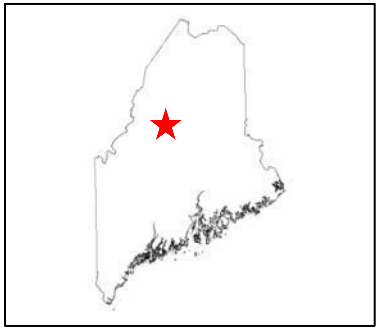
Maine Geologic Facts and Localities

June, 2005

Moosehead Lake and the Tale of Two Rivers



45° 53' 5.09" N, 69° 42' 14.54" W

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Introduction

The last great Pleistocene ice sheet in New England, began its recession from Maine approximately 14,000 years ago. The weight of the ice sheet caused regional depression of the Earth's crust, allowing the ocean to follow the retreating ice front and leading to the ocean flooding much of the coastal part of Maine, well up into the Kennebec and Penobscot Valleys. As the crust adjusted to the removal of the melting ice, the land surface rose, causing a relative fall of sea level to a lowstand of approximately 200 feet (60 m) below modern sea level approximately 11,000 years ago. Following the lowstand, worldwide sea level rose rapidly, and then more slowly, to its current position (Figure 1).

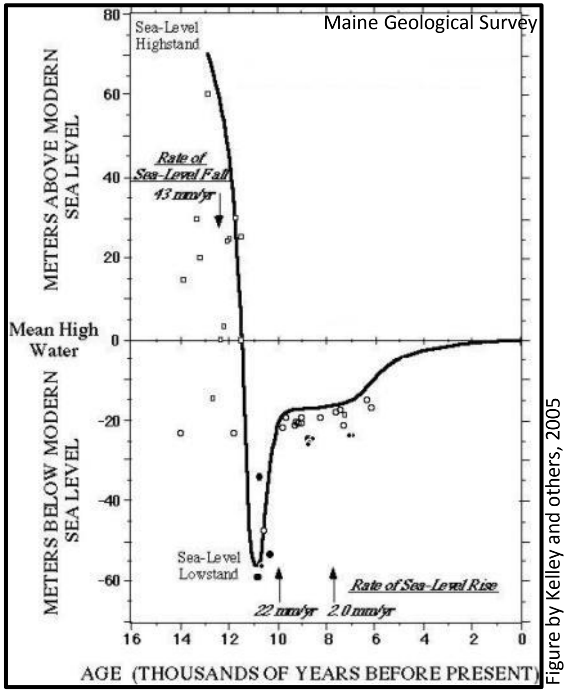

Figure 1. Sea-level change in coastal Maine.

Forebulge

Later a smaller, localized crustal adjustment also occurred. A forebulge of material in the earth's upper mantle formed beyond the ice front, and followed the receding ice, moving from the coast inland. Analysis of relative sea level curves from the region shows passage of this bulge under the Maine coast at approximately 10,000 years ago, and beneath the Saint Lawrence Valley in Quebec at approximately 6,000 years ago (Barnhard and others, 1997; Dionne 1988). Work by Balco and others (1998), on the margins of Moosehead Lake, demonstrated tilting of the lake in response to the migration of the forebulge.

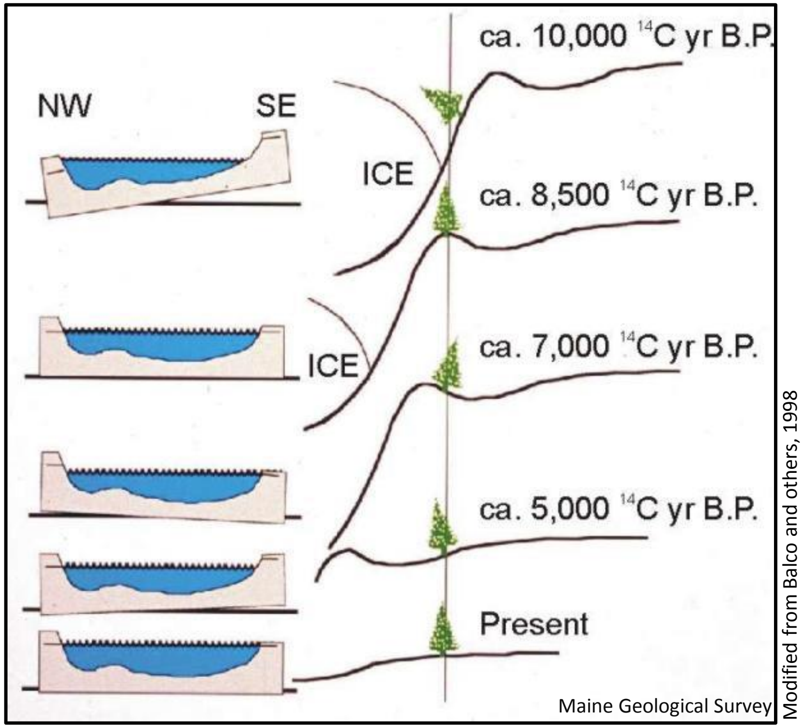

Figure 2. Cartoon showing migration of forebulge and its effect on Moosehead Lake.

Moosehead Lake

They identified a now abandoned, northward draining outlet, connecting the lake with the West Branch of the Penobscot River. Currently, Moosehead Lake, the state's largest lake, drains to the south, into the Kennebec River. (Figure 3, and Figure 4)

Figure 3. Location map of Maine showing Penobscot (East and West Branch) and Kennebec River Drainage Basins, Moosehead Lake, and Penobscot Bay.

Moosehead Lake

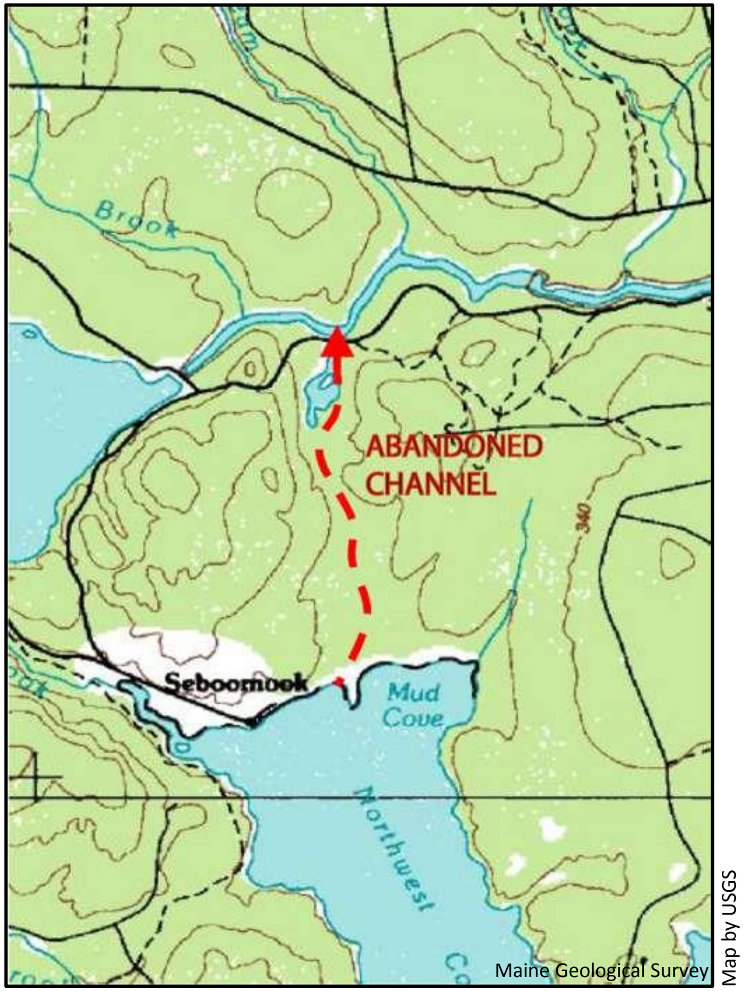

Figure 4. Topographic map showing the location of the abandoned northern outlet from Moosehead Lake into the West Branch of the Penobscot River.

Moosehead Lake

Ground-penetrating radar was used to characterize the abandoned outlet, illustrating a bedrock channel, now filled with fresh water vegetation and peat. Radiocarbon dating of organic material from the base of the outlet suggests that it was abandoned approximately 9,000 years ago (Figure 5).

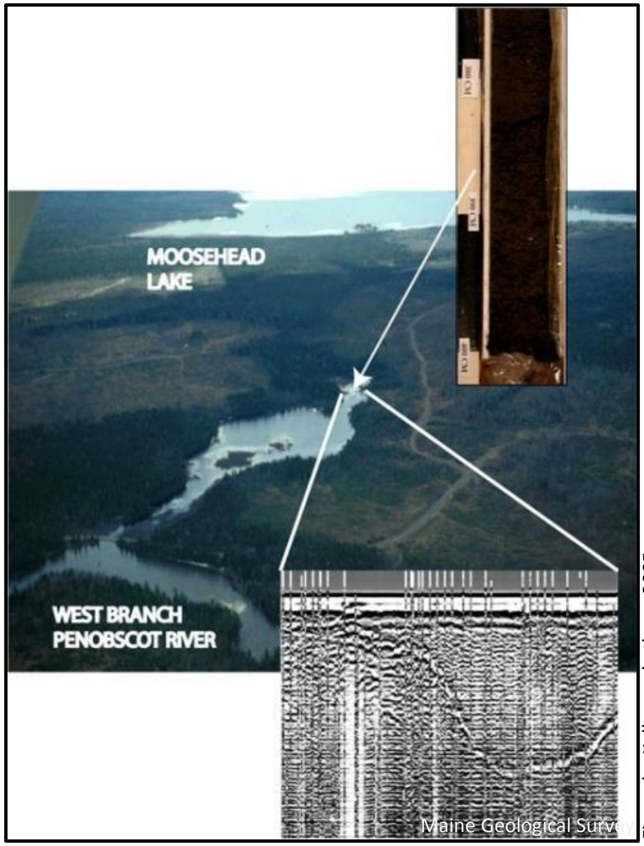

Figure by Kelley and others, 2005

Figure 5. Aerial photo of the abandoned northern outlet of Moosehead Lake, looking south. Ground-penetrating radar section and base of peat core used for radiocarbon dating shown.

Paleodelta

The change in river discharge and related transport of sediment is linked to the deposition and abandonment of the newly discovered Penobscot Paleodelta in central Penobscot Bay (Belknap and others, in press). The paleodelta consists of steeply dipping beds composed of sand and gravel, and is graded to a water depth of approximately 100 feet (30 m) below present sea level, suggesting formation at approximately 10,000 years ago.

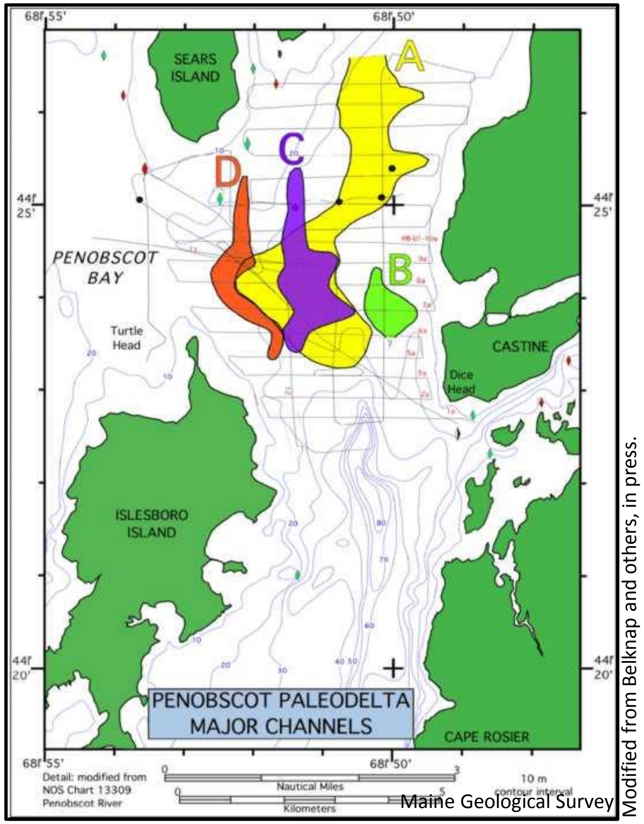

Figure 6. Penobscot Paleodelta, Penobscot Bay.

Paleodelta

The paleodelta is covered by up to 33 feet (10 m) of mud, and has no surface expression on the sea floor. Cores taken from the mud deposits over the paleodelta contained shallow water organisms, Mya arenaria shells, indicative of a tidal flat environment after active deltaic deposition ceased. Radiocarbon dating of these shells places the end of delta growth prior to 8700 years ago (Barnhardt and others, 1997), correlative with the switch in outlets of Moosehead Lake from the Penobscot River to the Kennebec (Figure 7).

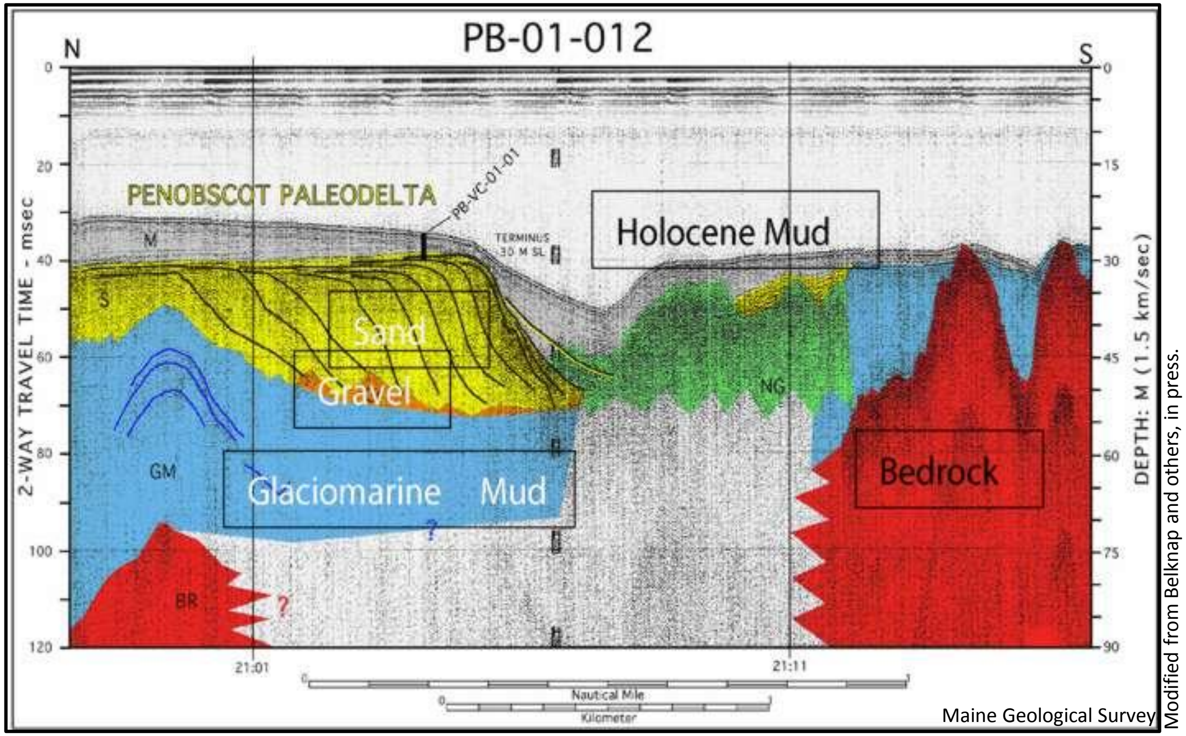

Figure 7. Seismic reflection line showing a north-south section through the Penobscot Paleodelta..

Paleodelta

A large paleodelta has been identified at the mouth of the Kennebec River (Barnhardt and others, 1997). This feature has lobes associated with the lowstand elevation of approximately 200 ft (60 m) below current sea level, and is radiocarbon dated to circa 10,850 years ago. While the Kennebec Paleodelta continued to grow through the early Holocene, its final lobe was deposited circa 9000 years ago at an elevation of 66 feet (20 m) below present sea level and may represent a pulse of sediment driven by the Kennebec's enhanced discharge after gaining the contribution from the Moosehead Lake drainage basin (Figure 8).

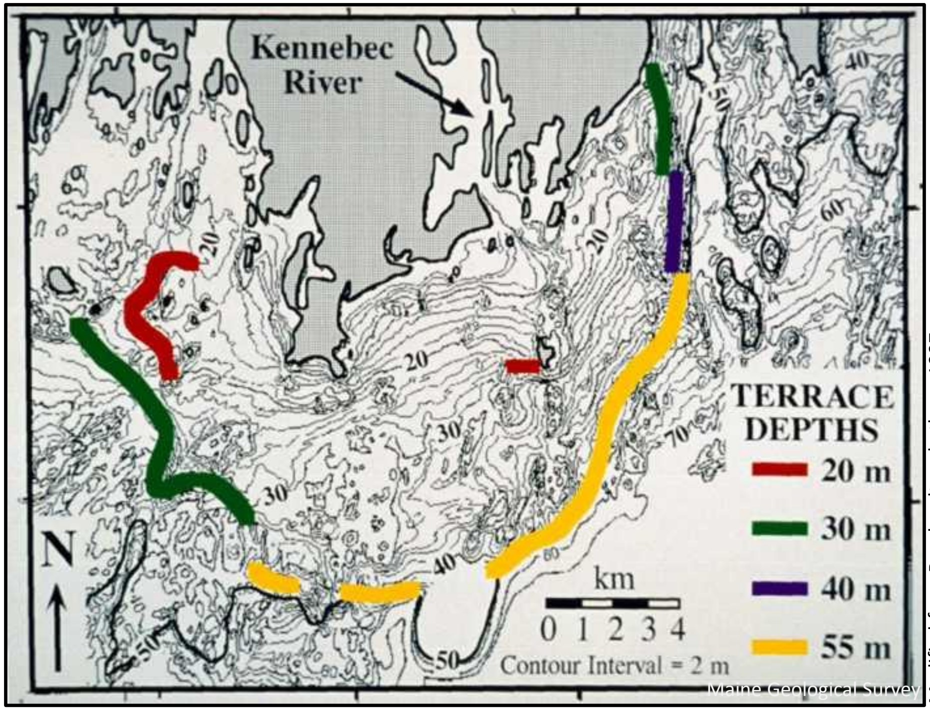

Figure 8. Kennebec River Paleodelta; 20m lobes may be associated with deposition from Moosehead Lake outlet change.

Surficial Geologic Formations

Deposits in the upper Kennebec Valley may also be linked to the outlet switch of Moosehead Lake. In the upper Kennebec River Valley, Borns and Hagar (1964) mapped glacial-marine mud (the Presumpscot Formation) and sandy silt (Embden Formation) (Figure 9). These units respectively represent glaciomarine deposits overlain by shallower water sediment as sea level fell relative to land rebound.

Photos by Kelley and others, 2005

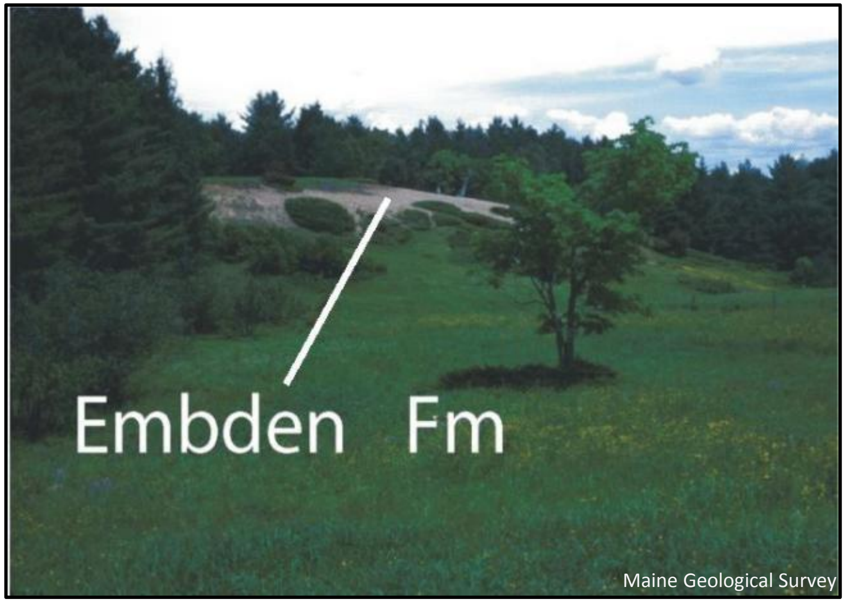

Figure 9. Gray Presumpscot Formation (Left) overlain by Kennebec River terrace deposit, Augusta. Embden Formation (Right) is the tan sand in background; grass-covered terraced surface in foreground is incised into Presumpscot Formation (no exposure visible).

Surficial Geologic Formations

These units respectively represent glaciomarine deposits overlain by shallower water sediment as sea level fell relative to land rebound. A younger sand and gravel deposit (North Anson Formation) (Figure 10) unconformably rests on an eroded surface of the Embden and Presumpscot Formations, and caps terraces incised into these units.

Photo by Kelley and others, 2005

Figure 10. North Anson Formation; fluvial sand and gravel at the North Anson town dump (now closed).

"Change in Regime"

Borns and Hager recognized that this deposit clearly represented a "change in regime" (1964, p. 1246), and identified the North Anson Formation as outwash deposited by melting of a late Pleistocene ice mass on the basis of "meager evidence" (Borns and Hager, p. 1248). In a comparison of the Kennebec and Penobscot Valleys, they note the similarity of the surficial geology of the two valleys "...with the exception of a late-glacial influx of a definite stratigraphic equivalent of the North Anson Formation" in the Penobscot Valley (Borns and Hager, 1964, p. 1247). The North Anson Formation may represent sediments mobilized by water associated with the establishment of the southern Moosehead Lake Outlet, when high discharge combined with an ample supply of sediment lead to the deposition of the coarse-grained deposit. The deposits in the Penobscot Valley are absent because that drainage basin lost, rather than gained, discharge at this time.

Another implication of the shift of the drainage basins is the local and regional effect on human populations. Changing patterns of human settlement associated with lake tilting have been demonstrated in Sweden (Bergman and others, 2003), and may well also apply to Moosehead. Prior to abandonment, the northern outlet of Moosehead Lake provided a water-related transportation link from a large river basin to a major lake. With cessation of flow in the outlet and accompanying vegetation changes, this once important route would become more difficult to traverse, and perhaps, diminish in importance, affecting regional settlement patterns. Large-scale changes associated with crustal adjustment have the potential to affect other lakes and streams in the region, altering stream catchment areas, flow directions, and creating lakes. These resource-rich environments would be attractive to ancient people, but are obscured by the present day landscape.

References and Additional Information

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