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RESULTS OF SEISMIC MAPPING IN THE ST. GEORGES BAY AREA: IMPLICATIONS FOR STRATIGRAPHY, STRUCTURE, SALT TECTONISM AND PETROLEUM POTENTIAL [1]

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INTRODUCTION

Under the Canada-Nova Scotia Cooperation Agreement on Mineral Development (1992-1995), the Geological Survey of Canada and the Nova Scotia Department of Natural Resources undertook a seismic reflection study of the St. Georges Bay area (Fig. 1). Digital seismic data, reprocessed by the Nova Scotia Department of Natural Resources, and paper seismic data were interpreted on a computer workstation at GSC-Atlantic. The results show complex structural and stratigraphic relationships in the subsurface, which have significant implications for the petroleum potential in the area.

Four seismic horizons were mapped: 'A' - base Windor Group; 'B' - top Windsor Group; 'C' - ?Westphalian A coal; and 'D' - ?Westphalian C coal (Fig. 2). The two-way time maps (Figs. 5,6,7 and 8) show different distribution of faults and folds at various horizons within the basin. We suggest that these differences are the result of evaporite flowage during post-Windsor Group faulting and folding.

Several faults were recognized that offset basal Windsor Group and older rocks. The faults range from steeply to shallow dipping (Figs. 3 and 4). Stratigraphic relationships, (i.e. older rocks over younger rocks) determined from petroleum boreholes and outcrop data, suggest reverse offset of basal Windsor Group reflections. However, these movements were not transmitted through the Windsor Group evaporite layers to the younger rocks. The younger rocks appear to be deformed by high angle faults, evaporite intrusion and related folding
(Fig. 10). Thickness changes of strata adjacent to evaporite structures suggest sedimentation coeval with evaporite structure development.

The structure and stratigraphy of the area dictate the quality, amount and distribution of hydrocarbons. Numerous surface shows and studies of potential source rocks (Fig. 9) suggest that hydrocarbons may be present in St. Georges Bay. We present a schematic diagram (Fig. 11) suggesting possible traps

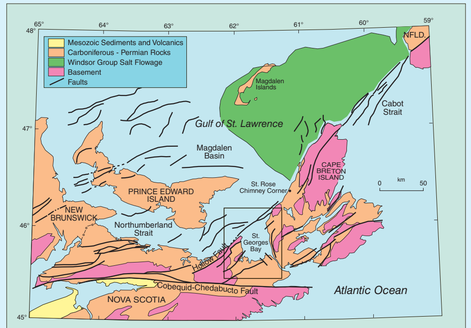

FIGURE 1: Simplified geological map of the southern Gulf of St. Lawrence and adjacent areas. The study is centered on St. Georges Bay in northeastern Nova Scotia.

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Further information about the poster may be obtained from, Geological Survey of Canada (Atlantic), Bedford Institute of Oceanography, PO Box 1006, Dartmouth, Nova Scotia B2Y 4A2 Phone: 902-426-2773 FAX: 902-426-4648. Please quote the title and reference number P0137202

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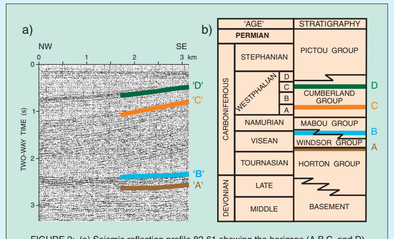

FIGURE 2: (a) Seismic reflection profile 82-61 showing the horizons (A,B,C, and D) mapped in this study. (b) Stratigraphic column showing the correlation between the mapped seismic horizons and stratigraphy.

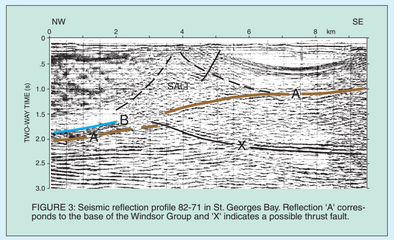

FIGURE 3: Seismic reflection profile 82-71 in St. Georges Bay. Reflection 'A' corresponds to the base of the Windsor Group and 'X' indicates a possible thrust fault.

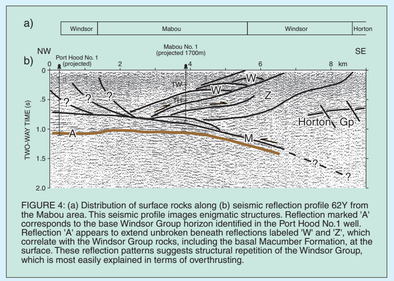

FIGURE 4: (a) Distribution of surface rocks along (b) seismic reflection profile 62Y from the Mabou area. This seismic profile images enigmatic structures. Reflection marked 'A' corresponds to the base Windsor Group horizon identified in the Port Hood No.1 well. Reflection 'A' appears to extend unbroken beneath reflections labeled 'W' and 'Z', which correlate with the Windsor Group rocks, including the basal Macumber Formation, at the surface. These reflection patterns suggests structural repetition of the Windsor Group, which is most easily explained in terms of overthrusting.

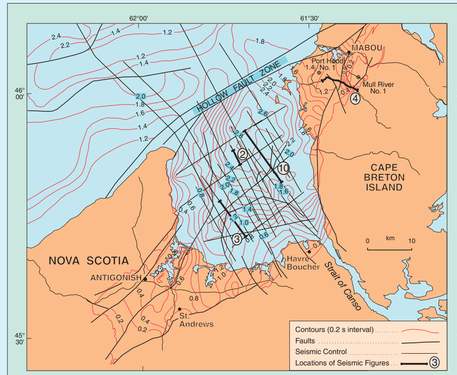

FIGURE 5: Time structure map on reflection 'A'.
- interpreted as near base Windsor Group
- forms base of evaporite structures
- deepest in north-central part of the bay
- elongate "tails" in NE and SW
- numerous basement involved faults

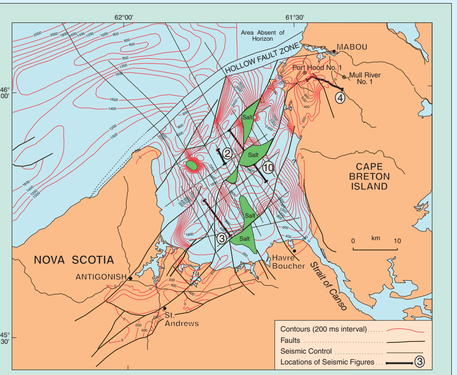

FIGURE 6: Time structure map on reflection 'B'.
- interpreted as top of Windsor Group
- reflection overlies evaporite structures
- contours cut by complex NE fault system
- difference in structural style between figures 5 and 6

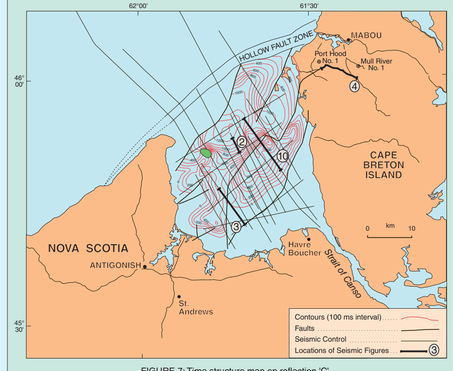

FIGURE 7: Time structure map on reflection 'C'.
- corresponds to strata about 300 m below 6' coal seam at Port Hood
- distribution restricted to NE part of basin
- folded into broad open synclines
- synclines separated by NE faults

FIGURE 8: Time structure map on reflection 'D'.
- corresponds to rocks that outcrop at the seafloor between Hood and Henry Islands.
- distribution restricted to NE part of basin
- folded into broad open synclines
- synclines separated by NE faults

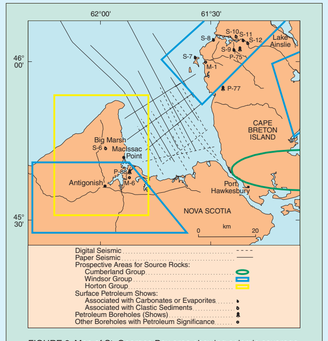

FIGURE 9: Map of St. Georges Bay area showing seismic coverage, petroleum shows and distribution of potential source rocks.

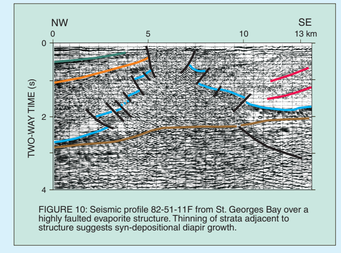

FIGURE 10: Seismic profile 82-51-11F from St. Georges Bay over a highly faulted evaporite structure. Thinning of strata adjacent to structure suggests syn-depositional diapir growth.

SUMMARY OF PETROLEUM SHOWS

M-6: NSDME Record No. 1836, Salt Hole No. 7; drilled 1952; "natural gas flow (17% ethane) between 1202 and 1204 feet" in salt and anhydrite.

P-88: Brador Amaruk Hole No.1; drilled 1976; "very light residue was also encountered in dolomite from 1070 to 1080 feet."

P-77: Inverness No.4; drilled 1958; "A faint trace of oil stained limestone was intersected from 400 to 410 feet."

M-1; unknown well name; drilled 1869; "At a depth of 562 feet, oil was struck and some was forced out with salt water under a strong pressure of gas."

P-75: Inverness No.2; drilled 1958; "A faint oil scum formed on the mud pit at a depth of 210 to 220 feet."

S-6: Big Marsh; "The Big Marsh Member of the Horton Group is the only member that may be considered reasonably to have potential value for petroleum formation. This zone, said to be at least 200 feet thick, contains black shales with pyrobituminous matter...."

S-7 to S-12; these all recorded surface petroleum shows either associated with carbonates, evaporites or clastic sediments.

SOURCE ROCK STUDY ONSHORE NOVA SCOTIA

- in spite of the amount of exploration activity and numerous occrrences of oil and gas, little data are focussed on the evaluation of source rocks
- work was undertaken by the Nova Scotia Department of Natural Resources (1987-1991) with the primary goal of coordinating and compiling existing organic geochemical data and gathering new data where necessary in order to arrive at a meaningful souce rock characterization

LOCALITIES AROUND ST. GEORGES BAY WITH POTENTIAL SOURCE ROCKS

- Horton Group rocks in the Big Marsh area
- Windsor Group Rocks at MacIssac Point and Lake Ainslie
- Cumberland Group rocks in the Port Hawkesbury area

SUMMARY OF HYDROCARBON POTENTIAL

St. Georges Bay has all necessary ingredients:
- organic-rich source rocks
  - Horton Group at Big Marsh (Fig. 9)
  - Windsor Group at MacIssac Point and Lake Ainslie (Fig. 9)
  - Cumberland Group at St. Rose-Chimney Corner (Fig. 1) and Port Hawkesbury (Fig. 9)
- migration pathways for hydrocarbons
  - northeast striking high angle faults
  - north to northwest striking high angle faults
  - low to high angle reverse faults
- structural and stratigraphic traps
  - evaporite-cored structures, anticlines, lenses, etc.
  - pinchouts, algal mounds, ?pinnicle reefs
  - flank conglomerate
- reservoir rocks
  - porous limestones or clastic rocks in the Windsor Group
  - coarse sandstones in Cumberland Group
- cap rocks
  - evaporites for Windsor Group reservoirs
  - shale or mudrock for Cumberland Group reservoirs

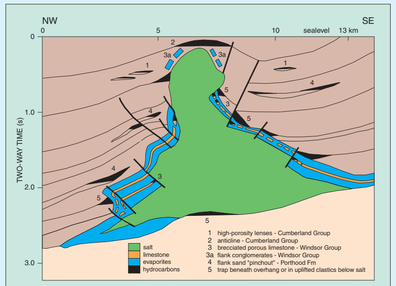

FIGURE 11: Schematic diagram depicting possible hydrocarbon traps in the St. Georges Bay area.