Geological Survey of Canada
Open File 8956

UNUSUAL FEATURES IN HALIFAX HARBOUR, NOVA SCOTIA, CANADA, PART 2

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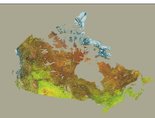
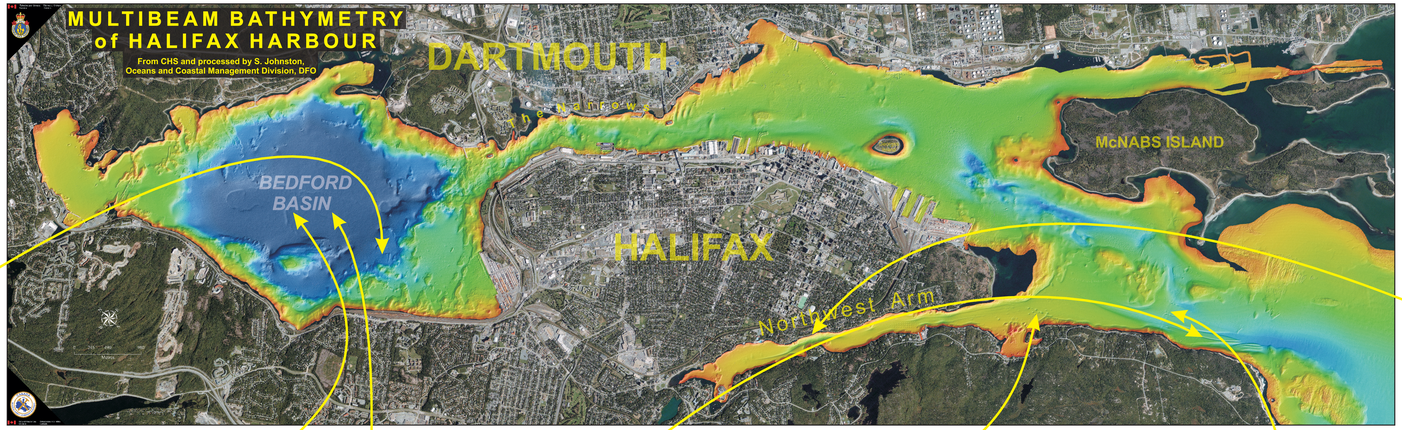


INTRODUCTION

The seabed of Halifax Harbour contains a number of features that can be classified into natural and anthropogenic features. Natural features are formed by nature and consist of bedforms such as sand waves, sedimentary furrows, boulder berms, moraines and pockmarks. Anthropogenic features are those formed by human activity and include anchor marks, cables, shipwrecks, dredge spoils, bridge and dock remains. The anthropogenic imprint on the harbour bottom is very dense, particularly in the inner harbour, and makes the collection of natural unaffected samples challenging.
This poster illustrates and describes anchor marks, gassy sediments, sedimentary furrows, pockmarks, the remnants of submarine net emplacements, vehicles dumped on the seabed, and an area of seafloor rich in glass bottles.



ANCHOR MARKS

Marks on the seabed formed by ship anchoring are widespread, especially in Bedford Basin and the inner harbour. They form local roughness on the sediments up to 2 m deep (Figure 1).

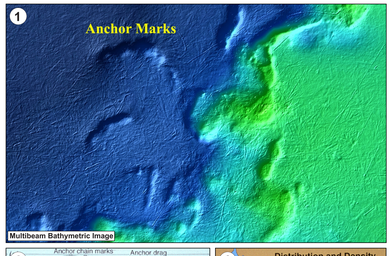
Sidescan sonar records provide the most detailed information on anchor mark character and distribution. Only some of the larger anchor marks show on the multibeam bathymetric imagery. One of the most important aspects of anchor marks is that anchoring disturbs and turns over the sediments. The term "anchor turbation" has been proposed for this process.

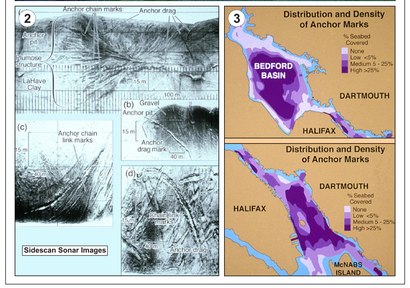
Anchor marks are classified into three major types: anchor pits, anchor-drag marks, and anchor-chain marks. Anchor-chain marks are further subdivided into anchor-chain-link marks (Figure 2).

Anchor marks occur in a variety of depths, sizes, and shapes. The largest ones are up to 2 m deep and 5 m wide. Anchor marks on gravelly, hard seabed tend to be shallow, most often less than 1 m deep, but are clearly defined because of the presence of boulders in their berms. Some have been traced for over 3 km along the seabed of the harbour. Many of the large harbour docks display radiating patterns of anchor marks indicating that anchors are used to help ships dock.

Most of the anchor marks occur in LaHave Clay (mud) sediments as both the anchoring and sediment deposition generally takes place in the deepest areas of the harbour (Figure 3). In the inner harbour, the densest distribution of anchor marks occurs in the broad region to the north, east, and southeast of Georges Island. This is the area of the harbour where formal anchorages are located. In Bedford Basin over 80% of the muddy seabed is criss-crossed with anchor marks. The densest distribution occurs in the central deep-water area with water depths generally greater than 50 m.

Some of the anchor marks are very old. Those in Bedford Basin are interpreted to have largely formed during World Wars I and II when large convoys of military and merchant ships assembled and anchored over broad areas of the basin, prior to sailing across the North Atlantic Ocean to Europe.



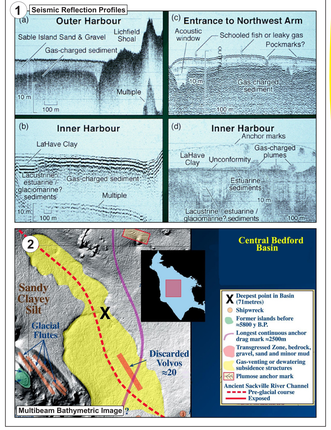


GASSY SEDIMENTS

Both the LaHave Clay (mud) and the older buried lake sediments of Halifax Harbour display large areas of gas-charging. This is clearly seen on the seismic reflection profiles where the sound energy does not penetrate areas of gas (Figure 1). The upper reflector, which represents the gas on the profiles, occurs at a variety of depths ranging from virtually at the seabed in areas of Bedford Basin and the inner harbour to 15 m below the seabed. This effect is referred to as "acoustic masking" or "acoustic blanking" and is attributed to the presence of gas within the sediments. The gas most frequently associated with this characteristic is biogenic methane, which is formed during bacteriological decay of organic matter at shallow depths within sediments.

It appears that the area of gas within the sediments has decreased since the first studies of 1974. One possible explanation for a decrease is that it could result from increased ship-related activities that impact the seabed. These include propeller-generated turbulence and widespread anchoring with larger anchors. Another possible explanation is that changes in bottom-water temperature and/or geochemistry within the sediments could result in increased gas venting.

Associated with the shallow gas at the seabed of Bedford Basin are large deep areas of seabed outlined by linear scarps. The linear scarps form large horseshoe-shaped depressions (Figure 2). The northernmost depressed area merges with the southern, large, depressed area and at their junction is the deepest depth of 71 m in the basin. These areas are interpreted to have formed by the release of methane-gas. Many of the large anchors from ships in the harbour penetrate the seabed to depths of between 1 and 3 m. This suggests that the gas-charged layer has been broken through in many areas, possibly releasing some of the gas.

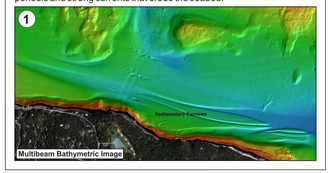


SEDIMENTARY FURROWS

A series of linear erosional scours in mud (LaHave Clay) occur in two areas in Halifax Harbour: at the boundary between the inner and outer harbour between Sandwich Point and Fergusons Cove, and in the Northwest Arm (Figure 1 and multibeam map above). The sidescan sonar records show that the furrow troughs consist of coarse sand and shells. They range up to 2 m deep and are almost 2 km long.

In the area off Sandwich Point the furrows fork, opening to the south, or seaward. They gradually shallow, narrow, and merge with the flat, muddy seabed in the north. The sedimentary furrows that occur in Northwest Arm are adjacent to Sir Sandford Fleming Park midway up the arm, and at the entrance to the arm. In this area the seaward starting point for the sedimentary furrows appears to coincide with shallow pockmarks (gas escape craters). The roughness of the pockmarks may have initiated the development of the furrows

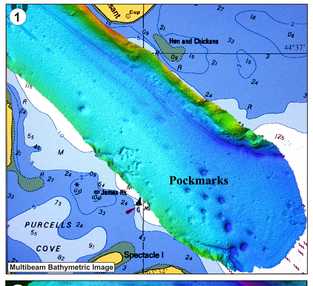
Researchers suggest that furrows develop in depositional environments swept by recurring, directionally stable, and episodically strong currents. It is postulated that unique circular flow within the bottom water is responsible for formation of sedimentary furrows. In addition, coarse sediment plays an important role as it is transported and erodes the seafloor. The distribution and geometry of the sedimentary furrows adjacent to Sandwich Point indicates that the currents that formed them moved from the south to north towards the inner harbour. Directly seaward of the furrows in Halifax Harbour, the sediment consists largely of sand, a ready source of coarse sediment supply. The sedimentary furrows are present on the surveys conducted over a 15-year period, suggesting some permanence. They indicate that this area of the harbour, although a general area for mud to be deposited, is likely subjected to periodic and strong currents that erode the seabed.



POCKMARKS

A large number of circular depressions occur in the LaHave Clay at the entrance to Northwest Arm (Figure 1). These are features termed pockmarks (gas-escape craters) similar to those first found in dense distributions in the basins of the adjacent Scotian Shelf. They display a variety of shapes from circular to ellipsoidal and reach up to 3 m in depth and 45 m in diameter. They also have flat bottoms in contrast to the more typical cone shape of pockmarks in the basins of the Scotian Shelf (Figure 2).

The majority of the pockmarks are slightly elongated parallel to the orientation of the Northwest Arm. This suggests that currents may play a role in elongating them.

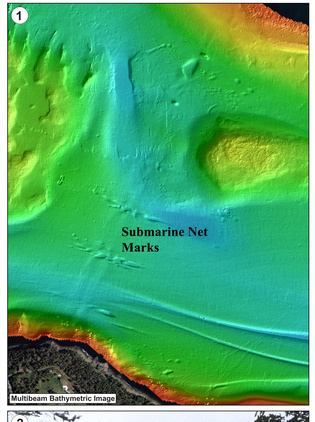


SUBMARINE NETS

World Wars I and II and associated military activities have had a large influence on the seabed of the harbour.

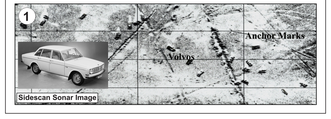
Two parallel linear depressions occur in the outer harbour extending between Sandwich Point and Maugher Beach (Figure 1). They are interpreted to have formed beneath antisubmarine nets that spanned the harbour in this location during World War II (Figure 2). Scouring of the seabed around the base of the nets is interpreted as the mechanism responsible for formation of these depressions.

A series of deeper scoured depressions at right angles to the antisubmarine net marks also occurs in the same area. Sidescan records show large square concrete blocks on the seabed with scoured depressions to a depth of several metres between the blocks. The scoured depression around the blocks forms an arrow-shaped feature that points toward the south. The erosion is concentrated only around the blocks and the shape of the depressions indicates that the currents that form them are from the south.



AUTOMOBILES

A group of approximately twenty-five 1969 Volvo automobiles were found on the seabed of Bedford Basin in 60 m of water (Figure 1). They were dumped to the seabed after severe water damage in transit across the Atlantic Ocean on a container ship. They provide excellent seabed targets for sidescan-sonar and multibeam-bathymetry equipment trials. Other automobiles have been found on the seabed of the harbour adjacent to the downtown docks and are suspected to have been purposely discarded to the seabed.



BOTTLE COLLECTOR HOLE

Mud is deposited in two areas of the Northwest Arm separated by an area of gravel and bedrock seabed adjacent to The Dingle (Sir Sandford Fleming Park) (Figure 1). Here the arm narrows and the currents increase in velocity, forming a large sedimentary furrow (Figure 2). This linear depression is not the result of previous sediment deposition followed by erosion, but merely a continued lack of deposition resulting from stronger currents that have persisted in this area of the arm.

The depression also acts as a trap for bottles thrown into Northwest Arm, hence the proposed term "bottle collector hole". Bottles thrown into the arm sink to the seabed in a neutral to slightly negative inverted position and move up and down the arm in response to currents and tides (Figure 3). Once in the depression off The Dingle, they become trapped. It is a popular dive location to retrieve old bottles.

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Some of the photographs and images are from the private collection of Gordon Fader.

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