Stratigraphy and Geologic History of Vatnsdalsvatn, Iceland.

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ABSTRACT

Combined data analyses of sub-bottom profiles (SBP), bathymetric maps, and sediment cores provide evidence for past geologic events that might be missed by single-method approaches. The utility of this method is demonstrated for an Icelandic lake, Vatnsdalsvatn. Presented here are four litho-facies and corresponding geophysical facies: 1) laminated and non-laminated mud sediments; 2) mud sediments containing dropstones; 3) ice-contact deposits; and 4) basalt bedrock.

The distribution of laminated lake muds is not uniform and may be controlled by stream-delta deposits. Highly erosional soils and steep valley walls are also possible contributors to these processes. Lack of deposition in the deeper parts of the lake may be due to high energy resulting from inlet/outlet flow. Several dropstones, indicative of periods of glacial rafting, were extracted from cores and appeared as isolated and grouped hyperbolic reflections in SBP data. Till deposits dominate the stratigraphy of the lake in the form of both ground and end-moraines. A large end-moraine, identified using SBP and bathymetric data as well as topographic maps and aerial photographs, are evidence of a glacial retreat that probably occurred in steps. The country rock is composed of Tertiary basalt that crops out on the valley walls but was not observed in cores or SBP data.

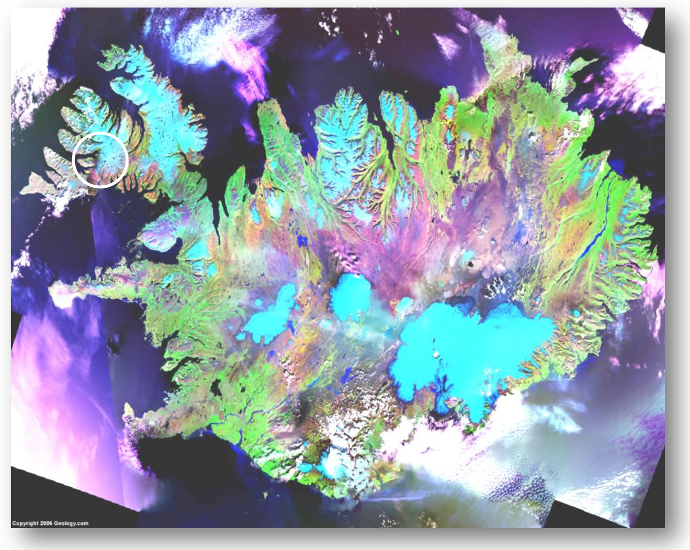
These data allowed for the division of Vatnsdalsvatn's evolution into five stages. The most recent stage is represented by laminated and non-laminated sediments likely controlled by deposition of upland eroded sediments, stream-delta deposition, lake energy states, and recent lacustrine deposition. The second and third stages encompass separate periods of ice-contact deposition, glacial retreat and stagnation indicated by a basin-wide till sheet, an identifiable end-moraine, and mud sediments with dropstones. An older stage involves the carving of the current lake-depression by multiple Quaternary glaciations. The earliest stage describes the genesis of the Tertiary basalt bedrock.

HYPOTHESIS

Vatnsdalsvatn contains laminated sediments (Thordarson & Hoskuldsson, 2008; Donor, 2003) of unknown origin and distribution. A working hypothesis concerning these laminations holds that they are uniformly distributed throughout the lake and that the major factors controlling sedimentation are annual runoff patterns associated with spring thaws and winter freezes.

FIELD LOCATION

Vatnsdalsvatn is a lake within this region and is roughly 3.5km in length and 0.9km wide. It sits 0.6km from the base of Vatnsfjordur, a south facing fjord. The long-axis of the lake runs north/south and the lower portion bends slighty westward, giving the lake an elongated elbow-shape. Fresh water is delivered via Vatnsdalsa, a stream that empties into the northern portion of the lake and is responsible for draining most of the 113Km^2 that makes up the Vatnsdalsvatn watershed. A small southern outlet links Vatnsdalsvatn to Vatnsfjorder and the North Atlantic Ocean. Numerous small overland-streams are found on the steep western and eastern banks and are additional sources of runoff.



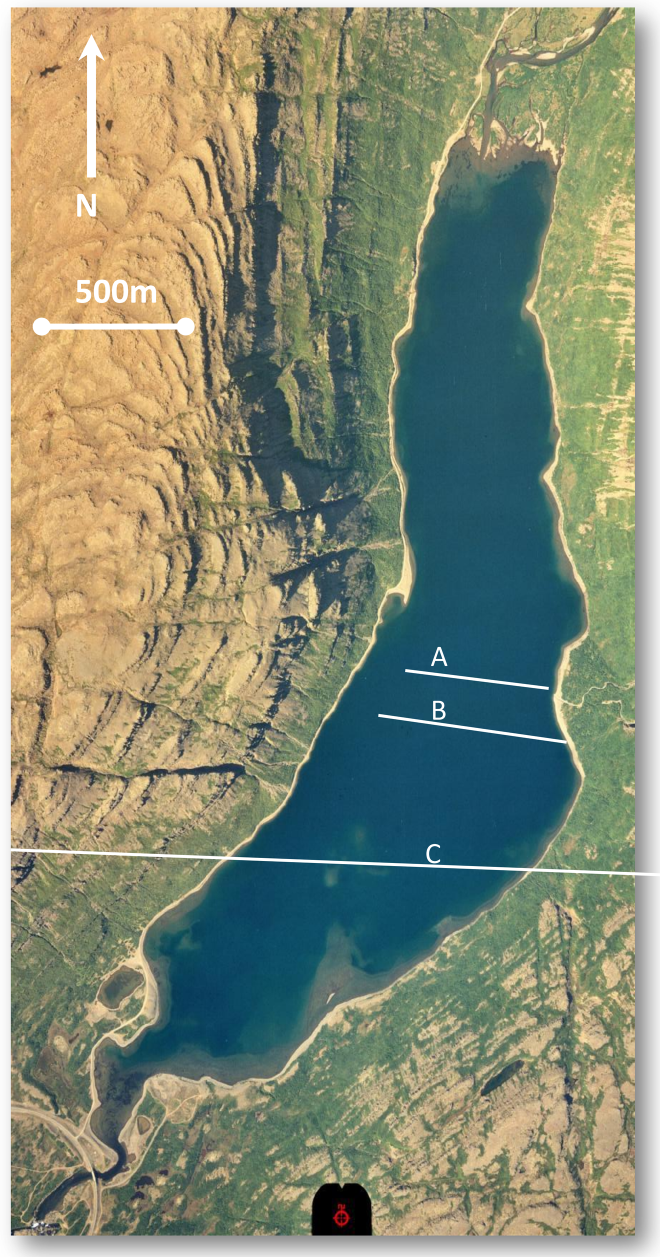


Fig 1. (top) The Westfjords are a penninsula in the NW corner of Iceland, just below the arctic circle. The circle indicates the approximate location of the lake in the Westfjords (photo from geology.com).
Fig 2. (left) Aerial photograph of Vatnsdalsvatn showing the northern inlet, weathered slopes, and the southern outlet. The Southern shallows are likely a moraine deposit. (The white lines represent the SBP and topo-profile lines found in figs. 6 (A), 7 (B), and 10 (C). (Photo from fluga.net).

METHODS

- *Magnetic Susceptibility (MS):* MS data are used to determine trends in sedimentation that may reflect the environment of deposition.
- *Initial Core Descriptions (ICD):* Data was logged by hand on "barrel sheets" which were later scanned and digitized.
- *Inlet/Outlet Discharge Data:* Discharge data was used to gain an understanding of its effect on sedimentation processes.
- *Topographic & Photographic Analyses:* Elevation profiles helped to determine slope characteristics and erosional scenarios. Photographs provided a more complete understanding of the lake and its watershed.
- *Bathymetry:* Lake-depth data was used to create a visual image of the lake-floor.
- *Sub-bottom Profiles (SBD):* Sonar provided a means to look beneath the lake-floor to see what information Vatnsdalsvatn's sediments and could provide.

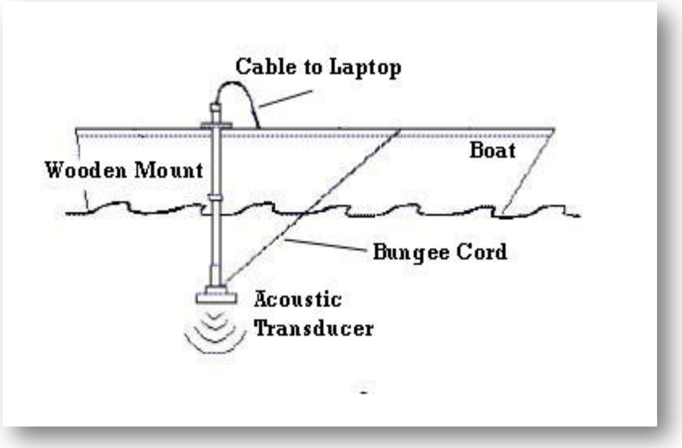
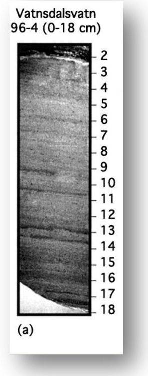


Fig 5. An image showing how the Stratbox acoustic transducer was mounted to the research vessel in order to collect SBP data.

Fig 3. (left) Northwest Iceland, March 2002. Photo by P. Sauer. It is likely that this is the team that provided the cores used in this study. (photo from Institute of Arctic and Alpine Research).
Fig 4. (right) This is an image of a freeze core from Donor's 2003 study showing distinct laminations. (Image from Donor, 2003).



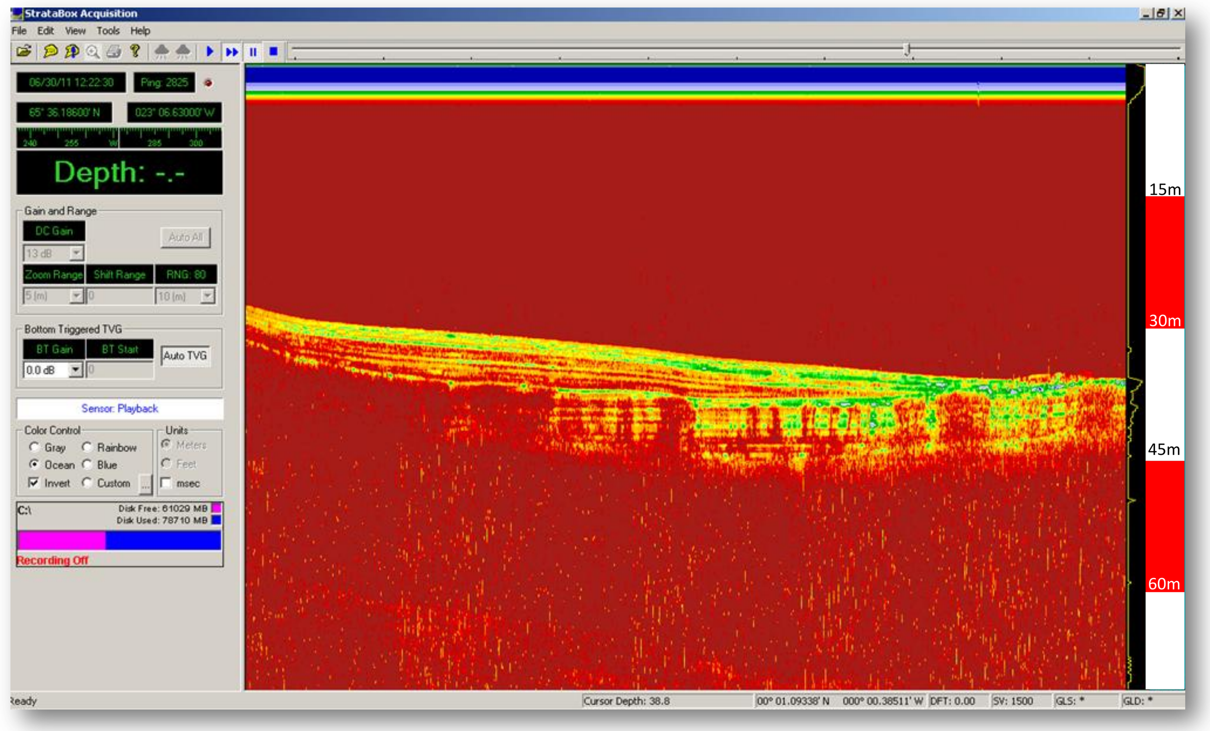
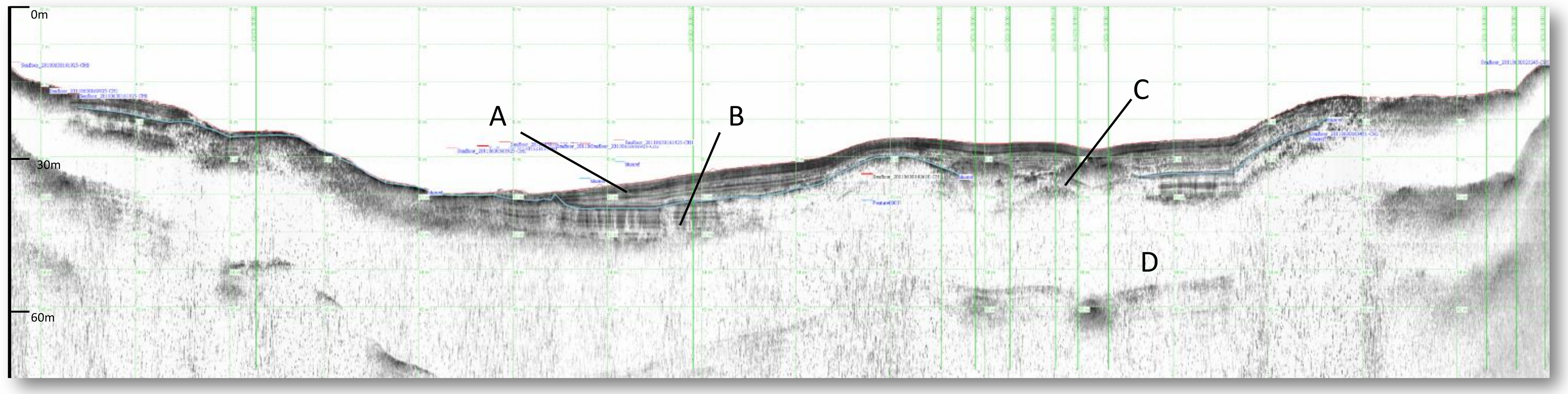


Fig 6. (above) A screen-capture of the Stratabox software in action. Stratabox allowed for real-time viewing of the sub-bottom as data was being collected (see fig. 2 for line location).

RESULTS



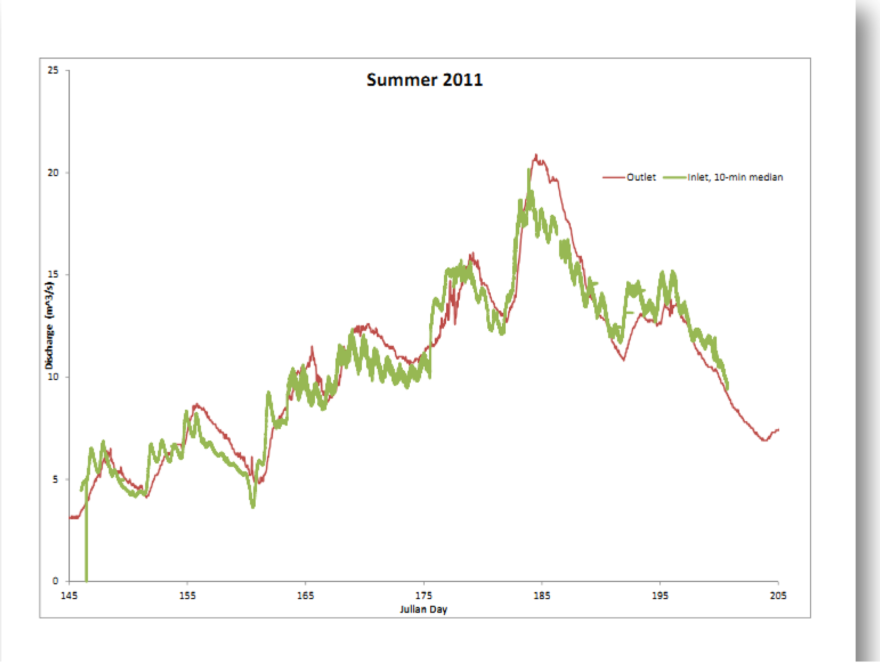
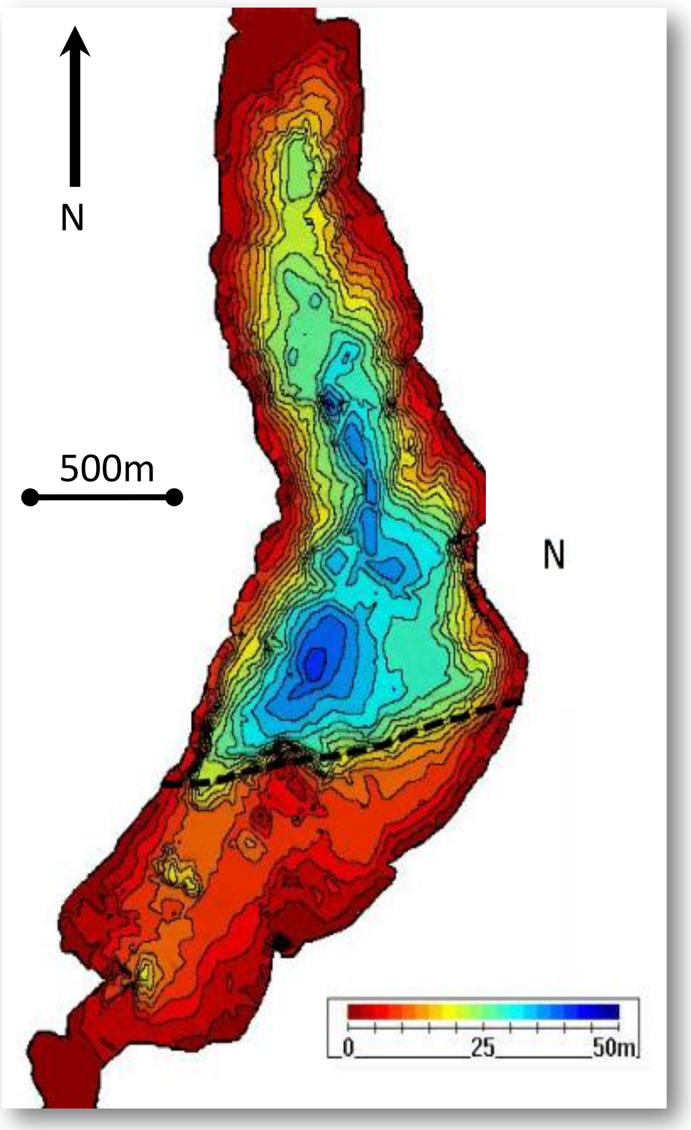


Fig. 7 (above) SBPline3 shows: A) Series A laminated sediments pinch-ing out above B) series B sediments, C) dropstones and D) glacial till. The basalt bedrock was not represented in SBP data (see fig. 2 for line location).
Fig. 8 (left) Inlet/Outlet discharge data shows a balance between the water entering the lake from t he north and water being removed via the southern inlet.
Fig. 9 (right) Bathymetric map of Vatnsdalsvatn . Note the sharp shallowing of the southern portion of the lake. A black-dotted line marks the location of an end-moraine.



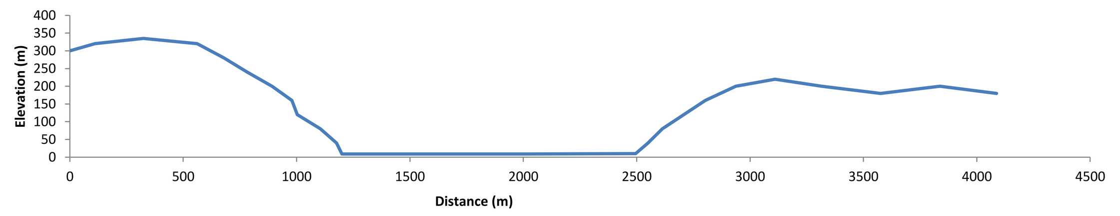
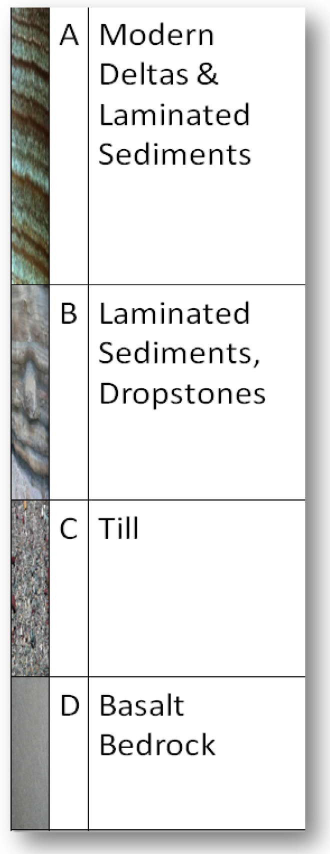


Fig. 10 (above) A total of four profile lines were created to determine slope-erosion relationships. The southernmost profile lines is displayed here. All profiles displayed steep slopes with scarps and suggest that the resident tephra soils and are prone to heavy erosion. (See fig. 2 for location of profile line).

CONCLUSIONS

Stratigraphy



Geologic History

1. Deposition of Basalt Bedrock (Thorarinson, 2008).
2. The lake-depression is carved out by multiple Quaternary glaciations.
3. Glacial retreat and stagnation indicated by a basin-wide till sheet, an identifiable end-moraine, and mud sediments with dropstones.
4. A second retreat-stagnation occurred and is evidenced by dropstones likely deposited by glacial rafting.
5. The most recent stage represented by laminated and non-laminated sediments likely controlled by deposition of upland eroded sediments, stream-delta deposition, lake energy states, and recent lacustrine deposition.

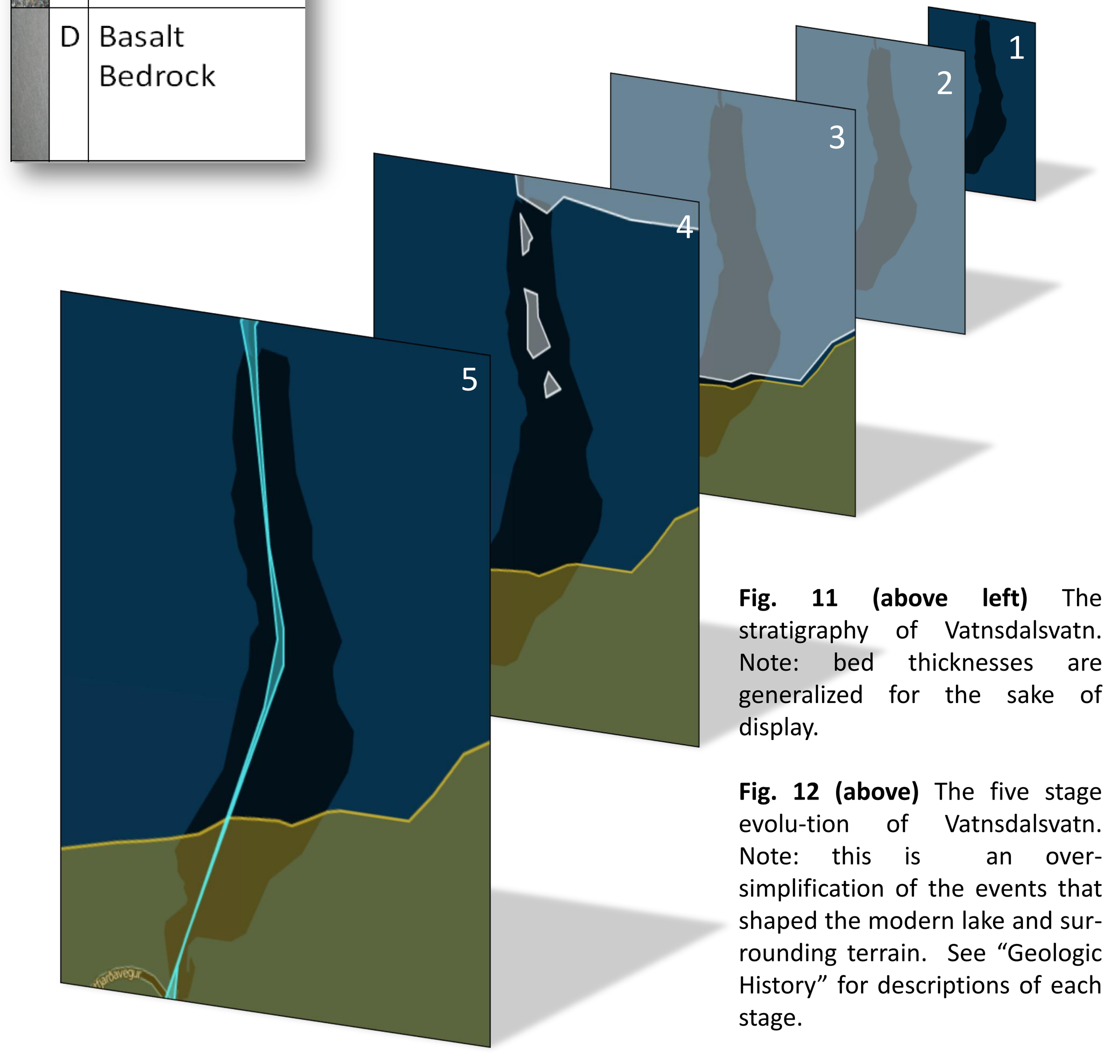


Fig. 11 (above left) The stratigraphy of Vatnsdalsvatn. Note: bed thicknesses are generalized for the sake of display.

Fig. 12 (above) The five stage evolu-tion of Vatnsdalsvatn. Note: this is an over-simplification of the events that shaped the modern lake and sur-rounding terrain. See "Geologic History" for descriptions of each stage.

FUTURE WORK

Loss on ignition and thin section analyses are currently underway and will provide a picture of Vatnsdalsvatn in even greater detail. To gain further understanding about modern deposition, the pinchout, deltas and terraces should be mapped because they are a prominent form of modern deposition. New, reliable cores are needed. Those used for this study were lacking specific coordinates which impeded correlation among data, most notably with SBP data.

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