

# Progress Report on Data Compilation, Surficial Mapping, Seismic Surveys and Drilling for the Targeted Geoscience Initiative Project in South-central Cape Breton Island<sup>1</sup>

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## Introduction

Work continued throughout 2001 in south-central Cape Breton Island as part of the federal-provincial Targeted Geoscience Initiative (TGI). The area of study includes NTS map areas 11F/11 and 11F/14 (Fig. 1). Within this area are several large Quaternary depositional basins, which are underlain by Carboniferous bedrock and infilled with glacial sediments. The surficial component of this project will focus on the River Denys Basin, the River Inhabitants/Kingsville Basin, and the Moran and Hawthorne basins (Fig. 2).

Prior to the TGI project, the structural nature and origin of these basins was largely unknown. New 3-dimensional stratigraphic models created as part of this project will provide additional data to define the structural history of these basins, and may also provide information for new mineral exploration targets. Preliminary results from seismic surveys and drilling completed in 2000 and 2001, indicate that these basins are complex fault-bounded blocks rather than simple glaciated valleys.

Fine-grained, massive clay deposits occur in several locations in the study area. These clays were deposited in glacial lakes present in the area ca. 11-10 ka (Stea *et al.*, 2002). Work to evaluate the potential of these clays for earthenware applications is currently being conducted.

## Data Compilation

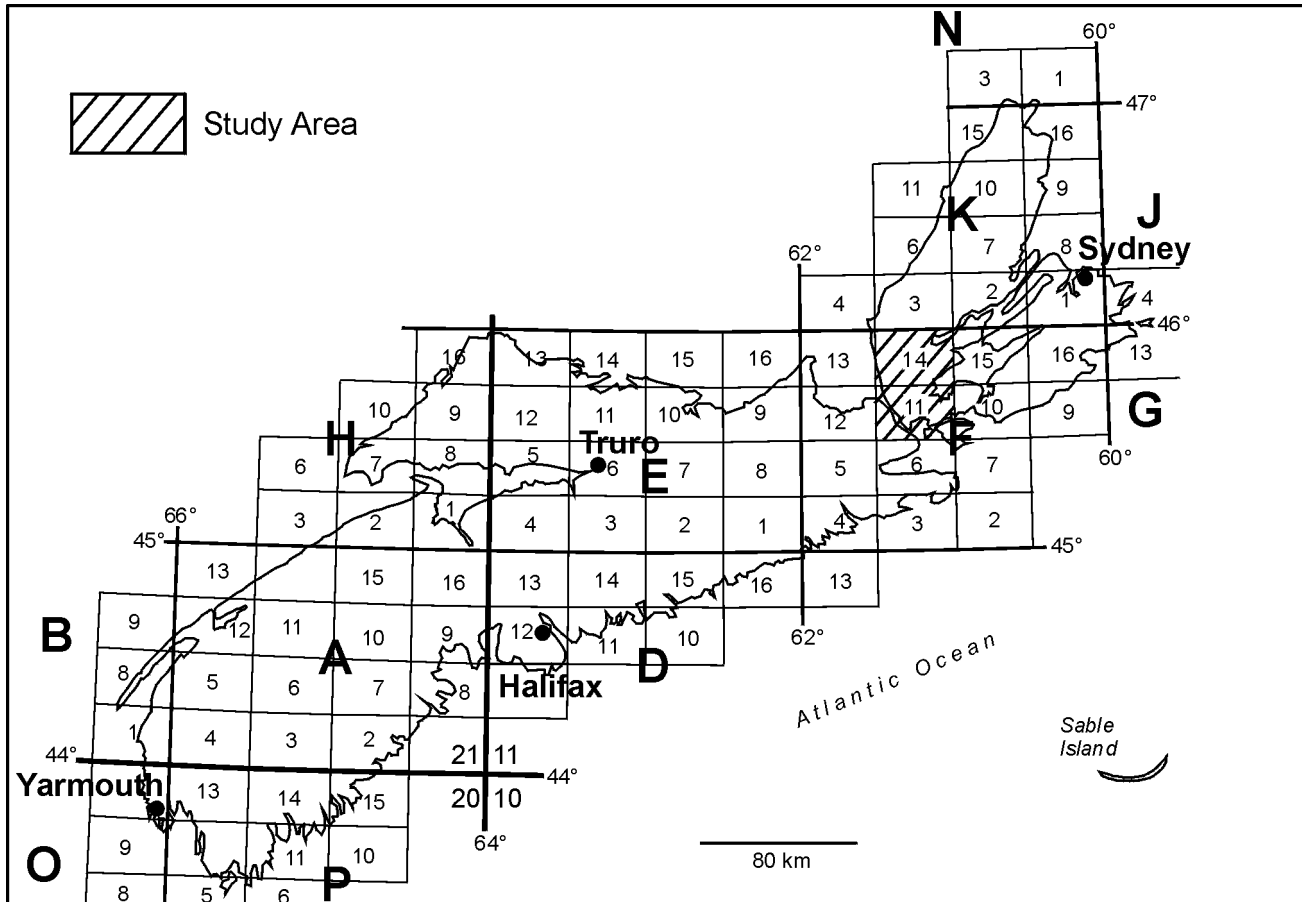
Throughout past decades, a multitude of mineral exploration data has been collected in south-central Cape Breton Island by private industry as well as government. Until now these data have not been compiled to create a comprehensive geological database. Both surficial and bedrock data are presently being compiled in a GIS format using ArcView® software. Key sources of data include the Department of Environment and Labour water well database, NSDNR drillhole database (containing industry and government drillhole data), geotechnical drill logs from the Department of Transportation and Public Works, drillhole databases from Georgia Pacific Canada Inc., and numerous bedrock geology maps. Current surficial mapping (R. R. Stea), seismic surveys (S. E. Pullan, Geological Survey of Canada), and drilling will supply new information on the basins.

## Field Work

Much of the 2001 summer field season was spent determining accurate locations for residential water wells using a hand-held Global Positioning System (GPS) unit. Approximately 364 water wells were located for NTS map areas 11F/11 and 11F/14 (Fig. 3). Depth to bedrock and type of surficial material are recorded in each well log in the Department of the Environment and Labour database. This information is an extremely useful

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**Figure 1.** Map of Nova Scotia showing location of the study area.

and inexpensive tool in obtaining data for large parts of the study area. The well logs and the location data have been incorporated in the TGI database, which can be viewed in ArcView®.

Work was also conducted to delineate and collect bulk samples of the previously unknown earthenware clay deposits (R. R. Stea *et al.*, this volume) in the western part of map areas 11F/11 and 11F/14. Field work also included assisting with seismic surveys conducted by the S. E. Pullan of the Geological Survey of Canada.

## Seismic Surveys

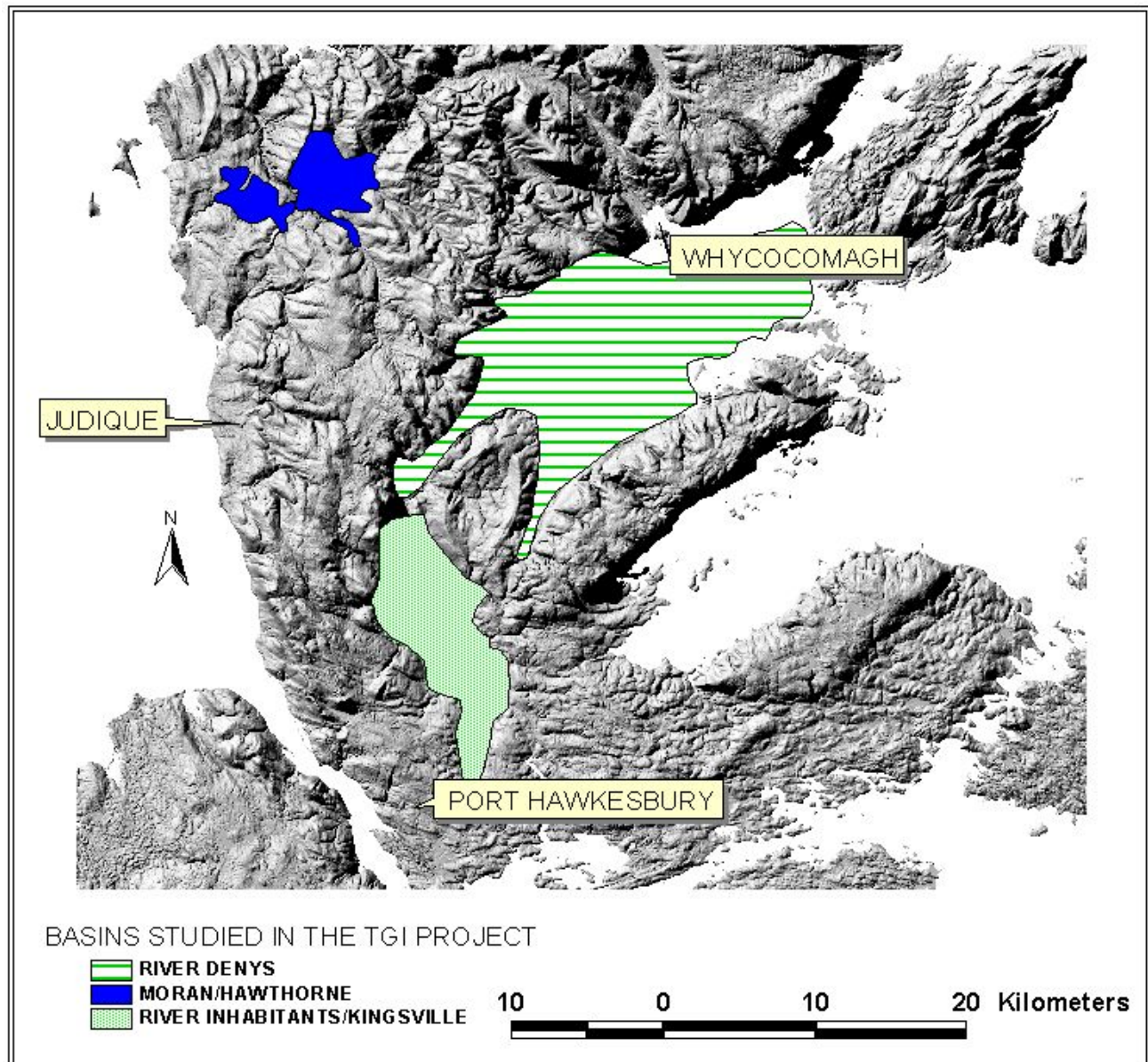
Shallow seismic reflection testing was conducted in the fall of 2000 and the summer of 2001 to assist in identifying areas of deep surficial cover and provide approximate depths to bedrock. Methods are described in Pullan *et al.*, (2001) and Stea *et al.*,

(this volume). Areas tested included locations where previous drillhole information indicated thick, unconsolidated sediments as well as sites where information was limited. A total of 139 test spreads were run over the entire study area, followed by a detailed seismic survey across the River Denys Basin in September 2001 (Fig. 4). These data are presently being incorporated into the GIS database.

## Drilling

### Introduction

Based on the compiled data, drill targets were established in three basins. These include the River Denys Basin, the River Inhabitants/Kingsville Basin and the Moran and Hawthorne basins (Fig. 2). Drilling was designed to gain specific information on the surficial and underlying bedrock



**Figure 2.** Location of the basins studied for the Targeted Geoscience Initiative project.

geology of these areas. Targets were established for several reasons: (1) to verify data from seismic surveys, (2) to confirm suspected faults within or at the edges of the basins, (3) to search for hidden Cretaceous sand and clay, and (4) to further delineate the earthenware clay deposits in the Moran/Hawthorne basins. Two additional drillholes were planned to test a magnetic anomaly in the Ashfield area. The first phase of drilling was

conducted in March 2001, followed by a longer program in November and December 2001. Results from drilling will be used to build cross-sections and 3-dimensional models for each of the basins.

### **Methods**

For the first phase of drilling (March 2001) a large track-mounted drill equipped with a wire line

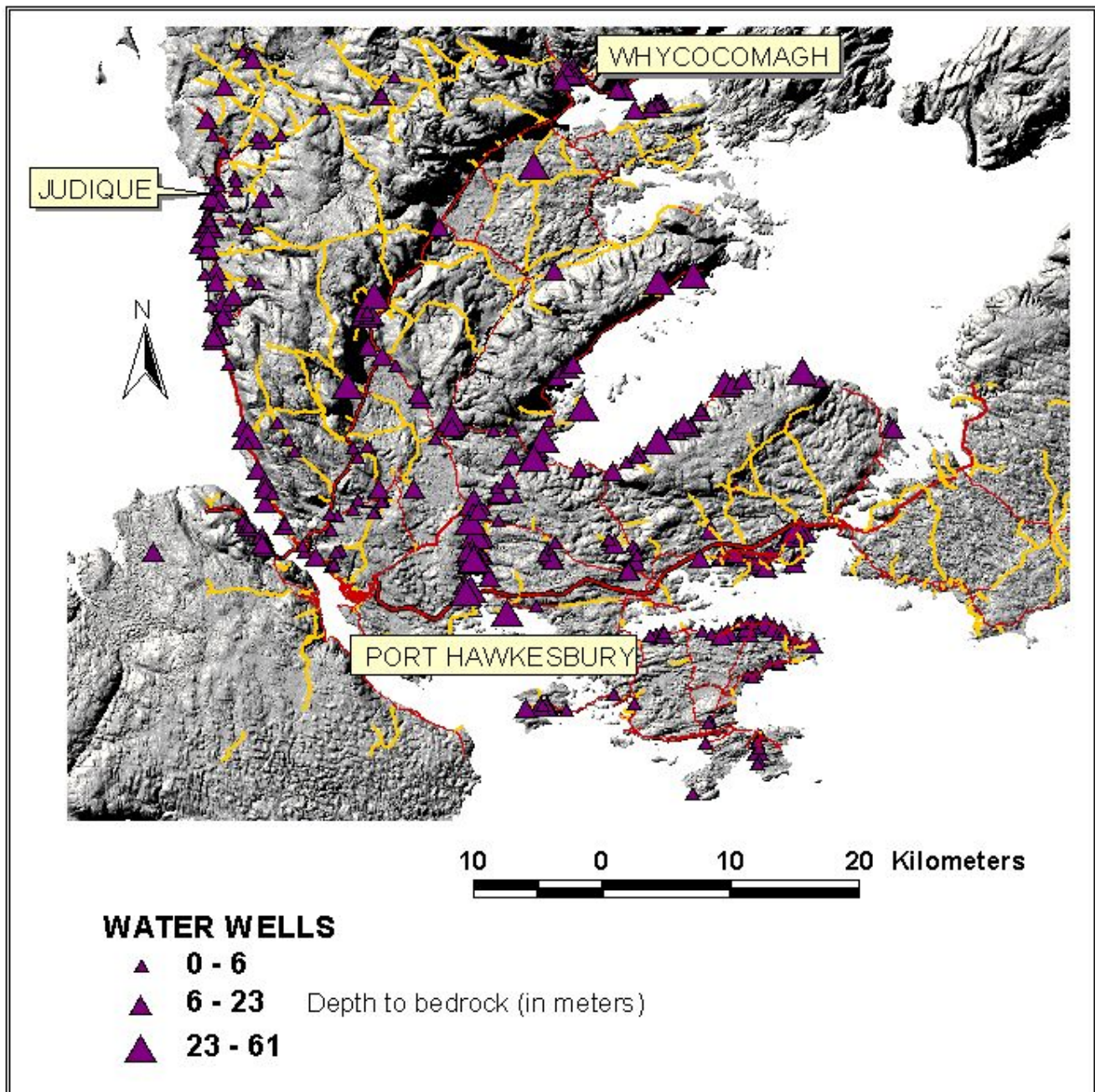
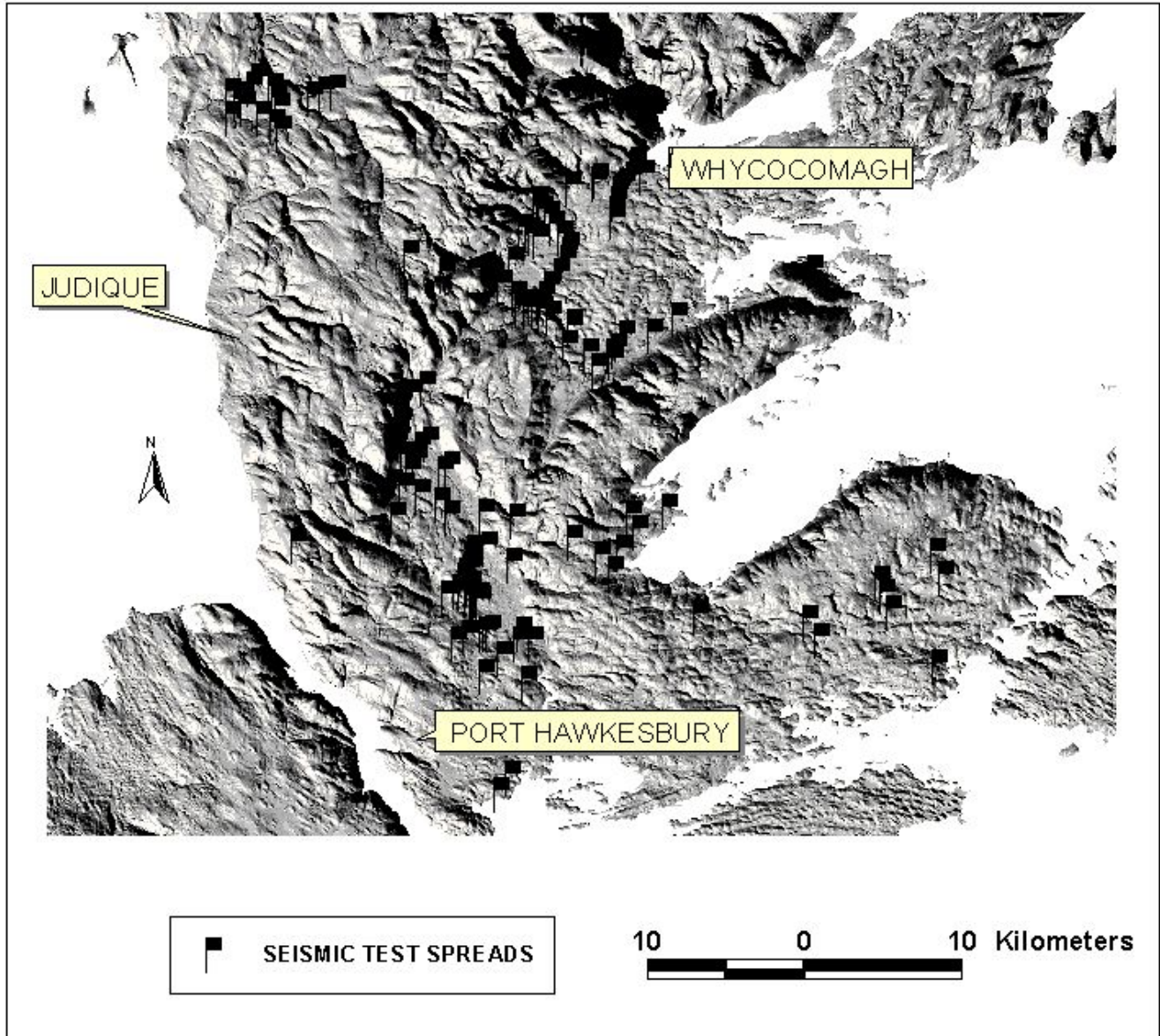


Figure 3. Locations of water wells presented in ArcView®.

coring system was used. It was designed to give high recovery in unconsolidated sand and clay, and was extremely mobile. Materials could be quickly triconed if core was not desired. Drilling in the fall of 2001 was conducted using a smaller, more versatile, track-mounted rotary drill. This multi-

purpose drill allowed for a variety of sampling techniques, including augering, split spooning and coring. Standard augers with a 4.5 inch diameter could be used to quickly drill down through surface clay, sand and gravel. Grab samples could be taken at 5 foot intervals along each auger. Alternatively,



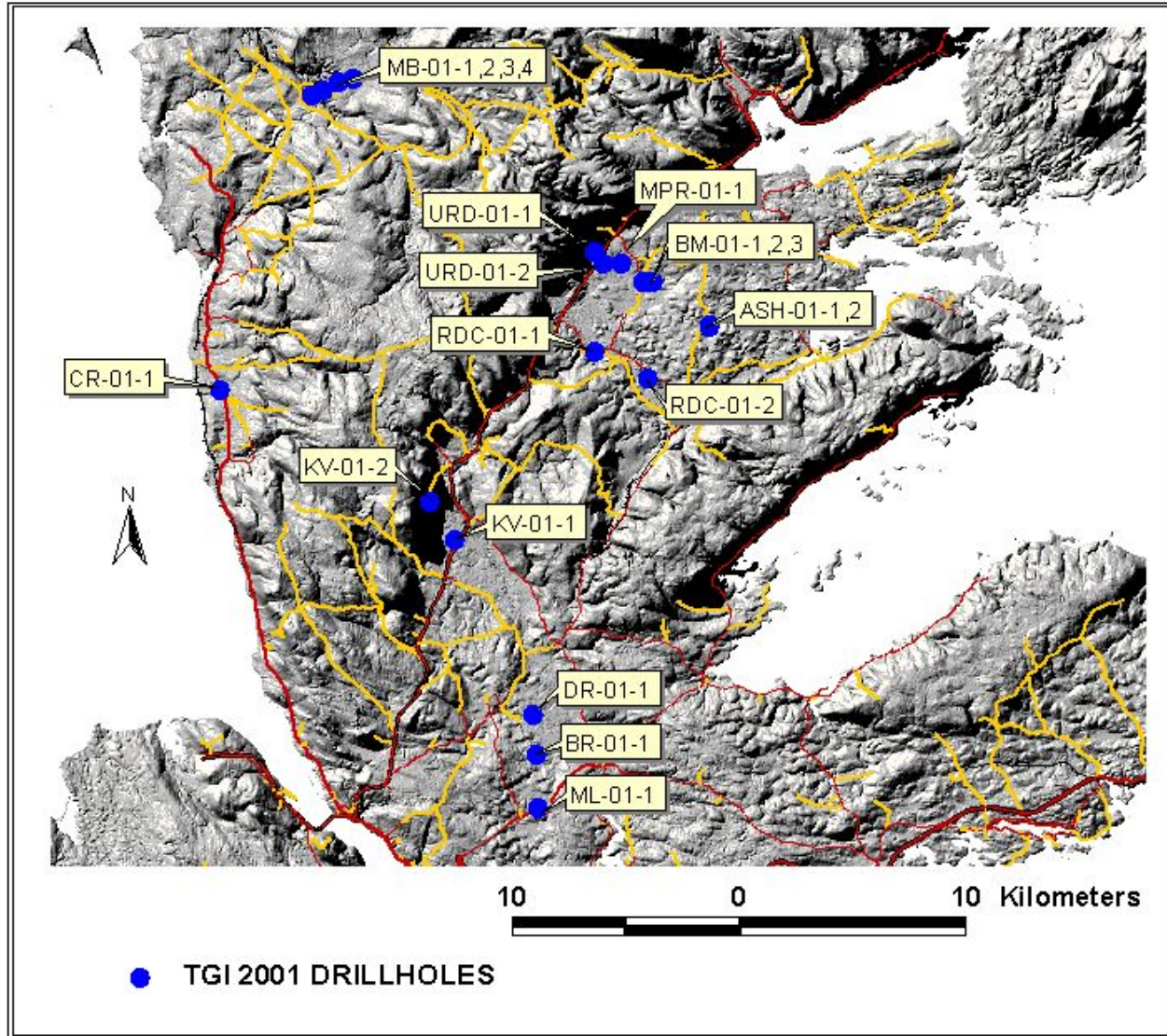
**Figure 4.** Map of study area showing locations of seismic test surveys.

a 1.5 inch diameter, 2 foot long split spoon sample could be obtained by driving a sampler ahead of the auger at the base of the hole. The drill was equipped with a 140 lb. hammer with a 30 inch drop. If ground conditions became unfavourable for auguring or split spooning, the drill could be switched over to diamond-drilling. Holes that were to be cored were cased with 3.9 inch HW steel pipe to keep holes from caving in. An HQ core barrel and rods were used to obtain a 2.5 inch core sample. All holes were drilled vertically, and the steel casing was removed when holes were

completed. Several of the deeper holes were lined with a 3-inch PVC pipe for later (summer of 2002) geophysical logging.

### ***Preliminary Results and Discussion***

Twenty drillholes totalling 828 m were completed in the study area (Fig. 5). Results are listed in Table 1. Nine holes were cased for down-hole logging. The drilling results and stratigraphy of the



**Figure 5.** Location of TGI drillholes, 2001.

basins will be discussed by grouping the holes into their geographic areas (basins).

### ***River Denys Basin***

The River Denys Basin extends from the Creignish Hills eastwards to the North Mountain in the central part of map area 11F/11. Holes were drilled in the northwest part of the basin where surficial cover is the deepest, as well as at the western margin to test for faults and possible hidden Cretaceous outliers. Ten holes were drilled in the basin. This includes two holes drilled to test a magnetic anomaly in the Ashfield area, which will not be discussed in this report.

Drilling results indicate that surficial sediments are dominated by thick sequences of red-brown glaciolacustrine clay, silty clay and sand, with thinner intervals of till and coarse gravel overlying them. Underlying this package are alternating blue-grey and red-brown silty-sandy clays (interpreted as part of the Windsor Group) up to 20 m in thickness, which are commonly strongly deformed. In turn, these overlie Carboniferous limestone and/or gypsum.

Maximum depth to bedrock exceeds 79.2 m in hole URD-01-2 (Fig. 5), which was abandoned in sand due to caving. To the east, hole BM-01-3 was drilled along seismic line 4 to test for faulting

Table 1. Data from TGI drillholes.

DRILLHOLE	NORTHING	EASTING	T_DEPTH	D_T_BED (m)	DATE DRILLED	CASED
CR-01-1	5077499	617728	15.2	>15.2	DEC 2001	NO
MB-01-1	5093438	624555	15.2	13.7	DEC 2001	NO
MB-01-2	5093204	623763	34.7	30.5	DEC 2001	NO
MB-01-3	5092791	623056	18.3	>18.3	DEC 2001	NO
MB-01-4	5092564	622424	7.6	7.0	DEC 2001	NO
URD-01-1	5084565	636830	83.8	80.8	NOV 2001	YES
URD-01-2	5083995	637277	79.2	>79.2	NOV 2001	YES
RDC-01-1	5079447	636858	31.0	>31.0	MAR 2001	YES
RDC-01-2	5078151	639559	51.0	12.8	MAR 2001	YES
MPR-01-1	5084020	638213	60.9	59.1	DEC 2001	YES
BM-01-1	5083071	639359	94.5	92.2	MAR 2001	YES
BM-01-2	5083026	639685	60.9	54.8	DEC 2001	YES
BM-01-3	5083056	639854	21.3	20.2	DEC 2001	NO
ASH-01-1	5080806	642721	17.0	7.9	NOV 2001	NO
ASH-01-2	5080759	642699	30.0	8.2	NOV 2001	NO
KV-01-1	5069857	629747	30.5	30.0	NOV 2001	NO
KV-01-2	5071854	628479	88.4	>88.4	NOV 2001	YES
DR-01-1	5061012	633713	17.1	13.7	NOV 2001	NO
BR-01-1	5058947	633895	56.0	51.4	MAR 2001	YES
ML-01-1	5056195	633996	15.4	13.8	NOV 2001	NO
TOTAL (M)			828.0			

inferred by the seismic surveys. Bedrock is shallow, and a brecciated, altered limestone was intersected which verified the results of the seismic work.

### **River Inhabitants/Kingsville Basin**

To the south, the River Inhabitants/Kingsville Basin is separated from the River Denys Basin by the Maple Brook Syncline. Five holes were drilled (Table 1) along the northwestern margin of the basin at the base of McIntyres Mountain, and to the south near Sugar Camp and McIntyres Lake.

Stratigraphy in the Kingsville area is similar to that of the River Denys Basin, characterized by a series of glaciolacustrine, red-brown massive clay, silty clay, and sand. The major difference is that in the Kingsville area the glaciolacustrine deposits occur near surface, overlying tills and gravel, thus indicating a younger age for the massive clay and sand compared to those in the River Denys Basin. This suggests changes in the location and timing of glacial ice, which must have been present to cause damming in order to deposit these thick sequences. As in the River Denys Basin, a blue-grey silty clay unit underlies these sediments; bedrock is grey siltstone containing gypsum veinlets.

Hole KV-01-2 (Fig. 5) intersected 12.2 m of red-brown earthenware clay similar to that found in western Cape Breton. Bulk sampling and testing will be required to evaluate the clay. Depth to bedrock is variable but generally deepest along the western margin of the basin adjacent to the Creignish Hills (>88.3 m).

To the south, (BR-01-1, ML-01-1, DR-01-1) the predominate lithologies are red-brown and grey-brown matrix-supported silty diamictos which are interbedded with minor clays and coarse gravels. This package of sediments is interpreted as till deposits. The glaciolacustrine massive clays, silty clays and sands common to the River Denys Basin and Kingsville areas are not evident here. Either they were not deposited or have subsequently been eroded. An interesting dark grey-black organic rich clay containing woody peat occurs at the base of BR-01-1 just above the gypsum bedrock contact. Depth to bedrock ranges

from 13.7-51.4 m in the holes drilled in these locations.

### **Moran and Hawthorne Basins**

Located in the northwestern part of map area 11F/14, these two small basins are infilled with earthenware quality clay, (Stea *et al.*, this volume) sand and gravel. Four holes (MB-01-1, 2, 3, 4) were drilled in an east-west line across the Moran Basin to delineate the clay deposit, as well as to test the seismic survey data. Thicknesses of the high quality clay range from 3.6-16.7 m, most commonly occurring near surface. Bedrock is gypsum in hole MB-01-2 and -4, and dark grey micritic limestone in hole MB-01-1. Hole MB-01-3 was augered to a depth of 20 m and did not intersect bedrock.

One additional hole (CR-01-1) was drilled south of Judique along Centennial Road. This hole was augered to a depth of 16 m. It intersected red-brown matrix-supported silty diamicton (interpreted as till) and did not reach bedrock. No massive clay or sand was evident in this hole.

## **Summary of Work Completed**

Most of the compilation work for the study area has been completed and data sets entered into the GIS database. Work in 2002-2003 will concentrate on interpreting the results from seismic surveys and new drilling. Preliminary results indicate a complex structural nature of the basins, as well as presenting hypotheses for timing and location of ice present in these localities during the last glaciation. Down-hole geophysical logging of the drillholes will be completed during 2002. Further sampling and testing of the earthenware clay deposits will also be done in the following year. All data will be made available for public access at the completion of the TGI project.

## **References**

Pullan, S. E., Hunter, J. A., Burns, R., Douma, M. and Stea, R. R. 2000: Testing of shallow seismic reflection technique, Cape Breton Island (NTS 11F/10, 11F/11 and 11F/14); *in* Minerals and

Energy Branch, Report of Activities 2000; Nova Scotia Department of Natural Resources, Report ME 2001-1, p. 73-79.

Stea, R. R., Finck, P. W., Pullan, S. E. and Ostrom, W. 2002: Deposits of earthenware clay in

southwest Cape Breton; *in* Minerals and Energy Branch, Report of Activities 2001; Nova Scotia Department of Natural Resources, Report ME 2002-1, p. ??