CORRELATION OF THE EASTERN MAINE PINEO RIDGE SYSTEM TO MORAINES ON MOUNT DESERT ISLAND THROUGH LiDAR IMAGERY AND 10Be SURFACE EXPOSURE AGES

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Digital elevation map of the Pineo Ridge System 10Be exposure ages sample sites. Yellow dots are samples sites from Koester et al. (2017). Red dots are sample sites from Hall et al. (2017).

LiDAR hillshade of Mount Desert Island showing 10Be exposure ages sample sites. Blue dots are samples sites from Koester et al. (2017). Green dots are sample sites from Braun et al. (2018).

The site with the triangle is Sargent Mountain Pond where there is a calibrated near basal radiocarbon age of 15,718 ± 363 yrs (Norton et al., 2011).
Probability distribution functions (camel plots) of $^{10}$Be surface exposure ages from Pineo Ridge and Mount Desert Island, Maine. Mean $^{10}$Be surface exposure ages for each grouping labeled in bold, and all four mean ages are indistinguishable at one standard deviation.

From Braun, D., 2018, Moraines on MDI and their relation to Pineo Ridge, fig. 33.FOP 2018 guidebook p. 30

Average of 3 moraine averages = 14,693 !??
We will see the 14.7 ka again later on.

PRS & MDI surface exposure ages are essentially the same age
LiDAR hillshade image of MDI; even at this scale some of the push moraines are visible. Red rectangles A – C are enlarged same-scale images shown next for comparison of moraine spacing.

LiDAR from COA GIS laboratory
LiDAR close-up of the widely spaced moraines, 100-150 m (330–500 ft) between successive ridges, on the northern part of MDI and on the mainland north of MDI. Same scale as B and C that follow.
LiDAR close-up of the closely spaced moraines 20-50 m (60-165 ft) between successive ridges) on the middle part of MDI. The crests of the northeast – southwest trending mountain range on MDI are just south of this image and are at the top of the next image C.
LiDAR close-up of the south ends of the glacial troughs with several much larger moraines. South of there the moraines have a somewhat variable spacing of 30–100 m (100–330 ft).
Identification of a zone of closely spaced moraines southwest of PRS prior to advent of LiDAR imagery

Surficial geology of portion of Cherryfield and Columbia Falls 7.5-minute quadrangles, Maine, showing location of Pineo Ridge (morainal bank) and Columbia Falls delta relative to the closely spaced moraine belt.

Quadrangle maps (Borns, 1975; Borns and Andersen, 1982). From Hunter & Smith, 2001, Morainal banks and the deglaciation of coastal Maine, fig. 6.
Closely spaced moraines in eastern Maine from the Pineo Ridge System (PRS) to MDI with the advent of LiDAR

The closely spaced moraine zone extends southwesterly from Pineo Ridge to MDI. Black dashed line marks the northwestern border of the zone while the continuous red line, a larger moraine, marks the southeastern border of the zone. The dashed red line is a prominent larger moraine within the zone that was traced southeast from PRS by Woody Thompson in 2010-2011.

Blue areas are where there is no LiDAR coverage.
Tracing the larger distinct moraine (Woody’s moraine) from PRS southwest towards MDI

**Thicker dashed red line** is the crest of the moraine

Town boundaries are thin **red lines**, some towns are named.
Tracing the larger distinct moraine (Woody’s moraine) from PRS southwest towards MDI

- Thicker dashed red line is the crest of the moraine
- White arrows – next images - photos of the moraine in blueberry fields
- Town boundaries are thin red lines, some towns are named.
View looking to southwest along Woody’s moraine from the south end of Burkes Hill – moraine is pinned to the bedrock in the foreground.

Ledge in foreground is at an elevation of about 73 m (240 ft), highest stand of sea level is at about 82 m (270 ft) in this area.
Proximal

Distal

View to the southwest along the moraine crest

Site is south of Mill Pond at an elevation of about 73 m (240 ft), highest stand of sea level is at about 82 m (270 ft) in this area

Next image of a pit in the moraine is just southwest of this image
Exposure in the moraine showing bouldery till

Boulder concentration at the surface suggests some wave erosion. Subtle layering visible on the left.
Tracing the larger distinct moraine (Woody’s moraine) from PRS southwest towards MDI.

**Thicker dashed red line** is the crest of the moraine.

Town boundaries are thin **red lines**, some towns are named.
Tracing the larger distinct moraine (Woody’s moraine) from PRS southwest towards MDI

**Thicker dashed red line** is the crest of the moraine

**White arrow** – next image - photo of the moraine in a logged area

Town boundaries are thin **red lines**, some towns are named.
View looking southeast at the proximal side of the moraine

Site is near Morancy Pond at an elevation of about 55 m (180 ft), highest stand of sea level is at about 79 m (260 ft) in this area
Tracing the larger distinct moraine (Woody’s moraine) from PRS southwest towards MDI

Thicker dashed red line is the crest of the moraine

Town boundaries are thin red lines, some towns are named.

This image is at a reduced smaller scale to reach across Frenchman Bay
Tracing the larger moraine that marks the southeastern edge of the closely spaced moraine belt to the southwest
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Northeast most image

East end of East PRS is 8 km north of here.

Esker with a chain of fans and deltas extending back to the east end of PRS.
Tracing the larger moraine that marks the southeastern edge of the closely spaced moraine belt to the southwest
Tracing the larger moraine that marks the southeastern edge of the closely spaced moraine belt to the southwest.
Schoodic Peninsula

Tracing the larger moraine that marks the southeastern edge of the closely spaced moraine belt to the southwest.
Tracing the larger moraine that marks the southeastern edge of the closely spaced moraine belt to the southwest.
Bar Harbor

Wave smoothed moraines

Beach ridges – possibly on top of moraines

Schoodic Peninsula

Winter Harbor

Overlapping with previous image

Tracing the larger moraine that marks the southeastern edge of the closely spaced moraine belt to the southwest to MDI

Eastern MDI
The two marker moraines from PRS can be traced towards but not directly to MDI thanks to Frenchman Bay.
MDI to PRS to Eastport overview showing locations of widely spaced moraine images that follow.

Transition zone from many closely spaced moraines to the west to mostly larger moraines with some closely spaced ones between them to the east.
Widely spaced moraines north of MDI

Widely spaced moraines northeast of PRS and Columbia Falls delta

Widely spaced moraines northeast of Machias

Northeast end of Columbia Falls delta

Moraines that pass into the east end of PRS – 10 km west of this image

Machias is at the north edge of the PRS moraine belt and lies 10 km to the southwest of this corner of the image

Hadley Point

Machias is at the north edge of the PRS moraine belt and lies 10 km to the southwest of this corner of the image.
Downeast Maine ice front retreat – intermediate speed - then a distinct slowing - then a rapid speed up for 100’s of years
Matching the Connecticut Valley retreat record to the Downeast Maine retreat record at 14.7 ka


NC = North Charlestown moraines in the Connecticut Valley of VT - NH

Green line above – Braun’s present preliminary projection the MDI – PRS closely spaced moraine belt to the southwest along mid-coast Maine and into western Maine.
Closely spaced moraine segments southwest from MDI to Sebago Lake
LiDAR image of the small push moraines with a 100-150 m (330–500 ft) spacing from the north side of MDI to north of Ellsworth. There are approximately 200 individual moraines in the 30 km from south to north on the image.

Blue arrow marks the crest of an esker that forms a reentrant in the ice front with the moraines curving northward into it.

The moraine spacing does not change to either side of the deltas indicating the deltas represent pulses of meltwater sediment rather than slowing of the ice front retreat.

Light blue rectangles are places on the water with no LiDAR coverage.
Closer view of Brunswick area moraines and curvature to north into esker channel around Lisbon Falls
Moraines northeast of Ellsworth and southeast of Graham Lake

Moraine curvature to either side of a shallow valley with no detectable esker
Penobscot Bay – no calving bay reentrant at head of bay

Belfast 9 km to west

Cape Jellison

Sears Island

Rt 1 Narrows bridge 9 km to north