NATURAL HYDROCARBON SEEPAGE AT SCOTT INLET AND BUCHAN GULF, BAFFIN ISLAND SHELF: 1980 UPDATE

Project 760015

E.M. Levy[1] and B. MacLean
Atlantic Geoscience Centre, Dartmouth

Introduction

Chemical, geological and geophysical investigations carried out in 1977 and 1978 have provided strong evidence that slicks, which are frequently present off the northeast coast of Baffin Island in the vicinity of Scott Inlet and Buchan Gulf are the consequence of natural seepage of petroleum from the seabed (Fig. 1) (Levy, 1979; MacLean, 1978; MacLean and Falconer, 1979). The distributions of petroleum residue concentration anomalies found in the sea surface microlayer, in the water column and surficial bottom sediments, as well as the repeated occurrence of slicks indicated that one of the most active of the seeps is associated with a structural high near the seaward end of the submarine trough that extends across the Baffin Island continental shelf at Scott Inlet. In addition, the data also suggested that other seeps, which may be less persistent, are probably present elsewhere at Scott Trough and also off Buchan Gulf. As all the available chemical and geological data indicated that natural hydrocarbon seepage is occurring at both Scott Trough and Buchan Trough, detailed studies of these areas were carried out in September 1980 (**CSS Hudson**, Cruise 80-028). During this cruise oil droplets were observed erupting at the surface of the sea and forming iridescent patches which quickly spread into slicks. Their number and frequency of arrival was considerably greater than previously observed (Loncarevic and Falconer, 1977). This phenomenon, is the most direct visual indication of seepage yet obtained in this area. In addition, the distribution of slicks is discussed and a brief summary is given of the kinds of chemical, geological and geophysical investigations carried out. More complete results must await the chemical and geological analyses of the samples and interpretation of the geophysical records.

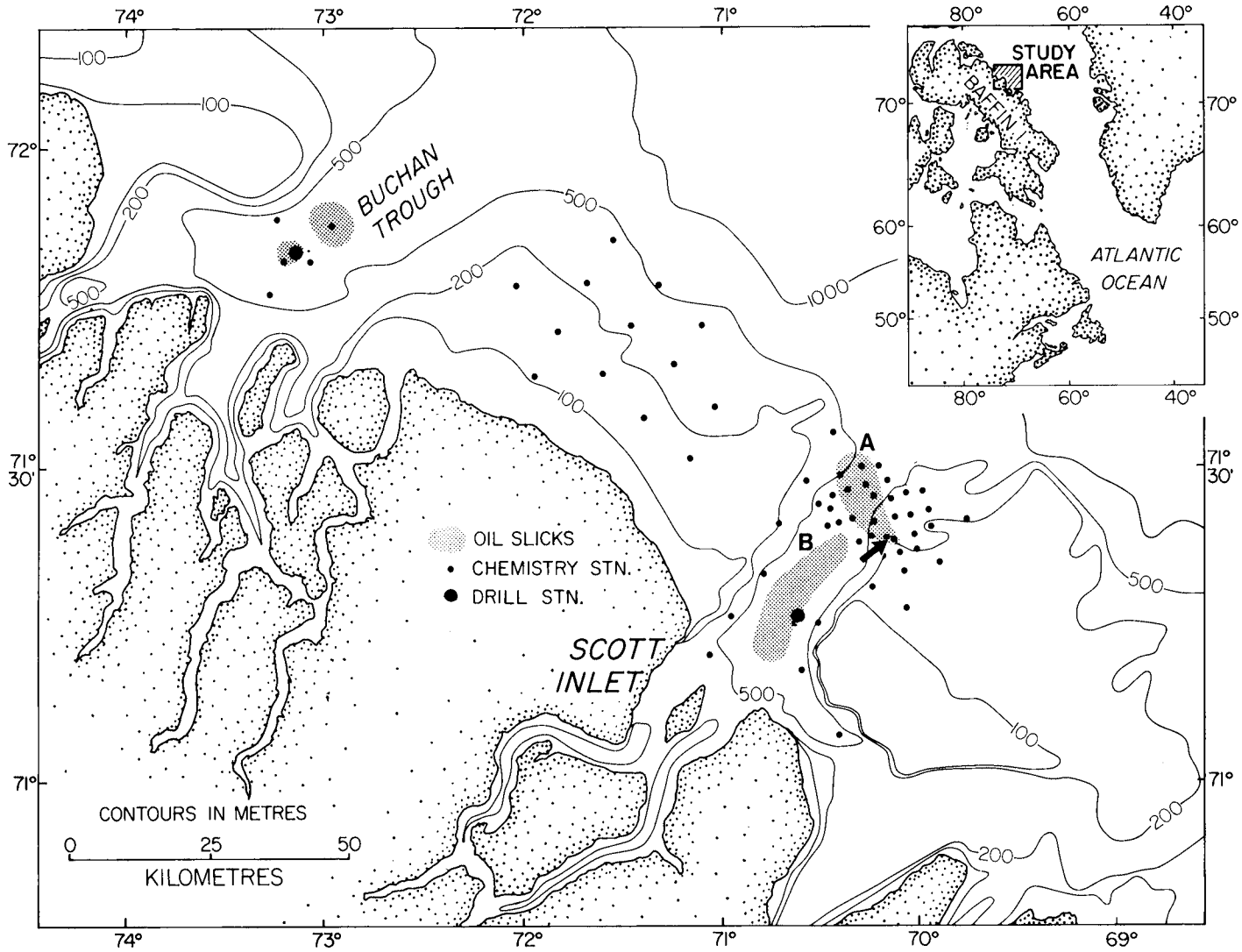

Figure 1. *Scott Inlet – Buchan Gulf area showing chemistry and drill sample locations and areas in which surface slicks were observed. The arrow indicates the outer Scott Trough locality where oil droplets and bubbles were erupting at the sea surface.*

[1]Atlantic Oceanographic Laboratory, Bedford Institute of Oceanography, Dartmouth, N.S.

From: Scientific and Technical Notes in Current Research, Part A; Geol. Surv. Can., Paper 81-1A.

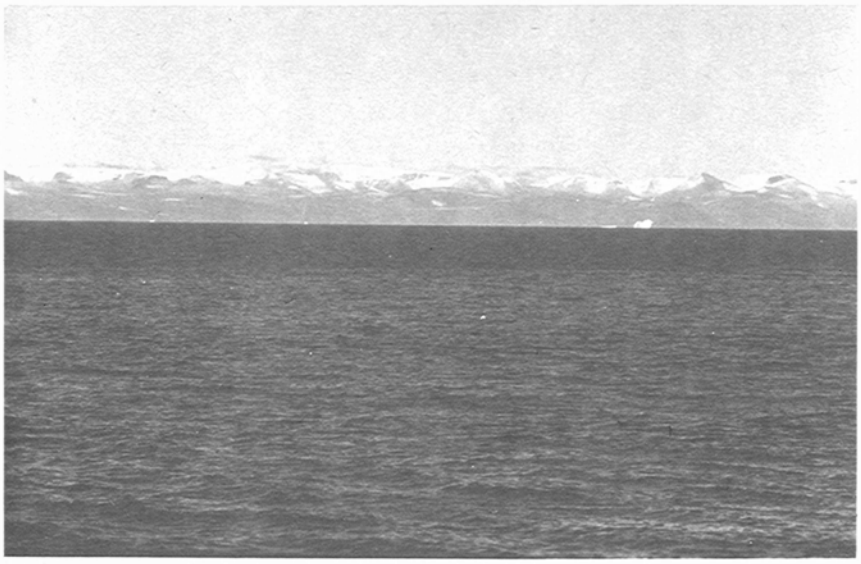

Figure 2

Oil slick at Area A (slick in foreground). GSC 203653

Field Program

During the 1980 cruise, samples of seawater were collected from the sea surface microlayer and at 10 depths throughout the water column at 5 stations at Buchan Trough, 32 at Scott Trough, and 13 over the shelf between the troughs (Fig. 1). Surficial bottom sediment samples were collected at these stations and at an additional 12 stations at Scott Trough. An attempt was also made to collect a sample of the slick-forming material and a piston core was taken at the site where seepage was occurring. Gas chromatographic analyses to determine the concentrations of volatile hydrocarbons (C_1 to C_6) in the water and sediment samples were carried out within a few hours of collection. Water samples were extracted with carbon tetrachloride and sediment samples were frozen for subsequent determination of petroleum residues by fluorescence spectrophotometry and other analyses. In addition, detailed analyses of the hydrocarbon mixtures will be carried out by gas chromatography/mass spectrometry.

Geological and geophysical investigations of the Scott-Buchan offshore area in 1977 and 1978 (MacLean, 1978; MacLean and Falconer, 1979) revealed the presence of Upper Cretaceous (Campanian) and upper Eocene to lower Oligocene strata as well as possibly older sedimentary rocks underlying the seafloor in this region. Upturned strata that flank a structural (basement) high beneath the outer south wall of Scott Trough are believed to be the source of persistent seepage observed in that area. Truncation of strata by erosion provides possible opportunities for escape of formation fluids or gases elsewhere.

Emphasis of the 1980 geological/geophysical program in the Scott-Buchan area was directed toward the collection of additional samples with the Bedford Institute of Oceanography rock core drill in an effort to define more fully the stratigraphic succession. Although the thickness of soft sediment cover over the bedrock in these areas severely limited the number of accessible sites, two bedrock cores were recovered from the floor of Buchan Trough. The cores appear to be lithologically similar to the Campanian strata sampled previously in the floor of Buchan Trough 10 km to the northeast (MacLean and Falconer, 1979; MacLean and Williams, 1980). A short drill core of limestone was recovered from the floor of Scott Trough. Although the age of this material has not yet been determined, it is thought to be part of the Cretaceous or Tertiary sequence.

Additional seismic reflection, magnetic, and gravity profiles were run in several areas to define geological boundaries in greater detail than afforded by previous surveys.

Distribution of Slicks

An attempt was made to determine the distribution of slicks by making visual observations of the sea surface whenever possible throughout the cruise. Although sea conditions were favourable for the formation and observation of slicks none was present during the passage from Thule via north central Baffin Bay to Buchan Gulf. At Buchan Gulf, under very light winds, conditions were ideal for the formation of slicks and excellent light conditions made their observation easy. Thin, scattered slicks were present at the stations at the inner portion of Buchan Trough (Fig. 1). This is the same general area where they were reported in 1978 (Levy, 1979). However, none was present shoreward of the sampling area. Since slicks may be formed by surface active molecules of recent biological origin as well as those derived from petroleum, it is often extremely difficult by visual methods to differentiate between the two. Therefore, the slicks at Buchan Gulf cannot be unequivocally attributed to natural seepage. Samples of water were collected from the surface microlayer and an attempt will be made to provide a definitive identification of the source of the slick-forming material through detailed chemical analyses by gas chromatography/mass spectrometry.

Conditions remained favourable for the formation and observation of surface slicks during most of the sampling program carried out at Scott Trough and the area between Scott Trough and Buchan Trough (Sept. 5-11). Slicks were not present over the shallow area between the two troughs or seaward of region A in Figure 1. Within region A, however, extensive slicks were observed at all stations and at several sites the entire sea surface has a "greasy" appearance (e.g. Fig. 2)*. As there had been several days of light south to southeasterly winds just before surveying this area, the

* It should be appreciated that slicks can only be clearly discerned where there is a distinct boundary between areas where capillary waves are damped by the presence of surface active materials and those where the surface is ruffled by capillary waves. Consequently, in the absence of interference colours and unless this contrast can be seen, it is difficult to decide whether the entire surface visible from the ship is covered with a continuous film or whether no film is present.

source of the slick must have been somewhere to the south or southeast. Slicks were also present on September 7 during a geophysical survey of the central portion of Scott Trough (area B, Fig. 1) where the sea surface again had a greasy appearance. At the rock core drilling station in area B, gas bubbles were observed rising to the sea surface but, because drilling was in progress on the seafloor at the time, it is not certain whether these bubbles were the result of natural gas releases from the seabed or were somehow related to the drilling operation. In either case, however, these bubbles were much larger and definitely not the type resulting from physical turbulence at the sea surface.

Near the southern edge of area A (Fig. 1) on September 11 slicks were sighted from a distance and on closer examination droplets of oil were observed erupting at the sea surface. Attempts were made to obtain some of this material but, because of the erratic random nature of the phenomenon, the thinness of the film and its rapid spreading, and the limited visibility from a dory used to collect the samples, it is doubtful whether sufficient material for detailed chemical analyses was collected. By the time the dory work was completed, the wind began to increase and the slick became much smaller but, at the same time, much better defined. Gas bubbles, some of them of golf ball size were observed erupting at the sea surface while we were collecting a piston core (234 cm) of bottom sediments. Oil was rising to the surface randomly in space and time but at a sufficient rate to maintain a slick over an area of perhaps 2 km by 2 km even with a wind speed of 20 knots. On breaking the surface, the oil droplets spread almost instantaneously into a circular slick about 25 cm in diameter. At first, the layers at the centres of these slicks were of sufficient thickness to display interference colours but immediately spread out to a film of monomolecular thickness within a few seconds. The slicks then drifted downwind and eventually were no longer visible under the wind conditions at the time. The random pattern of eruption suggests that the escape from the seabed occurs over an area, rather than from a single point source, and that the seepage is sporadic.

To have been at the site and to have watched hundreds of such droplets arrive at the sea surface provides more convincing evidence for natural seepage than any photographic or written description – or perhaps even the most sophisticated scientific measurements – can convey.

Acknowledgments

We gratefully thank Captain F.W. Mauger, Officers, Crew and Scientific Staff aboard **CSS Hudson** for their excellent co-operation and assistance in carrying out the field study and R.T. Haworth for review of the manuscript.

References

Levy, E.M.
1979: Further chemical evidence for natural seepage on the Baffin Island shelf; in Current Research, Part B, Geological Survey of Canada, Paper 79-1B, p. 379-383.

Loncarevic, B.D. and Falconer, R.K.H.
1977: An oil slick occurrence off Baffin Island; in Report of Activities, Part A, Geological Survey of Canada, Paper 77-1A, p. 523-524.

MacLean, B.
1978: Marine geological-geophysical investigations in 1977 of the Scott Inlet and Cape Dyer – Frobisher Bay areas of Baffin Island continental shelf; in Current Research, Part B, Geological Survey of Canada, Paper 79-1B, p. 13-20.

MacLean, B., and Falconer, R.K.H.
1979: Geological/geophysical studies in Baffin Bay and Scott Inlet – Buchan Gulf and Cape Dyer – Cumberland Sound areas of the Baffin Island shelf; in Current Research, Geological Survey of Canada, Paper 79-1B, p. 231-244.

MacLean, B. and Williams, G.L.
1980: Upper Cretaceous rocks in Baffin Bay; Geological Association of Canada, Program with Abstracts, v. 5, p. 69.