Preliminary Investigation of Abandoned Mill Tailings at the Montague Gold District, Nova Scotia: Implications for Development Potential

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Introduction and History

The advent of new and efficient leaching technology in the mining industry is leading to a rising interest in former gold mines in Nova Scotia and their potential for new development. Unconsolidated material, such as mill tailings from former gold producers is now being seen as possible mill feed for such an operation. The former Montague Gold Mines in Halifax County (NTS 11D/12) is currently under consideration as a possible contributor to such an operation.

Gold was discovered at Montague in 1862. The area was proclaimed a gold district and was mined from 1863 to 1927 by a variety of companies (Malcolm, 1976). Gold is hosted at Montague by quartz veins in the Cambro-Ordovician metasediments of the Meguma Group. The overwhelming majority of these veins are stratabound, as in many other gold districts in Nova Scotia. The gold-bearing veins lie in 'vein packages', restricted to pelitic assemblages that are relatively thin, on a scale of tens of centimetres to a few metres. These strata alternate between the much thicker beds of relatively massive psammite.

Reports from previous mining indicate an overall grade of over 1.6 oz. of gold per ton for veins mined in the deposit (Brunton, 1927). Ore generally consisted of high grade, vein quartz from the pay zones, which was crushed in stamp mills and fed over amalgam plates. Generally, oversize material was re-crushed to approximately 25 mesh and, once over the amalgam plate, was fed through a variable sizing trommel that led to two Wifley tables. One table was for coarse material and one for the fines. Efficiency of this milling technique was approximately 65-70%, indicating that a significant portion of the gold in the ore remained in the tailings.

This study has several objectives. The first is to determine the areal extent of the tailings at Montague using air photographs. The second is to seperate them into categories of different confidence levels, based on air photo information. The third is to calculate tonnage estimates of available tailings that could be mined and leached by modern methods. Accurate depth measurements of the tailings were not part of this study. Estimates of tailings with lower confidence levels are also identified as targets for further study.

Methods

For the purpose of this study, tailings at Montague were divided into three categories (Fig. 1). 'Confirmed tailings' include those areas that are unquestionably tailings and probably have dependable, though variable, gold levels. There are two categories of 'possible' tailings, as some of the possible areas have a higher confidence level than others. 'Possible' tailings areas include areas where tailings have been dispersed, such as through runoff into swamps, and are divided into categories of higher and lower confidence depending upon estimates of the grade and/or tonnage.

Primary (area) calculations leading to tonnage measurements were performed on the tailings using measurements taken from the Faribault (1902) map of the district. Spatial data for the tailings locations came from 1992 government air photos. These location data were entered into Arcview®, the geographic information system software employed by the Nova Scotia Department of Natural Resources. Measurements for the tailings areas were made and calculations then performed on each corresponding polygon (Tables 1 and 2). All units are metric.

Data were also collected for tailings density (Table 3). Samples were weighed in air, then in filtered water. Immersed weight was subtracted from the raw weight and the sum divided into the raw value to derive a density measurement. With the density calculated, this number was multiplied by the estimated volume of the tailings to calculate tonnage estimates (L. Dorian, Technical University of Nova Scotia, personal communication).

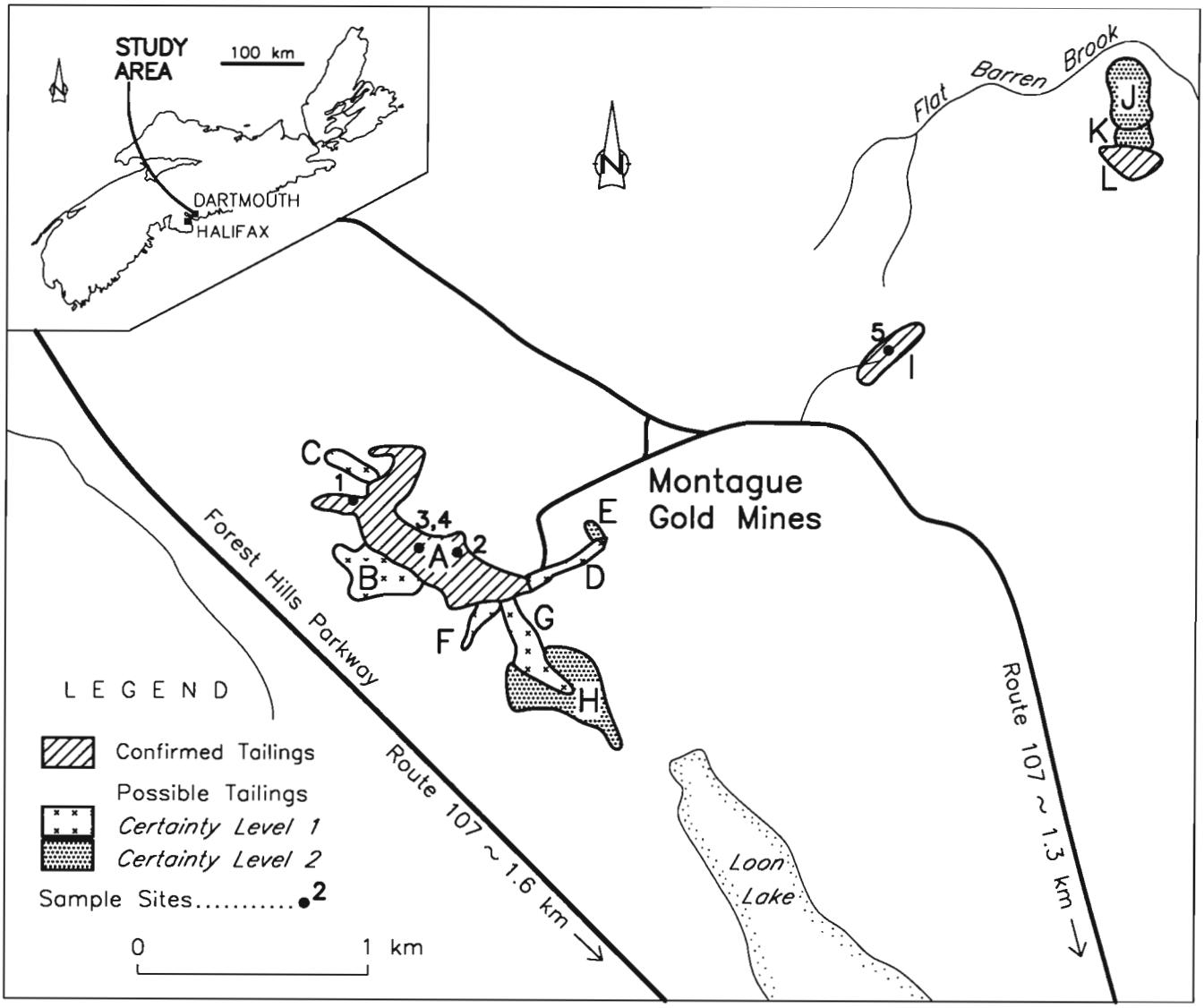

Figure 1. Location map of the Montague Gold Mines Gold District's tailings and samples 1-5 collected during this study, Halifax County.

Table 1. Approximate areas (m^2) of confirmed tailings from the Montague Mines Gold District, Halifax County (see Fig. 1 for location).

CONFIRMED TAILINGS	
Tailings Pile	**Area Calculated by ArcView® (metres^2)**
Area "A"	96 054.8
Area "I"	4 488.1
Area "L"	4 831.9
Total Area Confirmed Tailings	**105 375 Metres^2**

There is no study that has derived the depths of tailings piles at Montague. A table of the possible average depths of the tailings has been created for the next stage of the calculations, which is to determine the tailings volume. Tailings volume multiplied by density yields an estimate of the metric tonnes of ore at Montague.

Results

Two analyses were performed on samples from Montague tailings, taken from depths between 10 centimetres and 60 centimetres. These samples were agglomerated, bottle rolled and leached at the Minerals Engineering Centre of the Technical University of Nova Scotia in Halifax, using

Table 2. Approximate areas (m^2) of possible tailings (certainty levels 1 and 2), from the Montague Mines Gold District, Halifax County (see Fig. 1 for locations).

CERTAINTY LEVEL 1	
Tailings Pile	**Area Calculated by ArcView® (Metres²)**
Area "B"	23 192.2
Area "C"	16 753.3
Area "D"	9 620.0
Area "F"	6 496.3
Area "G"	7 123.1
Total Area Certainty Level 1	**63 184.9 Metres²**
CERTAINTY LEVEL 2	
Tailings Pile	**Area Calculated by AreView® (Metres²)**
Area "E"	4 274.8
Area "H"	36 893.8
Area "J"	27 758.4
Area "K"	2 339.7
Total Area Certainty Level 2	**71 266.7 Metres²**

the vat leach technique described by Cole (1993). The leach solutions returned values of 2.8 and 4.62 grams/ tonne of gold by fire assay.

Calculations for confirmed tailings distribution, reveal a total area of 105 375 square metres. Cubic metre calculations for assumed thickness are included in Table 3(b). For instance, assuming an average of a thickness of 1.3 metres (4 feet) the confirmed tailings would equal 140 148 m^3 (Table 3b, sum of areas A, l and L). Multiplying this product by the factor for average density given in Table 3(a) (1.333 tonnes per cubic metre), this would equal 186 397 metric tonnes of ore. Assuming an average thickness of 0.3 m, this area would constitute 42 045 tonnes of ore.

Discussion

The estimate of total tonnage of confirmed tailings (assuming a mean thickness of 1.3 m) is higher than that reported for production at Montague. Figures for historical production of gold there indicate 134 279 tons removed prior to 1943 (Nova Scotia Department of Mines, 1944). This figure should not be considered a true reflection of total production. Often, production figures at Nova Scotian gold mines were reported to be lower than actual production, as mine management payed out royalties for ounces of gold produced. On an examination of the development at Montague, one can see evidence of this "fudging of numbers", over several years, especially in the 1860s. For instance, there is no direct evidence in the historical reports of development along more than 500 m of the St. Patrick Lead. Yet the lead was well developed along a strike length of over 800 m. Such inconsistencies in the historical record for Nova Scotian gold districts is common.

Historical records for the Montague Gold District also illustrate that the grade of the tailings should increase substantially at depth. In 1938, one of the last years mining took place at Montague, statistics report that 910 oz. of gold were extracted from 8622 tons of ore for an overall grade of 0.1 oz./ton. In 1871, however, 3151 oz. of gold were produced from 848 tons of ore, for an overall grade of 3.71 oz./ton. Most of this production came from the Lawson Lead (2,272 oz. from 408 tons) which had a grade of 5.56 oz./ton. In the 1860s, some leads were reported to have grades as high as 80 oz./ton at Montague.

Tonnage estimates from this study of tailings at Montague reveal small amounts. However, several factors must be taken into consideration to fully appreciate these results of the study. Firstly, area calculations were performed on tailings with three different levels of status. Calculations for density and tonnage were performed on only one subset at Montague, the 'confirmed' tailings. Noting the area calculations for those ore candidates in Table 1 that did not have these (other) calculations performed on them, the tonnage of tailings at Montague could be increased substantially with further investigation of these ore sources. Secondly, there are many other former gold operations in the immediate area. It is possible that additional mill feed may be present at other well known gold tailings locations close by, such as Lake Catcha, Lake Charlotte, Oldham, West Gore, Waverley, Mt. Uniake, and Mineville, making the addition of further mill feed from a reasonable haulage distance possible. Tailings depths at these, and other sites, have had varying degrees of investigation performed on them, from detailed examination to little or no examination. Further investigation is necessary to determine grades, tonnages and leachability of tailings in these areas.

Table 3. (a) Mean density and tonnage of samples. (b) Approximate total tonnages for various assumed thicknesses of confirmed tailings area from the Montague Mines Gold District, Halifax County.

Table 3(a).

Sample	Raw Weight (g) (WR)	Immersed Weight (g) (WI)	(WR-WI)	Density D WR/(WR-WI)	Approximate Tonnage per Metre^3 (T/m^3)
1	373.53	193.7	179.86	2.08	1.352
2	453.23	236.8	216.43	2.09	1.359
3	216.48	107.3	109.18	1.98	1.287
4	94.68	49.62	45.06	2.1	1.365
5	644.1	321.8	322.3	2	1.3
Mean	**356.404**	**181.844**	**174.566**	**2.05**	**1.333**

Table 3(b). Confirmed Tailings Area "A" (96 054.8 m^2)

	Assumed Thickness (m)	Volume (m^3)	Approximate Total Tonnage (m^3 x 1.33 T/m^3)
	0.33	31 698.08	42 158.5
	0.66	63 396.17	84 316.9
	1	96 054.8	127 752.9
	1.33	127 752.9	169 911.3
	1.66	159 451.0	212 069.8
	2	192 109.6	255 505.8
	2.33	223 807.7	297 664.2
	Confirmed Tailings Area "I" (4488.1 m^2)		
	0.33	1481.073	1969.8
	0.66	2962.146	3939.7
	1	4488.1	5969.2
	1.33	5969.173	7939.0
	1.66	7450.246	9908.8
	2	8976.2	11938.3
	2.33	10457.27	13908.2
	Confirmed Tailings Area "L" (4831.9 m^2)		
	0.33	1594.527	2120.7
	0.66	3189.054	4241.4
	1	4831.9	6426.4
	1.33	6426.427	8547.1
	1.66	8020.954	10667.9
	2	9663.8	12852.9
	2.33	11258.33	1473.6

Conclusions

Tailings at Montague and other locations mined during the same period (and of similar grade) could form parts of a viable project to exploit their gold content. Modern milling and leaching technologies make this previously discarded material a target for new mill feed. Tailings in these and other areas should undergo further investigation to determine grade, depth, density and tonnage. While these ore targets are small, together they might form a small cohesive mining project, as haulage costs would be offset by the fact that the material is loosely consolidated and, therefore, primary milling costs would be very low.

References

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