GEOLOGICAL ASSOCIATION OF CANADA
NEWFOUNDLAND SECTION

THE EXPLOITS SUBZONE: GEOLOGY AND MINERAL DEPOSITS

FALL FIELD TRIP GUIDEBOOK

Central Newfoundland

October 1 to 3, 1999

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Contacts in **Grand Falls**:
Mount Peyton Hotel: 709-489-2255 or 1-800-563-4894

... in **Gander**:
Irving West Hotel: 709-256-2406
Comfort Inn: 709-256-3535 or 1-888-256-3535

TRIP ITINERARY: DAY 1

Stop 1-1: **Jumpers Brook gabbro quarry and fabrication plant - International Granite Corp.**, *Ambrose Howse*

Leader: Sherry Dunsworth

[*Text and diagram modified from NAMS - Newfoundland Field Trip 2 Guidebook (1999)*]

LOCATION

Access to the area is provided by a well-maintained forest access road. Turn south from the TCH at Jumpers Brook, located 3 km east of the junction of the Baie d'Espoir Highway and the TCH. The plant and several small gabbro quarries are located approximately 9 km to the south along this road.

INTRODUCTION

International Granite and an associate company, Ebony Granite, quarry "Black Granite" gabbro from a number of locations near Borney Lake in the Mount Peyton area of central Newfoundland. In 1996, the companies started exporting blocks from the Jumpers Brook quarry, thereby initiating a period of growth. Cabot Granite Fabricators Inc., a subsidiary of International Granite, has established a slab and polishing facility at the Jumpers Brook quarry for the manufacture of slabs, monument-grade stone, finished monuments, and custom products. International Granite markets their products in central Canada, northeastern United States, and Newfoundland.

DESCRIPTION

The gabbro quarry is located near Borney Lake in Central Newfoundland within the northwest corner of the Silurian to Devonian Mt. Peyton Intrusive Suite (Figure 1-2a). The intrusion is an elliptical-shaped body comprising an area of about 1800 km^2, about one third of which consists of grey-black, fine- to medium-grained varitextured gabbro with small intruded areas of equant monument-grade material. The stone is easy to work and has a subtle "rift and run" or crystal alignment. Monument-grade material, where present, occurs as discontinuous primary igneous bands of varying thickness, separated by bands of the varitextured stone. The latter has attractive features making it suitable for use as countertops and tiles. According to Dunsworth (1998) "the geology in the vicinity of the Borney Lake quarries consists of a primary igneous layered mafic sequence, with a consistent northeasterly strike (35-40°) and a moderate southeasterly dip (30-35°). This layered sequence developed along the inclined margin of a magma chamber, adjacent to the intrusive contact with the Silurian Botwood Group metasediments. The gabbro is essentially post-kinematic, except for variably developed, penetrative jointing."

Quarry development at Borney Lake is a highly technical process that must take into account many geological features, including variations in the thicknesses and dips of layering, textural variations, and the subtle alignment of minerals in the gabbro. The intrusion of granitic and pegmatitic veins into the layered gabbro can further complicate its development. Recovery rates of useable stone from these quarries range between 5-10%, values typical of black granite quarried elsewhere (*ie*. South African). Block extraction is by wire-saw so as to minimize the possibility of producing fractures in the stone (Dunsworth, 1998). Current operations are focussed on premium quality monument-grade slab production and export.

Due to the logistical considerations of our large group, we will split into two smaller groups; one half will tour the fabrication plant while the other visits International Granite quarry No. 5, located a few hundred metres behind the plant. After approximately one hour the two groups will switch places. Although some useable stone remains in quarry No. 5, the company has recently opened up a new quarry located near Upper Christmas Pond, some 16 km to the northeast of the plant. We will not be visiting this quarry today due to the poor condition of the access road leading to it.

REFERENCES

Dunsworth, S. (pers. comm., 1999)

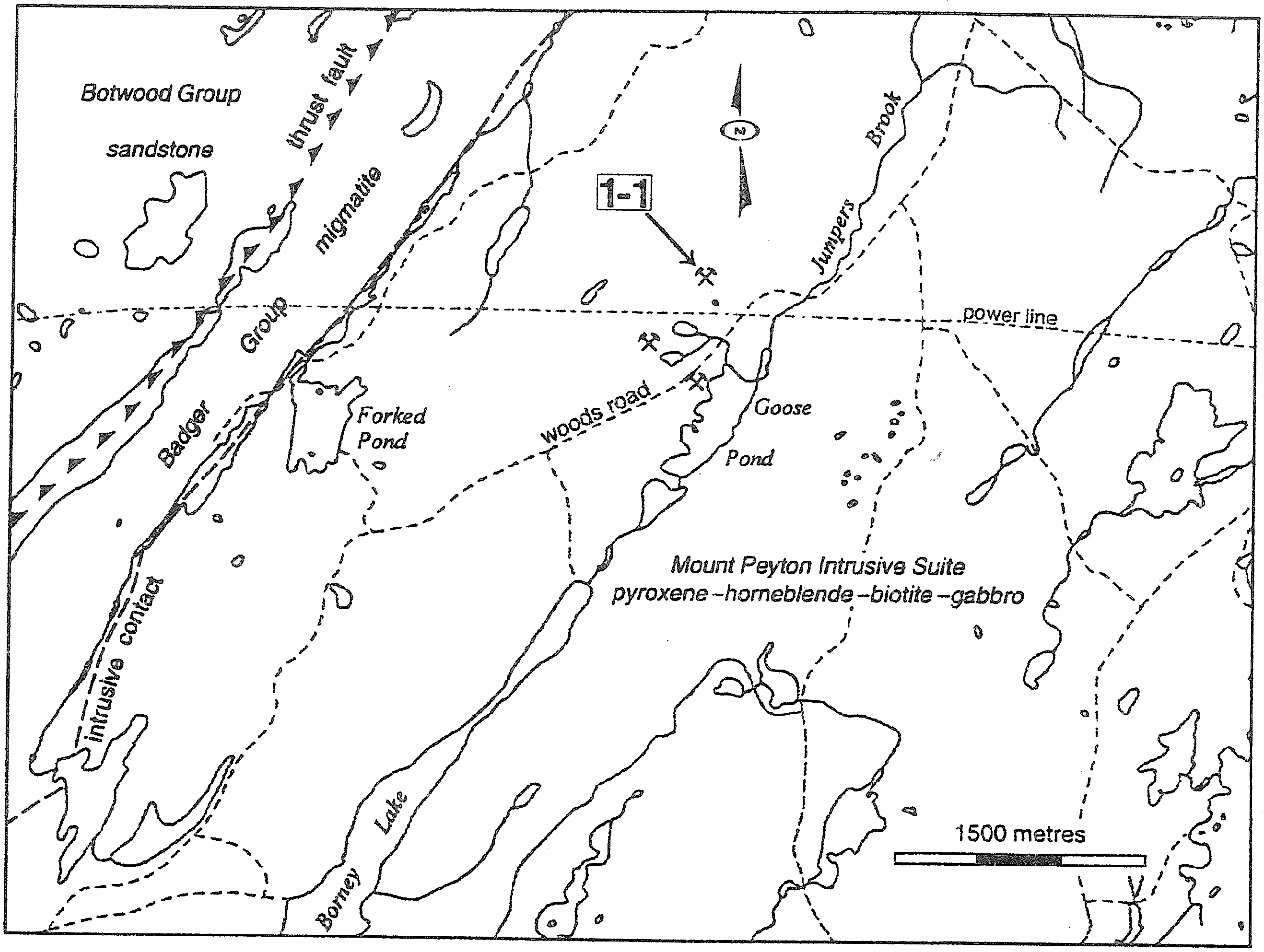

Figure 1-1. *Location of the International Granite Corp. operations within the Mount Peyton Intrusive Suite.*

Stop 1-2: **(optional) Metamorphic aureole of the Mount Peyton Intrusive Suite.**, *Lawson Dickson*

Leader: Toby Rivers

[*Text and photograph modified from* Dickson (1994)]

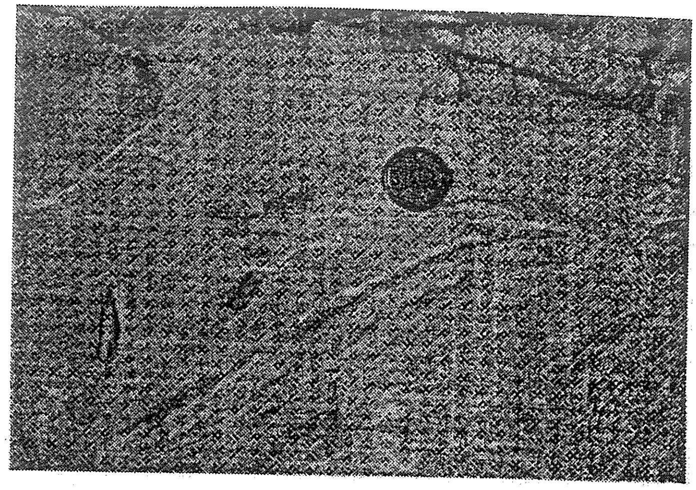

Plate 1-2. *Disrupted beds of the Point Leamington Formation sandstone (subunit 2a) enclosed in a gabbro matrix typical of the aureole of the Mount Peyton Intrusive Suite. Trans-Canada Highway, 1.5 km west of the contact. Lens cap is 5 cm in diameter. (LD930044; UTM grid reference 211329)*

LOCATION

This low, flat-lying outcrop is situated beside the highway on the north side of the TCH about 5.5 km east of its junction with the Jumpers Brook access road, and about 1 km west of the crest of this gradual uphill rise, heading eastward. Park on the shoulder of the highway or on a dirt road leading off the highway to the north about 400 m to the east.

DESCRIPTION

Sedimentary strata immediately to the north and west of the Mount Peyton intrusive suite have been assigned to the Upper Ordovician to Early Silurian Badger group. The group comprises a variety of turbididtic sedimentary rocks including siltstone, sandstone, pebbly sandstone and conglomerate. Some of these components have been assigned formation names such as Point Leaminington Formation, Goldson Formation, Samsom Formation. The Badger group conformably overlies the Caradocian Shoal Arm Formation in many areas, although tectonic contacts are also found.

The strata located along the highway were considered by Dickson (1994) to be equivalent to the Point Leamington Formation. In the Norris Arm - Jumpers Brook area, the dominant rock type is thin- to medium-bedded, grey turbiditic sandstone and siltstone which is generally dipping and younging to the southeast. However, folding and thrusting are also apparent and cleavage is variably developed in the finer-grained beds. The sequence locally contains conglomerates and siltstones that are highly fossiliferous. These are located along the Exploits River and one locality will be visited tomorrow. The fossils comprise a wide variety of types including brachiopods, trilobites, corals, gastropods and ostracods. These indicate that the Point Leamington Formation is Llandoverian in age (Early Silurian) and more precisely Llandoverian C_3 - C_6 (see Boyce, this volume) possibly giving a date of about 430 Ma.

The Badger group was intruded by the Mount Peyton gabbro at 423 ± 2 Ma (U/Pb zircon age from the gabbro). This date is equivalent to the base of the Ludlow (see Boyce, this volume) The contact metamorphic effects are widespread and quite apparent. The aureole of the gabbro forms the higher ground south of the Exploits River. About two kilometres from the intrusive contact of the Badger Group with the gabbro of the Mount Peyton intrusive suite, the rocks lose their slaty cleavage, become hard and brittle and are black on fresh surfaces. The weathered surfaces are generally lighter coloured and the individual beds are apparent. Metamorphic minerals are generally not obvious but biotite and amphibole porphyroblasts are found in some beds. As the gabbro contact is approached, granitic segregations are found and bedding becomes disrupted. This disruption increases towards the contact and ultimately the individual bed fragments are engulfed in sea of fine-grained gabbro and also granodiorite dykes.

The field trip stop will display the highly disrupted and migmatized sediments (see Plate 1-2, Page 4).

Note: Small drill-holes in the outcrop were made by Pierre Lapointe (1979) during a paleomagnetic study of the Mount Peyton Intrusive suite and its aureole.

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Dickson, W.L., 1994
Geology of the southern portion of the Botwood map area (NTS 2E/3), north-central Newfoundland. In Current Research. Newfoundland Department of Mines and Energy, Geological Survey Branch, Report 94-1, pages 101-116.

Lapointe, P.L., 1979
Paleomagnetism and orogenic history of the Botwood Group and the Mount Peyton Batholith, Central Mobile Belt, Newfoundland. Canadian Journal of Earth Sciences, Volume 16, pages 866-876.

TRIP ITINERARY: DAY 2

Stop 2-1: **Wigwam Formation redbeds, Botwood Group**, *Henry Williams*

Leader: Henry Williams

LOCATION

Salmon interpretation centre, Grand Falls.

DESCRIPTION

Red, green, buff and grey micaceous sandstone with siltstone, shale and pebble conglomerate interbeds characterize the Wigwam Formation, the upper division of the Botwood Group; these overlie volcanics of the Lawrenceton Formation (see Williams *et al.*, 1995). Based on sparse fossil evidence from local development of marine sediments (Boyce and Ash, 1994), the Wigwam Formation appears to be of late Silurian (Ludlow-Pridoli) age. Sedimentary features indicate mostly terrestrial deposition, including cross-bedding, current and oscillatory ripple marks, mud cracks, and raindrop prints.

En route to the stop, a spectacular view of the sediments is seen crossing the main logging access bridge behind the Abitibi plant. The red sandstones are accessible in the area around the interpretation centre, where well-preserved ripple marks and other sedimentary structures are present.

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Boyce, W.D. and Ash, J.S. 1994.
New Silurian-Devonian faunas from the Gander (NTS 2D/15) and Botwood (NTS 2E/3) map areas. *In* Current Research. Newfoundland Department of Mines and Energy, Geological Survey Branch, Report 94-1, p. 53-63.

Williams, H., Dean, P.L and Pickering, K.T., 1995.
Botwood Belt. *In* Chapter 4 of Geology of the Appalachian-Caledonian Orogen in Canada and Greenland, (ed.) H. Williams. Geological Survey of Canada, Geology of Canada, No. 6, p. 413-420.

Stop 2-2: **Peat harvesting and products - Hi-Point Industries (1996) Limited, Bishop's Falls**, *Ambrose Howse*

[*Text and diagram modified from NAMS - Newfoundland Field Trip 2 Guidebook (1999)*]

INTRODUCTION

Peatlands form a large component of the island of Newfoundland, comprising 11% of the land mass or 1.1 million hectares (Figure 2-1a). Acres International Ltd. (1992) summarized data from a number of peat inventories and studies carried out between 1978 and 1983. Total volume is 17.0 billion cubic metres consisting of 7.3 billion cubic metres of horticultural peat and 9.7 billion cubic metres of fuel peat. Using an arbitrary size of 30 hectares or greater as a cut-off limit, Wells and Heringa (1972) estimated the island's peat resource at 4944 deposits totalling 4 billion metres (horticultural) and 6.5 billion cubic metres (fuel).

DESCRIPTION

The last decade has seen much progress towards greater utilization of the province's peat resource. The advances made by Hi-Point Industries (1991) Ltd. of Bishop's Falls are of particular note. This company is the original producer of an oil absorbent from peat moss called "Oclansorb". First introduced into the international market in 1983, it has earned worldwide recognition as a premier organic absorbent used for the containment of hydrocarbon spills. The company also produces horticultural peat for local and export markets and has recently started excavating horticultural peat from its Gander Bay (Island Pond Bog) deposit. Hi-Point is the largest peat producer in the province, exporting over $1 million worth of products each year. There are many other small-scale peat producers, most of which market horticultural peat for local use.

Further information on the operations and products of Hi-Point Industries Ltd. can be accessed at their website: www.oclansorb.com

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Acres International Ltd., 1992
Newfoundland Peat market study, final report, Newfoundland and Labrador Mineral Development Division, Open File NFLD/2271, 134 pages.

Wells, R.E. and Heringa, P.K., 1972
Soils of the Gander-Gambo area, newfoundland Agriculture Canada Research Branch, Newfoundland Soil Survey, Report no. 1, [002D/0089], 52 pages.

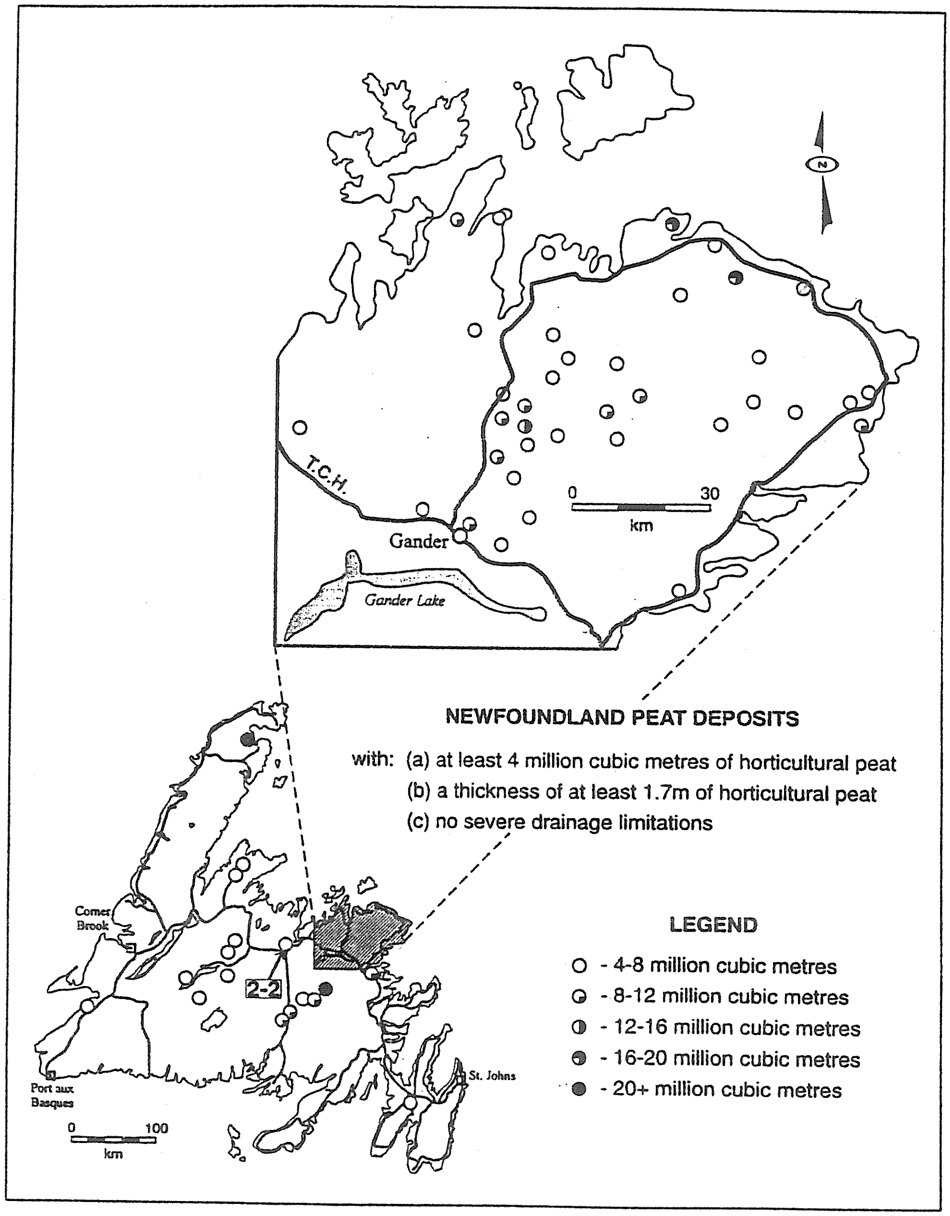

Figure 2-2. *Location of the Hi-Point peat production bog (Stop 2-2) in relation to several other significant peat deposits in Central Newfoundland.*

Stop 2-3: **An Epithermal Silica Sinter - Rolling Pond**, *Dave Barbour, Rod Churchill, Brian Dalton, Roland Butler Jr. and Renee Turmel, Altius Minerals Corporation, Suite 201, 53 Bond Street, P.O. Box 385, St. John's, Newfoundland, A1C 5J9.*

Leader: Brian Dalton

LOCATION AND ACCESS

The Rolling Pond property is located 31 km south-southeast of Grand Falls in central Newfoundland. Access is via the Baie d'Espoir highway where a gravel surface logging road turns east from the highway 40 km south of the Trans-Canada highway intersection. This forest access road traverses the entire property for a distance of 2.5 km.

REGIONAL GEOLOGY

The Rolling Pond property is located within the Exploits Subzone of the Dunnage tectonostratigraphic zone of Newfoundland. This subzone comprises of Cambro-Ordovician ophiolitic rocks, early Paleozoic island-arc and back-arc derived sedimentary and volcanic rocks, post-accretion Silurian sedimentary and volcanic rocks, and Siluro-Devonian intrusive rocks. The latter intrusive rocks include a large granitic to gabbroic intrusion, the Mount Peyton batholith, having surface dimensions of 30 x 60 km. Immediately southwest of the property, Mount Cormack subzone rocks are exposed in a thrust-bound window within the Exploits Subzone (Colman-Sadd and Swinden, 1984). Ultramafic rocks commonly mark fault contacts of the Mount Cormack Subzone. This subzone is included in the Gander Tectonostratigraphic Zone of Newfoundland and is dominated by variably deformed and metamorphosed Lower Ordovician and older sedimentary rocks.

The Rolling Pond property straddles the boundary between Spruce Brook Formation metasedimentary rocks of the Mount Cormack Subzone to the south, and Botwood Group sedimentary rocks of the Exploits Subzone to the north (Dickson,1991) on the Eastern Pond mapsheet (Figure 2-3). Mapping by Colman-Sadd and Russell (1981), on the Miguels Lake map area, suggests that Botwood Group sedimentary rocks underlie the property, and that the Spruce Brook Formation outcrops farther to the south. The latter workers record a major east-northeast trending fault zone, marked by ophiolitic rocks that runs through Miguels Lake. Farther to the west, this fault marks the contact between the Spruce Brook Formation and the Botwood Group. East of Miguels Lake this fault zone appears to bend southeasterly into the boundary mapped by Dickson (1991). The southern tip of the Mount Peyton batholith outcrops just east of the Rolling Pond property. This batholith is interpreted as being contained within a thin thrust sheet that has been transported west over the Botwood Group. The thrust sheet contains thermally metamorphosed turbidites representing the contact metamorphic aureole of this pluton. The intrusion is nowhere seen to intrude the Botwood Group. Subaerial volcanic rocks of the Siluro-Devonian Stony Lake Volcanics occur 16 km west of the property.

Rocks of the Silurian Botwood Group generally contain one good cleavage, which is dominantly northwest trending and steeply northeast dipping in the project area. Rocks of the Spruce Brook Formation to the south are polydeformed. The Mount Peyton batholith is unfoliated. Metamorphic grade increases from lower greenschist facies in the Botwood Group, to amphibolite facies southward in the Spruce Brook Formation.

PROPERTY GEOLOGY

Bedrock exposures in the Rolling Pond area are sparse with geology constructed from seven outcrops, felsenmere-like boulders of possible sub-crop and five diamond drill holes.

Three main rock units underlie the Rolling Pond grid area (Figure 4). The lithologic units trend east-southeast to southeast, and dip steeply (~70°E) to the northeast. The southern part of the grid is underlain by a buff to pale gray coloured, fine grained,

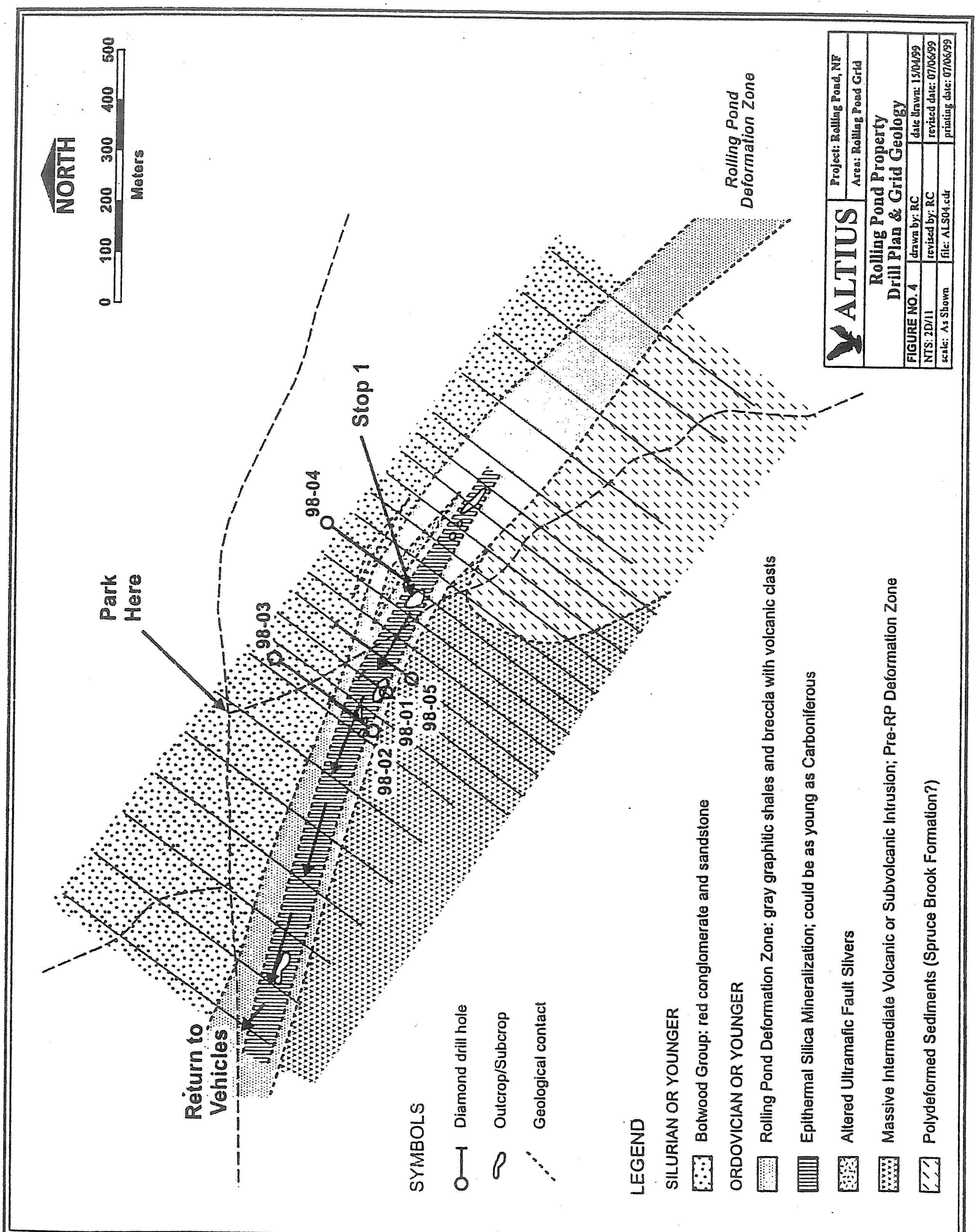

Figure 2-3. *Drill plan and grid geology of the Rolling Pond property.*

massive, felsic to intermediate volcanic rock that may be a massive flow. The rock is essentially unfoliated and featureless, except for occasional thin pillow selvage-like bands. These bands may represent flow tops, or a flow-related fracturing. Abundant quartz veins locally cut the volcanic rock. This unit was intersected in drillcore, and occurs as numerous felsenmere-like boulder piles that cover a large part of the grid. Some of these boulder piles occur up to 200 m northeast of the unit, suggesting some glacial movement, and that the boulder piles are not truly sub-crop. The extent of the boulder distribution implies that the volcanic unit underlies most of the south part of the grid. Previous workers did not note this unit. The volcanics that are most proximal to this unit are the Siluro-Devonian Stony Lake Volcanics 16 km to the west; it is unknown whether there is a correlation with these volcanics.

The second rock unit is a relatively narrow unit (100 to 200 m surface width) which overlies the volcanic unit to the northeast. The unit is a breccia or a conglomerate composed of fragments of the volcanic rock in a dark grey, variably graphitic, argillaceous to shaly matrix. Rare clasts of a dark gray fine-grained silicified breccia were also noted. Clasts are generally subrounded to subangular. Immediately adjacent to the volcanic unit the breccia has a high clast content, is locally clast supported, and may represent a flow-top breccia. The contact with the volcanic unit is conformable. The clast content of the breccia decreases with increasing distance from the contact, being typically less than 50% and the breccia is matrix supported. The rock also has a more sedimentary appearance away from the contact with the volcanics. The breccia matrix is strongly foliated, obliterating original textures, and making it difficult to ascertain whether the rock is a breccia or a conglomerate. This unit appears to widen to the southeast, based on three areas of surface exposures. However, the two exposures in the south corner of the grid are somewhat different, and may represent Spruce Brook Formation rather than the breccia unit. The breccia unit locally encloses fault-bound panels of ultramafic rocks. The ultramafics are white to pale green coloured strongly altered and deformed, quartz-(magnesite?)-serpentine-talc rocks.

The breccia unit is overlain to the northeast by a conglomerate-dominated sedimentary sequence that is typical of Botwood Group rocks. This sequence is in depositional contact with the underlying breccia. The conglomerate is grey-green to locally reddish coloured. It is composed of about two-thirds clasts of fine grained sedimentary lithologies which also resemble Botwood Group rocks. The other one-third of the clasts are beige to pale gray coloured, fine grained, massive, quartz- veined volcanic rock which resembles the volcanic unit to the southwest. Rare jasper clasts also occur in the conglomerate. The conglomerate is very poorly sorted, and is clast supported. It has essentially no matrix, just very tight packing of clasts that range down to a coarse sand size. Clasts are typically sub-angular to sub-rounded, and mostly less than 2 cm in size. Volcanic clasts are occasionally up to 3 m in size, these clasts being haphazardly distributed in a matrix of much smaller clasts. Bedding in the conglomerate is defined by an alignment of the long axes of clasts, or more prominently by thick bedding of individual units. The conglomerate sequence fines to the east. Drill hole RP.98-04 intersected a thin to thick-bedded sequence of siltstone, sandstone and fine pebble conglomerate. This sequence displays slump folding, mud cracks, load casts, flame structures and scours. Graded beds were noted throughout the conglomerate sequence. These give stratigraphic tops to the northeast, although a couple of graded beds give the opposite sense. The latter may represent reverse grading, because they do not occur on fold limbs.

A foliation is variably developed in rocks underlying the Rolling Pond linegrid. The foliation is only locally weakly developed in the volcanic unit, and is weakly developed sub-parallel to bedding in the conglomerate sequence. The graphitic breccia unit is strongly foliated, with the foliation sub-parallel to the trend of the unit. The two outcrops at the south end of the grid have a strong domainal foliation. This foliation is folded by open to close, symmetric, mesoscopic folds. The axial surfaces of the folds trend about 112° and dip steeply north, and the folds plunge steeply east.

Faulting is a prominent feature of the Rolling Pond area. The faults are focused within the graphitic breccia unit, are sub-parallel to the trend of the unit, and record several episodes of movement. This structural zone is referred to as the Rolling Pond structure. Early faulting is evidenced by a series of anastomosing graphitic and chloritic shears and fault breccias. This faulting introduces slivers of ultramafic rocks into the graphitic breccia unit, and locally repeats the sequence of conglomerate and graphitic breccia. These faults probably represent significant thrust and/or strike-slip movements. Another major fault, possibly extensional, served as a major epithermal fluid conduit, resulting in deposition of a large zone of silicification, hydrobrecciation and quartz veining. Breccias within this silicified zone record repeated episodes of movement and silica deposition. The quartz zone is sub-parallel to the trend of the host unit.

The age of movements on the thrust/strike-slip faults, relative to the fault hosting the siliceous zone is uncertain. Vuggy quartz veins associated with the quartz zone fault were not noted cutting the ultramafic slivers, implying that the latter was emplaced after mineralization occurred. Conversely, the ultramafic rock may have acted as an impermeable barrier to the hydrothermal fluids. The absence of crosscutting relationships may also be a function of the lack of data (one drill hole intersection). Regional relationships suggest that the mineralization is late in the tectonic evolution of the terrane, and should post-date emplacement of the ultramafic. Earliest movement on the main fault, which controls the mineralization, is unconstrained; mineralization could relate to late extensional reactivation of a pre-existing fault.

The latest fault movement is represented by very abundant anastomosing, millimeter to metre-thick, graphitic to chloritic to sericitic, soft, fault gouge seams. The gouge seams are most abundant in the graphitic breccia unit, but also cut the conglomerate and volcanic units. The sense of movement on these gouge zones is unknown.

MINERALIZATION

The Rolling Pond property hosts a large epithermal-style zone of silicification, hydrobrecciation, and quartz veining. The zone represents a fossil fault zone, which is hosted within the graphitic breccia unit, and which is conformable to the trend and dip of the host unit. Felsenmere- like boulder piles, one outcrop, and five drill hole intersections define the zone over a distance of 1100 metres along strike. The zone has a fairly uniform thickness of 30 to 60 m, and has been intersected by drilling down to 160 m vertically below surface. Vuggy quartz veins and hydrobreccia zones extend up to 25 m into the host graphitic breccia unit on both sides of the quartz zone. The veins may comprise up to 50% of the rock adjacent to the quartz zone, with decreasing intensity away from the zone. Similar veined screens of host rock may occur internally within the quartz zone. The quartz zone does not display a distinct asymmetry similar to the "Buchanan model".

The mineralized zone is an intensely quartz flooded zone which exhibits varying styles of breccia textures. In the dominant breccia type fragments are angular to rounded, and generally several centimeters in size. The fragments vary from unaltered to completely silicified. They consist of the host graphitic breccia unit, lesser material resembling the volcanic unit, occasional fragments of a previously silicified breccia, and completely silicified fragments of indeterminate origin. The latter fragments blend into the matrix silicification and locally produce a 'ghost breccia texture. The fragment content in these breccias is normally less than 50%. The matrix is composed of pale gray to white silicification, and vuggy quartz veins that blend into the silicification. Quartz crystals lining the vugs vary from less than a millimeter to 2 cm in size. Some of the vugs may be quite large, with open spaces of up to 1.3 m encountered during drilling.

A second breccia type consists of a pale to dark gray, finer grained, angular tectonic breccia. This breccia contains abundant fragments of vein quartz, and common fragments of the earlier silicified breccia.

Breccia fragments are typically less than 2 cm in size. The matrix consists of gray colored, vuggy silicification, with lesser vuggy quartz veining than in the above breccia. This breccia shows gradational contacts with the breccia described above.

The third breccia type consists of thin zones of hydrobreccia that cut, and blend into, the other two breccia types. Fragments in this breccia are commonly rimmed with silica, and may display cockade textures.

The mineralized zone exhibits several stages of silica deposition. The fragments of silicified breccia represent earliest silicification. Subsequent stages include silicification of matrix and fragments, silicification associated with hydrobrecciation, and with rimmed fragments. The vuggy veins represent latest quartz deposition. Accompanying the silicification is a pervasive clay mineral alteration, which probably represents a late stage steam-related overprint. The clays occur as white to cream coloured aggregates interstitial to quartz, or replacing rock fragments in the breccia.

Preliminary XRD work indicates that the clays comprise a mixture of kaolinite and dickite. Minor amounts of a pale green clay mineral are also present. Minor amounts of an orange to reddish colouration in the silica indicate the possible presence of adularia. However, local zones of Fe-Ti oxide "impurities" produce a similar coloration of the silica. The latest minerals deposited by the epithermal fluids consist of pyrite and goethite. Pyrite occurs as tiny crystals, or as massive, locally botryoidal, crystal aggregates growing on top of quartz crystals in open vugs. Similarly, goethite occurs in minor amounts as vitreous botryoidal masses growing on top of quartz crystals.

The Rolling Pond mineralization contains numerous textures typical of epithermal systems. These include the vuggy quartz veining, and hydrobreccias with cockade textures. Surface samples at the northwest end of the zone contain a spectacular texture consisting of a rock composed entirely of perfectly formed rosettes of quartz crystals. These rosettes/balls are up to 6 cm in diameter. This rock could only have formed in a silica gel pool, where the rosettes were suspended and allowed to grow independently. Another characteristic feature is a lattice texture of large bladed calcite or barite crystals, which have been completely replaced by silica. These crystals may be up to 20 cm long, and only one or two millimeters thick. Locally, small quartz crystals grow orthogonally on the bladed material, into the open spaces between blades. This lattice texture is considered to be evidence of boiling in the epithermal system.

REFERENCES

Colman-Sadd S.P. and Russsell, H.A.J., 1981
Miguels Lake (2D/12), Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, open file, Map 81-108.

Colman-Sadd S.P. and Swinden, H.S., 1984
A tectonic window in Central Newfoundland? Geological evidence that the Appalachian Dunnage Zone may be allochthonous. Canadian Journal of Earth Sciences, Volume 21, pages 1349-1367.

Dickson, W.L., 1991
Eastern Pond (west half) map area (2D/11W), Newfoundland. Newfoundland Department of Mines and Energy, Geological Survey Branch, M 91-166.

Stop 2-4: "*Leptaena* Hill"

Leader: Doug Boyce

LOCATION

The site is a low hill, 400 metres south of Route 351, and 6 kilometres west of Rattling Brook (Locality LD93-0555 of Dickson, 1994: UTM 619000 5433800).

DESCRIPTION

This fossil locality within the Point Leamington Formation was discovered by Mr. Barry Wheaton in 1993. Deformed fossils have been collected from the cleaved dark blue gray siltstone and mudstone exposed here; the following have been identified (Boyce and Ash, 1994, page 58):

Arthropoda—Trilobita
Acernaspis newfoundlandensis (Shrock and Twenhofel, 1939)
Bumastus sp.
Encrinurus anticostiensis Twenhofel, 1928
proetid gen. et sp. undet.

Brachiopoda—Articulata
Atrypa reticularis (Linné, 1758)
Cyrtia exporrecta (Wahlenberg, 1823)
Eospirifer radiatus (Sowerby, 1839)
Gen. et sp(p). undet.
Leptaena sp. cf. *L. depressa* (Sowerby, 1823)
Plectodonta sp.

Brachiopoda—Inarticulata
Orbiculoidea sp.

Echinodermata—Crinoidea
Gen. et sp(p). undet.

Talus on the south side of the hill, the following taxa were recovered (Boyce and Ash, 1994, page 58):

Arthropoda—Trilobita
Gen. et sp. undet.

Brachiopoda—Articulata
Atrypa reticularis (Linné, 1758)
Leptaena sp. cf. *L. depressa* (Sowerby, 1823)

Leptaena sp. cf. *L. depressa* (Sowerby, 1823) is by far the most common fossil at this site. Many of the trilobites and crinoids are partly articulated, indicating relatively undisturbed conditions. Boyce and Ash (1994, page 58) correlated the fauna with that reported by Shrock and Twenhofel (1939, pages 245-246) from the "fossiliferous argillite" of their Pike Arm Formation exposed on Fossil Arm, Pike Arm, New World Island (Twillingate — NTS 2E/10). Both faunas are late Llandovery C_3 to C_4 (latest Aeronian to middle Telychian) in age.

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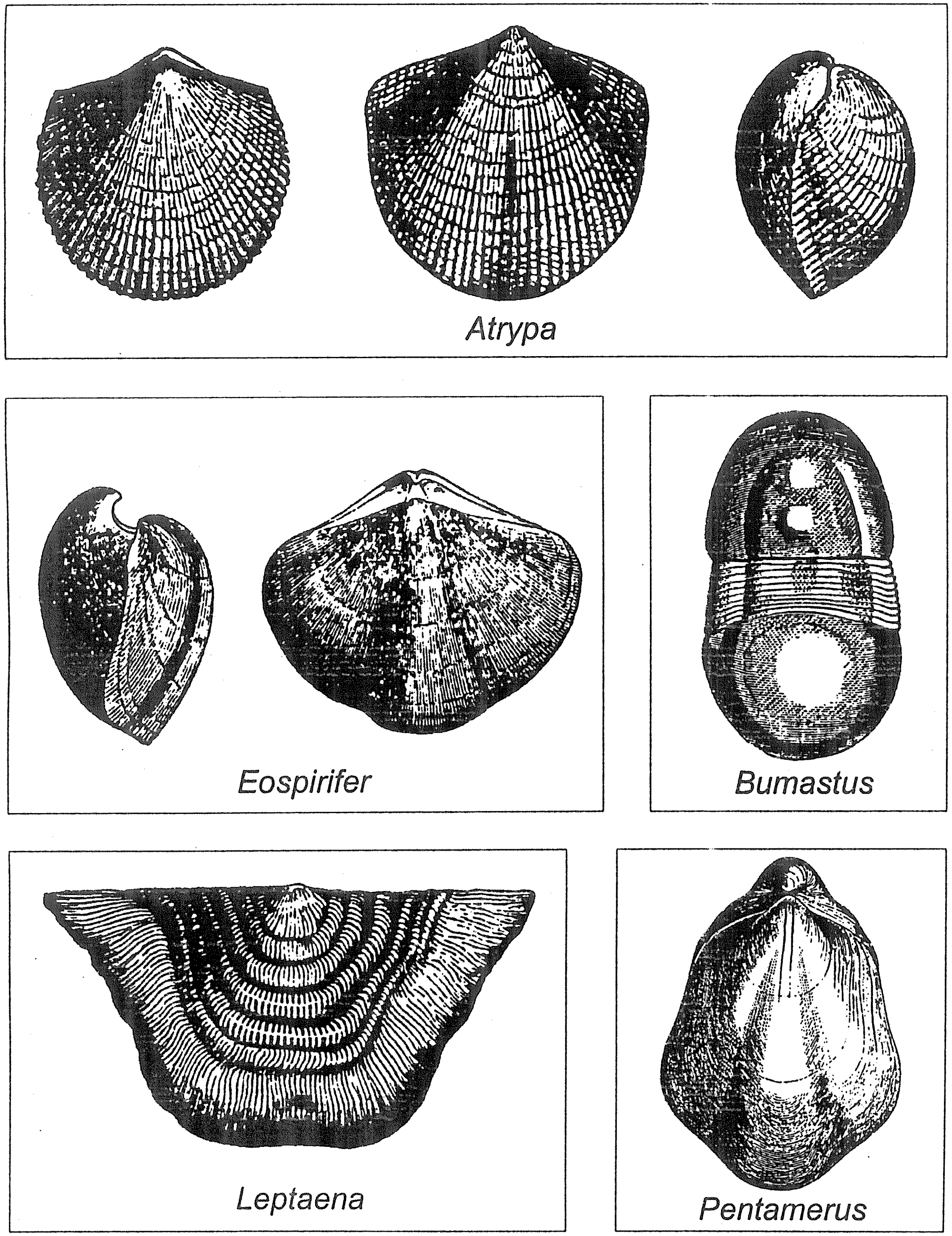

Figure 2-4a: Representative fossil genera of "*Leptaena* Hill" (not to scale). Images from Logan *et al.* (1863).

Age (Ma)	Standard Subdivisions of the Silurian System: Series	Stage	Zone	Botwood (2E/3)	Gander (2D/15)
417–419	Přídolí Series	(Stages not defined)		Wigwam Formation (Botwood Group) Camp Emmanuel	Indian Islands Group Careless Brook
419–423	Ludlow Series	Ludfordian Stage		Wigwam Formation (Botwood Group) Camp Emmanuel	Indian Islands Group Careless Brook
	Ludlow Series	Gorstian Stage		Wigwam Formation (Botwood Group) Camp Emmanuel	Indian Islands Group Careless Brook
423–428	Wenlock Series	Homerian Stage			Indian Islands Group Careless Brook
	Wenlock Series	Sheinwoodian Stage			Indian Islands Group Careless Brook
428–443	Llandovery Series	Telychian Stage	C_6	Goldson Group	
		Telychian Stage	C_5	Point Leamington Formation	
		Telychian Stage	C_4	Point Leamington Formation	
		Aeronian Stage	C_{1-3}	Point Leamington Formation	
		Aeronian Stage	B_3		
		Aeronian Stage	B_2		
		Aeronian Stage	B_1		
		Rhuddanian Stage	A_4		
		Rhuddanian Stage	A_3		
		Rhuddanian Stage	A_2		

Figure 2-4b: Correlation of Silurian sedimentary rocks of the Botwood (2E/3) and Gander Lake (2D/15) map areas.

Stops 2-5a,b: **Davidsville Group**, *Henry Williams*

Leader: Henry Williams

LOCATION

a. Road cuts along TCH between Glenwood and the Little Harbour turnoff

b. Small disused quarry on logging road off north side of TCH, ca. 100 m west of Little Harbour turnoff.

DESCRIPTION

The Davidsville Group is the basal sedimentary unit in the eastern part of the Dunnage Zone. The group is divisible into a lower unit of conglomerate, sandstone, calcareous siltstone and minor limestone and an upper unit of monotonous grey and greyish black siltstone with minor sandstone. Biostratigraphically useful fossil assemblages include late Arenig trilobites and shelly faunas in calcareous sandstone along the shores of Gander Lake (Boyce et al., 1988), late Llanvirn brachiopods, cephalopods and trilobites in limestones of the Weirs Pond Formation (Boyce et al., 1988) and Upper Ordovician (Caradoc) graptolites in black shales of the upper shale/siltstone portion (H. Williams, 1995, p. 159).

In the roadcut, folded and cleaved grey siltstones and minor, thin sandstone beds of the Davidsville Group are exposed. The cleavage is the the principal regional foliation. In the quarry, weathered fossiliferous calcareous shales and silty limestones contain locally abundant, tectonically deformed brachiopods. These probably belong to the late Arenig-early Llanvirn shelly horizons which are exposed above the basal Davidsville Group unconformity along the shores of Gander Lake.

REFERENCES

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Stop 2.6: Gander River Ultrabasic Belt (GRUB) with unconformably overlying Davidsville Group, *Toby Rivers*

Leader: Toby Rivers

LOCATION

Little Harbour, on the north shore of Gander Lake. Turn south from Route 1 onto the access road to Gander Lake. Walk eastward along the shore of the lake for approximately 500 m over outcrops of the GRUB. The unconformity is exposed on a small hill immediately north of the lake shore.

DESCRIPTION

The ultramafic rocks of the GRUB are well exposed along the shore of Gander Lake, where they show evidence of shearing and serpentinization. Shear zones, which anastomose through the unit and divide it into 'lozenges', are characterized by strongly foliated and lineated serpentinite, whereas the interiors of the lozenges consist of massive serpentinite ± magnetite. As in many sheared ultramafic units, a consistent sense of displacement among lozenges is not readily established, and it appears that they moved in a chaotic fashion relative to one another during thrusting.

At the conglomerate locality, serpentinized ultramafic rock of the GRUB is separated from conglomerate of the Davidsville Group by a narrow (decimetre wide) shear zone. This is interpreted as a faulted unconformity (nonconformity). The conglomerate is overthrust along its western margin by GRUB gabbro and serpentinite. The GRUB and lower Davidsville lithologies appear to form part of an east-directed thrust stack.

DISCUSSION

The Gander River Ultrabasic Belt (Jenness, 1958) forms a linear zone west of, and structurally above the Gander Group. The ultrabasic belt consists of pyroxenite, variably metamorphosed to serpentinite- and magnesite ± talc-bearing assemblages, gabbro, mafic flows and volcaniclastic rocks and trondhjemite, and is interpreted to be part of an ophiolite suite. The conglomerate contains clasts that are representative of all rock types in the ultrabasic belt, and the clastic detritus was clearly derived almost entirely from it at this locality. The conglomerate is therefore inferred to have formed some time after the ophiolite was obducted and uplifted above sea level.

Although ophiolitic rocks along the GRUB itself have not been dated, those farther southwest at Pipestone Pond, assumed to be correlative with the GRUB, have been dated at 494 +3/-2 Ma (U-Pb zircon, Dunning and Krogh 1985), *i.e.* Lower Ordovician (Tremadoc). The age of the conglomerate at this locality is not known, but correlation with fossiliferous outcrops along strike to the north suggests a Middle Ordovician age.

In the Coy Pond area, southwest of Gander Lake, ophiolitic rocks correlated with the GRUB are cut by undeformed microcline-porphyritic biotite granite (Partridgeberry Hiills granite), which has been dated at 474 +6/-3 Ma (U/Pb zircon, Colman-Sadd *et al.*, 1992). It is therefore assumed that thrusting of the GRUB onto the Gander Zone occurred between 494 and 474 Ma, *i.e.,* Lower Ordovician (Tremadoc—Arenig).

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Stop 2.7: **(Optional) Gander Group Metasedimentary Rocks,** *Frank Blackwood and Pat O'Neill*

Leader: Toby Rivers

[*Excerpted from O'Brien et al., 1988)*]

LOCATION

Turn north onto Route 330, just on the east side of the town of Gander. The stop is located in a quarry, on the east side of the road, approximately 0.5 km north of the entrance to the Jonathan's Pond Provincial Park, and approximately 1 km south of the intersection of Route 330 and a dirt road leading eastward to a transmission tower.

DESCRIPTION

The thin bedded, fine to medium grained, grey-green psammitic rocks in this quarry are intercalated with thin pelitic layers. The rocks are folded by recumbent, asymmetric, tight to isoclinal folds, which are the earliest recognized and are designated as F1. The associated axial planar cleavage is locally strongly refracted in more quartzose sandstones. Crenulation folds assigned to a D2 event are locally developed in the quarry.

DISCUSSION

This exposure lies within the Gander Lake Subzone, the northeastern part of the Gander Zone, which is separated from the greater part of the Dunnage Zone to the west by the Gander River Complex. The purpose of this stop is to examine psammite of the Gander Group and contrast it lithologically and structurally with sedimentary rocks in the basal part of the Davidsville Group. The psammite is lithologically unlike basal members of the Davidsville Group. Gander River Complex detritus has not been reported from the psammite, and its apparent absence indicates that the psammite is either older than the ultrabasic belt, or was deposited in an area geographically too distant from the belt to receive detritus from it.

The systematic variation of planar structures from near-horizontal in the vicinity of Gander to steep farther east led Hammer (1981) to define a structural Flat Belt and a Steep Belt within the Gander Zone. This exposure forms part of the structural Flat Belt, and is characterized by greenschist facies rocks, in which a horizontal tectonic fabric is generally parallel to bedding. The flat-lying fabric is in obvious contrast, in this area, with the generally steep fabric in the Davidsville Group and Gander River Complex. Hammer (1981) concluded that the Flat Belt represented a subhorizontal ductile shear, or a southeastward-directed strike-slip thrust. Farther northeast, however, immediately east of the ultramafic rocks, the Flat Belt does not exist, and the steep, north to northeast trending fabric in the Gander Group is slightly oblique to the northeast-trending fabric in the Davidsville Group and Gander River Complex.

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TRIP ITINERARY: DAY 3

Stop 3-1: **Hydrobrecciation and Gold Mineralization – Mustang Property**, *Rod Churchill, Altius Minerals*

Leader: Brian Dalton

LOCATION

The Mustang property is located immediately south of the town of Glenwood, and 25 kilometres west of the town of Gander in central Newfoundland. Turn south from the TCH at Glenwood and drive for approximately 6 km through the community and then on to the well-maintained forest access road. Approximately three kilometers along the gravel road, a northwest trending cart trail intersects the main gravel road. Vehicles should park along the roadside at this point where participants will depart on a five-minute walk from the intersection along an old skidder trail. Participants should note that this area is quite marshy and proper footwear is advised.

DESCRIPTION

The Mustang property covers a linear belt of epithermal mineralization that had previously been traced for a five-kilometre strike length by Noranda. The mineralized zones are hosted by a sequence of dark gray argillites, siltstones and shales, with lesser interbedded sandstone and greywacke. The mineralization occurs in, and adjacent to, a major northeast trending fault zone, the Piper Fault, which is interpreted as the major fluid conduit for the hydrothermal solutions. Mineralization persists along subsidiary fractures up to 100 metres into the structural hanging wall of the fault, but does not penetrate into the structural footwall. Best gold grades, up to 28 g/t gold over 0.8 metres, are recorded in the hanging wall zones (Mustang Zone). A second mineralized zone is located 300 metres northwest of the Piper Fault. This zone may occur along another parallel fault structure. Typical textures in the mineralized zones include vuggy quartz veins and silicification, chalcedonic silicification, and very vuggy hydrobreccias that commonly contain good cockade textures. The mineralized zones contain finely disseminated arsenopyrite, pyrite, and locally stibnite, and have an anomalous mercury signature.

Exploration on the Mustang property in 1998 included examination and resampling of old Noranda trenched gold showings. An IP survey was conducted on five lines over the area of the showings. Ten diamond drill holes were drilled to evaluate the showings and geophysical anomalies.

The drilling and surface examinations determined that mineralization at the Piper and Mustang Zones consists of thin hydrobreccia units interspersed with quartz-veined and locally silicified host rock. The gold values are carried in the hydrobreccia units, which pinch rapidly along strike and downdip. Because of the lack of continuity of individual hydrobreccia units, the immediate environs of the Mustang and Piper Zones have a low potential to host economic gold concentrations. Best drill intersections in 1998 were in the range of 1 to 2 g/t gold over 1-metre intervals, with a best assay of 4.31 g/t gold over 0.3 metres.

Because of the very large extent of the epithermal system on the property, and of the consistency of gold values throughout the system, the property is still considered to have good potential to host an economic gold concentration. Future exploration on the property should focus on discovering zones of increased permeability along the main mineralized structures. These may be controlled by structural intersections, or by lithological changes. A key point of interest is that the mineralized structure on the property is a regional scale feature. Very high gold grades occur along it, or a parallel structure, at 7 to 10 kilometres to the northeast at the Knob and Appleton Linear properties.

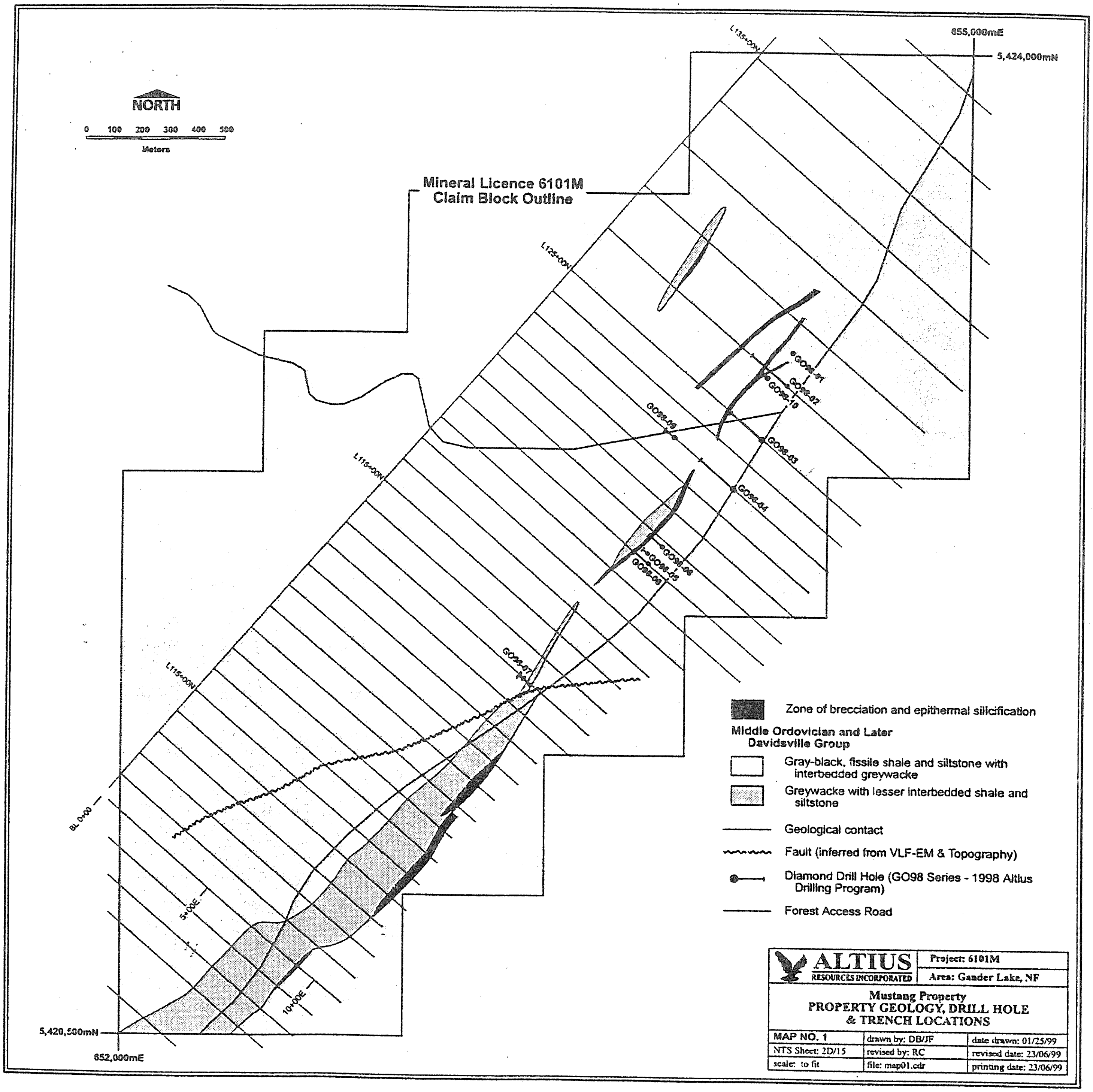

Figure 3-1. *Drill plan and grid geology of the Mustang property.*

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Stop 3-2: **The Linear Group, Appleton Area - United Carina Corp.**, *Peter Dimmell, 56 Carpasian Road, St. John's Newfoundland, A1B 2R2*

Leader: Peter Dimmell

[*Text and diagram excerpted from NAMS - Newfoundland Field Trip 1 Guidebook (1999)*]

INTRODUCTION

The first 8 claims on the Linear property (Figure 3-2) were staked by the KriASK syndicate (Alan and Kevin Keats and Krinor Resources Inc.) in October, 1998 to cover an area of float boulders carrying visible gold, which were discovered in the 1980's by Noranda prospectors on the west side of South Herman's Pond. Subsequent prospecting discoveries by Alan Keats and compilation of previous work, led to the staking of another 42 claims by the syndicate during the period from October 1998 to February 1999, giving the present group of 50 claims.

PRIOR WORK

Noranda Exploration Company Limited carried out limited exploration which included reconnaissance geochemistry and prospecting over the Appleton Linear in the mid to late 1980's. This work resulted in the discovery of quartz float boulders, carrying visible gold, on the west side of South Herman's Pond near the Trans-Canada Highway (TCH). Assay results from one boulder included 54.5 oz/t (yes oz/t). A recce, paced and flagged grid, with lines 400 m apart and soils taken at 50 m intervals, covered the Appleton Linear between the Trans Canada Highway and the Gander River, a distance of 4.7 km. Samples were analysed for gold only and values up to 590 ppb Au, with many in the 50 ppb plus range, were found. The anomalies showed good continuity, however only limited follow up prospecting was carried out. Also a quartz float boulder assaying 8.1 g/T Au was found on the west side of South Herman's Pond. No other follow up is documented.

The area of the Linear Group reverted to the Crown in March 1992 and was ground staked by two groups, Peter Tallman and Gander River Minerals. This staking lead to litigation over the mineral rights through the Mineral Rights Adjudication Board and subsequently the court system. The court ruled in the favour of Gander River Minerals and the company, after four and half years, finally received a licence for the claims in November 1996. The company did not work the claims and the property again reverted to the Crown in April 1998. During this period (Dec 93/Jan 94), prospecting by Calvin Keats for a Gander Group resulted in the discovery of gold values in grab samples of 8820, 830, 340 and 157,000 ppb, collected from outcrop on the east side of South Herman's Pond.

PRESENT WORK

Mineralization on the Linear Group is hosted in Ordovician, Davidsville Group, deep water sedimentary units consisting of locally graphitic, interbedded shales and greywackes. General structural trends (foliation) are parallel to the Appleton Linear, a deep seated structural feature, which trends approximately 020° to 030°. The dip of the zone is variable, but is generally near vertical. Some cross-faulting has been noted trending at 135°, with a near vertical dip and a sinistral sense of movement. Shearing is prevalent.

Prospecting discoveries by Alan Keats include a quartz breccia zone, the "Keats zone" in the southern portion of the property (it is from this zone that Calvin Keats collected the samples described above, the original sample sites have been relocated from the old flagging tape), the "dome" showing, near the north end of North Herman's Pond and the "Road vein" in the east central portion of the property. The "dome" and "Keats" zones are quartz vein "knobs" which occur as outcropping veins, which generally crosscut the structural trend at an oblique angle. Extensive visible gold (VG) and values of 16.9 g/t, with visible gold noted and 24.6 g/t with no visible gold apparent were located in grab samples from the "dome" showing. A value of 24.9 g/t was located from grab sampling of the "Road" vein with visible gold noted after the results were received. Anomalous values up to 1 g/t were located in grab sampling of the "Keats" zone,

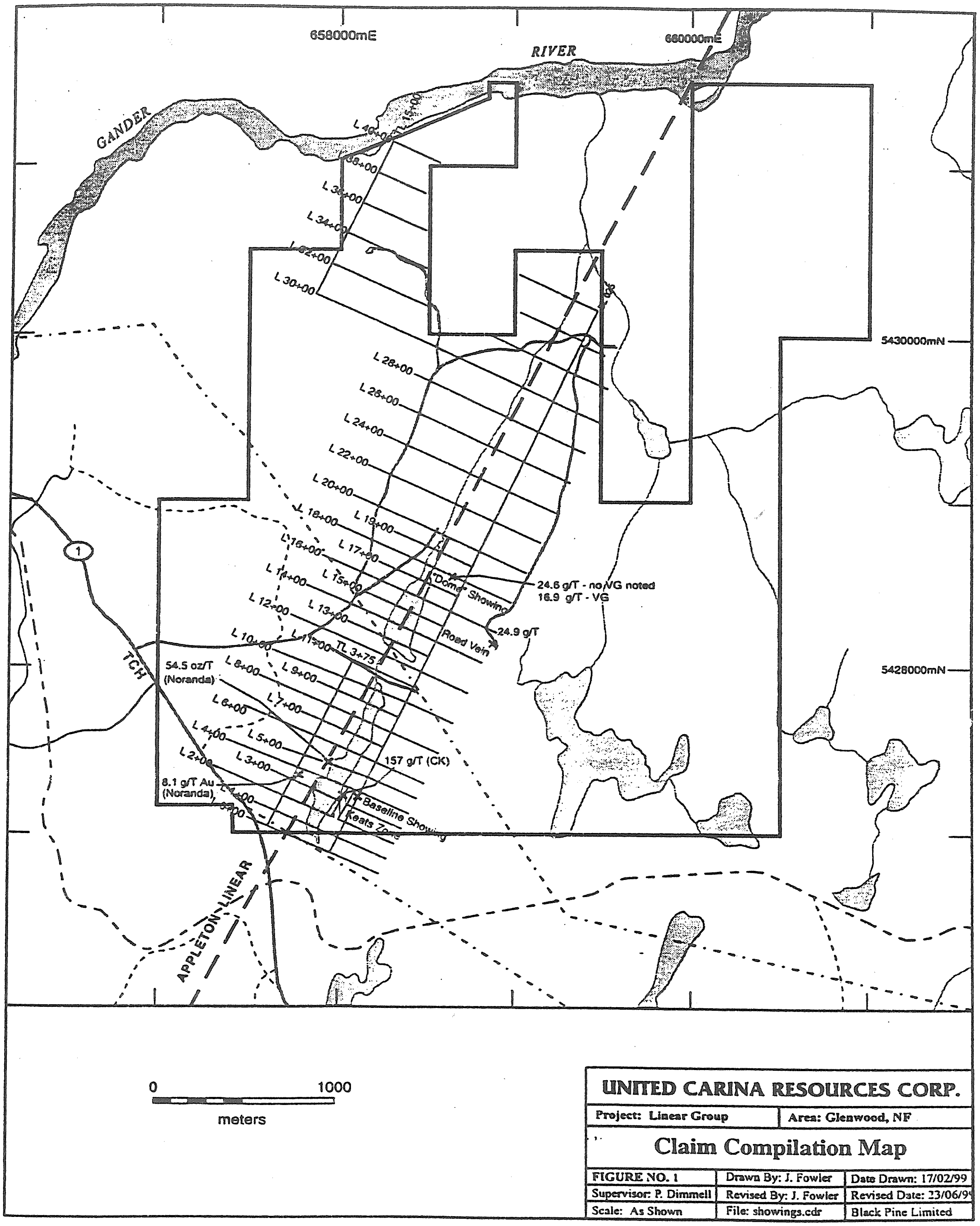

Figure 3-2. *Grid map, Appleton Linear Property, showing the location of the Dome, Road Vein, Baseline Showing and Keats Zone.*

however VG was noted at the southern end of the zone. VG has also been noted in the "baseline" showing.

The mineralization exhibits epithermal characteristics such as cockscomb and multiphase vein textures, brecciation with locally altered wall rock inclusions, and a geochemical association with arsenic and antimony.

Lake bottom sampling produced anomalous values in gold (4 to 11 ppb), arsenic (up to 369 ppm) and antimony (up to 5 ppm) in Herman's Ponds. Government lake bottom sampling had not previously covered these ponds although it had indicated anomalous values in gold, antimony and arsenic from other ponds in the area.

The property was optioned to United Carina Corporation in April 1999. Work commenced immediately on signing of the option and has included: line cutting, geophysics (VLF-EM, magnetics, IP), geochemistry (soils), prospecting, limited geological mapping and trenching.

Trenching (10 trenches), has evaluated the known showings - the "dome", "road", "baseline" and "Keats" zones. Results indicate a strong alteration system carrying gold in the host black shales and greywackes over a 1.5 km strike length, open to both the north and south. Alteration exposed in outcrop and by trenching includes extensive iron carbonate and quartz veining, with associated apple green sericite, kaolinite and chlorite. Sulphides associated with alteration and veining include pyrite, chalcopyrite and a grey metallic, copper bearing, mineral (boulangerite ?). Malachite and azurite are noted in some veins.

The "dome" showing consists of a sigmoidal shaped quartz "blowout" with associated narrow, brecciated quartz veins which carry abundant visible gold. The veins appear to be controlled by a dilation caused by shearing oblique to the Linear zone and/or a crosscutting kink or fold structure. A 7 m by 10 m area, tested by 4 orthogonal channel samples, gave an uncut grade of 42.9 g/T (1.25 oz/t) Au. Recent extension of the trenched area has exposed spectacular visible gold on fractures or healed vein margins on a vein lying subparallel to the large blowout.

The "Keats" zone, located 1 km to the south, exhibits a number of parallel zones, from 3 to 9 m wide, containing anomalous gold values, in the 1 g/t range. These zones are apparent over a width of up to 100 m with extensive associated quartz veining and iron carbonate alteration.

The interpretation of soil geochemistry results and geophysical data is ongoing. Work is continuing, with drilling planned to test the "dome", "Keats" and "baseline" showings which lie along strike approximately 1.5 km apart.

For an update on this property, check out United Carina's website:

www.unitedcarina.com