# Nova Scotia Gold Grain Study: Results from the 2007 Field Program to Examine Background Concentrations of Gold in Till

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## Introduction

During the 2007 field season, twenty-five 10 kg till samples were collected as part of the Nova Scotia Gold Grain Study. Most samples were collected on Cape Breton Island, with the remaining samples collected from the eastern and western extremities of the mainland (Fig. 1). Samples were collected at a sample density of one sample per 1600 $km^2$ and were collected at the same location as soil samples of the North American Soil Geochemical Landscape Project (see Goodwin, this volume, p. 29-33).

As in previous studies, gold grains recovered from till samples were counted and their morphology characterized in order to provide additional information with respect to background concentrations of gold grains on a regional scale and an estimate for the distance of glacial transport.

The Nova Scotia Gold Grain Study began in 2004. Results from the 2007 field season support the previous findings of Goodwin (2005, 2006, and 2007) and have significance for mineral exploration programs, especially for gold, in the entire Province of Nova Scotia.

## Regional Geology

### Bedrock Geology

The Atlantic Provinces are part of the Canadian Appalachian orogen, which extends from Newfoundland, Nova Scotia, Prince Edward Island, and New Brunswick into Quebec. From west to east these terranes include the Humber, Dunnage, Gander, Avalon, and Meguma zones. The Canadian Appalachian orogen consists of early Paleozoic as well as older terranes that were accreted to Laurentia during the middle Paleozoic.

In Nova Scotia, rocks representing the late Neoproterozoic to Ordovician Humber Zone are located along the northern edge of western Cape Breton Island. The Dunnage Zone (subdivided into the Notre Dame and Exploits subzones) contains remnants of numerous Cambrian-Ordovician arc systems that existed within the Iapetus Ocean. Rock units likely equivalent to the Exploits Subzone have recently been recognized in the Faribault Brook area and include the Jumping Brook Suite on Cape Breton Island (Tucker *et al.,* 2007). The Gander Zone occupies most of eastern Cape Breton as a distinct package of Lower Cambrian to Lower Ordovician sedimentary rocks likely formed on the edge of a passive continental margin. The Avalon Zone is a belt of distinctive Neoproterozoic, arc-related, volcanic and sedimentary sequences and related plutonic rocks. These rocks are overlain by Cambrian to Ordovician sedimentary rocks that are located in northern mainland Nova Scotia and eastern Cape Breton Island (Barr *et al.,* 1998). The outermost terrane in the Canadian Appalachian orogen is the Meguma Zone, a thick succession of dominantly Cambrian siliciclastics that are in turn disconformably overlain by the Upper Ordovician-Lower Devonian White Rock, Kentville and Torbrook formations (White *et al.,* 1999).

Sixty-four of the province's sixty-six gold districts are hosted in the rocks of the Meguma Supergroup, located within the Meguma Zone. Limited gold production has also been reported from Wagmatacook and Stirling, both located on Cape Breton Island (Bates, 1987).

Prior to the 2007 field season, all 10 kg till samples processed and analyzed as part of the Nova Scotia Gold Grain Study (Goodwin 2005, 2006 and 2007) were collected from mainland Nova Scotia, primarily from the Meguma Zone and to a lesser degree from the Avalon Zone.

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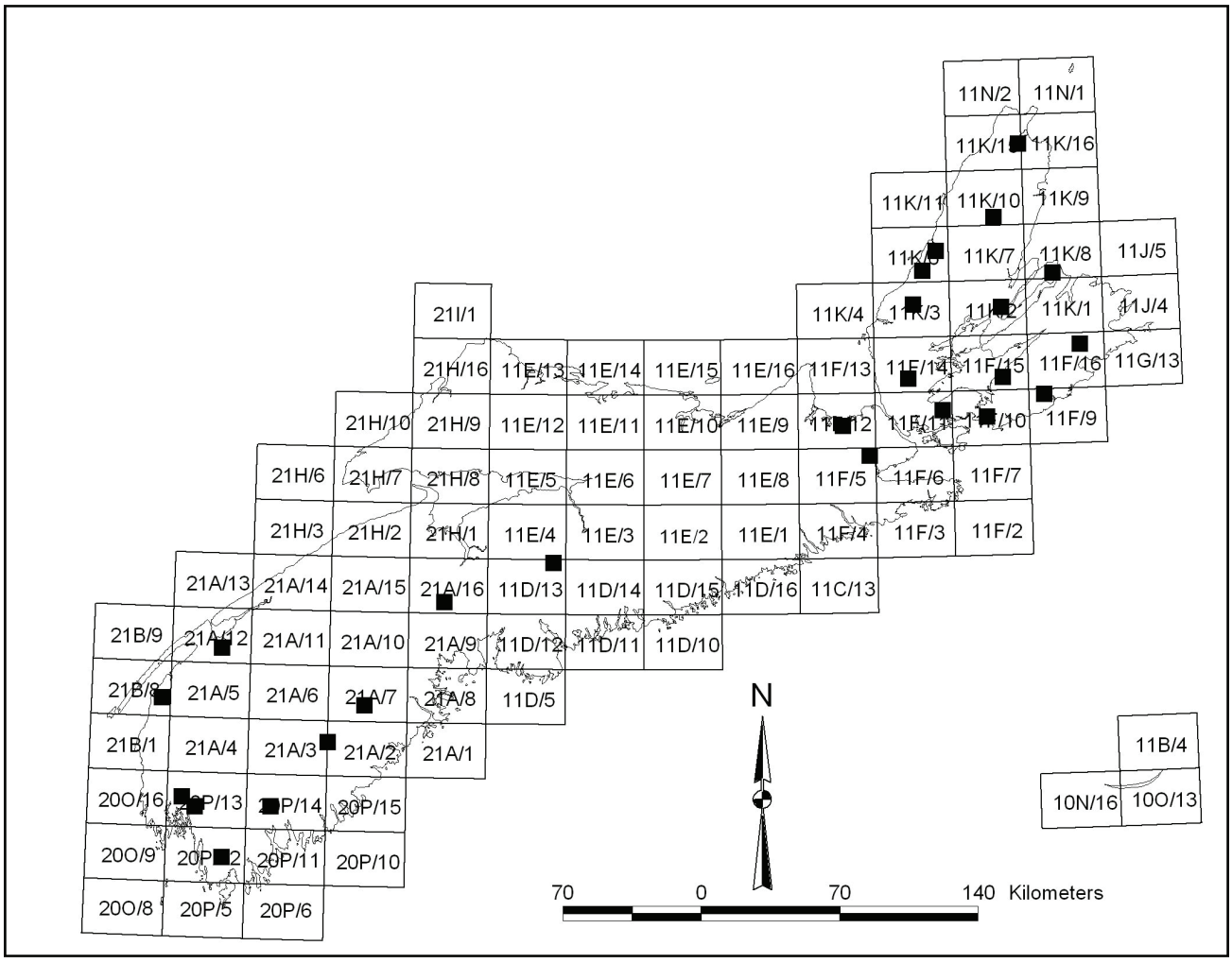


**Figure 1.** Sample locations for till samples collected during the 2007 field season.

## Surficial Geology

Most of the surficial glacial deposits and associated landforms throughout Nova Scotia were formed during the Wisconsinan glaciation in the last 70 000 years (Lewis *et al.,* 1998). Superimposed till sheets and various multiple-flow directional indicators, as the result of shifting ice centres, have been mapped and indicate that Nova Scotia is characterized by a relatively complex ice-flow history that includes palimpsest landforms such as lobate drumlins (Stea *et al.,* 1992; Stea and Finck, 2001; Stea, 2004).

The following summary of the glacial history of Nova Scotia is taken from Finck and Stea (1995), Stea and Finck (2001) and Stea (2004). The oldest observed ice-flow indicators on land are associated with the Caledonia Phase (75-40 ka), with movement toward the east and southeast. South and southwest flow of the Escuminac Phase (22-18 ka) deposited distally derived till (e.g. Lawrencetown Till). Bedrock source areas are often located tens of kilometres up-ice. The Scotian Phase (18-15 ka) was characterized by an ice divide situated over Nova Scotia and the resulting ice flow varied from northwestward in northern Nova Scotia to south and southeast in southern Nova Scotia. Till units (e.g. Beaver River Till) associated with the Scotian Phase are locally derived (hundreds of metres to a few kilometres) from up-ice bedrock sources. The Chignecto Phase (13-12.5 ka) was characterized by shifting ice flow associated with several small ice caps, the remnants of waning stages of the Scotian Phase glacier. The Collins Pond Phase was the final phase of glacier formation in response to a short-lived period of climatic cooling during the Younger Dryas Chronozone (approximately 11 ka).

# Methods

## Introduction

During the 2007 field season, twenty-five 10 kg till samples were collected at the same location as soil samples of the North American Soil Geochemical Landscape Project (see Goodwin, this volume, p. 29-33). Thirteen samples (GGS2007 - 02 to GGS2007 - 07 and GGS2007 - 09 to GGS2007 - 15) were collected from Cape Breton Island, two samples (GGS2007 - 16 and GGS2007 - 17) were collected from the eastern edge of mainland Nova Scotia, two samples (GGS2007 - 01 and GGS2007 - 08) were collected from central mainland Nova Scotia and the remaining eight samples (GGS2007 - 18 to GGS2007 - 25) were collected from the western edge of mainland Nova Scotia (Fig. 1).

## Field Sampling

A 10 kg till sample was collected at each sample site. Samples were collected from hand-dug till pits that were approximately 1.0 m in depth and located within 100 m from a driveable road. Notes regarding each sample site, including sample depth, till type, colour, texture and clast type and percentage, were recorded and a digital photograph was taken for future reference. Sample location co-ordinates (UTM 20T, NAD83) were collected using the averaging function of a GARMIN 12 GPS (Table 1). Large clasts were removed from the sample by hand (in the field) prior to the material being submitted for processing.

## Laboratory Preparation and Analytical Methods

All samples collected during the 2007 field season were sent to Overburden Drilling Management (ODM) Limited of Nepean, Ontario. ODM processed the 10 kg till samples, produced a heavy mineral concentrate (HMC) and reported the number of gold grains present as well as the gold grain morphology. Sample processing methods have remained consistent since the beginning of the project in 2004.

ODM removed the >2 mm fraction by wet screening and placed it into pre-labelled bags for future lithologic identification. The <2 mm fraction was preconcentrated by density separation while being passed across a shaking table; visible gold grains were identified and counted during this stage.

The table concentrate was then subjected to a heavy liquid separation in methylene iodide (specific gravity 3.3). A ferromagnetic separation was performed on the resulting HMC and the non-magnetic HMC was weighed and placed into pre-labelled vials.

ODM recorded sample weights after each processing stage and all material was retained for future reference. All equipment was thoroughly cleaned between samples. ODM is well recognized for their ability to recover and describe gold grains from glacial sediments and completed the work previously reported by Goodwin (2005, 2006 and 2007).

Geochemical analysis for gold in the HMC was not completed as part of this study. Estimates of the calculated visible gold grade of the HMC, however, were provided by ODM (Table 2).

# Results

Sample GGS2007 - 02 returned the highest gold grain count of six gold grains (one pristine, two modified and three reshaped grains) while sample GGS2007 - 06 returned four gold grains (one pristine, two modified and one reshaped grain). Except for these two samples, the remaining twenty-three samples collected returned gold grain counts of three gold grains or less per sample. This conforms very closely to the previously established regional background gold grain counts (from zero to three gold grains) for mainland Nova Scotia by Goodwin (2005, 2006 and 2007). The data have not been normalized; therefore, the background range is based on raw sample field weights.

Gold grains associated with regional background are typically reshaped. Results for the number and morphology of gold grains recovered for each till sample, including the calculated (ppb) gold concentration of the HMC, are presented in Table 2. Tabulated weights for the bulk till sample, table split, >2 mm size fraction, table feed as well as the magnetic and non-magnetic fractions of the HMC are presented in Table 3.

**Table 1.** Till samples with UTM (Zone 20T, NAD83) co-ordinates.

| Sample # | utm-E83 | utm-N83 | Location | Till Unit Description* |
|---|---|---|---|---|
| GGS2007 - 01 | 454195 | 4981350 | central Nova Scotia | Silty till plain |
| GGS2007 - 02 | 676756 | 5156289 | Cape Breton Island | Bedrock/thin till |
| GGS2007 - 03 | 689003 | 5193433 | Cape Breton Island | glaciofluvial |
| GGS2007 - 04 | 640693 | 5129146 | Cape Breton Island | Stoney till plain |
| GGS2007 - 05 | 647308 | 5139044 | Cape Breton Island | Silty till plain |
| GGS2007 - 06 | 635915 | 5111939 | Cape Breton Island | Stoney till plain |
| GGS2007 - 07 | 633604 | 5074551 | Cape Breton Island | Silty till plain |
| GGS2007 - 08 | 399287 | 4961698 | central Nova Scotia | Silty till plain |
| GGS2007 - 09 | 680536 | 5110960 | Cape Breton Island | Stoney till plain |
| GGS2007 - 10 | 706318 | 5128169 | Cape Breton Island | Stoney till plain |
| GGS2007 - 11 | 720356 | 5092205 | Cape Breton Island | Stoney till plain |
| GGS2007 - 12 | 702376 | 5067043 | Cape Breton Island | Silty drumlin |
| GGS2007 - 13 | 673312 | 5055543 | Cape Breton Island | Stoney till plain |
| GGS2007 - 14 | 681451 | 5075570 | Cape Breton Island | Bedrock/thin till |
| GGS2007 - 15 | 650871 | 5058710 | Cape Breton Island | Stoney till plain |
| GGS2007 - 16 | 600656 | 5050756 | eastern Nova Scotia | Silty till plain |
| GGS2007 - 17 | 614177 | 5035658 | eastern Nova Scotia | Bedrock/thin till |
| GGS2007 - 18 | 358685 | 4909417 | southwestern Nova Scotia | Silty drumlin |
| GGS2007 - 19 | 340079 | 4890714 | southwestern Nova Scotia | Stoney till plain |
| GGS2007 - 20 | 311169 | 4858329 | southwestern Nova Scotia | Stoney till plain |
| GGS2007 - 21 | 286647 | 4832786 | southwestern Nova Scotia | Hummocky ground moraine |
| GGS2007 - 22 | 273005 | 4858486 | southwestern Nova Scotia | Stoney till plain |
| GGS2007 - 23 | 266527 | 4863313 | southwestern Nova Scotia | Stoney till plain |
| GGS2007 - 24 | 256431 | 4913550 | southwestern Nova Scotia | Stoney till plain |
| GGS2007 - 25 | 286959 | 4938689 | southwestern Nova Scotia | Silty till plain |

*till descriptions modified from Stea *et al.,* 1992.

# Discussion

The till collected at each sample site, in general, was likely locally derived because the vast majority of the clasts recovered from each till pit reflected the underlying bedrock geology. Additionally, clasts typically exhibited an angular to sub-angular morphology suggesting minimal transport by glacial ice. There were a few exceptions. For example, samples collected from Lawrencetown Till were derived from a distal bedrock source because the till matrix and associated subrounded to rounded clasts were clearly not representative of the local underlying bedrock. The gold grains present in the 10 kg till, therefore, likely represent regional background gold grains associated with regional, late Wisconsinan glaciation.

**Table 2.** Summary of the number of recovered visible gold grains and the calculated content (ppb) of visible gold in the heavy mineral concentrate (HMC).

| Sample # | Number of Visible Gold Grains | | | | Calculated PPB Visible Gold in HMC | | | |
|---|---|---|---|---|---|---|---|---|
| | Total | Reshaped | Modified | Pristine | Total | Reshaped | Modified | Pristine |
| GGS2007-01 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GGS2007-02 | 6 | 3 | 2 | 1 | 11 | 5 | 6 | 1 |
| GGS2007-03 | 2 | 1 | 1 | 0 | 1 | 1 | 1 | 0 |
| GGS2007-04 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| GGS2007-05 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GGS2007-06 | 4 | 1 | 2 | 1 | 11 | 7 | 4 | 1 |
| GGS2007-07 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GGS2007-08 | 1 | 1 | 0 | 0 | 9 | 9 | 0 | 0 |
| GGS2007-09 | 1 | 1 | 0 | 0 | 19 | 19 | 0 | 0 |
| GGS2007-10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GGS2007-11 | 3 | 3 | 0 | 0 | 11 | 11 | 0 | 0 |
| GGS2007-12 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| GGS2007-13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GGS2007-14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GGS2007-15 | 1 | 1 | 0 | 0 | 3 | 3 | 0 | 0 |
| GGS2007-16 | 1 | 1 | 0 | 0 | 3 | 3 | 0 | 0 |
| GGS2007-17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GGS2007-18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GGS2007-19 | 3 | 3 | 0 | 0 | 28 | 28 | 0 | 0 |
| GGS2007-20 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| GGS2007-21 | 1 | 1 | 0 | 0 | 2 | 2 | 0 | 0 |
| GGS2007-22 | 2 | 2 | 0 | 0 | 42 | 42 | 0 | 0 |
| GGS2007-23 | 3 | 3 | 0 | 0 | 9 | 9 | 0 | 0 |
| GGS2007-24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GGS2007-25 | 2 | 2 | 0 | 0 | 7 | 7 | 0 | 0 |

Results of the 2007 sampling program are very similar to previously reported regional results for mainland Nova Scotia (Goodwin, 2005, 2006 and 2007). With the addition of the 2007 till sample results (and previously reported results), the regional background for gold grains recovered from 10 kg till samples is between 0 and 3 gold grains per 10 kg sample for the entire province, as originally established by Goodwin (2005) for mainland Nova Scotia. Most of the gold grains recovered from a regional till sample are likely to be reshaped.

# Conclusions

An additional twenty-five 10 kg till samples were collected during the 2007 field season as part of the Nova Scotia Gold Grain Study. Thirteen samples were collected from Cape Breton Island, two from eastern mainland Nova Scotia, two from central Nova Scotia, and the remaining eight samples were collected from the western edge of mainland Nova Scotia. All samples were processed by Overburden Drilling Management (ODM) of Nepean, Ontario.

Results of the 2007 sampling program confirm that regional background of gold grains recovered from 10 kg till samples is between zero and three gold grains for both mainland Nova Scotia and Cape Breton Island. The highest gold grain count was from sample GGS2007 - 02, which returned six gold grains (one pristine, two modified and three reshaped grains). Sample GGS2007 - 06 returned four gold grains (one pristine, two modified and one reshaped grain) while all remaining samples returned three gold grains or less.

**Table 3.** Summary of sample weights at the various processing stages.

| Weight (kg wet) | | | | | -2.0 mm Table Concentrate Weight (g dry) Heavy Liquid Separation (S.G. 3.3) HMC | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sample # | Bulk Rec'd | Table Split | +2.0 mm Clasts | Table Feed | Total | Lights | Total | Non Mag | Mag |
| GGS2007-01 | 9.4 | 8.6 | 1.2 | 7.4 | 122.3 | 107.0 | 15.3 | 13.6 | 1.7 |
| GGS2007-02 | 10.3 | 9.5 | 0.8 | 8.7 | 153.9 | 11.1 | 36.8 | 32.7 | 4.1 |
| GGS2007-03 | 10.7 | 9.9 | 1.7 | 8.2 | 194.7 | 164.2 | 30.5 | 29.5 | 1.0 |
| GGS2007-04 | 10.6 | 9.8 | 4.8 | 5.0 | 130.7 | 129.5 | 1.2 | 1.0 | 0.2 |
| GGS2007-05 | 10.3 | 9.5 | 2.5 | 7.0 | 115.7 | 109.7 | 6.0 | 5.2 | 0.8 |
| GGS2007-06 | 10.2 | 9.4 | 2.2 | 7.2 | 148.9 | 141.1 | 7.8 | 6.8 | 1.0 |
| GGS2007-07 | 10.0 | 9.2 | 0.3 | 8.9 | 91.2 | 88.2 | 3.0 | 2.8 | 0.2 |
| GGS2007-08 | 10.1 | 9.3 | 3.9 | 5.4 | 221.6 | 211.9 | 9.7 | 9.4 | 0.3 |
| GGS2007-09 | 11.1 | 10.3 | 1.8 | 8.5 | 359.5 | 334.0 | 25.5 | 23.1 | 2.4 |
| GGS2007-10 | 10.4 | 9.6 | 1.2 | 8.4 | 253.0 | 251.4 | 1.6 | 1.5 | 0.1 |
| GGS2007-11 | 9.9 | 9.1 | 2.1 | 7.0 | 218.5 | 212.1 | 6.4 | 5.3 | 1.1 |
| GGS2007-12 | 13.2 | 12.4 | 3.7 | 8.7 | 205.4 | 199.9 | 5.5 | 5.2 | 0.3 |
| GGS2007-13 | 12.7 | 11.9 | 5.3 | 6.6 | 197.7 | 191.6 | 6.1 | 4.8 | 1.3 |
| GGS2007-14 | 11.9 | 11.1 | 5.6 | 5.5 | 208.5 | 202.0 | 6.5 | 6.0 | 0.5 |
| GGS2007-15 | 10.0 | 9.2 | 1.1 | 8.1 | 267.4 | 264.4 | 3.0 | 2.7 | 0.3 |
| GGS2007-16 | 11.9 | 11.1 | 4.0 | 7.1 | 184.0 | 182.0 | 2.0 | 1.8 | 0.2 |
| GGS2007-17 | 9.7 | 8.9 | 2.0 | 6.9 | 182.2 | 179.8 | 2.4 | 2.2 | 0.2 |
| GGS2007-18 | 10.6 | 9.8 | 4.2 | 5.6 | 137.5 | 122.8 | 14.7 | 12.6 | 2.1 |
| GGS2007-19 | 10.7 | 9.9 | 3.2 | 6.7 | 156.4 | 95.8 | 60.6 | 58.4 | 2.2 |
| GGS2007-20 | 11.0 | 10.2 | 4.0 | 6.2 | 184.1 | 149.7 | 34.4 | 34.3 | 0.06 |
| GGS2007-21 | 11.6 | 10.8 | 1.3 | 9.5 | 186.6 | 160.9 | 25.7 | 22.6 | 3.1 |
| GGS2007-22 | 11.5 | 10.7 | 2.5 | 8.2 | 237.8 | 168.0 | 69.8 | 69.5 | 0.3 |
| GGS2007-23 | 12.1 | 11.3 | 4.6 | 6.7 | 212.9 | 160.4 | 52.5 | 50.5 | 2.0 |
| GGS2007-24 | 10.4 | 9.6 | 5.1 | 4.5 | 130.3 | 128.0 | 2.3 | 2.3 | 0.04 |
| GGS2007-25 | 10.7 | 9.9 | 2.5 | 7.4 | 237.2 | 226.8 | 10.4 | 8.9 | 1.5 |

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