



The Bárðarbunga central volcano, crustal structure and eruption history

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The Bárðarbunga central volcano is located in the northwestern part of Vatnajökull, the largest ice cap in Iceland. The volcano forms the centre of the largest volcanic system in Iceland, about 190 km long. Bárðarbunga rises 1000-1200 metres above the bedrock around it and is heavily ice covered. The caldera is fully subglacial and none of the inner rims are exposed. The caldera is elliptical in shape with the long axis trending roughly E-W. The area within the topographic rims is 65 km² and the bottom of the caldera lies 600-700 m below the subglacial rims while the ice is 700-850 m thick in the caldera. Bárðarbunga has a positive Bouguer gravity anomaly of about 20 mGals, caused by dense intrusions in the uppermost 4-5 km of the crust. Superimposed on this gravity high is a smaller relative gravity low caused by a shallow body in the uppermost 2-3 km, with a center slightly to the southeast of the midpoint of the caldera. Minor geothermal activity has been detected as small ice cauldrons over the subglacial caldera rim in two places. Seismic activity was relatively high in Bárðarbunga for decades before the present unrest, with M5 events occurring annually for over two decades prior to 1996, but displaying a more varied activity between 1996 and 2014. Tephrochronology has revealed the Holocene volcanic history of the Bárðarbunga system. Holocene products have been almost exclusively basaltic. During the period since the settlement of Iceland (the last ~1100 years) the Bárðarbunga system has been highly active. The historical activity includes sizable effusive eruptions occurring in the fissure swarm to the north of Vatnajökull, the largest being the 4 km³ Frambruni lava field formed before the 13th century. It also includes two large basaltic explosive eruptions (VEI 5 and VEI 5-6) on the fissure swarm to the southwest of Vatnajökull. Several moderate-sized subglacial to explosive phreatomagmatic eruptions have occurred on the ice covered part of the fissure swarm to the northeast of Bárðarbunga, notably in the early part of the 18th century. Pre-historic Holocene activity includes a large number of basaltic phreatomagmatic eruptions, the deposits being partly preserved as tephra layers in soil. Pre-historic activity also includes early to mid Holocene flood basalt lava flows and shields including some of the largest found in Iceland. Bárðarbunga is also considered to be the source of catastrophic jökulhlaups towards north in the early to mid-Holocene, leading to the formation of the Jökulsárgljúfur canyon. The meltwater in these floods may have been generated by eruptions within the caldera, allowing considerable accumulation of meltwater before drainage. The present activity may be an example of one mode of behaviour of basaltic calderas on Iceland. This mode of behaviour implies that caldera collapse can be gradual and incremental and associated with large fissure eruptions on the fissure swarms.