite, calcite, etc., 4) recrystallized, 5) colloform, banded, open-space filling, 6) finely laminated to bedded, 7) soft sediment deformation and slumping.

Chert-Carbonate-Sulfide "Exhalite":

Chert-carbonate-sulfide consists of finely laminated (<1mm to 5 cm) calcite, chert, pyrrhotite, pyrite, chalcopyrite, hematite, magnetite. In places it contains a tuffaceous and argillaceous component. Rarely, the chert beds contain minute plagioclase microlites. This material is thought to overlie the main sulfide mass, somewhat akin to the "tetsusekiei" of the Japanese Kuroko deposits (e.g. Kalogeropoulis & Scott, 1983) and the "tuffite" of volcanogenic massive sulfide deposits in the Canadian Shield (Mattagami, Main Contact Tuff-Noranda).

Structure:

Folding and deformation of the deposit have been noted previously (Gammon and Chandler, 1986). Drilling results in 1982 and surface mapping on the North Face in 1983 suggested a tight synclinal fold structure plunging moderately to the northwest.

Current interpretation of the structure of the deposit by the writer is that the massive sulfide mass has been folded into a large, upright syncline doubly plunging fairly steeply to the northwest and southeast. The intensity of folding varies from broad and open in the central and northwestern part of the sulfide body to tight and isoclinal in the southern part. The western limb of the syncline dips steeply to the north, whereas the eastern limb has a more gentle dip.

Stringer type mineralization is most prevalent nearest the hinge and on the western limb of the syncline. Massive pyrrhotite is predominantly situated in the western limb, whereas massive pyrite is most common in the eastern limb of the syncline.

It must be stressed that this picture is only preliminary and will have to be refined in the future as present drilling has only covered a strike length of the deposit of about 250 meters at most. Detailed structural data is being collected from drill core in the hope that this information will prove useful in more closely defining the style, attitude and orientation of structural features. Falconbridge geologists have noted previously that a second folding event is evidenced in drill core by folded S1 cleavage planes; on surface this is seen in broad, secondary F_2 open folds.

Conclusions:

Fieldwork to date has entailed approximately two weeks of underground mapping of the entire North Drift. The rest of the time has been spent logging and sampling drill core. Over 300 geological samples comprising all rock types and styles of mineralization in the vicinity of the deposit have been collected to date. The timely marriage of the drill program and the fieldwork for this project has given the writer the unique opportunity to sample and observe the deposit in three dimensions.

Further drilling along the extended North and South Drifts is planned for next field season. Continued field investigations and sampling of these areas of the deposit will be of paramount importance in determining the large scale mineral zoning of the deposit. The northernmost part of the exposed mineralization has given indications of containing significantly more zinc than that portion of the deposit investigated to date. This mineralization appears to be more closely associated with argillites rather than volcanics.

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