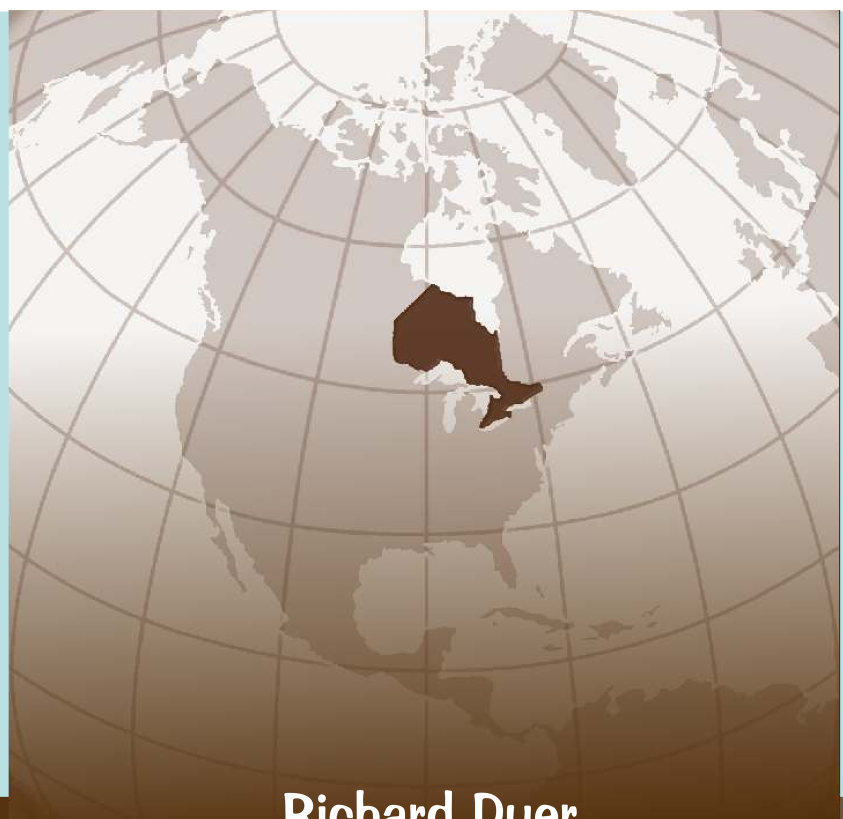

Physical gold dispersion and geochemical response in surficial media, southern Abitibi greenstone belt

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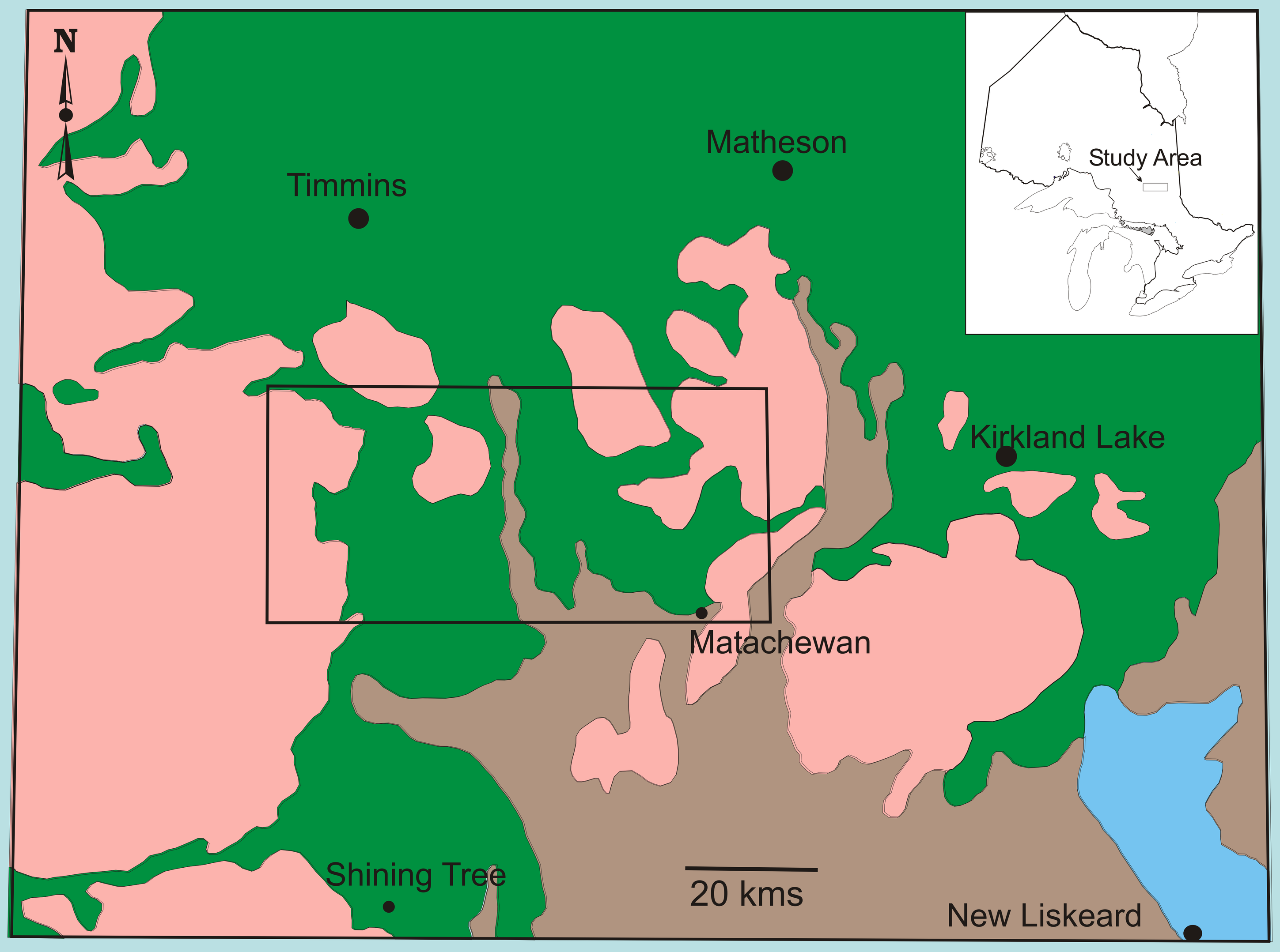
Introduction

A project focusing on the dispersion of gold from point source bedrock mineral occurrences and from associated glacial dispersion plumes was initiated over the southern Abitibi greenstone belt of northeastern Ontario during 2005 (Figure 1). Numerous studies have demonstrated that gold migrates from mineralized bedrock occurrences and associated till deposits into drainage pathways, including groundwater and ultimately into lake basins, however, opinions vary as to the mechanism (physical versus hydromorphic) of Au transport that operates on the low relief Canadian shield.

Regardless of the mode of transport, landscape complexity clearly plays a role in the geochemical patterns observed (or lack of), however, other factors that may have a significant impact on gold include: sampling methods; sample size; sample preparation procedures; precision and accuracy of laboratory analysis; and the classic nugget effect. In support of this project, samples of till, stream sediment and lake sediment were sampled near (and where appropriate in the down-ice and up-ice direction) existing bedrock gold occurrences, lake sediment anomalies and till anomalies (containing anomalous levels of gold grains).



Paleozoic carbonate and clastic rocks
Huronian metasedimentary rocks
Archean felsic-intermediate intrusive rocks
Archean supracrustal rocks

Figure 1. Location of study area, southern Abitibi greenstone belt.

Table 1. Comparison of Au results by Fire Assay (FA), INAA and micro-panning.

Lake Sediments (-80 mesh pulp)	Au by FA ppb	Au by INAA ppb	Calc ppb Au (ODM)*
01-LS-0017	12.4	<2	n/a
01-LS-0064	30.0	<2	n/a
01-LS-0289	35.2	<2	n/a
01-LS-0507	1.8	16	n/a
01-LS-0550	16.7	<2	n/a
01-LS-0611	2.6	41	n/a
01-LS-0639	2.5	20	n/a
01-LS-0722	1.9	31	n/a
01-LS-0993	13.5	<2	n/a
01-LS-1083	2.6	40	n/a
01-LS-1098	57.3	<2	n/a
01-LS-1200	1.0	61	0
01-LS-1244	1.8	59	0
01-LS-1255	22.4	<2	n/a
01-LS-1485	11.9	<2	n/a
01-LS-1639	1.0	74	0
01-LS-1815	2.0	29	n/a
01-LS-2056	66.4	<2	n/a
01-LS-2135	2.8	21	n/a
01-LS-2161	2.6	22	n/a
01-LS-2342	<1	15	n/a
01-LS-2470	2.0	17	n/a
01-LS-2578	1.0	23	n/a
01-LS-2582	<1	15	n/a
01-LS-2585	1.6	24	n/a
01-LS-2592	23.6	3	n/a
01-LS-3739	78.0	<2	0
01-LS-4158	101.9	<2	0
Stream sediments (-80 mesh pulp)	**Au by FA** Ppb	**Au by INAA** ppb	**Calc ppb Au (ODM)****
01-SS-139	<1	365	321
01-SS-226	27.3	84	54
01-SS-229	1.2	338	317
01-SS-329	<1	130	255
01-SS-346	144.5	35	0
01-SS-419	<1	160	260
01-SS-585	<1	622	712
01-SS-586	25.8	64	0
01-SS-624	2.0	623	1082
01-SS-666	96.3	55	13
01-SS-772	n/a	266	208

* based on micro-panning of remaining -80 mesh fine pulp
** based on micro-panning of irradiated INAA material

Table 2. Comparison of Au results by Fire Assay (FA) and INAA from field duplicates.

Lake Sediments (-80 mesh pulp)	Original sample Au by FA ppb	Field Duplicate Au by FA ppb	Original sample Au by INAA ppb	Field Duplicate Au by INAA ppb
01-LSS-658	<2	<2	<2	7
01-LSS-778	<2	<2	10	4
01-LSS-831	<2	<2	<2	8
01-LSS-963	<2	<2	8	<2
01-LSS-1297	41.1	2.1	<2	<2
01-LSS-1316	2.3	<2	9	16
01-LSS-1350	<2	n/a	20	<2
01-LSS-1370	<2	21.8	5	6
01-LSS-2087	<2	<2	<2	20
01-LSS-2182	15.3	<2	<2	<2
01-LSS-2294	<2	13.9	<2	<2
01-LSS-2567	10.7	6.2	5	<2
01-LSS-2692	<2	9.5	<2	<2
01-LSS-2843	<2	n/a	8	<2
01-LSS-2878	3.3	13.8	<2	<2
01-LSS-3974	28.0	2.2	<2	<2
01-LSS-4462	10.1	<2	<2	<2
01-LSS-4610	<2	6.7	<2	<2

Note: field duplicates were collected approximately 1 month after original samples were obtained.

Background

An important impetus for this project has been the reliability of OGS regional geochemical surveys to adequately assess gold potential. Highly disparate results from the same sample pulp and from field duplicates sent for INAA and FA-ICPMS for Au analysis have been common (see Table 1 and 2). Preliminary work (examination of quality control standards) has ruled out laboratory error, therefore, this problem is more likely a sampling and preparation issue, exacerbated by the classic "nugget effect". For example, sample size is important with any media in order to obtain a representative sample and to help overcome heterogeneity. Typical lake sediment samples collected by the OGS have a volume of ~1 l and a wet weight of ~1 kg. However, after drying and surveying, the resulting fine pulp that is sent for analysis can be as little as 15 grams. Although organic lake sediments are considered very homogenous, such a small sample size may not be adequate to overcome the inherent heterogeneous nature of gold distribution. The assumption that homogenous organic lake sediments are relatively uneffected by this phenomenon (largely due to the presumed dominance of hydromorphically transported gold) has come into question.

Project Objectives

What is the optimum sample handling procedure, through initial collection in the field to final analysis at the laboratory?

What is the most reliable method for Au determinations in surficial media. Does it depend to any degree on the type of surficial media?

Are the current methods of sampling and analysis of lake sediments adequate for the determination of precious metals such as gold?

Would an alternate or weaker digestion/leach method be more suitable for gold determinations? (e.g., MMI, Enzyme Leach, SGH)

What is the best analytical method for the determination of Au in lake sediment? What size fraction of lake sediment is optimum?

For Au INAA analysis of lake sediment, is epithermal or thermal irradiation best? How do the results for Au analysis compare between these methods?

How does landscape variability (bedrock dominated terrain versus drift dominated terrain) rank as a factor affecting the geochemistry of Au in lake sediments?

Can this variability be reliably filtered out or compensated for during data processing?

Under what environment(s) does clastic/physical transport of Au predominate over hydromorphic transport, or vice versa?

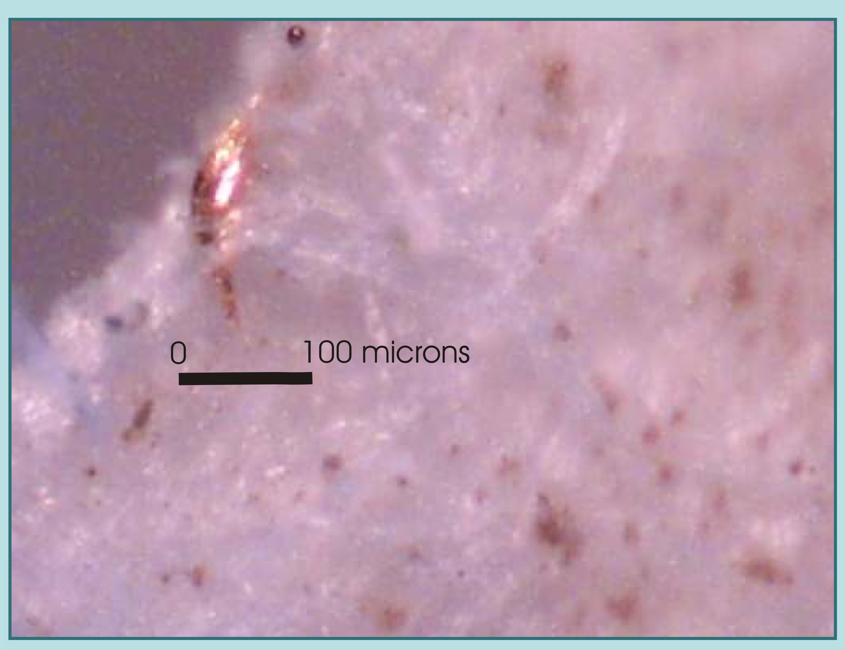


Photo 1. This image, obtained by binocular microscope, shows a gold grain (encased in glue) recovered from a 10 gram sample briquette analyzed by INAA and returned a Au value of 293 ppb.

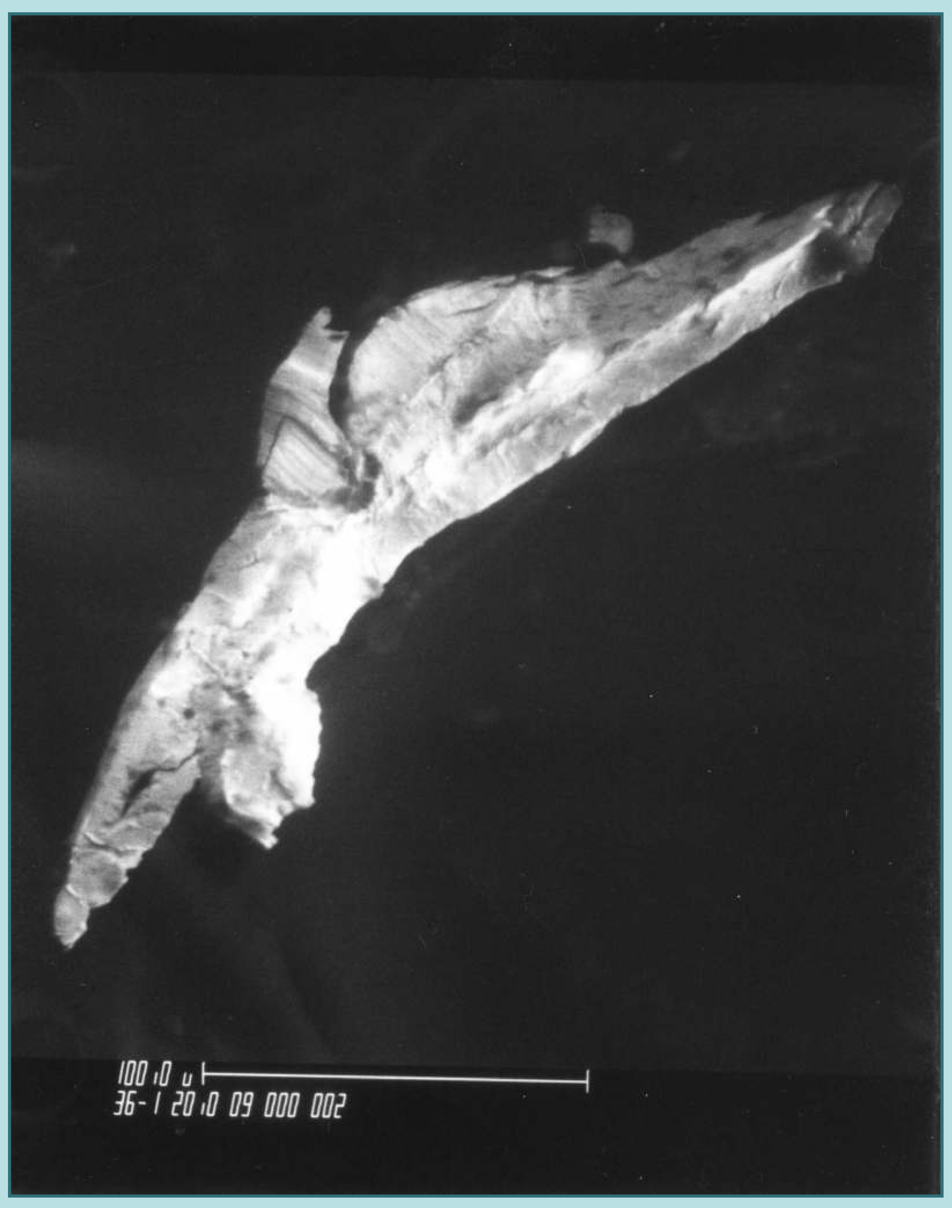


Photo 2. SEM photomicrograph of smeared gold grain recovered from a lake sediment sample INAA briquette.

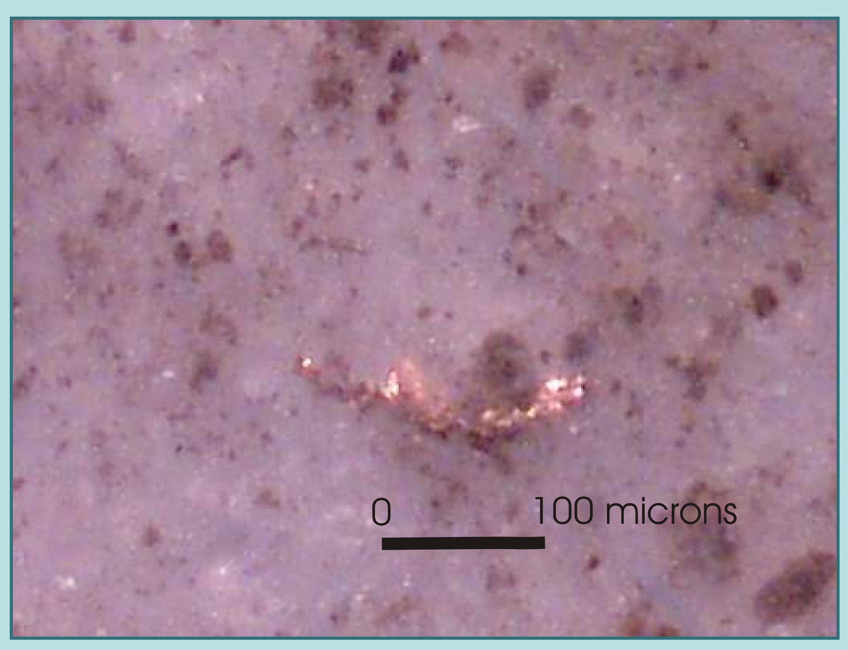


Photo 3. This gold grain, also recovered from a 10 gram sample briquette, returned a Au value of 180 ppb by INAA.

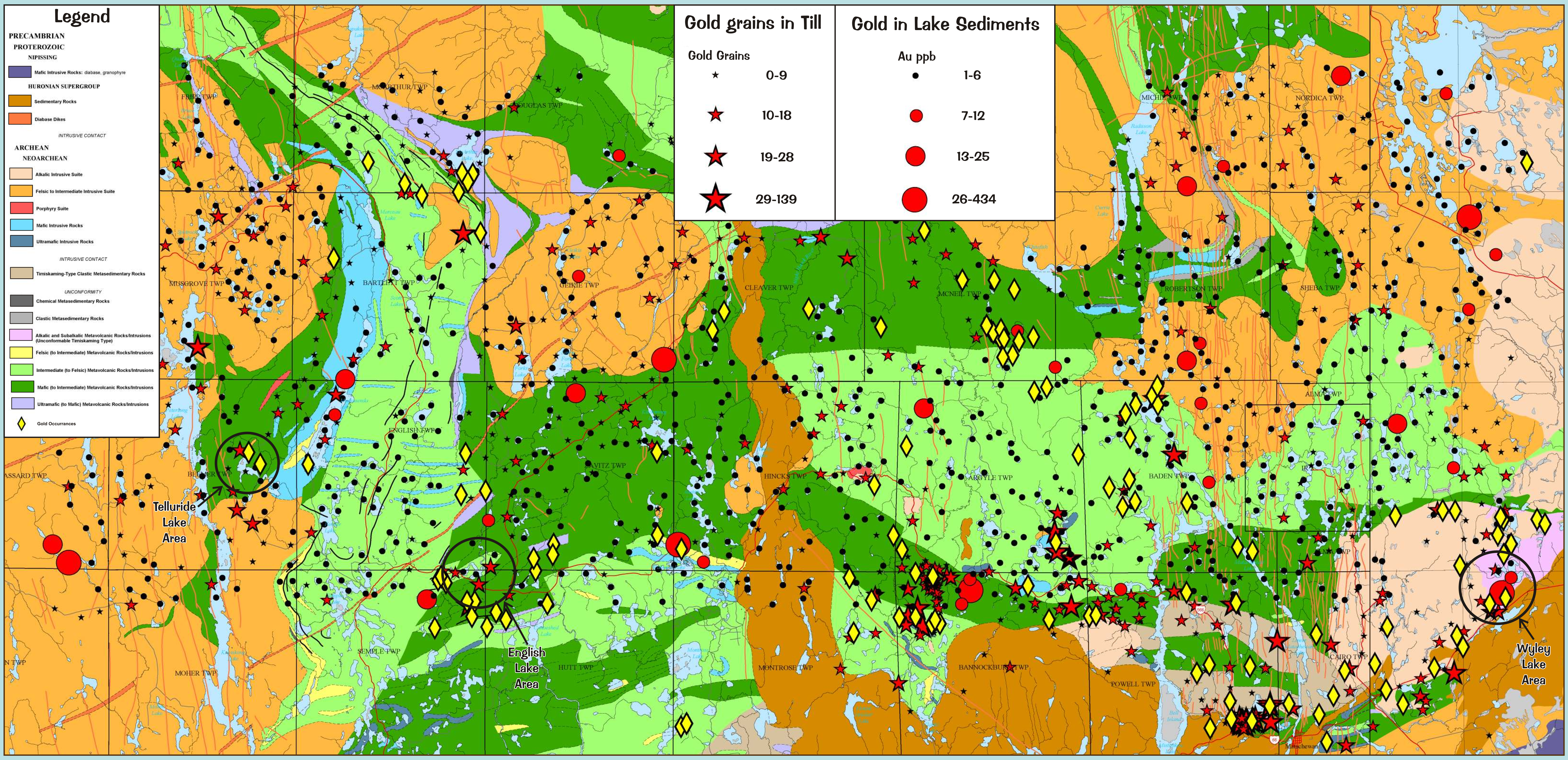


Figure 2. Peterlong-Matachewan portion of the southern Abitibi greenstone belt (geology from Ayer et al. 2003) showing distribution of known gold occurrences, gold grains recovered from till samples and gold determined in lake sediment samples. Location of detailed study areas are circled.

Field Work

Suitable gold dispersion study areas were guided by the presence of at least 3 characteristics: the presence of an existing Au bedrock showing; an associated gold anomaly in surficial media (till or lake sediment); and a nearby lake within the drainage watershed of the bedrock gold occurrence. A portion of the Abitibi greenstone belt, south of Timmins between Matachewan and Peterlong Lake, was chosen due to the abundance of gold showings (Figure 2) and the wealth of recent data for the area including Quaternary mapping (Bajc and Paterson 2000a, 2000b), till geochemistry and indicator mineral sampling (Bajc 1996; Bajc et al. 1996; Bajc 1997; Bajc and Crabtree 2001), bedrock mapping (Ayer et al. 2003; Berger 2004; Berger and Prefontaine 2005; Prefontaine and Berger 2005) and lake sediment geochemistry (Bajc et al 1996; Ontario Geological Survey 2001).

Three lakes with nearby gold occurrences were identified for detailed investigation (Figure 2). Two of these (Telluride Lake and English Lake) also have significant (anomalous) gold grains in till (up to 33 grains) in their general area (Bajc 1996). The third lake (Wyley Lake) has a very strong Au anomaly (132 ppb by FA-ICPMS and 434 ppb by INAA) in lake sediment (Bajc et al. 1996; Ontario Geological Survey 2001). A total of 45 lake sediment samples, 18 "C" horizon till samples, 8 stream sediment and 6 rock samples were collected. At each lake sediment sample site, 2 samples were collected using the OGS torpedo coring apparatus and one large sample with an Ekman dredge. The Ekman dredge (see photos below) was used in order to obtain larger bulk samples for tabling and micro-panning to isolate any gold grains. Till samples (typically between 15 to 20 kg) were taken to verify (and attempt to repeat) the previous Au grain results and to better define the extent and direction of glacial dispersion trains related to the gold occurrences.

Photo 4. Lake sediment sampling with Ekman dredge. The messenger is about to be sent down to activate the jaws of the sampler.

Photo 5. Ekman dredge breaking surface with lake sediment sampler.

Photo 6. Looking for gold at the Bruce gold occurance.

Photo 7. Soil test pit showing good development of Ae and B horizons above olive green C horizon till.

Sample Preparation and Analysis

Lake sediment samples (~1 to 1.5 kg) collected by torpedo coring were placed in breathable fabric bags and allowed to partially air dry prior to oven drying at 35 degrees celsius. Samples collected by Ekman dredge (~4 to 10 kg) were double bagged in large plastic bags. Till and stream sediment samples were also collected in large plastic bags after being passed through a 5 mm screen. Approximately 30 to 50 pebbles were collected from each sample for pebble lithology study.

The bulk samples of till and lake sediment have been submitted to isolate a heavy mineral concentrate followed by micro-panning to accurately determine gold content. Gold grain morphology will be classified as described by Averill (2001) and a gold concentration in ppb will be calculated based on the size dimensions of the grains recovered.

The lake sediment samples obtained by gravity coring (~1 to 1.5 kg), after drying, were gently disaggregated followed by sieving at 80 mesh to isolate the -177 m size fraction. The entire prepared pulp will be separated into aliquots and consumed by replicate analysis for Au using INAA (thermal and epithermal irradiation) and fire assay ICP-MS. After a suitable period of cooling, the INAA briquettes will be submitted for micro-panning to isolate any gold grains, determine grain morphology and compare the calculated Au concentrations to that determined by INAA and FA-ICP-MS.

Photo 8. Quartz vein near Telluride lake.

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