THE ROLE OF HYDROTHERMAL FLUIDS IN IDENTIFYING BASE AND PRECIOUS METAL SOURCES ON THE PROPERTY OF FLAG RESOURCES IN RATHBUN AND MACKELCAN TOWNSHIPS, ONTARIO

Prepared for:
Mr. Murdo C. McLeod
President
FLAG RESOURCES INC.

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Prepared by:
Eva S. Schandl Ph.D.
INTRODUCTION

The present report was prepared at the request of Mr. Murdo C. McLeod, President of Flag Resources Ltd. The report summarizes and evaluates existing geological information on the property of Flag Resources in Mackelcan and Rathbun Townships, Ontario, including drill logs from two drill holes; DDH CH 92-1 and DDH ML 94-1. The drill cores from hole ML 94-1 were logged by Mr. Frank H. Toews and Mr. Peter E. Giblin and from hole CH 92-1 by Mr. Robin E. Goad of Fortune Minerals Ltd. Additional information supplied by Mr. McLeod included a short assessment of drill cores (0'-1600') from hole ML 94-01 by Dr. A.J. Naldrett, the 1991 and 1992 company reports of Mr. Robin Goad on the “Cobalt Hill Gold-Cobalt Occurrence”, Wolf Lake property, Mackelcan Township, which included a sketch map of 14 grab samples with associated chemical analyses (Chemex Labs Ltd.).

Several occurrences of locally high grade Ni, Cu, Au, Ag, Pt and Pd mineralization are known and have been reported within the Gowganda and Lorrain Formations on the Flag property (i.e. Cobalt Hill, Rathbun Lake, Wolf Lake). The general consensus is, that, some of the mineralization in the area is related to albitionization, some are related to faults and some to the Nipissing gabbro. While elevated concentrations of highly mobile elements such as Au, Ag and Cu in the silicified and sodium metasomatised sediments can be attributed to circulating hydrothermal fluids facilitated by the complex fault system in the region, the enrichment of sediments in Ni (and Co), Pd and Pt is enigmatic. Enrichment of these metals in the sediments would require a nearby mafic igneous source with elevated concentration of Ni, Co, Pd and Pt. While the differentiated Nipissing gabbro which intrudes the Huronian sediments qualifies as a major mafic intrusion in the region, it has been demonstrated by Lightfoot et al. (1987) that the Nipissing gabbro (at least in their study area) is not enriched in Pt and Pd, nor is it likely to host Sudbury-type massive sulfide mineralization at depth. However, if the Nipissing gabbro is not a possible source for the metals in the sediments, then other, mineralized mafic/ultramafic igneous intrusives must be present at depth. And because these elements are less mobile than Au, Ag and Cu, they are unlikely to have moved too far from the source.

In support of the presence of a mafic/ultramafic igneous complex at depth is, the ubiquitous occurrence of fuchsite (Cr-rich muscovite) in quartz veins of the albitized Lorraine Formation in drill hole CH 92-1 on Cobalt Hill. Fuchsite is a relatively common alteration mineral at lode gold deposits hosted by talc-carbonate altered ultramafic rocks in the Abitibi Belt (cf. Dome, Kerr Addison and Aquarious mines), fuchsite occurs at various gold prospects in ultramafic rocks along the Destor-Porcupine Fault and it is also abundant within the talc-
carbonate altered ultramafic rocks at the Kidd Creek VMS deposit, Ontario. On a global scale, fuchsite (often called listwanite in the literature) is commonly associated with altered ultramafic rocks. As Cr is considered to be one of the most immobile elements on the periodic table, and because Cr-rich micas generally occur in the vicinity of ultramafic bodies, the source of Cr in the cross-cutting quartz veins of the Lorrain Formation is enigmatic and cannot be easily explained without appealing to ultramafic rocks at depth.

Objectives

The objectives of the present report are, (1) to integrate and evaluate geological information provided by Flag Resources taking into consideration geological setting, multiple stages of metamorphism, metasomatism and hydrothermal alteration in the area - all of which believed to have contributed to the mobilization and localized reconcentration of metals in the Huronian sediments (2) to identify geological processes (and their signature) instrumental in the mobilization and localized concentration of precious and base metals (2) to draw upon related information in the literature and (3) to make recommendations for future work.

Regional Setting

The property of Flag Resources Ltd. is located in the Mackelcan and Rathbun Townships of Ontario, north-east of Lake Wanapitei. The area is approximately 20 km north-east of the eastern rim of the Sudbury structure which contains one of the world’s largest Ni-Cu-PGE deposits, it “straddles the western side of the Wanapitei magnetic and gravity high anomaly and includes most of the western peak of the anomaly” (Goad, 1992). The Wanapitei anomaly is considered to be comparable to the Sudbury anomaly that outlines the Sudbury Nickel irruptive. The property is covered by Huronian sediments of the Cobalt Group and the sediments are locally intruded by the Nipissing gabbro. Sediments in Hole CH 92-1 consist of quartz arenites and arkosic sandstones of the Lorrain Formation, and in Hole LM 94-1, they consist of wackes, siltstones and conglomerates of the Gowganda Formation. The Cobalt Group represents the uppermost sedimentary cycle of the Huronian Supergroup whereas Lorrain Formation overlies the Gowganda Formation. The lower age limit of the Huronian Supergroup is constrained by the 2450 Ma age of rhyolites at the base of the Supergroup (Krogh et al., 1984) and the upper limit by the age of the Nipissing gabbro which intruded the Huronian sediments at 2.2 Ma (Noble and Lightfoot, 1992).
The property of Flag Resources Ltd. is located within the southern part of the Cobalt Embayment in the region of sodium metasomatised (albitized) Huronian sediments. Albitization is pervasive not only in the sediments, but it also affected the Sudbury breccias and Nipissing gabbro (Gates, 1991; Schandl et al., 1991, 1994). Albitization is regionally extensive, it has been documented between north-east of Lake Wanapitei (as far as Davis Township to the east) and Espanola (Meyer, 1987; Gates, 1991; Schandl et al., 1991, 1994), enveloping the entire Sudbury igneous complex. The event of sodium metasomatism has been dated at 1.7 Ma (Schandl et al., 1991, 1994) by the U-Pb age of monazite associated with albitization at the Scadding mine, Scadding Township and the Sheppard Property, McLennan Township. Although it post-dated the "Sudbury event" of 1.85 Ma (Krogh et al., 1984), the 1.7 Ma age corresponds to a period of granitic plutonism in the Southern Province, the time of collisional orogeny and the development of the Killarney magmatic Belt (Easton, 1991). Sodium metasomatism was post-dated by extensive brecciation, silica flooding, the emplacement of fracture-filling quartz-carbonate veins and extensive chlorite alteration in the Huronian sediments (cf. Schandl et al., 1994). Several gold mines and gold occurrences have been documented in albitized Huronian sediments where gold generally occurs either as free gold in fracture-filling quartz, quartz-carbonate veins or as inclusions in sulfides (cf. Gates, 1991, Schandl et al., 1991, 1994).

Summary of Log Results from the Flag Property: Mineralization, Alteration, Lithology

**DDH CH 92-1**

DDH CH 92-1 (Cobalt Hill, Mackelcan Tp.) was drilled into brecciated quartzites of the Lorrain Formation. The rocks are albitized, sericitized and extensively silicified with localized quartz flooding. Microbrecciation, pink albite and sericite alteration, as well as quartz flooding extends through the entire 2,500 feet length of the core. Emerald-green fuchsite (Cr-rich mica) was identified in the silicified quartzite.

The first appearance of fuchsite was reported at the depth of 71.9'. It re-appears again at 1,267' within quartz veins (often associated with chlorite and carbonate) which cross-cut the albitized quartzite. From 1,267' there is a progressive increase in the abundance of fuchsite with depth, as well as an increase in the abundance of chlorite and carbonate (some carbonates are reportedly Fe-rich) up to 2,276 feet, where fuchsite abruptly disappears. The 2,276' depth more or less coincides with a slight change in lithology as the lower contact of the Lorrain Formation is approached. Greywacke clasts and narrow bands of interbedded greywacke (of the underlying Gowganda Formation) are
common in the lower 1,000 feet section of the core. Figure 1 is a schematic diagram, it demonstrates the distribution of fuchsite with depth.

**Sulfide Mineralization**

Pyrite is the only sulfide reported in drill hole CH 92-1 (Goad, 1991). Pyrite generally occurs (a) within fracture-filling quartz veins, (b) as small stringers, (c) as up to 5 cm wide massive bands, (d) as disseminated aggregates and (e) as relatively coarse, euhedral “diamond-shaped” grains which were interpreted to have the morphology of Co-Ni-rich pyrites (Goad, 1991, 1992). Pyrite occurs (but varies in abundance) throughout the entire length of the drill core and there appears to be an inverse relationship between the abundance of fuchsite and pyrite.

0-100'
Albitized quartzite breccia is cut by quartz veins
Quartz flooding, fuchsite grains occur in quartz veins
Minor chlorite patches and halos along quartz veins

100-400'
Albitized quartzite, silica flooding
Sericite-rich bands
Quartz-carbonate veins
Chlorite veins (cross-cut albite, quartz and sericite)

400-1,000'
Intense brecciation at 425', 750-1,000'
Variably albitized quartzite
Silica flooding, sericite-rich bands
Minor hematite, carbonate
Quartz veins with minor chlorite

1,000-1,500'
Intense brecciation, locally hematite-rich
Silica flooding, sericite-rich bands
Fuchsite (re-appears at 1,267’) in quartz-chlorite-pyrite veins

1,500-2,000'
Intense microbrecciation of variably albitized quartzite
Silification, sericite-rich bands
Fuchsite increases with depth (mostly in quartz veins in breccia)
Increase in chlorite and carbonate
Fe-rich carbonate at 1,647’
Figure 1

DDH CH 92-1

Fuchsite-bearing zones: Cobalt Hill

Depth (feet)

<table>
<thead>
<tr>
<th>1000</th>
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<tbody>
<tr>
<td>1500</td>
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<tr>
<td>2000</td>
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<tr>
<td>2500</td>
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</tbody>
</table>
2,000-2,250'
Fuchsite in quartz veins within breccia
Contact with Gowganda Formation at 2,200'
FAULT at 2,245', Fe-rich carbonate
Lower contact of Lorrain Formation: interbedded with greywacke

2,250-2,486'
Last appearance of minor fuchsite at 2,276'
Greywacke fragments interbedded with quartzite
Minor quartz veins – some replace earlier quartz veins
Chlorite alteration increases
Quartz+chlorite veins

END OF HOLE

DDH ML 94-1

DDH ML 94-1 was drilled into albitized Gowganda Formation (west of Matagamasi Lake, Rathbun Tp.) consisting of laminated to massive wackes. Brecciation, hematite staining and the abundance of fracture-filling quartz-carbonate veinlets (orientation to bedding: parallel, sub-parallel and cross-cutting) characterizes the upper 2,600 feet of the core. The lower 1,000 feet grades into relatively unfractured more feldspathic sandstones and siltstones mixed with arkose. Sudbury-type breccia is common in the upper 2,500’ section, but it is absent below 2,600’.

Sulfide Mineralization

Figure 2 is a schematic cross-section of the 3,600’ deep drill hole, showing the distribution of sulfide-bearing bands with depth. The following sulfide minerals have been identified; pyrite, pyrrhotite, chalcopyrite, rare sphalerite and possibly galena. Sulfides are described throughout the drill log as “scaly pyrite”, “replacement pyrite or pyrrhotite” some of which replace pebbles, also as “veinlets” (chalcopyrite-pyrite-pyrrhotite) within fracture-filling quartz and carbonate veins, and as “disseminated” aggregates within the sediment matrix or on “chlorite slips”. There is no mention of detrital, subrounded sulfides in the log, thus, most of the sulfides must have been introduced with fracture-filling quartz-carbonate veins which cross-cut the albitized rocks and with late chlorite alteration, some of which is associated with slip-surfaces.

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Type of sulfides</th>
</tr>
</thead>
<tbody>
<tr>
<td>70-350</td>
<td>very few pyrite</td>
</tr>
<tr>
<td>350-400</td>
<td>pyrite and minor chalcopyrite</td>
</tr>
</tbody>
</table>
Figure 2

DDH ML 94-1

Zone of disseminated sulfides (range: <1% - 3%)

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Material</th>
</tr>
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<tbody>
<tr>
<td>1000</td>
<td>py-po-cp-sph</td>
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<tr>
<td>2000</td>
<td>po-cp-py</td>
</tr>
<tr>
<td>3000</td>
<td>py-cp</td>
</tr>
<tr>
<td>4000</td>
<td>py</td>
</tr>
</tbody>
</table>
It is evident that the most sulfide-rich section of the core occurs at depth between 920' and 2,434' and the sulfides taper off below 2,500'. The sulfide-rich domains are characterized by extensive fracturing, crackle-brecciation of albitized rocks, the abundance of fracture-filling quartz-carbonate veinlets which carry pyrite, pyrrhotite and chalcopyrite (average orientation of the veins is 50-70° to core axis).

The decrease in sulfides coincides with the disappearance of Sudbury-type breccia, the absence of crackle-brecciation, the absence of quartz-carbonate gash-type veins, the appearance of minor epidote-secondary albite-chlorite alteration, and the slight change in lithology to feldspathic wacke with intercalated siltstone.

**0-500’**
Sudbury-type breccia, crackle-brecciation
Albitized fragments floating in quartz, silicification
Numerous quartz-carbonate veinlets in fractures

**500-1,000’**
Numerous quartz-carbonate veinlets in gashes
Most sulfides occur in fractures with quartz and carbonate veins
Minor chlorite-quartz veinlets

**1,000-1,500’**
Numerous quartz-carbonate-chlorite veinlets
Chlorite occurs on slip surfaces (shear?)
Chlorite increases with depth

**1,500-2,000’**
Sudbury-type breccia continuous from 1,580 to 2,000’
Crackle brecciation, extensive shearing
Replacement of some pebbles by sulfides
Gash-filling quartz-carbonate-chlorite veinlets (1,530-1,600’)

420-775 minor pyrite, pyrrhotite and chalcopyrite
920-1,580 pyrrhotite, pyrite, chalcopyrite (minor) sphalerite
1,770-1,911 pyrite, pyrrhotite, chalcopyrite
1,911-2,110 pyrrhotite, chalcopyrite, pyrite
2,137-2,232 pyrrhotite, pyrite, chalcopyrite
2,424-2,434 pyrite, pyrrhotite, chalcopyrite
2,437-2,500 minor pyrite only
2,511-2,621 minor pyrite, chalcopyrite
3,043 minor chalcopyrite, pyrite
3,436-3,492 pyrite
Extensive silicification, quartz with chlorite

2,000-2,500'
Decrease in Sudbury-type breccia
Carbonate-chlorite-quartz veinlets
Brecciation, minor albite alteration
Appearance of epidote in vein with albite at ca. 2,437' depth
Wacke is intercalated with arkose

Deepening Hole at 2,500'

2,500-2,630'
Minor Sudbury-type breccia
Change in lithology to a more feldspathic wacke with siltstone
Change in alteration to albite-chlorite-epidote
Granite pebbles
Several sulfide stringers are parallel to core axis

2,630-3,000'
Feldspathic sandstone, siltstone
Minor chlorite slips (increasing with depth)
Minor epidote alteration

3,000-3,570'
Sandstone, pebbly wacke
Chlorite slips increase
Minor quartz-epidote veinlets
Granite cobbles

END OF HOLE

DISCUSSION

Drill log descriptions of DDH CH 92-1 and DDH ML 94-1 from Mackelcan and Rathbun Townships demonstrate that albitization is pervasive at both localities, although the different lithological units (Lorrain quartzite and Gowganda wacke) also show significant differences in alteration assemblages. Some of these differences can be attributed to inherent differences in the geochemistry of the host rocks, but some represent the addition of elements from an outside source. The addition of Na₂O, SiO₂, CO₂, Cu, Zn, Cr to the sediments is apparent from albitization (Na₂O), silicification-quartz flooding (SiO₂),...
carbonate alteration (CO₂), the presence of chalcopyrite (Cu), sphalerite and fuchsite (Cr).

The albitized Lorrain quartzite is characterized by brecciation, quartz flooding, extensive silicification and sericite alteration, including Cr-rich muscovite (fuchsite) and variable chlorite alteration. The abundance of fuchsite increases with depth between 1,267 and 2,276', and it abruptly disappears at 2,276'. This depth more or less coincides with a fault at 2,245' and also with the lower contact of Lorrain quartzites with the Gowganda wackes. Pyrite is the only sulfide in the quartzites. It occurs in up to 5 cm-wide massive bands, as disseminated grains in albite and as fracture-filling veinlets with quartz, chlorite and/or fuchsite. The morphology of some pyrite grains suggest that they may be nickeliferous (Goad, 1992).

The albitized Gowganda wackes from DD ML 94-1 are cross-cut by quartz-carbonate gash-type veins, they are locally carbonatized, and crackle-brecciation and hematite staining is pervasive in the rocks. With a slight change in lithology (to more feldspathic wacke) at 2,500' depth, there is a change in alteration within the wackes; quartz-carbonate gash veins disappear and they are replaced by epidote-chlorite-albite veinlets. This depth coincides with a slight change in lithology to more feldspathic wacke, the disappearance of Sudbury-type breccia and a decrease in the intensity of crackle-brecciation. Epidote-albite assemblage in the more feldspathic wacke may reflect the higher plagioclase content of the rocks where calcic plagioclase breaks down during metamorphism to form albite and epidote. Sulfides in the Gowganda wackes include chalcopyrite, pyrrhotite, pyrite and minor sphalerite. Sulfides are ubiquitous between 920' and 2,500' and decrease in abundance below 2,500'. Most sulfides occur in fracture-filling veinlets with quartz and carbonate.

Mineralization Reported on Cobalt Hill

Although chemical analyses from the drill core samples was not available, in a company report to Flag Resources Mr Goad (1991) included the analyses of 14 grab samples from the Cobalt Hill quartzites of the Lorrain Formation, north of Jones Lake. He described the location as an area of extensive brecciation, sodium metasomatism and silicification. The pyrite-rich samples show elevated Ni, Co and Au values. Ni = 153 - 3370 ppm, Co = 162 - 6160 ppm and Au = 82 - 7500 ppb. The high Co concentrations are often accompanied by high Au but not necessarily high Ni values, which for the most part, appear to be independent of Au. The morphology of “diamond-shaped doubly-terminated pyrite” suggests nickeliferous composition (Goad, 1991). The Cu, Pt and Pd concentrations were found to be only slightly higher than average. In the same area, north of Jones
Lake, Gates (1991) also reported anomalous Ni (765 ppm), Co (815 ppm) and Au (3500 ppb) values within a gossan–rich zone.

The 14 grab samples collected and described by Goad (1991) are albitized quartzites with quartz veins and matrix pyrite. They have unusually high Cr concentration for quartzites; 81-521 ppm (av. 350 ppm). The high Cr values would be commensurate with the presence of fuchsite in quartzites as reported by Goad (1991, 1992). The significance of the presence and relative abundance of fuchsite in quartz veins and secondary quartz in the Lorrain quartzites at Cobalt Hill is two-fold; it implies the presence of ultramafic source rocks in the not too far distance and it raises the probability of gold mineralization in the area.

The suggested source of Cr for fuchsite and the mobility of Cr in hydrothermal fluids are briefly discussed below:

(1) Cr-bearing minerals in igneous rocks are chromite and pyroxenes. As chromite is stable during metamorphism and hydrothermal alteration, the only available source of Cr would be pyroxenes which are replaced by amphibole during metamorphism or hydrothermal alteration. Because the amount of Cr in pyroxene tends to be proportional to the Cr in the host rock, in ultramafic rocks (which contain thousands of ppm Cr) pyroxenes are much more Cr-rich than in mafic rocks. Therefore, the amount of Cr liberated during the metamorphic recrystallization of pyroxene in mafic rocks would be negligible, whereas in ultramafic rocks it would be significant. The only known mafic intrusion in the vicinity of drill hole CH 92-1 is the Nipissing gabbro which has an average Cr content of 200-350 ppm (cf. Lightfoot et al., 1987), thus, an unlikely donor of Cr. In accordance, fuchsite is not known to be associated even with the most altered Nipissing gabbro. An alternative source for Cr would be altered ultramafic rocks in the vicinity of the drill hole. However, at present, no ultramafic rocks are known in the area.

(2) As Cr is one of the most immobile elements on the periodic table, it will not move far from its source even when rocks are completely replaced by secondary minerals. This has been observed in pervasively altered ultramafic rocks, most of which host gold deposits. In carbonate + talc ± quartz altered ultramafic rocks fuchsite commonly occurs on the selvages of gold-bearing quartz veins. Such deposits include the Dome, Kerr Addison and Aquarious mines in Ontario, the Cassiar gold mine in British Columbia, and several gold prospects along the Destor-Porcupine fault. In addition to gold deposits, talc-carbonate altered ultramafic rocks at the Kidd Creek VMS deposit, north of Timmins, Ontario also contain fuchsite which crystallized during regional metamorphism by the addition of Cr from the breakdown of pyroxene in the ultramafic host and by the addition of
K$_2$O and Al$_2$O$_3$ from the contact rhyolites (cf. Schandl, 1989; Schandl et al., 1990; Schandl and Wicks, 1993; Smith et al., 1993).

Mineralization on the Rathbun Township Property

The Gowganda wackes on the Rathbun Township property display a different style of mineralization and accompanying alteration than the Lorraine quartzites on Cobalt Hill. Sulfide minerals include pyrite, chalcopyrite, pyrrhotite, pentlandite and minor sphalerite. Extremely high PGE values have been reported by Rowell (1984) and Goad and Rowell (1985) at Rathbun Lake. The highest concentrations of PGEs were; Pt: 33,000 ppb, Pd: 37,000 ppb, Rd: 23 ppb, Ru: 40 ppb, Ir: 28 ppb and Os: 23 ppb. Ni concentration was up to 2.12 %, Cu: 19.9 %, and Au up to 5,500 ppb.

As chemical data was not available from the 3500' long core (DDH ML 94-1) drilled by Flag Resources on the Rathbun Property (between Matagamasi and Rathbun lakes), the detailed core description (by Mr. Frank Toews and Mr. Peter Giblin) serves as a basis for evaluating the type of alteration and mineralization encountered in the core.

The albitized rocks in the core are silicified, brecciated (crackle brecciation) and locally show pervasive carbonate alteration. Fractures in the rocks are filled by gash-type quartz-carbonate-chlorite veins which carry the sulfides. Silicification is extensive and chlorite occurs on slip surfaces and increases in abundance with depth. Extensive shearing was observed at ca. 2,000' depth which also coincides with an increase in silicification and the abundance of veins.

There is a change in the type of alteration below 2,500' as gash-type veins are replaced by small epidote-albite-chlorite veinlets. This depth coincides with a decrease in sulfide content, with a change in lithology to more feldspathic wackes and siltstones which contain granite cobbles. Thus, the appearance and increase in epidote content in the core may be the consequence of the increasing plagioclase content of the wacke (feldspathic), as plagioclase often breaks down to epidote-albite assemblage during metamorphism.

Drill cores from the two different locations represent different lithological units, different alteration and somewhat different style of mineralization. There is however, a notable decrease in sulfides with depth in both drill cores as changes within the underlying lithological units are encountered. This decrease is accompanied by a decrease in fracturing and brecciation and a change in the style of alteration. As the rocks in the drill holes represent two different formations in the Cobalt Group (Lorraine and Gowganda), the decrease in sulfides with depth in both drill holes is puzzling. A possible explanation may be that channelways of hydrothermal solutions exploited zones of weakness more or less parallel to bedding planes, or alternatively, fluid conduits were sealed at depth during the waning stages of hydrothermal activity.

Wackes from the Gowganda Formation have variable and sometimes relatively high Cr and Ni concentrations, thus, Ni enrichment in the rocks is not
always apparent. A relatively simple way to identify Ni-enrichment is, to look at the Cr:Ni ratios in the sediments. The reason for this is, that, when sediments are derived from mafic rocks, they inherit the original Cr and Ni values of the source rocks. In mafic igneous rocks the absolute concentrations can vary from tens to hundreds of ppm, but Cr:Ni ratios generally have a range from about 1.5 to 2. Thus, sediments derived from mafic rocks reflect these ratios, not only in the Huronian sediments but also in sediments on the global scale. Therefore, if the ratio of Cr to Ni is consistently low (<1), Ni must have been introduced to the sediments from an external source via hydrothermal fluids.

The Significance of Sodium Metasomatism (albitization) with Respect to Mineralization (with an emphasis on the Flag property)

Albitization of the Huronian sediments is widespread around the Sudbury basin, it extends several tens of kilometers outside the basin, forming a wide halo around the deposit. Based on field observations (cf. Meyer, 1987; Gates, 1991) and precise U-Pb age dating, it has been suggested that sodium metasomatism, which occurred at 1.7 Ma (Schandl et al., 1991, 1994) post-dated the Sudbury event of 1.85 Ma (Krogh et al., 1984). The role of sodium metasomatism in gold mineralization around the Sudbury structure has been debated over the past decade. The common occurrence of albitized rocks at gold deposits and prospects in the area cannot be disputed, however, the actual role of sodium-rich fluids in mineralization has not been established. Where mineralization occurs, gold in the albitized rocks is present in cross-cutting quartz-carbonate veins, quartz veins or chlorite veins – most of which also contain pyrite. Thus, quartz, carbonate, chlorite, vein pyrite and gold, appear to have post-dated sodium metasomatism.

The significance of sodium metasomatism in terms of mineralization is, that albitized sediments define a regional zone of hydrothermal alteration, providing the proverbial “ground preparation” for mineralizing fluids. Albitized rocks are generally very fine-grained, massive and have a cherty texture. Where associated with mineralization, they are often brecciated, fractured and fractures are locally filled by veins of quartz+carbonate±chlorite±pyrite (cf. Schandl et al., 1994). At the Crystal, Comstock and Last Chance mines in the Rathbun Tp., for example, gold occurs in quartz ± carbonate ± pyrite veins which cross-cut albitized Gowganda sediments, as well as the Nipissing gabbro (Gates, 1991). The Wolf Lake occurrence in Mackelcan Tp. is described by Gates (1991) and Goad (1992) as an area of extensive alteration and deformation. The Lorrain quartzite is variably albitized, brecciated and silicified. Gold is apparently associated with quartz veins and sulfides which cross-cut the albitized sediments and the Sudbury breccia (Gates, 1991). South of Rathbun Tp., the Scadding mine (Scadding Tp.) is another example of a small gold deposit within the
albitized Gowganda wackes. The wackes are extensively albitized (Na₂O=7.68 wt.; Schandl et al., 1994) and the albitized rocks are partly to almost completely replaced by chlorite and sulfides. However, gold mineralization is restricted to rocks with high chlorite and sulfide concentrations (Schandl et al., 1994).

CONCLUSIONS

After careful evaluation of log results, partial geochemistry and various reports on the property held by Flag Resources Ltd. in Mackelcan and Rathbun Townships, the following conclusions were reached:

(1) The Cobalt Hill property is considered to be a favorable exploration target for Au and Ni-Co sulfide mineralization. The occurrence of fuchsite (Cr-rich muscovite) in late quartz veins and in brecciated, silicified Lorrain quartzite suggests (a) the presence of an ultramafic intrusion in the vicinity and (b) potential gold mineralization. Fuchsite is a common key mineral in ultramafic rock-hosted lode gold deposits (cf. Dome, Kerr Addison, Aquarious, Cassiar). Because Gr is a relatively immobile element, even if mobilized during hydrothermal alteration, it is unlikely to move far from the source rock. In drill hole CH 92-1 fuchsite first occurs at 71.9' depth within quartz veinlets. It re-appears again at 1,267' within interstitial secondary quartz and in quartz veins and progressively increases in abundance with depth up to 2,276'. The sudden disappearance of fuchsite below this depth is probably the result of a slight change in lithology as the base of the Lorraine quartzite unit is approached. To determine the path of Cr (and its ultimate source), the orientation of fuchsite-bearing veins with respect to the orientation of bedding planes and faults should be mapped in detail.

(2) When available information in the literature is re-examined and re-interpreted, it becomes evident that (1) albitized Huronian sediments represent an excellent, but passive host for mineralizing solutions. Brecciated and fractured, they provided channelways for the quartz-carbonate-chlorite-sulfide-Au veins or sulfide-rich quartz veins. (2) The spatial relationship between the Sudbury breccia and albitized Huronian sediments around the Sudbury Basin suggests that collisional orogeny and attendant sodium metasomatism in the area at 1.7 Ma (Schandl et al., 1994) probably re-activated fractures associated with the earlier Sudbury event, resulting in extensive albitization of not only the sediments but also the Sudbury breccia. Regional deformation continued, as is evident from the widespread occurrence of brecciated albitized rocks, quartz flooding and the emplacement of quartz-carbonate-chlorite-sulfide±Au veins. I believe that gold mineralization in the area has occurred during this last
event, as well as the mobilization of Ni, Co, Cu, Pd, Pt. The source of these elements must have been mafic to ultramafic intrusive rocks at depth. Thus, areas of extensive post-albite brecciation, quartz flooding and the abundance of quartz-carbonate-chlorite-sulfide veins and pods would provide excellent exploration targets on the Flag property. Such areas represent the center of hydrothermal activities. And while Cu-Ni sulfides are formed by magmatic and not hydrothermal processes, the mobilization of some metals during hydrothermal alteration can lead us to the “real McCoy” by identifying the path of the hydrothermal fluids.

(3) The high Ni and Co values (also Au) in siliceous and sulfide-rich grab samples from north of Jones Lake (Goad, 1991) suggests significant Ni and Co enrichment of the hydrothermally altered Lorrain quartzites. Introduction of Ni and Co via hydrothermal fluids implies a nearby mafic/ultramafic intrusion and possibly massive sulfides as the source for the metals.

(4) The site of drill hole ML 94-1 in Rathbun Township represents an area of extensive hydrothermal activity. The 3,570 feet deep hole drilled into albitized and hydrothermally altered Gowganda wackes at Rathbun Township contains a variety of disseminated sulfides; pyrite, pyrrhotite, chalcopyrite, sphalerite and possibly galena – most of which are included in late quartz-carbonate veins and in the chlorite-rich slip surfaces of the core. Although sulfides are present throughout the entire depth, most sulfides occur between 400' and 2,600'. Sudbury-type breccia occurs throughout the upper 2,500' section of the core, and its abundance coincides with the zone of crackle brecciation, silicification and carbonate alteration. There is a positive correlation between Sudbury-type breccia and sulfide abundance. A small change in lithology to more feldspathic wackes below 2,500' corresponds to the appearance of epidote-albite veinlets, a decrease in sulfide content and the disappearance of quartz-carbonate veins.

(5) As geochemistry was not available from the drill cores and Ni-bearing sulfides were not identified, I cannot comment on the possible addition (via hydrothermal fluids) of Ni, Co, Au, Pd and Pt to these rocks. However, the ubiquitous presence of Fe, Cu and Zn sulfides within quartz-carbonate veins, and their association with chlorite-rich slip surfaces in the core suggests that metals have been mobilized and concentrated by hydrothermal fluids.

(6) The high Ni, Co, Cu, Pt and Pd concentrations reported from the Rathbun Lake property (Dressler, 1982; Rowell, 1984; Goad and Rowell, 1985),
coupled with the paucity of Ni-sulfides in the area suggests that the metals were concentrated by hydrothermal fluids. However, considering the very close spatial relationship of this enrichment to the Nipissing gabbro, a possible genetic link to the gabbro should not be ruled out. It is unlikely however, that the high metal concentrations could have been achieved by releasing the metals from the presently exposed gabbro during alteration (Gates, 1991). It appears that the hydrothermal fluids were in contact with mineralized rocks.

RECOMMENDATIONS

(1) Because the inferred source rocks for Ni, Co, Cu, Au and PGE's (which were mobilized by hydrothermal fluids) are presently hidden under a thick cover of Huronian sediments on the Flag property, it is important to identify the path of the metal-rich solutions. An interesting feature common to several sulfide and gold occurrences in the area (within and outside the property) is, that they generally occur at shallow depths and mineralization seem to discontinue with increasing depth. This would imply that the path of hydrothermal fluids was probably not orthogonal to stratigraphy, but it was controlled, at least in part, by bedding planes and by the contact between lithological units. If this is true, then source rocks for metal-rich fluids may occur at shallower depths than has been previously suggested. This hypothesis should be tested by integrating and re-assessing existing structural and geophysical information obtained by previous work on the Cobalt Hill and Rathbun Lake occurrences.

(2) Detailed mapping should be carried out locally on the known sulfide and Au occurrences on the property, noting the orientation of sulfide-bearing quartz and quartz-carbonate veins, orientation of fractures and shears with respect to bedding planes, stratigraphy and structure, in order to identify the path of mineralizing fluids.

(3) Determine the Ni content in pyrite in selected sulfide samples, as high Ni concentration in pyrite could well define a potential zone of mineralization. Ni-rich pyrite is relatively common in the Sudbury ores (cf. Naldrett, 1984).

(4) Determine Cr:Ni ratios to identify Ni-enrichment in selected rocks; low Cr:Ni ratios (consistently <1) suggest the addition of Ni from an external source, defining possible exploration targets.

(5) Geochemistry and mineralogy (identification and microprobe analysis of selected minerals) must be an integral part of exploration as they provide
tremendous help in evaluating potential targets. While log description is an essential part of exploration, it is merely the initial step towards finding an orebody. When samples are carefully selected for geochemical and mineralogical work, the analytical expenses will be very small compared to drilling costs.

References


Goad, R.E. 1991, Drill Core log of DDH CH 91-1: Flag Resources


Goad, R.E. 1992. Report to Flag Resources on mineralization at Rathbun Lake and Cobalt Hill.


Work Report Summary

Transaction No: W0270.00555  Status: APPROVED (D)
Recording Date: 2002-APR-02  Work Done from: 2001-AUG-06
Approval Date: 2002-JUL-01  to: 2001-AUG-06

Client(s): 132132  FLAG RESOURCES (1985) LIMITED

Survey Type(s): DATA

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External Credits: $0
Reserve:

$1,200 Reserve of Work Report#: W0270.00555

$1,200 Total Remaining

Status of claim is based on information currently on record.
Dear Sir or Madam

Submission Number: 2.23283
Transaction Number(s): W0270.00555

Subject: Deemed Approval of Assessment Work

We have approved your Assessment Work Submission with the above noted Transaction Number(s) as per 6(7) of the Assessment Work Regulation. Only eligible assessment work is deemed approved for assessment work credit. The attached Work Report Summary indicates the results of the approval.

NOTE: The report has not been reviewed for technical deficiencies and reported expenses were not evaluated based on the Industry Standard.

At the discretion of the Ministry, the assessment work performed on the mining lands noted in this work report may be subject to inspection and/or investigation at any time.

If you have any question regarding this correspondence, please contact BRUCE GATES by email at bruce.gates@ndm.gov.on.ca or by phone at (705) 670-5856.

Yours Sincerely,

Ron Gashinski
Senior Manager, Mining Lands Section

Cc: Resident Geologist
Flag Resources (1985) Limited
(Claim Holder)

Assessment File Library
Flag Resources (1985) Limited
(Assessment Office)
MINING LAND TENURE
MAP

Date / Time of Issue: Feb 27 1982
11:08h Eastern

TOWNSHIP / AREA
RATHBUN

PLAN
G-4093

ADMINISTRATIVE DISTRICTS / DIVISIONS
Mining Division Sudbury
Land Titles Registry Division SUDBURY
MINISTRY OF NATURAL RESOURCES
SUDBURY

TOPOGRAPHIC

LAND TENURE

LAND TENURE WITHDRAWALS

LAND TENURE WITHDRAWAL DESCRIPTIONS

IMPORTANT NOTICES
General Information and Limitations

Date / Time of Issue: Feb 27 2002
TOWNSHIP / AREA: MACKELCAN
PLAN: G-2894

TOPOGRAPHIC

LAND TENURE

ADMINISTRATIVE DISTRICTS / DIVISIONS
Mining Division: Sudbury
Land Titles/Registry Division: SUDBURY
Ministry of Natural Resources District: SUDBURY

IMPORTANT NOTICES

LAND TENURE WITHDRAWALS

LAND TENURE WITHDRAWAL DESCRIPTIONS

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