Mapping and 3-dimensional stratigraphic modelling of unconsolidated Mesozoic and Cenozoic deposits in Nova Scotia: plans for the new millennium

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The topography of Nova Scotia started to take shape during the last stages of the breakup of Pangaea in the late Mesozoic, when a thick cover of Cretaceous fluvial sediments was uplifted and faulted. This exhumation cycle continued through the Tertiary and resulted in hills of Paleozoic or older rocks, and valleys filled with pre-tectonic Cretaceous deposits and post-tectonic Quaternary sediments. During the Quaternary, ice sheets further eroded the highland areas and preferentially deposited till sheets and meltwater sediments in lowland areas. Glacial lakes formed repeatedly, before and after glacial advances. Nova Scotia is one of the few places in the world that has a distinctive sedimentation record of a globally-significant climatic event that occurred at the end of the last glaciation (Younger Dryas).

Little is known about the stratigraphy and architecture of the unconsolidated Mesozoic and Cenozoic sediments in these lowland areas, blanketed by glacial till. How extensive are the buried Cretaceous sediments and are Tertiary sediments preserved in hidden valleys? How many glaciations are recorded in the Quaternary sequence, and what are their ages? Geological mapping is essential to answer these important scientific questions. The Geoscience Needs Workshop (Voluntary Planning, 1996), a two-day meeting of geoscience stakeholders in Nova Scotia, identified surficial mapping as a high priority for the division.

Nova Scotia has a patchwork coverage of surficial maps at different scales and styles, produced for different purposes. Surface mapping is incomplete in some areas, and a comprehensive look at the Mesozoic and Cenozoic subsurface deposits has only been completed in a few areas of deep surficial cover. Mapping efforts will be modelled after a 3-dimensional pilot mapping project just completed in the Carboniferous Lowlands of central Nova Scotia (NTS sheet 11E/03, Fig. 1), which has provided tangible benefits to the economy of Nova Scotia as well as advancing geological knowledge. The discovery of large, hidden Mesozoic basins formerly thought to be isolated, small outliers resulted in a staking rush and a multi-million dollar kaolin exploration program. Several confined aquifers within the buried basins are presently being evaluated by a groundwater company as a water supply for the town of Shubenacadie. A glacial lake of Younger Dryas age was discovered in central Nova Scotia, which may be host to valuable brick clays and aggregate deposits.

It is the goal of the surficial mapping group to produce 1:50 000 scale maps in three high priority areas of Nova Scotia, based on the age of existing coverage and the thickness of drift cover. These areas include the (1) Central Lowlands and Annapolis Valley, (2) southwest Nova Scotia, and (3) Cape Breton Island.

At present we are working on NTS map area 11E/04 (Fig. 1), and intend to finish the adjacent map sheets within the next few years. Mapping consists of road, stream and coastline traverses, guided by air photograph interpretation and digital elevation imagery. Water-well logs and old diamond-drill hole records are checked for accuracy and location. Seismic reflection test spreads will be done at sites where subsurface information is minimal and seismic reflection profiles can provide the details of basin architecture across suspected deep drift basins and buried valleys.

Selected deep drift sites defined on the basis of this information need to be drilled, logged and sampled. Drillholes should be cased and analyzed using down-hole geophysics to supplement the stratigraphic information obtained through coring. Aquifer characteristics can also be obtained at certain drill sites.

Representative samples of the mapped surficial deposits are obtained and analyzed for a variety of physical and chemical properties, including: (1) grain size, (2) lithology (pebble counts), (3) till geochemistry (regional or detailed sampling), (4) geotechnical and hydrological properties (e.g. hydraulic conductivity, Atterberg limits), (5) aggregate properties (e.g. abrasion tests, petrographic number), and (6) economic testing (e.g. refractory clay firing properties).

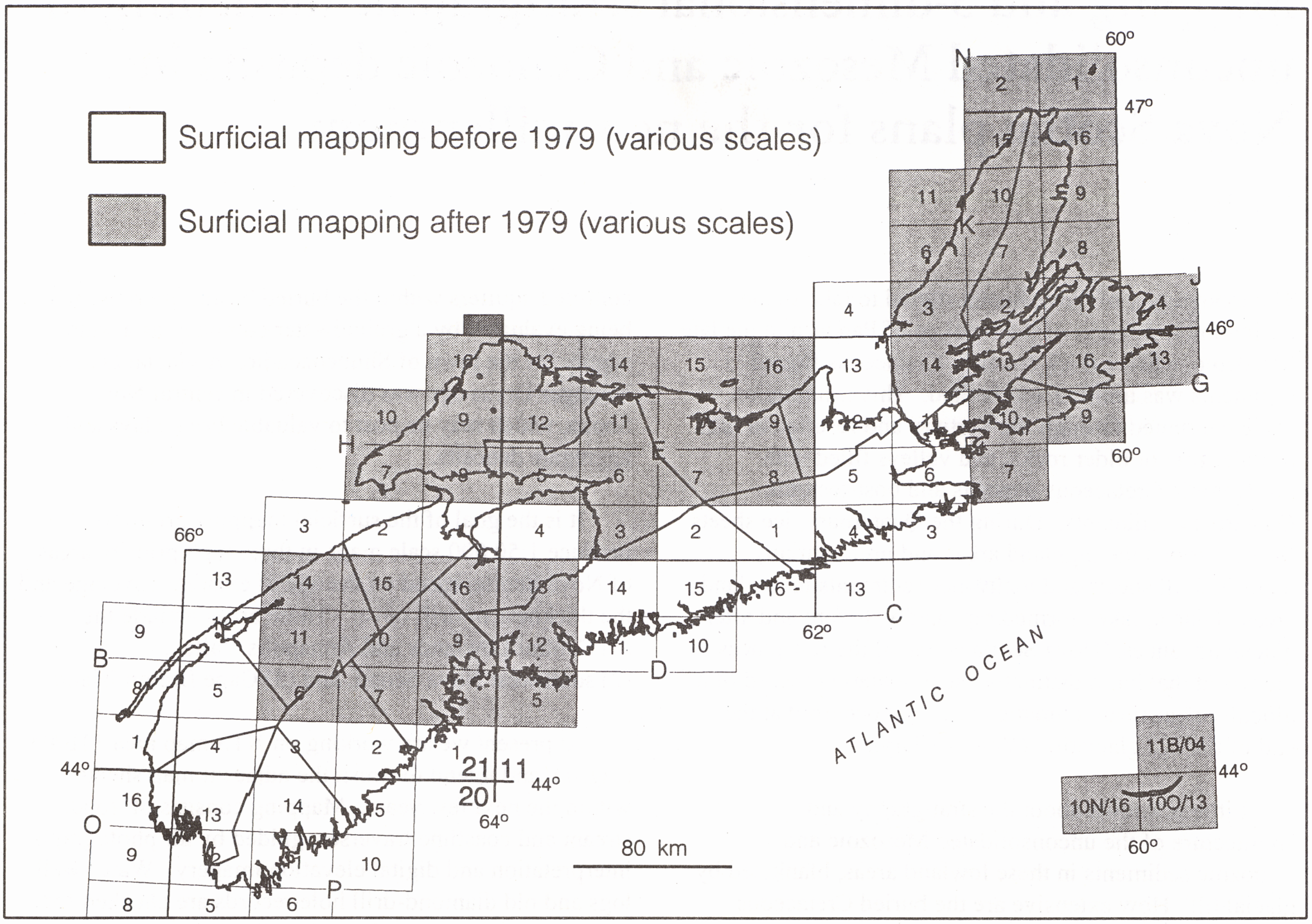

Figure 1. NTS index map of Nova Scotia showing coverage of surficial geological mapping.

The outputs will be AutoCad®-generated digital and hard-copy colour surficial maps, and an ArcInfo®-ArcView® compatible, fully interactive digital database of sediment properties, site descriptions, stratigraphic sections, photographs, core logs, and seismic test spreads and profiles. This will be designed after the digital 1:500 000 surficial map of Nova Scotia (Stea *et al.*, 1992). A digital and hard-copy report will accompany each map, describing the map units, sediment properties, stratigraphy, and inferred geological events.

The completed maps and database with common formats will provide baseline data for pipeline construction, aggregate resource evaluation, agriculture, and mineral exploration. The integrated geological and geophysical approach to stratigraphic mapping of surficial deposits can be used as a model for the exploration of buried valleys in other areas of Maritime Canada.

In 1999, and into the 21st century, the objectives of the surficial mapping group will be as follow.

(1) Production of a new series of colour surficial geological maps for Nova Scotia at a scale of 1 50 000. Surface mapping will involve the integration of digital elevation models and radarsat imagery with traditional aerial photography and field methods.

(2) Mapping and 3-dimensional stratigraphic modelling of unconsolidated Mesozoic and Cenozoic surficial materials, primarily found in lowland areas of deep drift. The methods employed will be; (a) seismic reflection profiling; (b) compilation of water well-logs, diamond-drill holes, geotechnical drilling and other stratigraphic databases; and (c) new diamond-drilling and auguring.

(3) Compilation of a fully interactive surficial geology database (GIS-ArcInfo®) including the mapping information, subsurface stratigraphy, section and sample site descriptions (colour photos, section schematics; radiocarbon dates and paleo-ecological data), grain-size, geotechnical properties, hydrogeological data and

geochemistry of surficial materials, individual map sheet reports, and a summary report on the surficial geology.

This is admittedly a wish-list and budgetary contraints will define how much of this work gets done. We are presently trying to fund this mapping program through the National Mapping Initiative (NATMAP) and are also looking for alternative sources of funding through private enterprise.

References

Stea, R. R, Conley, H. and Brown, Y. 1992: Surficial geology map of the Province of Nova Scotia; Nova Scotia Department of Mines and Energy, Map 92-3, scale 1:500 000.

Voluntary Planning 1996: Nova Scotia geoscience needs workshop: a summary of focus group discussions; workshop co-sponsored by the Nova Scotia Department of Natural Resources and the Geological Survey of Canada, May 13-14, 1996, 37 p.