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Geomorphic Evolution of the Gígjökull Basin

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High magnitude volcanically-induced jökulhlaups (glacial outburst floods) can deposit significant volumes of sediment and ice, causing major landscape change and potential environmental management issues. The 2010 Eyjafjallajökull eruption and its associated jökulhlaups provide a perfect opportunity to reconstruct jökulhlaup hydrological processes, to test conceptual models of jökulhlaup sediment deposition and post-depositional landscape change. Combining new low-frequency (40 MHz) ground penetrating radar (GPR) and differential GPS surveys of the Gígjökull basin with existing datasets, we have: (1) geophysically characterised the deposits associated with the 2010 Eyjafjallajökull eruption; and (2) quantified post-depositional (2010-2016) elevation change, to evaluate the role of buried ice on post-jökulhlaup landscape response and recovery.

The Gígjökull basin jökulhlaup deposits are up to 80 m thick and are characterised by 4-5 macro-scale sedimentary units, delimited by strong continuous reflectors. Two extensive units bounded by the former lake bed and an internal reflection are inferred to be linked to the highest magnitude jökulhlaups. The abundance of meltout structures and ice-block obstacle marks within these units indicates the widespread and rapid deposition of ice, as well as the ice-distal post-event modification of sediments by degradation of buried ice-blocks. Upper sedimentary units are linked to lower magnitude and waning stage jökulhlaup events. These units are typically characterised by down-flow dipping structures at angles of $\sim$30-35°, inferred to be dune forms preserved through the rapid aggradation of the sediment body. The reduced number of ice-block obstacle marks within these units indicates a lower concentration of ice-block deposition within the later lower magnitude flood flows. Our geodetic observations demonstrate significant lowering of parts of the surface of the jökulhlaup sediments over the six years since deposition (i.e. 0.46 m a-1 between 2010 and 2015; increasing to 1.93 m a-1 between 2015 and 2016), interpreted to be the result of the meltout of buried ice within the deposits.

Our geophysical data adds to the limited inventory of GPR-characterised jökulhlaup sediments in Iceland and around the world. The use of GPR data in conjunction with geodetic datasets, and primary jökulhlaup observations allows for a convincing conceptual model of the Gígjökull deposits to be created, incorporating primary and post-depositional processes. The findings from this study offer new insights into the depositional processes, post-depositional modifications, and hazard potential of ice-rich and volcanogenic jökulhlaups.