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Glass shard chemistry and the identification of microscopic tephra isochrons

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The chemical characteristics of single glass shards can be a powerful means of identifying microscopic tephras and the isochrons they may form, but the utility of shard chemistry depends on a range of variable factors. These issues are explored through an assessment of Icelandic tephra layers in proximal areas and in Holocene deposits in the Faroe Islands and the UK. The differing diagnostic power of tephra geochemistry is highly conditional and rarely 'absolute'; it depends upon both the character of the source volcano and other environmental factors that vary spatially and through time. Some eruptions produce glass shards with quite distinctive chemistries, while others may be of very similar chemistries. Whether these chemistries can be used to definitively identify specific tephras, or not, depends on the age of the tephra and local stratigraphies, in particular the closely related presence or absence of other tephras and other palaeoenvironmental indicators. There are fundamental differences in the scope for correlation of Icelandic tephra deposits of different ages, and three broad categories may be identified. Firstly tephras produced since the Norse colonization (or landnám) of Iceland, roughly speaking Icelandic 'historical age' tephras. Secondly, tephras formed before landnám and yet after the early Holocene deglaciation; thirdly, tephras produced before the early Holocene, when most of the island was glaciated and the geography of areas receiving distal fallout was also very different. 'Historical-age' tephras are best-known, and good proximal records are known (or potentially exist) for most tephras produced since Icelandic glaciers retreated to approximately their current limits and soil formation became extensive. Within this 'prehistoric' part of the Icelandic Holocene there are some periods and areas of greater uncertainty (such as the immediate aftermath in areas affected by major eruptions), and the record generally deteriorates with time because its quality is related to the progressive devel-

opment of soils across Iceland. The third category of the Icelandic tephra record, that for earlier times, has the greatest general uncertainty because of the absence of an effective, wide spread proximal record in Iceland. Further qualifications to the utility of shard chemistry relate to the associated stratigraphy; for example, shard chemistries may be effectively replicated in different eruptions, but if these eruptions are large and infrequent, identification may still be unambiguous. Alternatively, equally good identifications may also be achieved in a sequence with many very similar tephras if a 'stratigraphic barcode' can be established. Crucially these approaches rely on a good knowledge of volcanic history and a high quality stratigraphic record. Complications to the process of tephra isochron identification exist where tephras have been reworked, and although shard identification may be accurate, the current stratigraphic context of the shard may not be of the same age. This process may arise as a result of both localized and more distant sediment erosion and transport. Although this process of tephra re-deposition complicates the identification of isochrons, it also forms a valuable record of past environmental processes.