Memo Report: Submerged Glacial Features Offshore Kennebunkport, Southern Maine

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Maine Coastal Mapping Initiative, March 2017

Disclaimer

This report is preliminary, but data and information published herein are accurate to the best of our knowledge. Data synthesis, summaries and related conclusions may be subject to change as additional data are collected and evaluated. While the Maine Coastal Program makes every effort to provide useful and accurate information, investigations are site-specific and applicability of results to other regions in the state is not yet warranted. The Maine Coastal program does not endorse conclusions based on subsequent use of the data by individuals not under their employment. The Maine Coastal Program disclaims any liability, incurred as a consequence, directly or indirectly, resulting from the use and application of any of the data and reports produced by staff. Any use of trade names is for descriptive purposes only and does not imply endorsement by The State of Maine.

For an overview of the Maine Coastal Mapping Initiative (MCMI) information products, including maps, data, imagery, and reports visit http://www.maine.gov/dacf/mcp/planning/mcmi/index.htm.

Introduction

During the 2014 survey season (April – November) the Maine Coastal Mapping Initiative (MCMI) conducted hydrographic surveys using a Kongsberg EM2040C multibeam echosounder (MBES) in the waters off the coast of southern Maine. The approximately 40 mi^2 (104 km^2) coverage area was centered approximately 9 miles (14.5 km) east-southeast of Kennebunkport, with depths ranging from 30 to 105 meters (below mean lower low water) (Figure 1). The main objective of these surveys was to support the Federal Bureau of Ocean and Energy Management's (BOEM) efforts to enhance coastal resiliency through identification and characterization of potential sand and gravel resources on the outer continental shelf that may be used for beach nourishment and state efforts to update coastal data sets and increase high resolution bathymetric coverage for Maine's coastal waters. Visualization and experienced interpretation and of seabed features within these high-resolution MBES data (bathymetry and backscatter intensity) and 1st-order derivatives (e.g. bathymetric hillshade) may also provide additional geomorphologic context within the region.

Regional Quaternary Geology and Surficial Sediment

This region has experienced multiple Quaternary glaciations resulting in eustatic sea level changes as well as local, relative sea-level changes caused by regional isostatic adjustments. The combination of terrestrial and marine processes has resulted in extensive reworking of surficial sediments. Terrestrial deposits of glacial till (e.g. ground moraine, recessional moraines, and drumlins) are generally well-preserved and have been extensively mapped (at 1:24,000) throughout the region (Katz and Keith, 1917; Smith, 1981; 1982; 1985). As a result of the most recent marine transgression, many glacial landforms have either been destroyed by reworking and/or completely submerged. Although surficial seafloor sediment along southern Maine's inner continental shelf has been mapped (Barnhardt et al., 1996) and the processes driving phases of erosion and deposition recorded are well understood (Kelley et al., 1987), submerged glacial landforms are generally not included in these maps largely due to the lack of high-resolution seafloor data.

Glacial Landforms in LiDAR Data

The relatively recent (within the last 10 years) addition of statewide, high-resolution LiDAR (light detection and ranging) data enabled the visualization of a multitude of terrestrial landforms (e.g. recessional moraines, landslides, drumlins, etc.) previously obscured by low-resolution elevation data sets or dense vegetation. Similarly, the high-resolution seafloor data collected by the MCMI add the same value for identifying submerged glacial features. Terrestrial examples of glacial features in LiDAR data can help us recognize them in bathymetric data. For example, Figure 2 illustrates recessional moraine sequences southeast of Sebago Lake in southwestern Maine.

Submerged Glacial Landforms in MBES Data

Although the majority of the seabed in the 2014 coverage area was exposed bedrock, several areas contained laterally extensive deposits of unconsolidated sediment. A recent review of these data identified seven zones containing features of suspected glacial origin (Figure 3). These features are briefly described below.

Zone A and B were located in the southern portion of the coverage area at depths between 45 and 50 m. These two zones contained broad areas of relatively flat unconsolidated sediment that were punctuated by low-relief (1 – 3 m) northeast-southwest trending sinuous ridges of

presumably coarse, gravelly and/or bouldery sediment. It is likely that the broad flat areas are glacial till (e.g. ground moraine) and the sinuous ridges are recessional moraine sequences (Figure 4a, b, and c).

Zones C, D, and E were also interpreted as recessional moraines (Figures 4a, b, and c). However, these moraines are present at depths of 60 – 70 m.

Areas F and G were located in the northern portion of the coverage area and contained glacial features at depths ranging from 35 to 60 m (Figure 5b). Similar to the recessional moraines identified in zones A through E, those in zone G were present at 40 – 45 m. Zone F contained a broad range of glacial features that were not observed in the other areas (Figure 5a, b, and c). For example, a northwest-southeast trending sinuous ridge with relatively high-relief extends for approximately 1000 m in the northwest portion of zone F. Data indicate this feature is made of coarse gravelly and/or bouldery sediment. Depths along the length of this feature range from 35 to 40 m. This feature has been interpreted as an esker. The attributes of recessional moraines in the central and southern portions of this zone are similar to those observed in zones A through G (e.g. depths range from 45 – 60 m). However, the crests of the moraines in the eastern-most portion of zone F appear to be truncated at depths below approximately 50 m, which is roughly coincident with the early Holocene lowstand sea-level (10,800 years before present) described for this region (Schnitker, 1974; Kelley et al., 1992; Barnhardt et al., 1995). If these features are in fact recessional moraines, then it is possible that their crests became truncated due to marine transgression and reworking of sediment. Another interpretation for these features could be that this area contains fluvially-incised/dissected glacial outwash and/or glacial till (e.g. ground moraine).

Summary

Interpretations of MBES data collected offshore of Kennebunkport in southern Maine suggest that many types of glacial landforms still remain preserved and submerged in nearshore waters. Although the geologic framework of Maine's nearshore surficial sediment has been well described in the published literature (cited in this report), many of these small scale features would remain unseen/undescribed without the addition of high-resolution MBES data collected by the MCMI.

Please contact the Maine Coastal Mapping Initiative with any future inquiries or data requests.

Sincerely,

Kerby Dobbs
Hydrographer – Maine Coastal Program

References Cited

Barnhardt, W.A., Belknap, D.F., Kelley, A.R., Kelley, J.T., and Dickson, S.M., 1996, Surficial geology of the Maine inner continental shelf: Ogunquit to the Kennebec River, Maine: Maine Geological Survey, Geologic Map 96-7, scale 1:100,000.

Katz, F. J., and Keith, A., 1917, The Newington Moraine, Maine, New Hampshire, and Massachusetts: U.S. Geological Survey Professional Paper 108-B, p. 11-29.

Kelley, J. T., Shipp, R. C., and Belknap, D. F., 1987, Geomorphology and sedimentary frame work of the inner continental shelf of south western Maine: Maine Geological Survey, Open- File Report 87-5, 86 p.

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Smith, G. W., 1985, Chronology of late Wisconsinan deglaciation of coastal Maine: Geological Society of America Special Paper 197: 29-44.

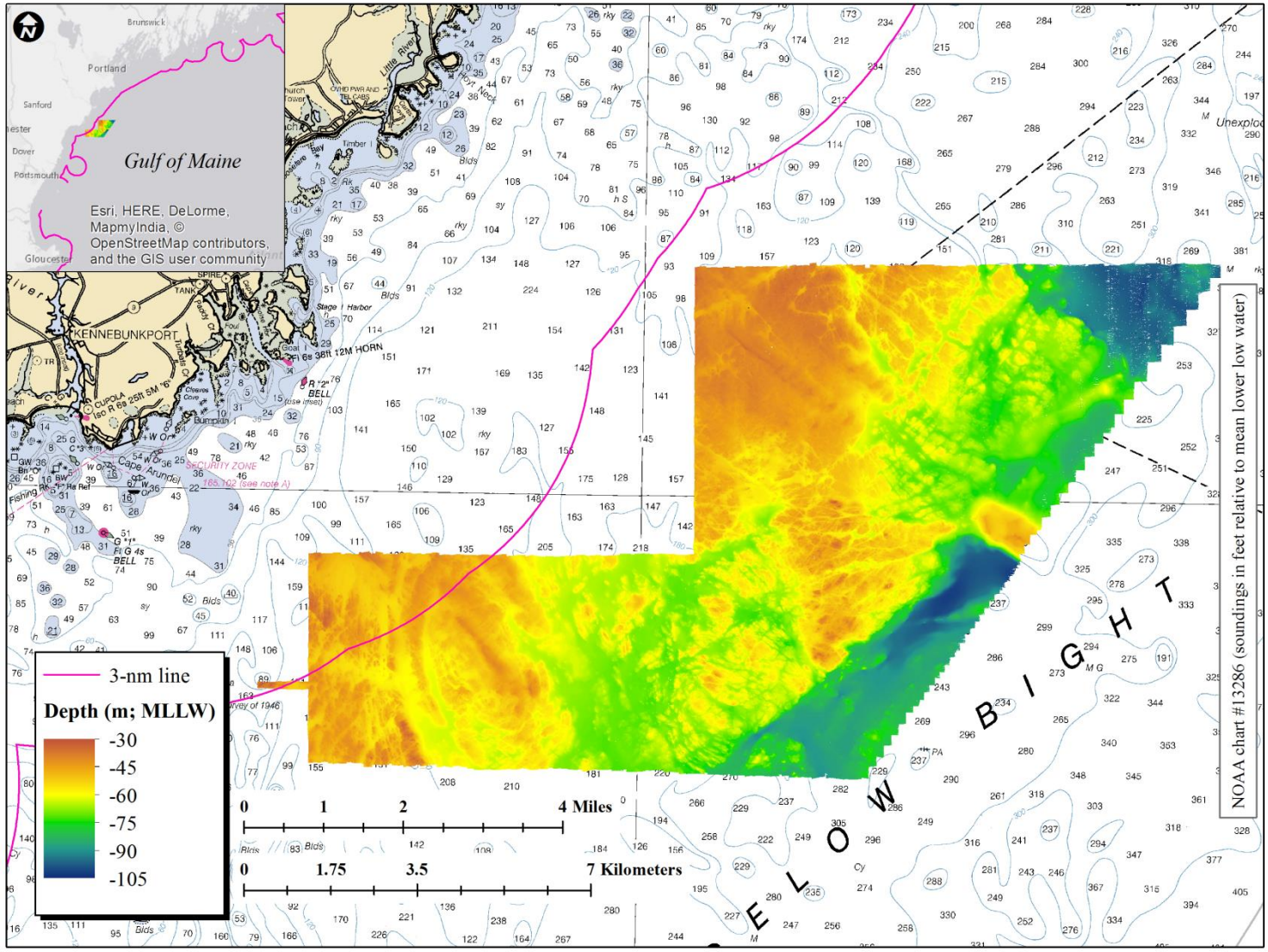

Figure 1. Overview of southern Maine MBES coverage area bathymetry (2-m grid; depths in meters relative to mean lower low water). MBES bathymetry is overlain on NOAA chart #13286 (soundings in feet relative to mean lower low water).

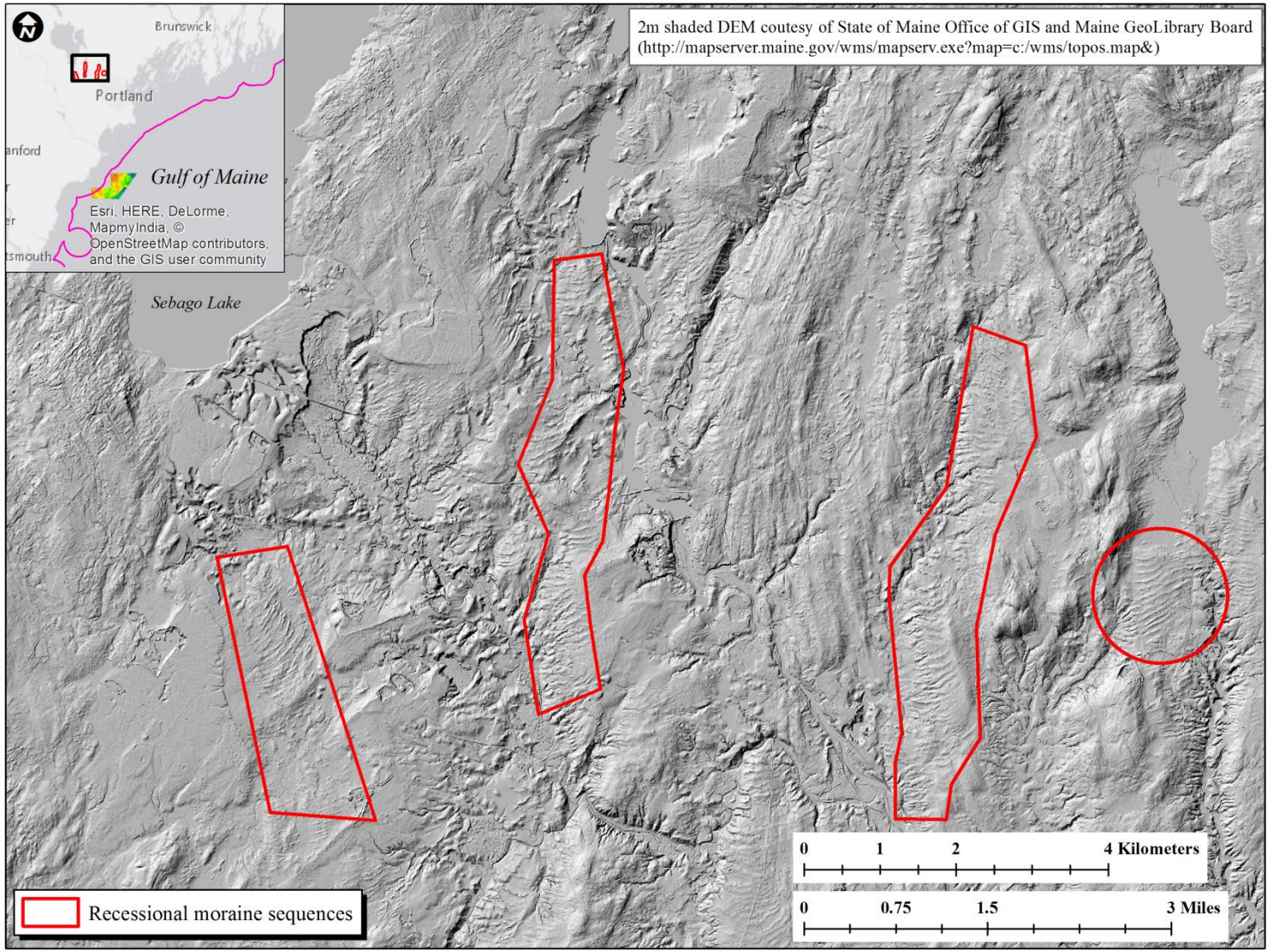

Figure 2. Shaded-relief LiDAR digital elevation model (2-m resolution) showing recessional moraine sequences (outlined in red) southeast of Sebago Lake in southwestern Maine. Pink line in inset is 3-nautical miles from nearest land. Colored area in inset represents bathymetry in 2014 MBES coverage area shown in Figure 1.

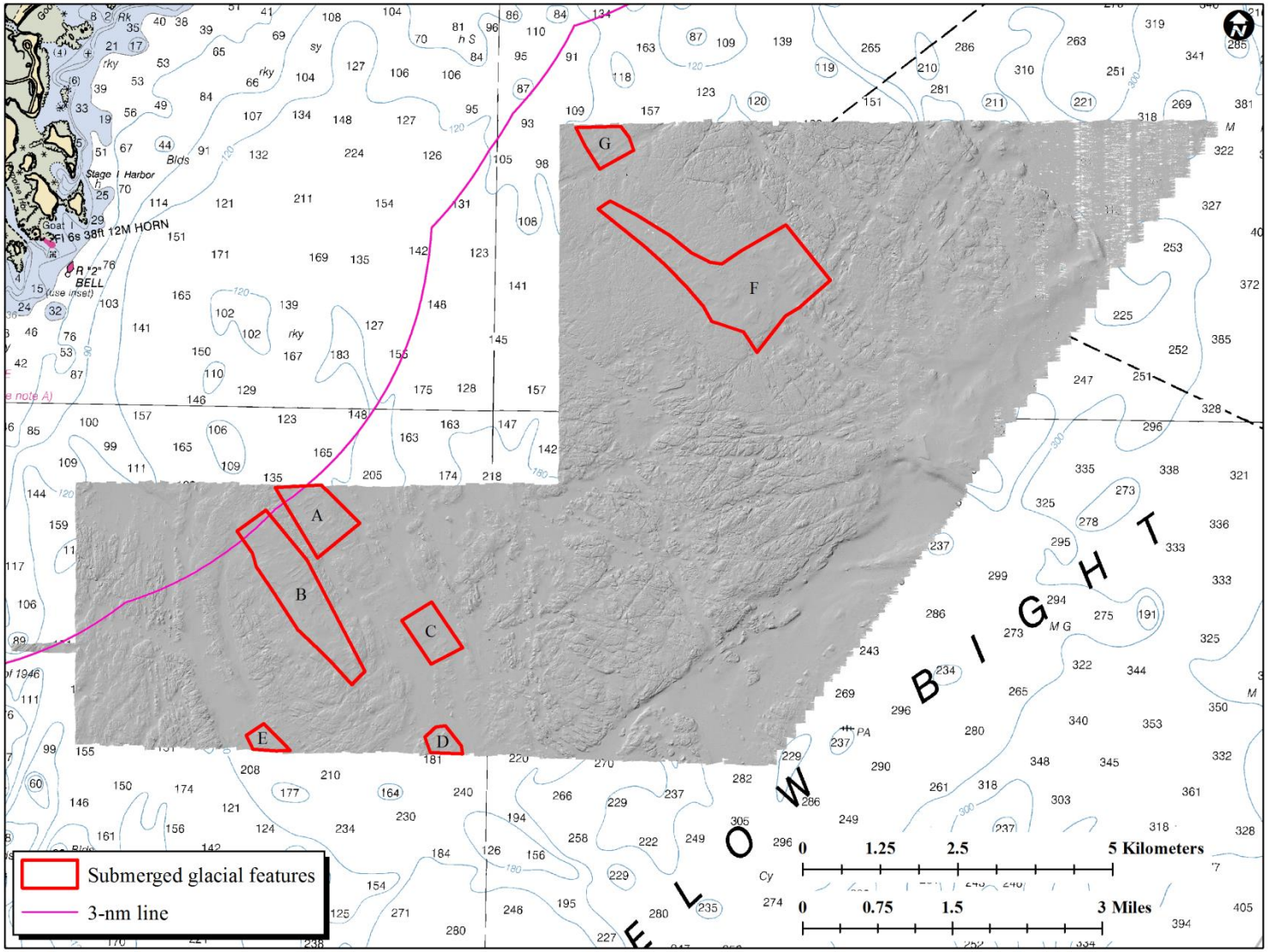

Figure 3. Bathymetry hillshade raster shown with general locations containing submerged glacial features (red polygons). Features within polygons A through G are illustrated in Figures 4a-c and 5a-c.

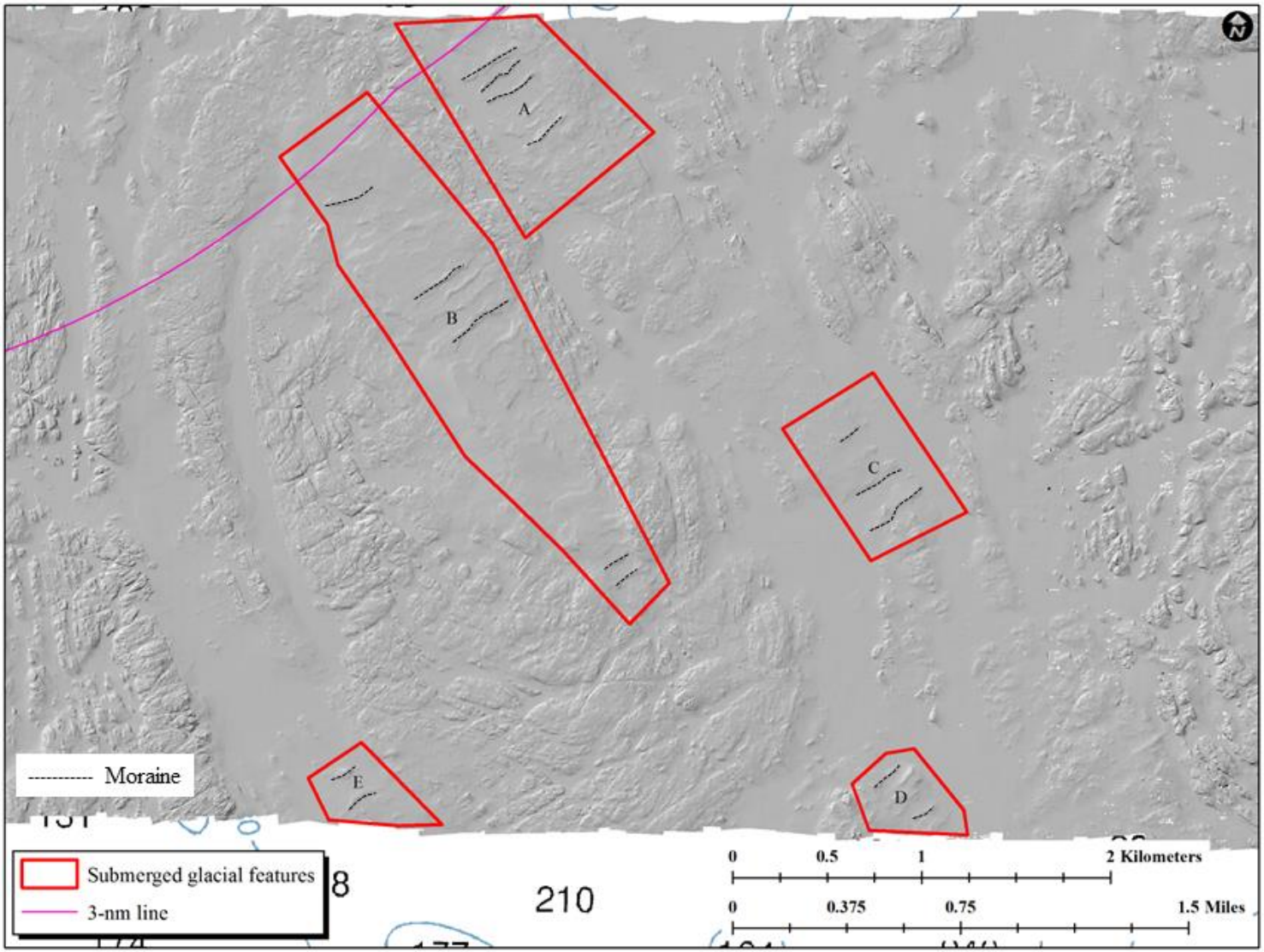

Figure 4a. Bathymetry hillshade raster shown with zones A through E (red polygons). Northeast-southwest trending ridges represent recessional moraine sequences (black dashed lines). All moraines are not delineated in this image.

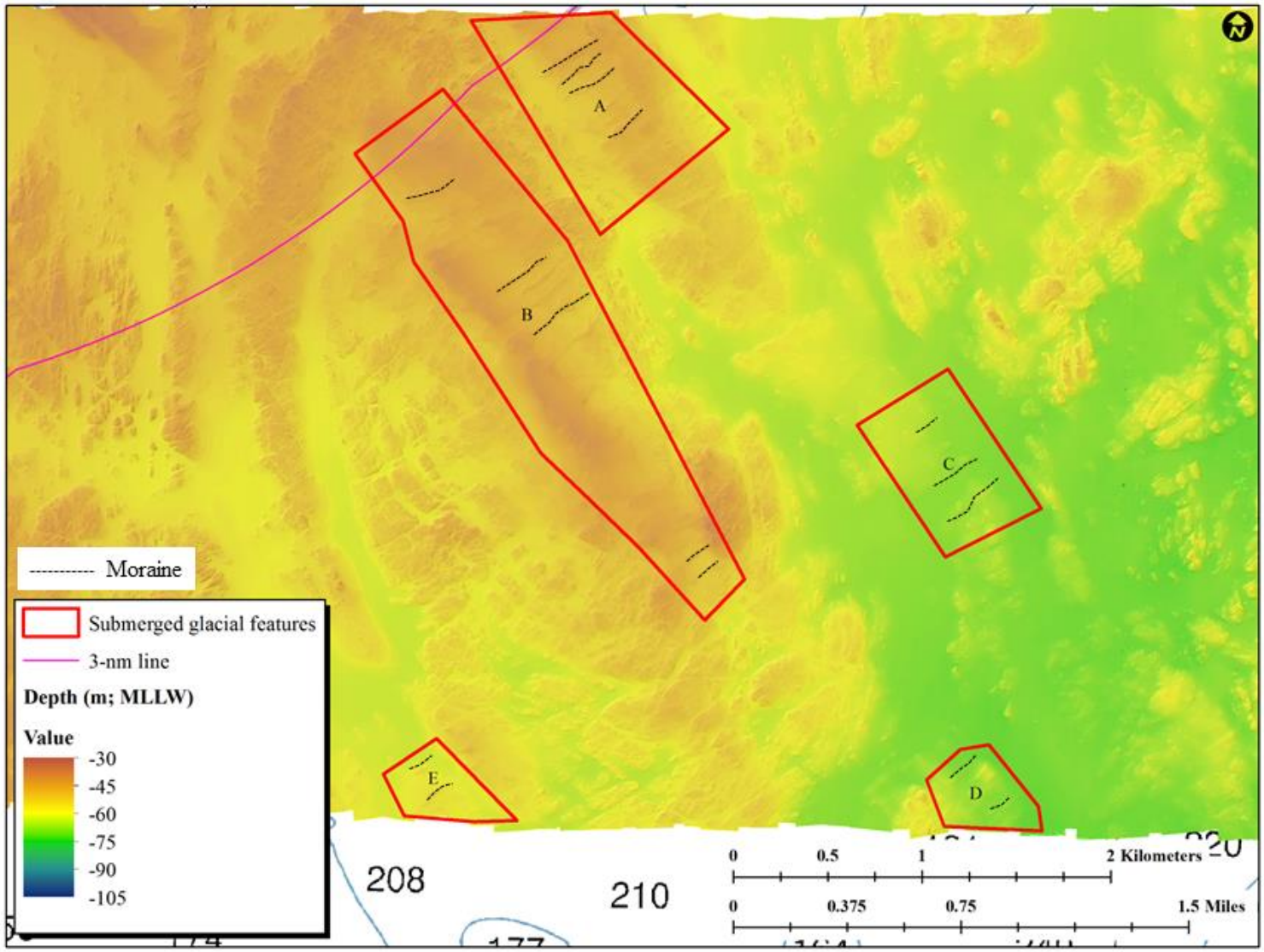

Figure 4b. Bathymetry (2-m grid) shown with zones A through E (red polygons). Northeast-southwest trending ridges of unconsolidated sediment unconformably overlie and cut across the strike of local bedrock. These features represent recessional moraine sequences (black dashed lines). All moraines are not delineated in this image.

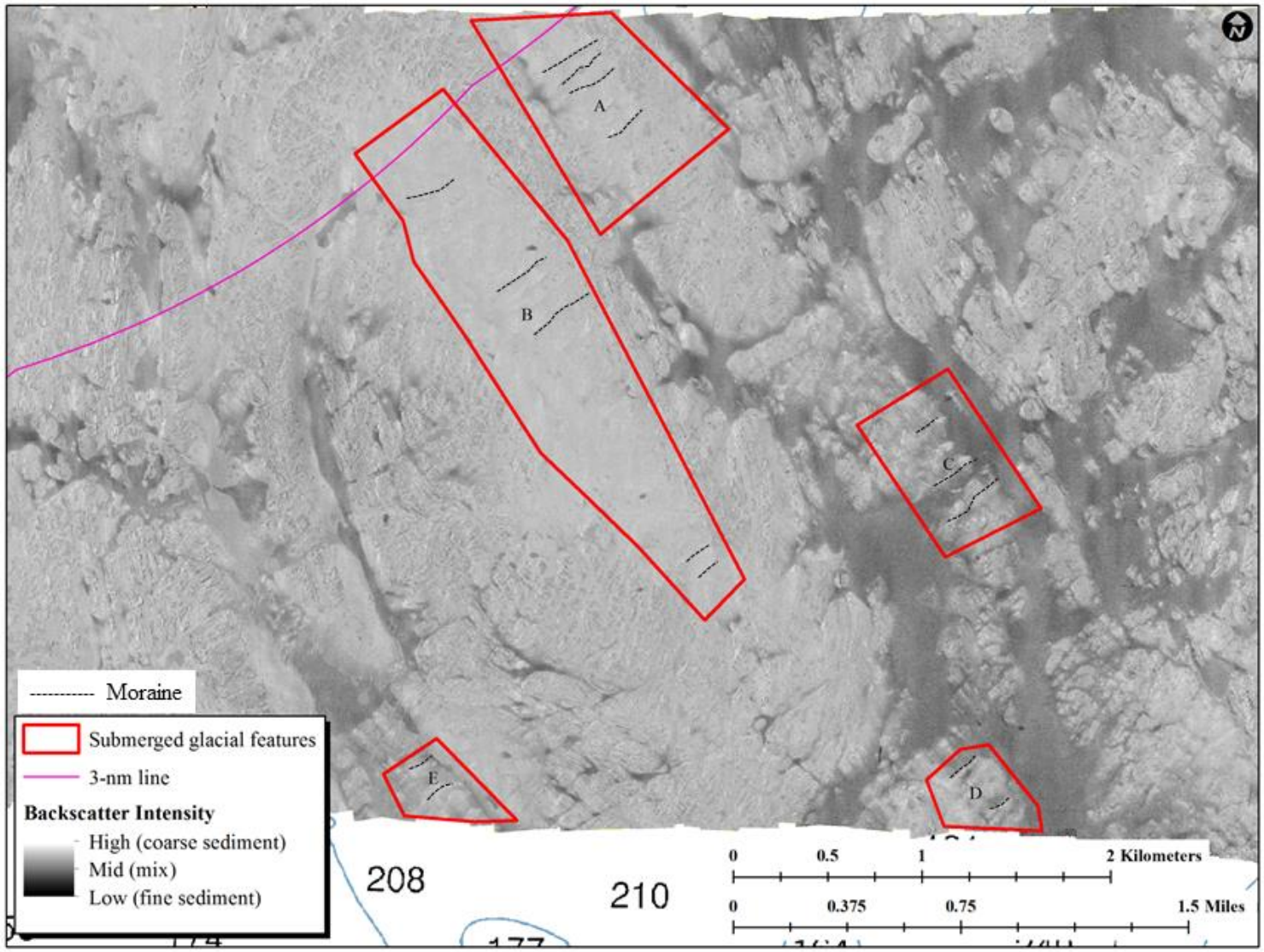

Figure 4c. Backscatter intensity mosaic (2-m grid) shown with zones A through E (red polygons). Northeast-southwest trending moraines have slightly higher backscatter intensity due to coarser sediment content. These features represent recessional moraine sequences (black dashed lines). All moraines are not delineated in this image.

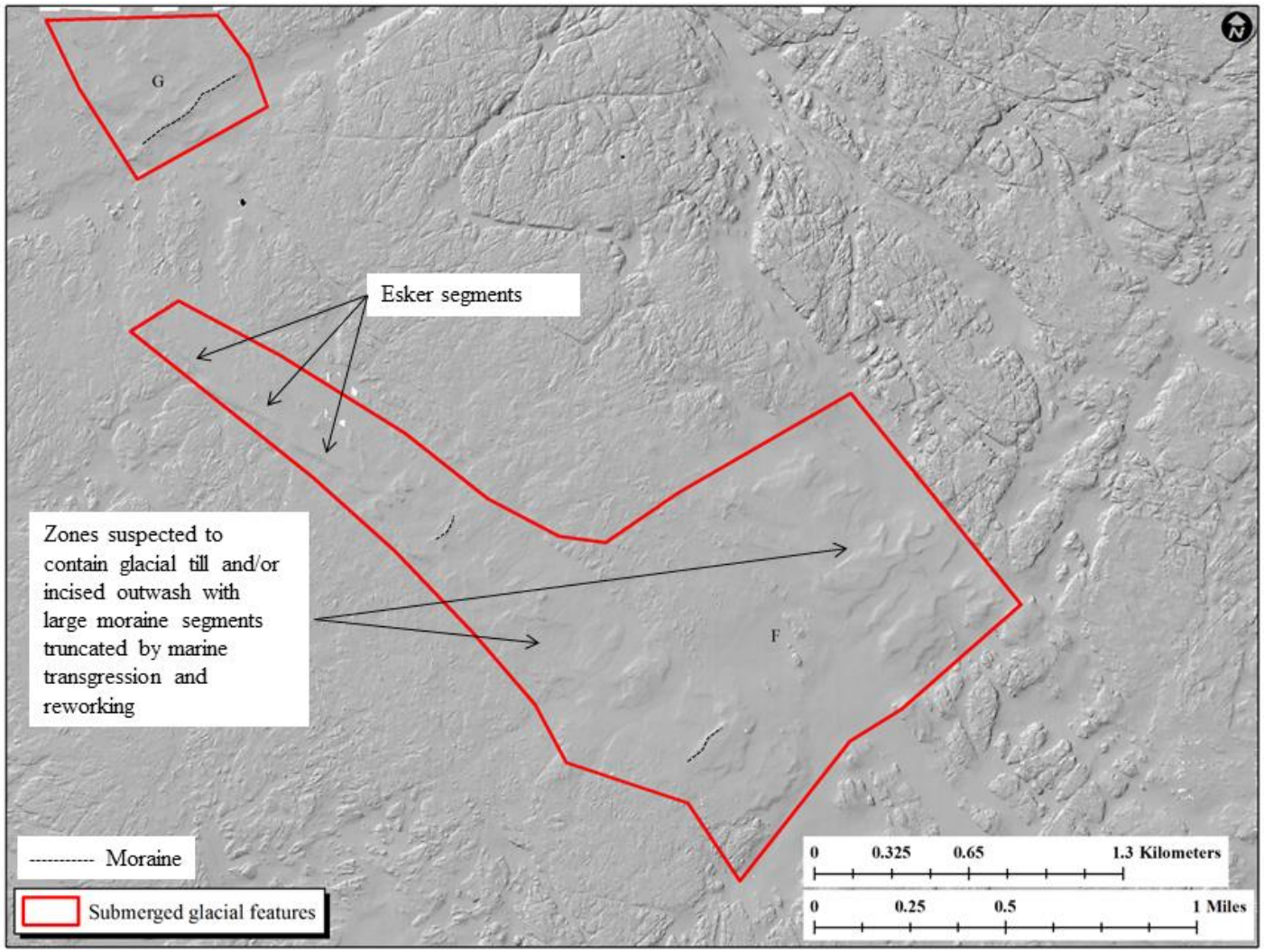

Figure 5a. Bathymetry hillshade raster shown with zones F and G (red polygons). Northeast-southwest trending ridges represent recessional moraines and northwest-southeast trending ridges represent suspected lateral moraine segments (black dashed lines). All moraines are not delineated in this image. These zones also contain evidence of truncation and reworking of sediments due to marine transgression. Some areas may also contain fluvially-incised glacial outwash deposits.

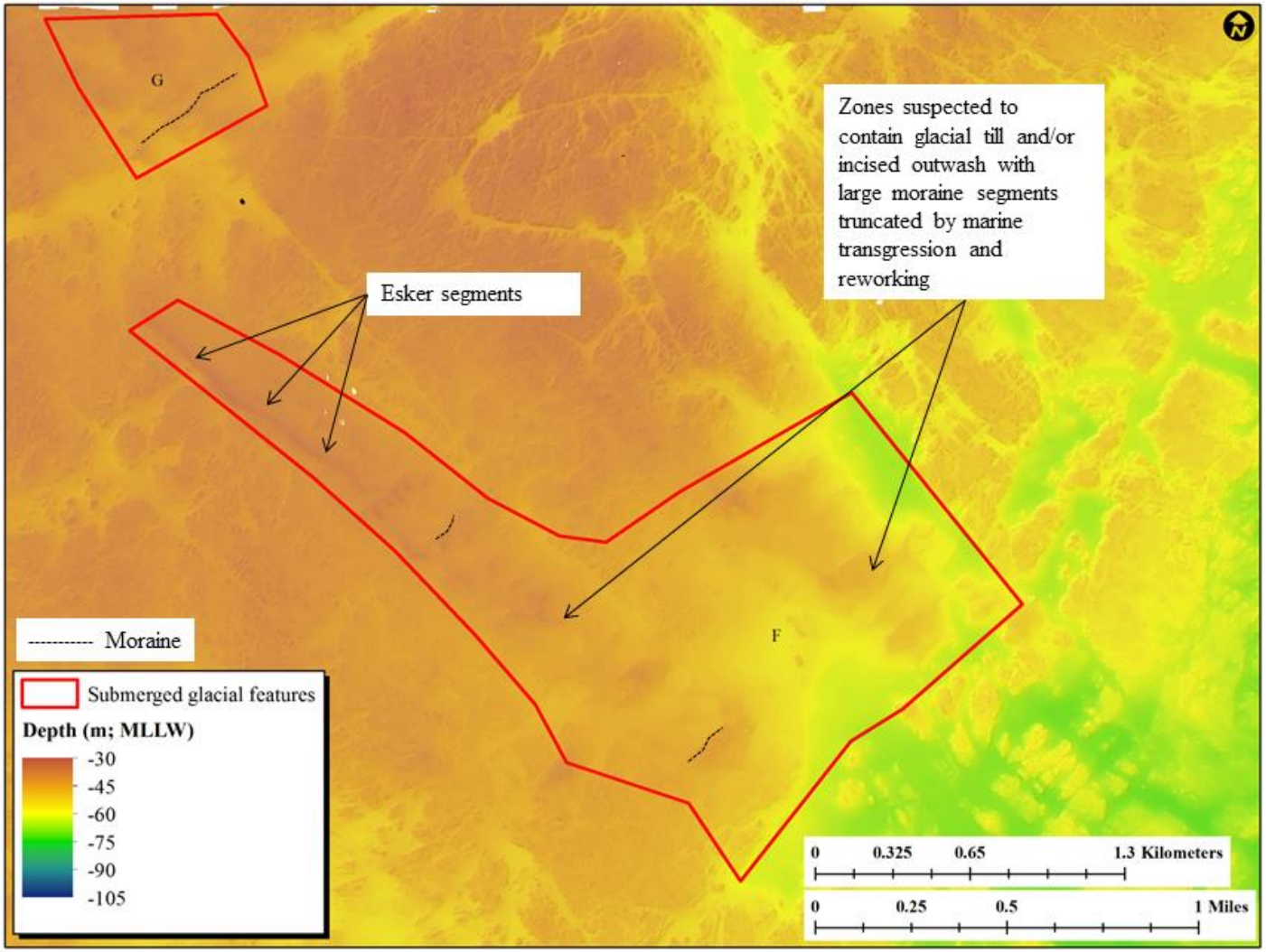

Figure 5b. Bathymetry (2-m grid) shown with zones F and G (red polygons). Northeast-southwest trending ridges represent recessional moraines and northwest-southeast trending ridges represent suspected lateral moraine segments (black dashed lines). All moraines are not delineated in this image. These zones also contain evidence of truncation and reworking of sediments due to marine transgression. Some areas may also contain fluvially-incised glacial outwash deposits.

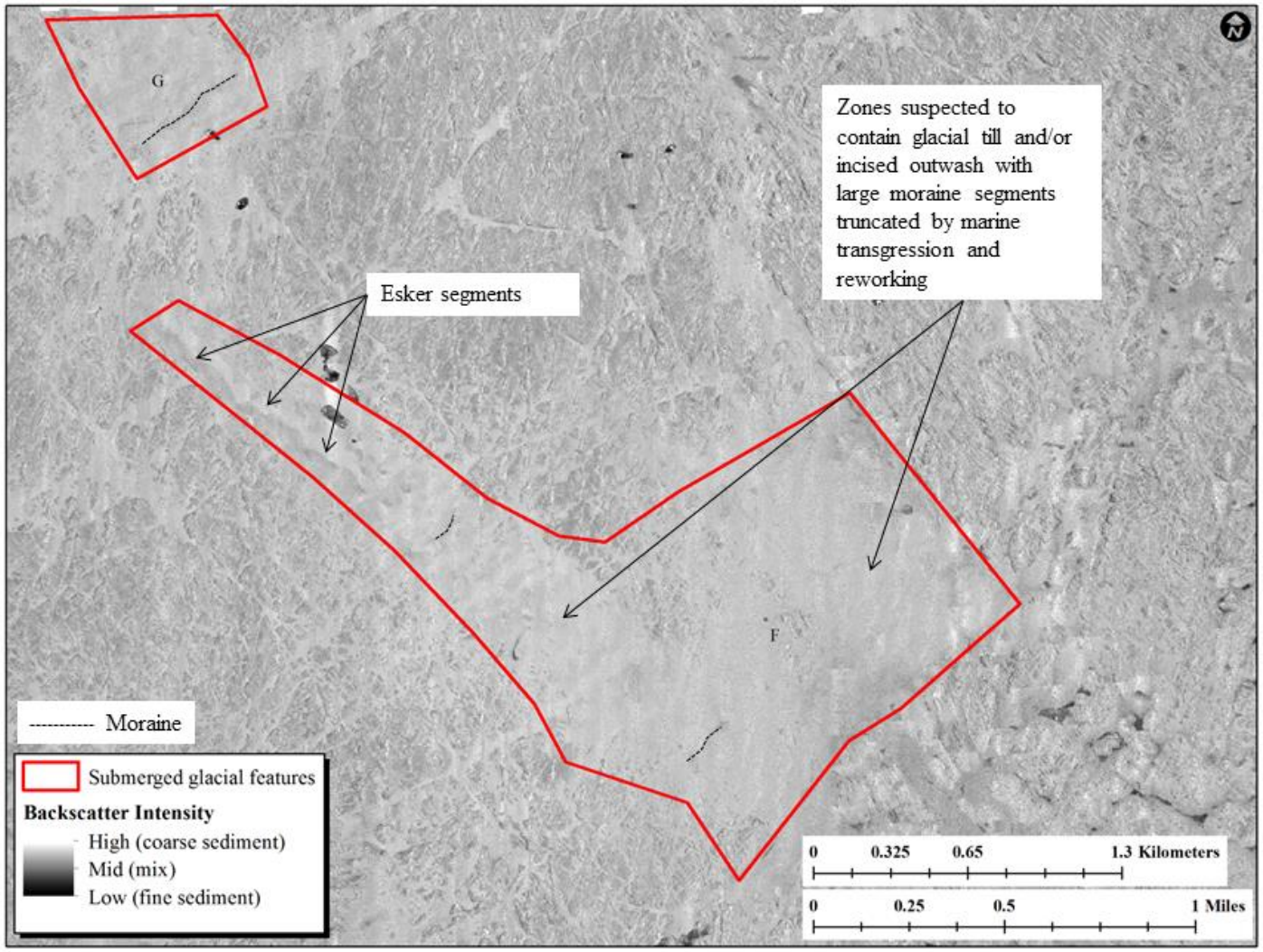

Figure 5c. Backscatter intensity mosaic (2-m grid) shown with zones F and G (red polygons). Irregular areas of intermediate-dark tones generally represent fractured bedrock outcrops. Lighter, uniform grey tones indicate broad zones of unconsolidated sediment interpreted as reworked ground moraine and/or fluvially-incised glacial outwash. Northeast-southwest trending ridges represent recessional moraines and northwest-southeast trending ridges represent suspected lateral moraine segments (black dashed lines). All moraines are not delineated in this image.