

SURFACE EXPOSURE DATING USING COSMOGENIC ^3He AT SKÁLAFELLSJÖKULL,
SOUTHEAST ICELAND

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Background and rationale

Surface exposure dating using cosmogenic nuclide dating has become a well-known and accepted dating technique in glacial geomorphology, used for understanding issues such as timing and extent of glacial advances (Darvill, 2013), using a variety of lithologies at any altitude and latitude (Gosse and Phillips, 2001). Cosmogenic nuclides such as

^3He , ^{10}Be , ^{14}C , ^{21}Ne , ^{26}Al and ^{36}Cl are the most used in surface exposure dating (Darvill, 2013), and are produced in surface materials as cosmic rays interact with the earth's surface (Licciardi *et al.*, 2007). Cosmogenic ^3He is a stable, noble gas isotope (Darvill, 2013) and has received less focus compared to other cosmogenic nuclides in surface exposure dating (Blard, 2021). The use of ^3He requires specific lithologies, like mafic rocks such as basalt, which

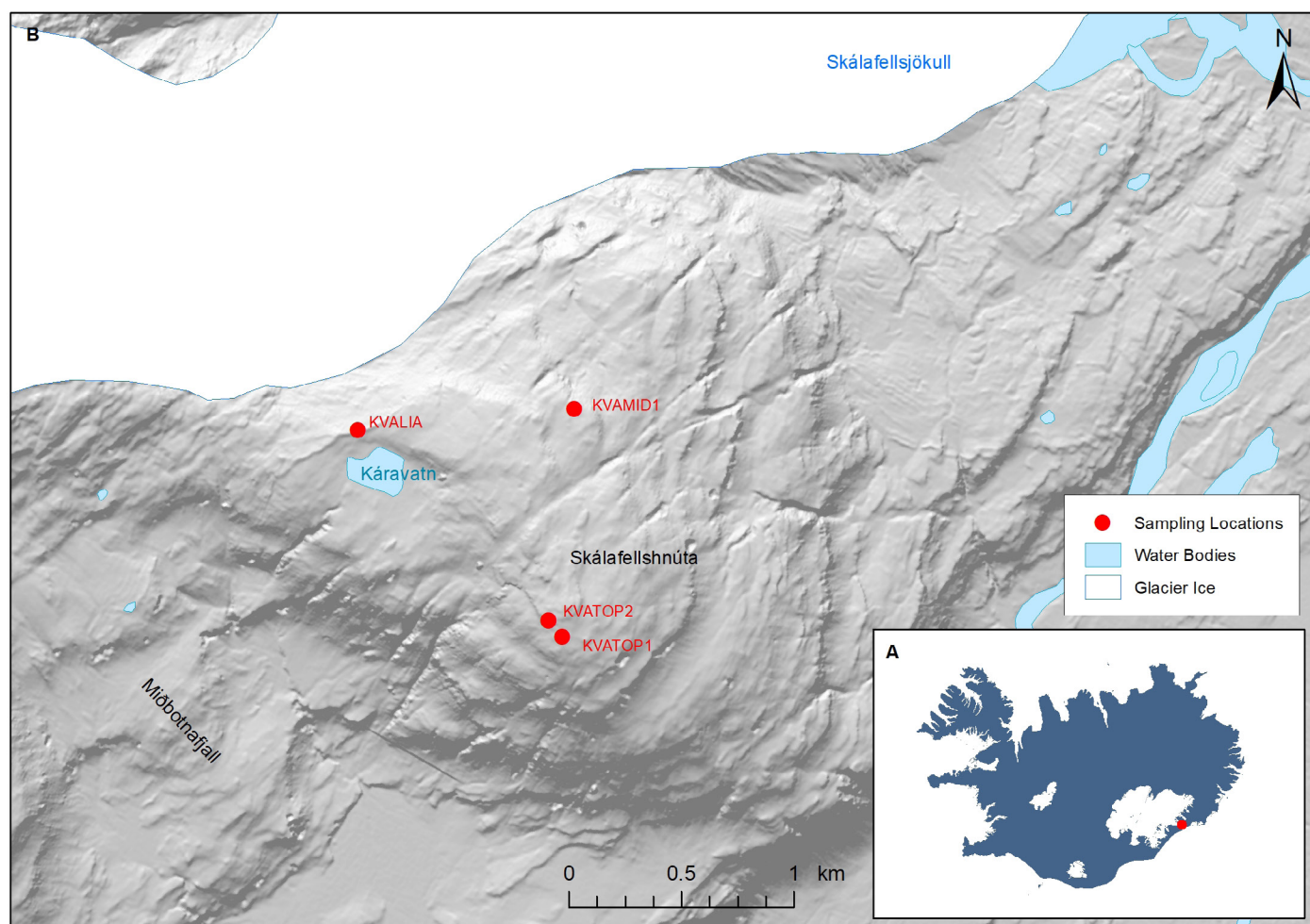


Figure 1. Map displaying the study area in southeast Iceland (A) and sampling locations (B). Hill shade from Arctic 2 m DEM (Porter *et al.*, 2018). Based on data from the National Land Survey of Iceland (IS 50V | National Land Survey of Iceland (lmi.is)).

contain olivine and pyroxene (Blard, 2021). Surface exposure dating using cosmogenic ^3He has been used in a variety of applications in Iceland focusing on dating postglacial basalt flows (Licciardi *et al.*, 2006), ice sheet surface elevation and thickness (Licciardi *et al.*, 2007), extreme flood events (Baynes *et al.*, 2015), and river terraces (de Quay *et al.*, 2019). This highlights the potential for using cosmogenic ^3He to date glacial extent and ice thickness from glacial landforms such as glacial erratics and bedrock using basaltic lithologies in southeast Iceland.

Funding from the QRA New Research Workers Award (NRWA) was used for sample processing at the Palaeoenvironmental Research Unit at the National University of Ireland, Galway (NUI). Funding from the QRA NRWA will also be used for further analysis of the processed samples using an accelerator mass spectrometer (AMS).

Methods and Results

Skálafellsjökull is an outlet glacier from the southeast margin of the Vatnajökull ice cap in southeast Iceland (Figure 1). Samples for cosmogenic ^3He nuclide dating have been collected from boulders and bedrock at different elevations, ranging from ~480 to ~650, from Skálafellshnúta (~653 m a.s.l), south of Skálafellsjökull (Figure 1 and Figure 2A, B, C and D). Samples were processed at the National University of Ireland in Galway, following methods outlined in Bromley *et al.* (2014). Samples were crushed, pulverised, and sieved to 150-250 μm and 250-500 μm size fraction, before separation (Figure 2E, F, G and H). The samples were washed with water to remove dust and lichen before adding Hydrochloric acid (HCl) and heated using a hot plate to dissolve any metals. The HCl was removed, and the samples were washed using water before leaving to dry through completely. Heavy liquid, lithium sodium heteropoly tungstate (LST), was used to separate the pyroxene from the rest of the crushed samples. Measurements of ^3He will be carried out using an AMS.

Significance

Glacial reconstruction in southeast Iceland has mostly focused on the LIA (LIA; ca. 1250-1900 AD; Geirsdóttir *et al.*, 2009), and retreat since this period. Dating techniques such as lichenometry (e.g., Bradwell *et al.*, 2006), tephrochronology (e.g., McKinney *et al.*, 2005) and Schmidt Hammer dating (e.g., Evans *et al.*, 1999) have been used in southeast

Iceland to date LIA moraines in the forefield of southeast Vatnajökull outlet glaciers. However, no cosmogenic nuclide dating has been carried out in the southeast. The use of this method will be valuable for constraining ice thickness in southeast Iceland during the Holocene, which is useful for developing accurate models of the Icelandic Ice sheet (IIS) throughout the Younger Dryas and Holocene (e.g., Hubbard *et al.*, 2006). This research will also be useful for assessing the application of surface exposure dating glacial landforms such as glacial erratic boulders and glacially polished bedrock using cosmogenic ^3He in southeast Iceland.

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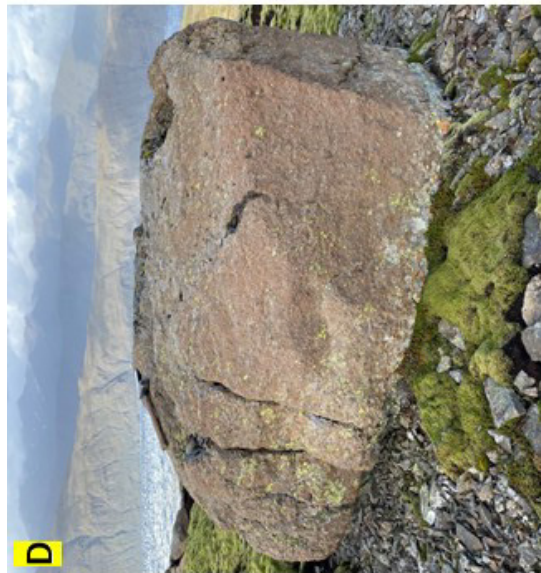


Figure 2. Images showing sample sites KVALIA (A), KVATOP1 (B), KVATOP2 (C) and KVAMID1 (D). Images showing lab work at NUI Galway, displaying rock crushing (E), sieving (F), heavy liquid separation (G) and pyroxene within the crushed sample under a stereo microscope (red circle) (H).

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