

Tephra layers as part of Holocene volcanic history

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Explosive volcanic eruptions - eruptions where the products are partly or solely tephra - are a substantial part of volcanism in Iceland. In the majority of the explosive eruptions the magma is basaltic, the reason for the explosivity being the presence of ice and water in the volcanic areas.

Tephra layers can be regarded as data files on the eruption history of volcanic systems where explosive eruptions are a dominant or substantial part of the activity. Each tephra layer also preserves a record of the eruption that produced it, information on the type of activity and course of events can be obtained from grain size and type, dispersal patterns of the tephra and structures in the tephra deposit. Mapping of the deposits indicates the source of the tephra and the magnitude of the eruption. Chemical composition of the volcanic glass can also correlate the tephra to a source volcano. In Icelandic terrestrial soils the tephra record may cover the last 8000-9000 years. In marine sediments the record is much longer and will not be treated here.

The tephra record is not complete for various reasons. The preservation potential of the tephra varies, depending on the environment. Tephra deposited in lakes and in vegetated areas is most likely to be preserved. Tephra deposited on ice caps has a limited residence time, currently about 1000 years in case of Vatnajökull. Small eruptions in volcanoes within Vatnajökull may only deposit tephra within the regime of the ice cap. Much information has also been lost where large areas have been denuded by wind ablation or covered by lava flows and jökulhlaups. However, a great deal of information still exists.

The eruption history of the past 11 centuries is fairly well known. Over 200 eruptions have been verified by analysis of their eruption products and/or by trustworthy written sources. Less certain events are excluded here. In about 130 of these eruptions tephra was the only product and another 25 eruptions produced substantial tephra deposits in addition to lava flows. Hence over 75% of the verified eruptions left a tephra layer and about 65% left only a tephra layer. Obviously, the great deal of the eruption record of these last 11 centuries is preserved as tephra layers. The eruption history of the four most active volcanic systems, the Grímsvötn-, Katla- Veidivötn- and Hekla systems, has been revealed through studies of tephra layers and written records. Some of the largest explosive eruptions, such as the 15th century Veidivötn eruption, are however barely mentioned in the old documents - in this case the tephra told the story. Periodic eruptive activity in volcanoes below Vatnajökull was revealed by studies of tephra layers in the ice.

The prehistoric eruption history is less well known. Several hundred prehistoric tephra layers are anticipated and most of them are thought to originate in the four volcanic systems mentioned above. The best known prehistoric eruption record is that of the Katla system, to be treated in another paper at this symposium. The eruption record of the Grímsvötn system is, however, partly lost because the Vatnajökull ice that contained that record has long since melted away. The largest explosive eruptions of Hekla took place 3000 and 4300 years ago and spread tephra over 80% of Iceland.

Individual tephra layers can be used as isochrons or time-parallel marker-horizons within the tephra-fall area - which may cover several hundred thousand square kilometers. Once a tephra layer has been dated that particular date applies to all the area where the tephra layer is found. In the 1930ies Sigurdur Thorarinsson began his pionering research to develop tephrochronology as a tool for dating, a method now used world-wide in various branches of environmental sciences as well as in geosciences. In Iceland tephrochronology and eruption history are closely tied, with the Hekla volcano as a central point.