Sediment thickness and Holocene erosion rates derived from a seismic survey of Hvítárvatn, central Iceland.

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Abstract — More than 100 km of seismic reflection profiles of the sediment fill in the glacier-dominated lake Hvítárvatn, central Iceland, reveal over 65 m of stratified postglacial sediment in the main depositional basin. Five diagnostic seismostratigraphic units, defined on the basis of acoustic properties tied to lithostratigraphic breaks in sediment cores from the lake, can be traced throughout the sediment fill. Isopach maps of these units exhibit different spatial patterns, suggesting significant changes in the primary sediment delivery systems throughout the Holocene, and implying significant changes in the size and position of Langjökull. The mass of sediment in the lake is estimated to be between $35 \times 10^{13}$ g and $121 \times 10^{13}$ g. Suspended sediment loss from the lake currently averages $5 \times 10^{10}$ g of fine sediment each year. The average Holocene bedrock erosion rate across the catchment is calculated to be between 2 and 5 cm ka$^{-1}$, although actual erosion rates under Langjökull are probably much higher, whereas erosion across the non-glaciated portion of the catchment is presumably significantly less.

INTRODUCTION

Lake sediments are one of the most reliable sources of proxy data for paleoclimate reconstructions (Bradley, 1999). Glacial lakes in particular often have high sedimentation rates, and their sediment fill may be annually laminated (varved). Varve thickness commonly reflects climatic controls, especially through the influence of summer melting on sediment flux to the lake. However, glacial lakes can also experience large sediment gravity flows or glacier advances that may cause major disturbance of the sediments (Francus et al., 2002). Seismic surveys provide baseline information of the distribution, thickness, and nature of lacustrine sedimentation that allow an evaluation of the integrity of the sediment fill. In basins subject to disturbances, such as glacial advances, jökulhlaups, or other extreme events, they provide essential information required to design a successful sediment-coring program. Modern GPS-based seismic surveys are capable of providing secure estimates of the total volume of sediment and allow quantitative reconstruction of sediment distribution within lake basins. Seismic surveys, combined with lacustrine sediment cores, have been used to provide constraints on the glacial history of southern Iceland from Hestvatn (Hardardóttir et al., 2001) and to study changes in sediment delivery through the Holocene at Lagarfljót, eastern Iceland (Gudjonsson and Desloges, 1995).

Hvítárvatn is a glacier-dominated lake on the eastern margin of Langjökull, Iceland’s second largest ice cap (925 km$^2$; Figure 1). It is ideally positioned to provide a continuous record of Holocene climate change as: 1) glacial erosion and soft bedrock result in high lacustrine sedimentation rates, 2) diagnostic tephas of known age aid the geochronology, 3) Iceland’s sensitivity to changes in North Atlantic circulation is expected to produce clear signals in key environmental proxies preserved in the lacustrine