Early Holocene Tephrochronology in West Iceland and its Application for Paleoclimate Studies

Guðrún Eva Jóhannsdóttir, Þorvaldur Þórðarson, Áslaug Geirsdóttir,
Earth Science Institute, University of Iceland, 101 Reykjavík (gudrunb@hi.is)

The climate in Iceland is sensitive to changes in the North Atlantic circulation because of its location at the boundary of the cold East Greenland and warm Irminger currents. This factor along with high sediment accumulation rates (up to 5 m per 1000 yrs) makes lacustrine sediments in Iceland ideal for studying the timing and magnitude of Holocene climate events. Accurate high-resolution age determinations of the sediments support stratigraphic correlations and are critical for paleoclimate and paleoenvironmental research. Explosive basalt to rhyolite volcanism in Iceland has produced numerous widespread tephra fall deposits that are important marker horizons in Holocene sedimentary sequences. Consequently, tephra layers of known age are ideal for stratigraphic correlations and high precision dating. Furthermore, AMS ^{14}C age determinations of lake sediments in Iceland give inaccurate and inconsistent results. Therefore, an accurate tephrochronological record together with continuous paleomagnetic records from these sediment cores underpins the construction of an unambiguous high-resolution chronology across the marine and land based sedimentary environments.

We have established the tephra stratigraphy of sediment cores from four lakes lying on a transect from south to northwest Iceland, which collectively provide a near-continuous high resolution tephrochronological record extending as far back as 12 ka BP. Here we focus on the period from 4 to 12 ka BP. The geographic distribution of the lakes as well as their position relative to the active volcanic zones in Iceland allow us to discriminate between marker layers of regional and local importance. A total of 86 layers have been analyzed in the cores for the period in question, 80 of which are basaltic, 3 are dacitic and 3 rhyolitic. Most of the layers (94%) are produced by subglacial eruptions at ice-capped volcanoes in the Eastern Volcanic Zone (EVZ). The phreatomagmatic origin of the basaltic layers indicates that water to magma interactions, which amplify explosivity of eruptions, play a critical role in forming widespread basaltic tephra layers.

Thus far we have identified 6 large regional marker layers, the Vedde tephra (~11,980 cal BP), the SILK A9 and A8 layers (~7,500 and 7,300 cal BP) and the H5 and H4 layers (~7,000 and 4,260 cal BP). We have also identified three successive layers at about 10,000 cal BP formed by eruptions spaced over approximately 100 years. These three layers are identical in major element composition to the Saksunarvatn tephra (10,180 cal BP) but which of the three is Saksunarvatn is not known at this stage. Furthermore we have identified 12 layers of more local importance that can be correlated between at least two sites. These are three layers from the Veiðivötn volcanic system (ThE-1 ~9,175 cal BP, ThB-2 ~8,680 cal BP and ThB-1 ~8,560 cal BP), two mildly alkaline layers most likely originating in the Hekla or Vatnafjöll volcanic systems (AlB-1 ~8,930 cal BP and the T tephra ~6,120 cal BP), five layers from the Katla volcanic system, similar in chemistry but distinguishable by slightly different MgO and CaO contents (AlA-5 ~8,830 cal BP, AlA-4 ~7,090 cal BP, AlA-3 ~6,830 cal BP, AlA-2 ~6,710 cal BP and AlA-1 ~6,340 cal BP), one layer originating in the Grímsvötn volcanic system resembling the composition of the Saksunarvatn tephra but with a slightly lower TiO_2 content and ca 1,500 years younger (ThA-1 ~8,700 cal BP), and lastly one layer with low Na_2O and K_2O contents, presumably originating in the Western Volcanic Zone (ThH-1 ~8,610 cal BP).