Haukadalsvatn: moving toward a high resolution of environmental change

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Haukadalsvatn (3.3 km^2, max depth 42 m) is a glacier eroded valley lake at the head of Hvammsfjörður, western Iceland, with the largest part of the catchment (172 km^2) above 500 m a.s.l. This location results in high sedimentation rates that exceed 1.5 m/ka in the central basin. In summer 2003, we recovered two long sediment cores from the deepest basin, using the DOSECC GLAD-200 core rig. The cores captured the entire 30 m thick sediment fill; the lower 14m consist of rapidly deposited ice-proximal to ice-distal deglacial marine sediment, the upper 16 m are lacustrine. We have obtained several ^{14}C dates from the cores suggesting a basal age of ca. 13000 yr.

The sediment cores are very finely laminated with numerous thin tephra layers that aid in the correlation between Haukadalsvatn and other Icelandic lakes. A radiocarbon-based age model for the lacustrine portion indicates that sedimentation rates in the early Holocene were less than half the late Holocene sedimentation rates with a substantial increase around 4.5 ka. Newly obtained Biogenic Silica record indicates higher summer temperature in the early Holocene between 9 and 7 kyr. A strong initial decline in Biogenic Silica at about 4.5 ka signals the onset of early Neoglacial time. This is also reflected in fluctuations in Total Organic Carbon (TOC) content suggesting increased soil erosion and landscape instability. Even though there are no glaciers in the Haukadalsvatn catchment, increased periglacial activity and decreased vegetation cover in the surrounding highland areas as summer temperatures dropped is likely to encourage soil erosion.

The upper 4.5m represent the last 2000 years of sedimentation. This interval includes the Medieval Warm Period, the colonization of Iceland (ca. 1100 BP), the Little Ice Age (LIA), and 20th century warming. We have measured total organic carbon (TOC%) continuously at 3-year intervals (every cm) and Biogenic Silica at 10- to-15 year intervals (every 3 to 5 cm) for the past 2000 years. Against a background of about 1% carbon, several coherent intervals of higher carbon percentages occur, particularly between 150 and 300 years and from 450 and 850 years. An antiphase relationship to the TOC appears in the Biogenic Silica record for the same time period with low $BiSiO_2$ content (lower temperature) between 100 and 300 years and from 500 to 850 years. Studies of modern terrestrial and aquatic vegetation document a large difference in their $\partial^{13}C$, with terrestrial vegetation typically 8‰ lighter. The $\partial^{13}C$ of total organic carbon from Haukadalsvatn sediment indicates that carbon stored in the lake sediments is dominated by carbon from terrestrial sources. However, intervals of low total carbon concentrations are also periods of relatively heavy $\partial^{13}C$, suggesting that they represent intervals of reduced terrestrial erosion with a stronger contribution from aquatic sources. Overall, the interval from 2000 to 900 BP is characterized by relative stability with low rates of soil erosion, and slow rates of change. Sharp increases in soil erosion begin about 800 BP, ending late in the 19th century, broadly coincident with the LIA. This period of landscape instability is punctuated by about a century of landscape stability between 300 and 400 BP. This pattern broadly follows the historical record of sea ice variability off the coast of Iceland.