Investigation of Tills as Placer Ore Sources at Lake Catcha (NTS 11D/11) and Moose River (NTS 11D/15), Halifax County, and Kemptville (NTS 21A/04), Yarmouth County

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Introduction

There are many placer gold operations in production in Canada that focus on deposits from modern or Quaternary glacio-fluvial environments. Recent work by the Nova Scotia Department of Natural Resources (DNR) to investigate glacial tills in the vicinities of known lode-gold deposits supports the consideration of such overburden as a credible ore source. The discovery of a buried adit in till at Tangier in 2003 (Fig. 1) led to an investigation of the site as a possible placer ore source in 2004. Several samples were taken as close to bedrock as possible to investigate possible placer gold deposition in buried outwash gravel, without success (Mills *et al.,* 2004). Ore-grade gold levels, however, were present at the adit location in a stony, locally derived till (Stea *et al.,* 2004).

Following this assessment of till material as a possible source of placer gold at Tangier (Mills *et al.*, 2005; Stea *et al.*, 2005), preliminary assessment of tills at several Nova Scotian sites took place during the 2005 field season. Sites investigated were the Lake Catcha and Moose River gold districts, Halifax County, and the Kemptville gold district, Yarmouth County (Fig. 2).

These sites were chosen for several reasons. They are all past-producing gold districts currently under investigation. They are all easily accessible and have co-operative land owners and access to water that can be recirculated in a closed sluice system. Known gold-producing veins are present in the immediate area, oriented perpendicular to the direction of ice flow. Furthermore, a sufficient volume of surficial material is present at each site, so that exploitation of the resource could eventually be considered.

Local Geology

Moose River

The Moose River gold deposit is hosted by pelitic to meta-pelitic rocks and intercalated meta-

Figure 1. Photo of adit in till uncovered in 2003 at Tangier, Nova Scotia.

Mills, R. F. and Chipman, J. D. 2006: *in* Mineral Resources Branch, Report of Activities 2005; Nova Scotia Department of Natural Resources, Report ME 2006-1, p. 115-126.

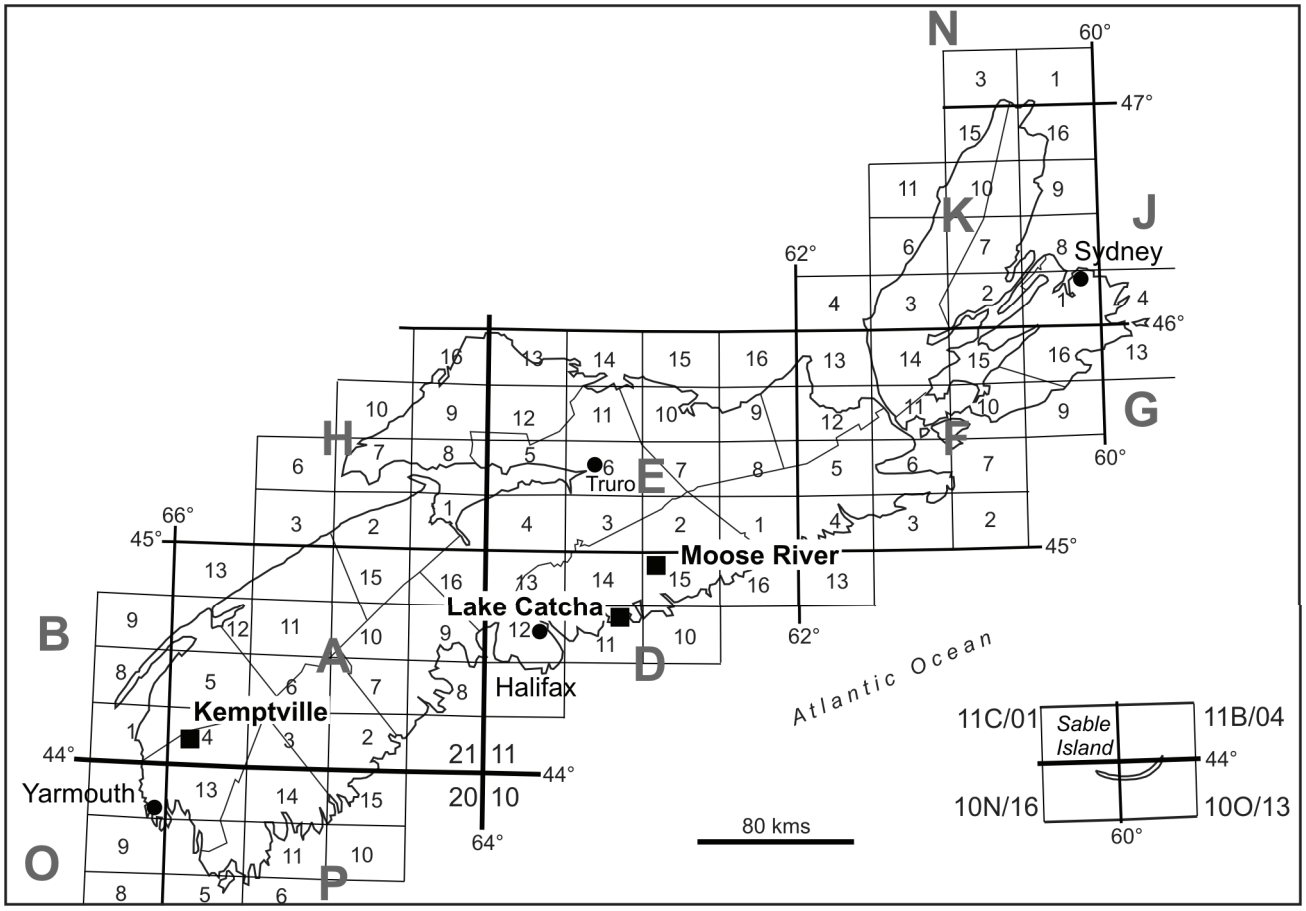


Figure 2. NTS map of Nova Scotia showing study area locations.

psammites of the Goldenville Formation. The deposit is located on a west-plunging secondary anticline (known locally as a 'crumple') trending east-northeast on the southeastern limb of the regional Moose River anticline. Faults of unknown displacement interrupt vein types that include stock work, bedding-parallel and AC veins. The Moose River gold district is covered by a relatively thin layer of Beaver River Till (Stea, personal communication, 2006) as well as abundant shallow drumlins of Lawrencetown Till (Fig. 3a).

Kemptville

Host rocks for the Kemptville gold district consist of psammites of the Goldenville Formation with minor intercalated pelitic layers. Mineralization has been linked to the East Kemptville shear zone (cf. Horne *et al.*, this volume). The shear zone hosting the Kemptville gold district is known to be several hundred metres wide and extends for at least 30 km through the Kemptville gold district (Horne *et al.*, this volume).

Till sections at Kemptville have been identified as consisting of Beaver River Till (Stea, personal communication, 2006). This is described as a, "stony till deposit" (Stea *et al.,* 2005) deposited during a glacial advance (Fig. 3b).

Lake Catcha

The Lake Catcha gold district is situated on the north limb of a major regional anticline in psammitic rocks at the Goldenville Formation. The anticline dips steeply on the north limb and this corresponds to the north limb of a regional box fold east of Halifax.

Host rocks for the auriferous veins in the district are pelites, semi-pelites and meta-psammites of the Goldenville Formation. Most veins at Lake Catcha are bedding-parallel veins. Nova Scotia gold districts are commonly cut by

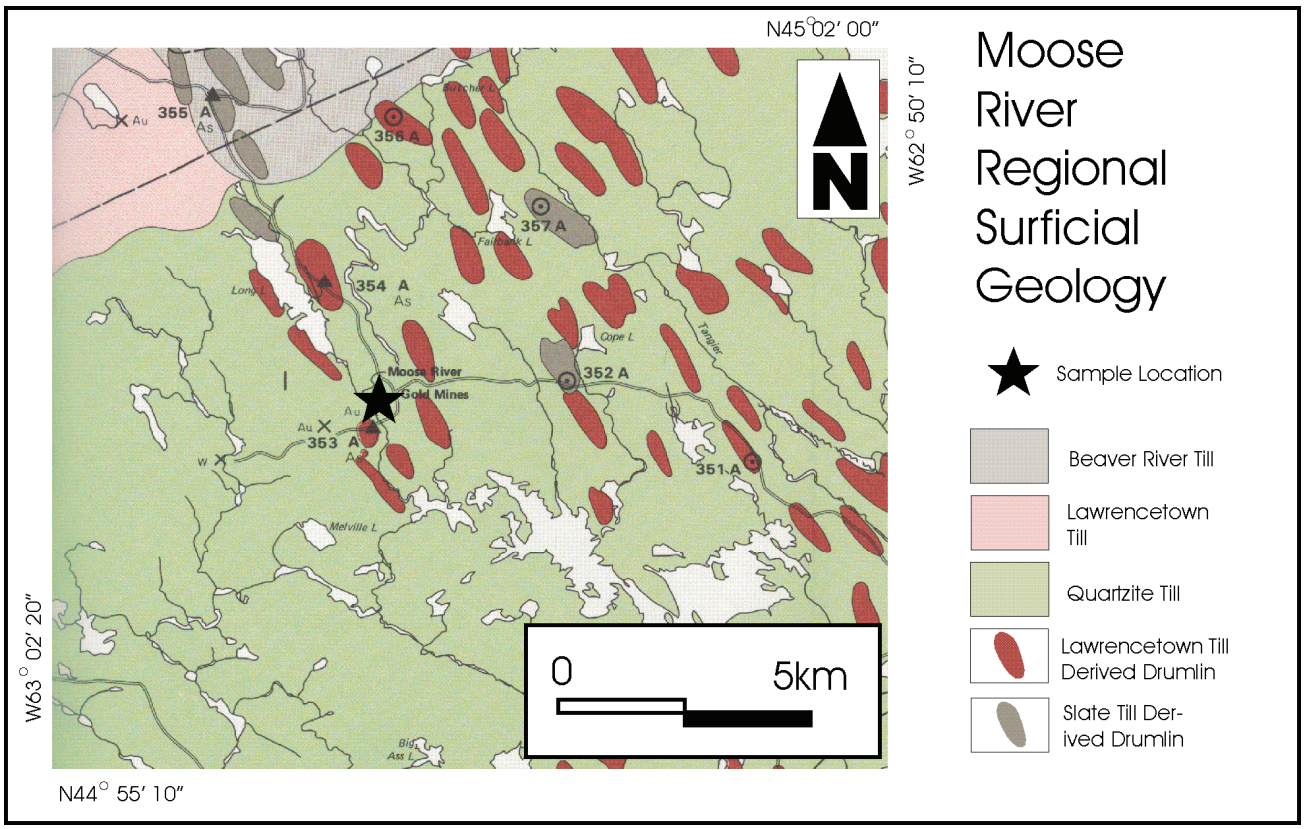


Figure 3a. Surficial geology map of the Moose River area, modified from Stea and Grant (1982).

numerous northeast-trending faults, and Lake Catcha is no exception (Rankin, 1986).

Overburden thickness ranges from about 3 to 6 m (Rankin, 1986). Lake Catcha is covered by Beaver River Till, a stoney till overlying the Lawrencetown Till (Fig. 3c).

Methods

Sampling Method

A bulk till sample of approximately 15 kg was taken at each site to determine head grade. The main samples consisted of a concentrate sluiced from 5 m^3 of overburden sampled from each site. A sample was taken from the sluiced tailings, as well as a sample of +2 inch rejected material (too large to fit through the sluice grizzly) for the purpose of lithological determination. Overburden was sampled using a backhoe prior to being shovelled into the sluice by hand.

The Long-Tom sluice (Fig. 4) was set up with a slope of approximately 7.5 cm/m (a 1 inch fall per 1 foot of run). Water flow was adjusted at each site according to the competency of the overburden, but averaged approximately 50 gallons per minute. The hopper of the sluice required frequent cleaning as it would quickly fill up with oversized material. In some cases the material could be broken down by hand and put through the sluice but most of the time it was removed from the hopper altogether.

Sample Preparation and Analysis

Sample preparation and analytical procedures are summarized in Figure 5. The head grade sample was split, with one split put through a stack of five sieves (sizes 12.7 mm; 3.75 mm; 1 mm; 0.25 mm; and 0.063 mm). Each size fraction from these sieves was prepared using bottle roll cyanidation for 48 hours and analyzed with an atomic adsorption spectroscopy (AAS) finish. The second split was analyzed in bulk using the same method, as well as the tailings sample from each site. The oversized material (+2 inch fraction of overburden) from the sluice was used to determine the percentages of various rock types in the till

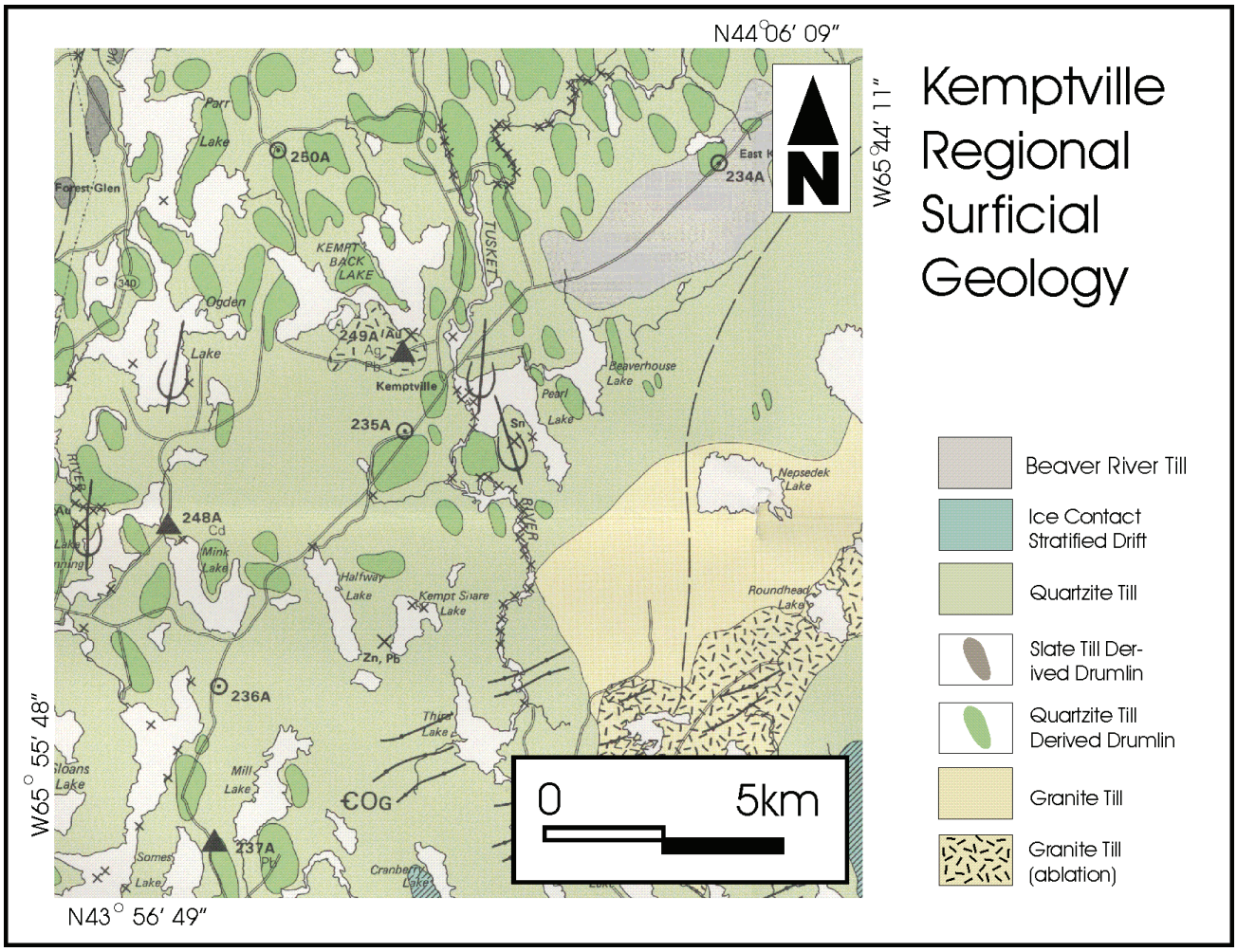


Figure 3b. Surficial geology map of the Kemptvile area, modified from Stea and Grant (1982).

using pebble counts. The dominant rock types were determined by counting 100 randomly selected pebbles from the oversized material at each site.

The sluiced concentrate was further concentrated using a vibrating Wifley table. Gold grains from this concentrate were randomly selected to undergo microprobe analysis for Ag content, as well as to investigate grain morphology with the scanning electron microscope. Microprobe and scanning electron microscope analyses were carried out at the Dalhousie Microprobe Lab. Gold grains used for analysis were mounted on slides with carbon tape and then coated with carbon in a vacuum.

Results

This project formed part of a B.Sc. (Honours) thesis, and the results have been previewed, summarized by Chipman (2006).

Head grade analyses at each site, as well as tailings analyses, are shown in Table 1. Note that there are no data for the tails from Lake Catcha as no tailings sample was analyzed for that site. Tables 2, 3 and 4 illustrate the results of the grain size analyses from Moose River, Kemptville and Lake Catcha, respectively.

Despite the care taken in choosing these sites, the sample at Lake Catcha did not access the local (Beaver River) till and sampled a hybrid till that consisted mainly of the more distal Lawrencetown Till. The sample was taken over known, enriched veins, yet there was little quartz in the oversize material and little visible gold returned in the sluice. This is still considered to be a good site for further evaluation, if a more local till can be found.

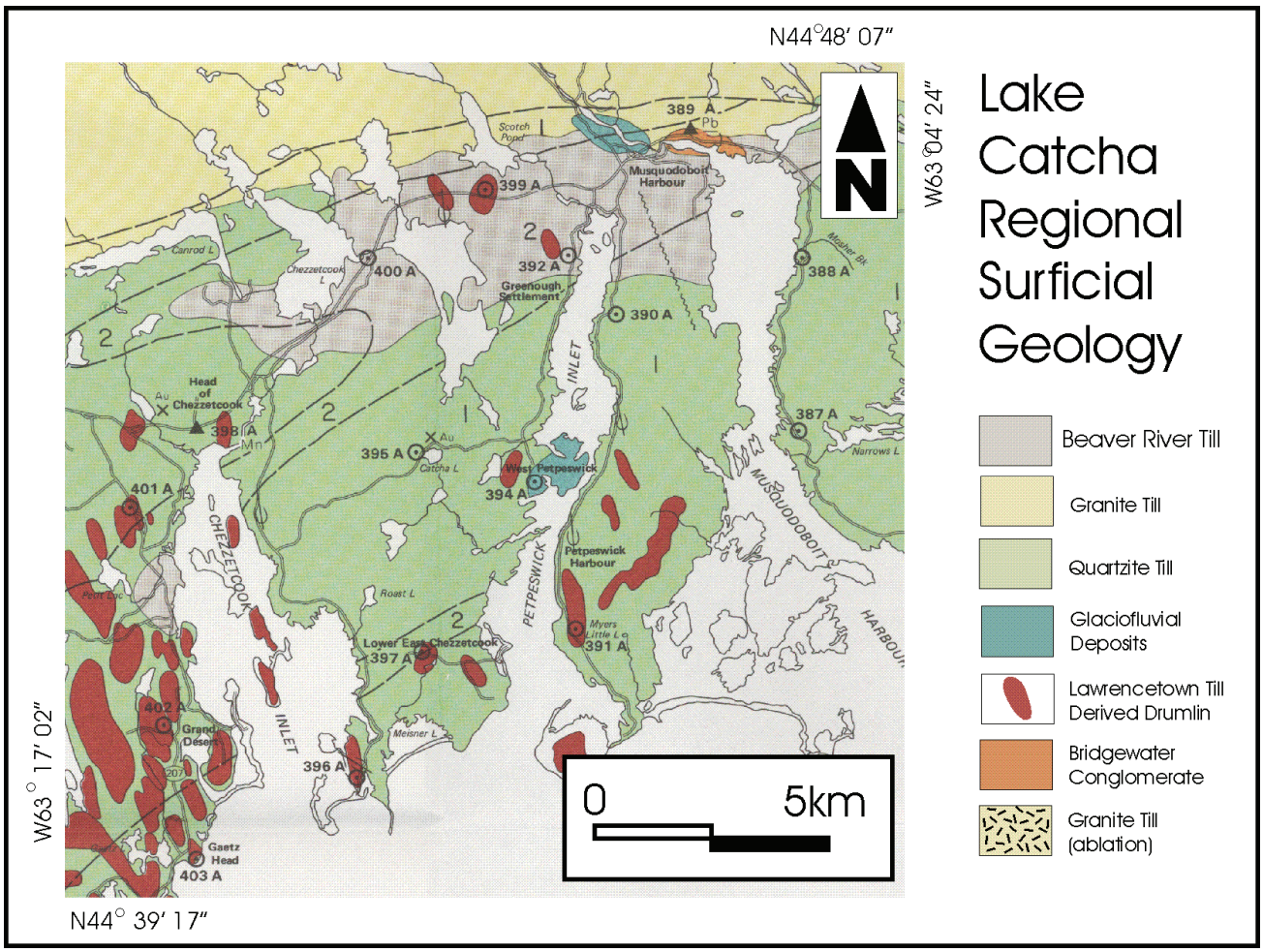


Figure 3c. Surficial geology map of the Lake Catcha area, modified from Stea and Grant (1982).

Pebble Count Results

Pebble counts and the associated rock types from each site are displayed in Figure 6. The common rocks are those found in Nova Scotia gold districts, namely pelites and psammites of the Goldenville Formation. Quartz vein material was found at Moose River and Kemptville, but was largely absent at Lake Catcha. Granodiorite and microdiorite were present at Lake Catcha, but these two rock types were absent at the other sample sites. Andesitic and rhyolitic rocks were present in the till at Kemptville, as well as a few granite clasts.

Grain Morphology

Scanning electron micrograph images were used to classify gold grains recovered from overburden into three types (pristine, modified, reshaped) according to the classification scheme described by DiLabio (1990). These classifications were used to interpret transport distances of grains from the lode source, according to the more local descriptions made by Goodwin (2005) for gold grains dispersed in Nova Scotia tills. All three sample sites display all three levels of grain modification (Fig. 7). The Moose River sample revealed pristine and modified grains. The Kemptville sample displayed mostly modified and reshaped grains. Lake Catcha revealed mostly modified grains.

Discussion

The higher gold grades were found in the same size fraction (-0.25 mm, +0.063 mm). To improve efficiency consideration should be given to concentrating the till down to a certain size fraction

Figure 4. Photo of operation of sluice at Kemptville.

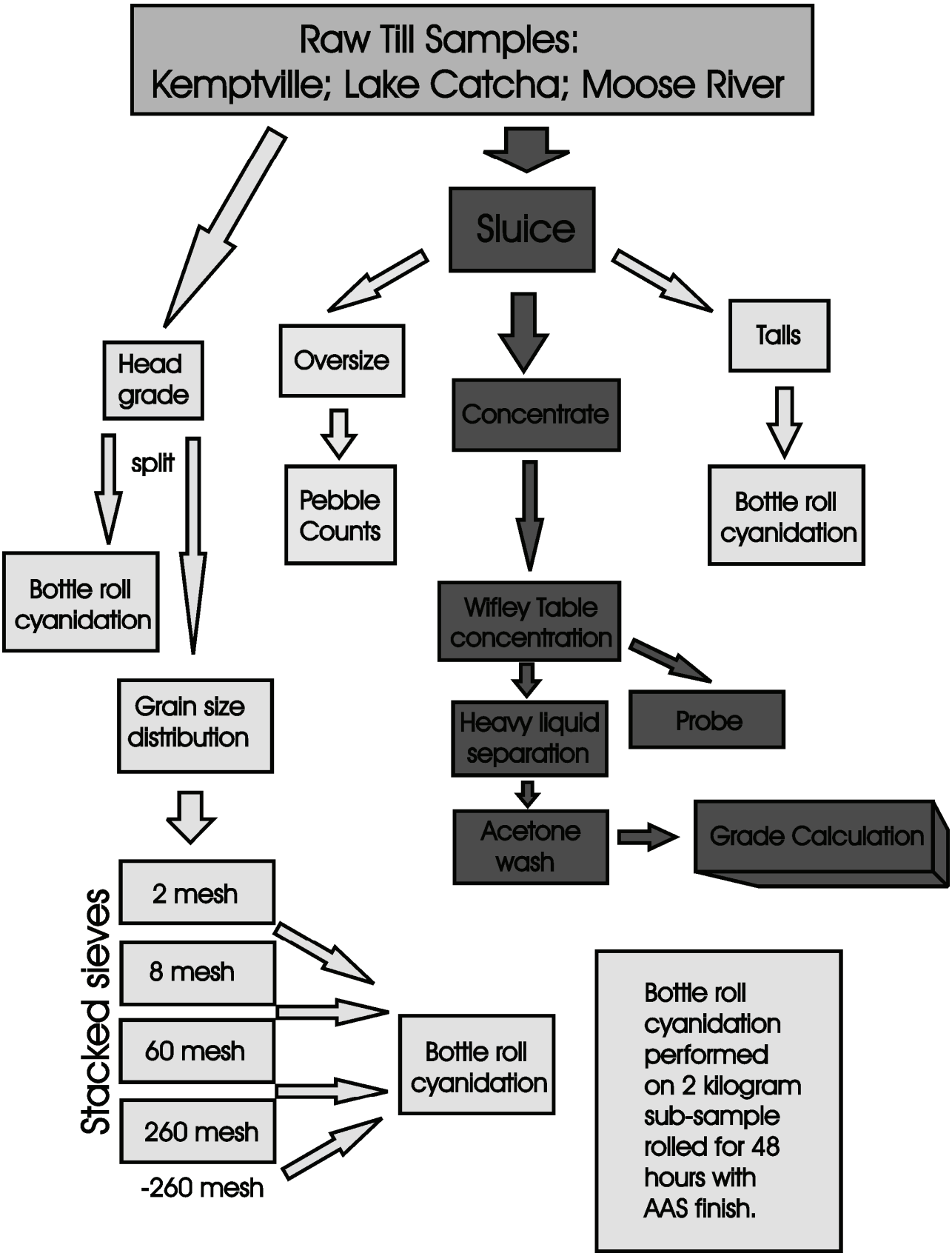


Figure 5. Flow chart outlining sampling process and treatment.

Table 1. Head and tail grades from Moose River (MR-1-05), Kemptville (DNR-K01-05), and Lake Catcha (DNR-LC-05)..

Sample	Site	Head grade (ppm)	Tails (ppm)
MR-1-05	Moose River	0.39	0.02
DNR-K01-05	Kemptville	0.49	0.03
DNR-LC-05	Lake Catcha	0.12	N/A

prior to sluicing. At Moose River anomalous grades are found in the -12.7 mm; +3.75 mm; -1.0 mm; + 0.25 mm and -0.25 mm, +0.063 mm size fractions. The largest size fraction (+12.7 mm), representing about 30% of the volume of the sample, contained 0.05 ppm gold. This size fraction should be screened off and discarded to minimize costs and focus the separation exercise on more payable fractions of overburden.

Free gold was seen in the sluice and noted to fall out of suspension at the top of the sluice within the first metre, and mostly in the first few centimetres. The catchment area of the sluice can, therefore, be reduced significantly from 10 feet while still recovering smaller size fractions.

Pebble counts are not entirely indicative of the surrounding geology. Volcanic rocks and granite at Kemptville represent foreign rock types in the local till. Low gold grades at Lake Catcha can be linked to the absence of quartz vein material in the till.

Table 2. Grain size analyses and associated grade from Moose River (MR-1-05).

Sample	Sive size	% of sample	Tails (ppm)
MR-1-05	+12.7 mm	31.28	0.05
MR-1-05	-12.7 mm, +3.75 mm	23.61	0.54
MR-1-05	-3.75 mm, +1.0 mm	13.03	0.15
MR-1-05	-1.0 mm, +.25 mm	8.92	0.72
MR-1-05	-.25 mm, +.063 mm	6.45	0.76
MR-1-05	-.063 mm	16.71	0.13

Table 3. Grain size analyses and associated grade from Kemptville (DNR-K01-05).

Sample	Sieve Size	% of Sample	Grade (ppm)
DNR-K01-05	+ 12.7 mm	8.5	0.015
DNR-K01-05	- 12.7 mm		
	+ 3.75 mm		
DNR-K01-05	- 3.75 mm		
	+ 1.0 mm	8.7	0.05
DNR-K01-05	- 1.0 mm		
	+ 2.5 mm	14.95	0.03
DNR-K01-05	- 2.5 mm		
	+ 0.63 mm	16.28	0.06
DNR-K01-05	- 0.63 mm	40.56	0.03

Pebbles at Moose River consist mostly of the pelitic material known to host the stockwork veins of the ore zone in this historical gold district.

Scanning electron micrographs from Moose River exhibit several pristine grains. The more prolific veins mined are very close to the sample site. The Touquoy pit historically hosted some of the best grades (anonymous, 1880) among Meguma gold deposits. Samples from Kemptville and Lake Catcha were also taken close to (between 50 and 200 m) the inferred lode source.

Gold concentrations in the sluice/Wifley table concentrates from Moose River and Kemptville (0.37 g/t and 0.46 g/t, respectively, Table 5) are significantly higher than they are for Lake Catcha (no concentrate level can be calculated as there is no tails grade available). This is believed to be directly related to the tills sampled. Tills from Moose River and Kemptville are locally derived. Lake Catcha appears to be covered by a hybrid of the Beaver River Till and the Lawrencetown Till mixed together. Gold levels approach zero in the Lawrencetown Till (Goodwin, 2005) and low grades from Lake Catcha are assumed to be a result of the dilution factor of the Lawrencetown Till.

By subtracting the tail levels from the original head grades one can deduce the sluice/Wifley recovery rate. This equates to almost 95% (94.9%) for Moose River and almost 94% (93.9%) for Kemptville. These rates can only be described in

Table 4. Grain size analyses and associated grade from Lake Catcha (DNR-LC-05)

Sample	Sieve Size	% of Sample	Grade (ppm)
DNR-LC-05	+ 12.7 mm	17.49	0.09
DNR-LC-05	- 12.7 mm		
	+ 3.75 mm	21.75	0.06
DNR-LC-05	- 3.75 mm		
	+ 1.0 mm	12.57	0.045
DNR-LC-05	- 1.0 mm		
	+ .25 mm	14.00	0.091
DNR-LC-05	- .25 mm		
	+ 0.63 mm	12.41	0.196
DNR-LC-05	.063 mm	21.78	0.11

positive terms, as there are few mill recovery systems that can rival a 94-95% recovery. Indeed, these rates rival that of a permanent mill system costing many millions of dollars.

Considering a cut-off grade of 0.25 ppm gold, defined at a gold price of $500 US an ounce with fuel prices set at $1.00/l, the sites at Moose River and Kemptville would appear to become economical, with concentrate levels of 0.37 g/t and 0.46 g/t, respectively. Further work must be done to evaluate each site including, profiling of the sites, further head grade evaluation of a plan site, and determination of the grade and homogeneity of the sites through tight grid evaluation, with the intention of defining the boundaries of a potential resource.

At Kemptville, the sample was taken from a source previously sampled and known to return gold. On analysis the site returned a head grade of almost 0.5 g/t (490 ppb) in a thick, volumous till (Black, personal communication, 2005). This site lies close to several known gold-bearing quartz veins within a massive shear zone transecting the Kemptville gold district (Horne *et al.*, this volume). On preliminary inspection, this site appears to be ore-grade placer material and preliminary work is progressing at the site to determine further grades and volumes.

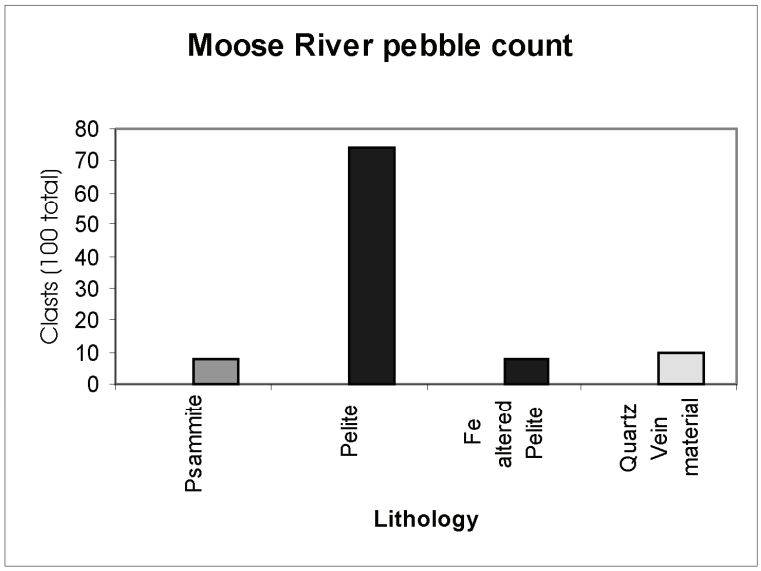
Table 5. Concentrate grades from the three study areas.

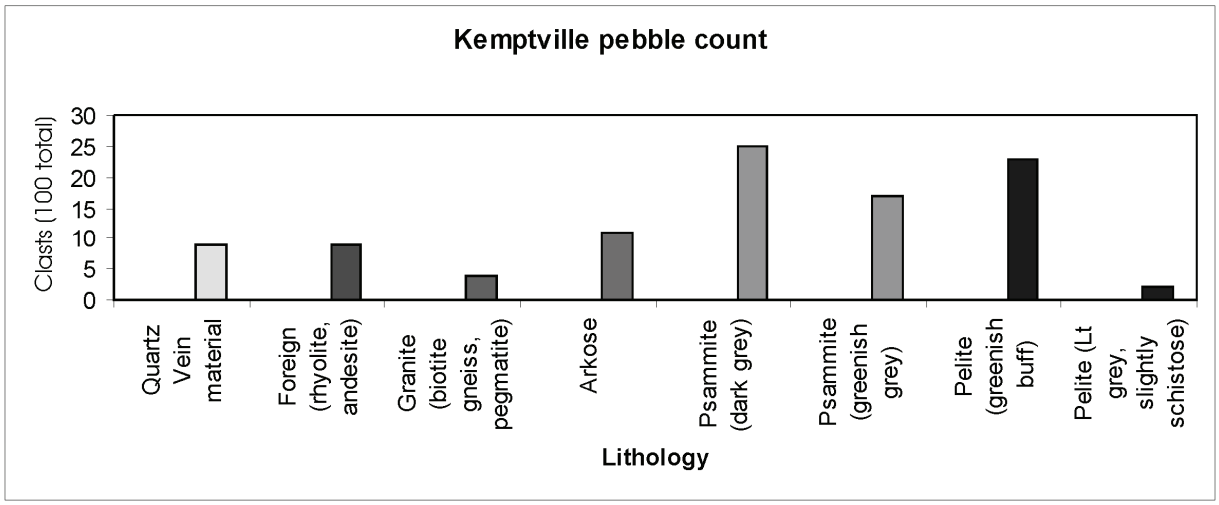
Sample Site	Grade (g/t)
Moose River	0.37
Kemptville	0.46
Lake Catcha	N/A

Till at Moose River was sampled close to the Touquoy pit. This pit was sampled in the 1980s near zones worked by Touquoy in the 1880s (anonymous, 1880). The overburden tested was originally stripped off the pit site when it was excavated. Touquoy described the till at Moose River as ore grade (approximately 2.5 g/t; anonymous, 1880) and ran a successful test of it as well. It is believed the sample for the 2005 test came close to his original site. Visual inspection of gold returned in the sluice at clean up revealed a very good return, consisting of small delicate grains up to 0.5 cm long, many small sand-sized and slightly larger nuggets, and flour gold in the rubber matting.

In this sampling program, all samples were taken less than 200 m, and as close as 50 m, from the inferred lode source. According to Stea *et al.* (2005) and Goodwin (2005), however, there is potential for gold levels to increase (Goodwin, 2005) at distances of up to 400 m down ice of the source. This fact should be integrated into any further sampling methods.

Further evaluation of Kemptville and Moose River as possible economic placer sources will continue. In the case of Moose River, the site is within the boundaries of a newly proposed open pit mine. Should this proposed development go forward, overburden will have to be moved from the site. In this case, a small wash plant added to the mill circuit could exploit this resource, separating gold from overburden as the site is prepared for removal of bedrock. It is conceivable that stripping costs (at least) would be recovered, as well as the development of a gravity separation wash system that could be easily added to the mill circuit to recover free gold.





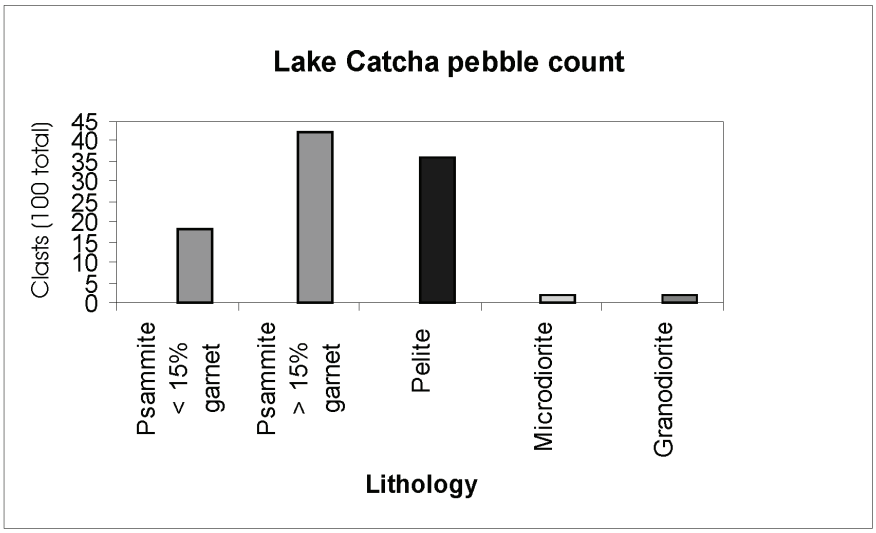
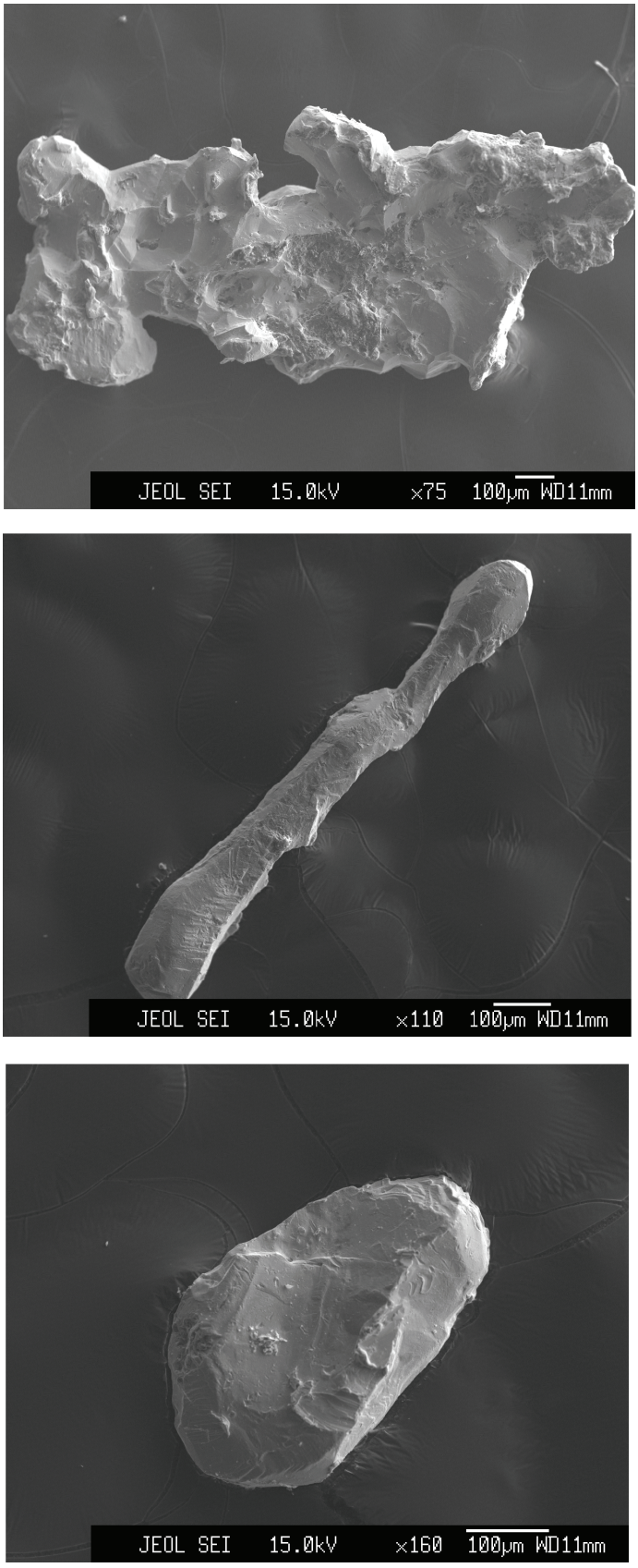


Figure 6. Pebble count results from Kemptville, Moose River and Lake Catcha (taken from random counts of 100 pebbles for each site.)



F**igure 7.** Scanning electron microscope images show various gold grain morphologies. The top image shows a slightly pounded flake from Kemptville. The middle image shows a slightly rounded wire from Moose River. The bottom image shows a round nugget, also from Moose River.

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