Holocene major eruptions

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During the Holocene, Iceland has experienced more than 20 eruptions per century from about 30 active volcanoes. The magmatic production is completely dominated by basalts. Intermediary and rhyolitic rocks make up less than 10%. The distribution is calculated to 91:6:3 (basalt / intermediate / rhyolitic) by Thordarson and Höskulsson (2008). They estimate that 2,400 eruptions has occurred and about 566 ± 100 km^3 of erupted material has been generated the last 11,000 years. This is the estimate of erupted material, which is only a part of the magma activated in the crust. Experience from the Krafla eruption and rifting episode 1975-84 suggests about 25% of the material in circulation made it to the surface. Using this observation, more than 2,000 km^3 have been activated during the Holocene. Deglaciation in Iceland at the end of the Weichselian glaciation, about 10,000 years BP, was associated with rapid glacial rebound, apparently reaching completion in only about 1,000 years in coastal areas. This exceptionally fast postglacial rebound suggests an increased eruptive activity. During the deglaciation of Iceland, at the Pleistocene-Holocene boundary, eruption rate is inferred to have been about 30-100 times its steady state. Increased decompressional mantle melting due to ice removal has been suggested as the main cause of the increase in melt production during deglaciation. The formation of more than ten lava shields with an erupted volume in the range of 20 km ^{3} were formed in a narrow time after the deglaciation. These lava shields are composed of numerous thin basaltic lava flows. Basaltic fissure eruptions are a common feature in Iceland as it is located on the mid Atlantic rift. The Thjorsa lava flow in South Iceland originates from the Bardabunga volcanic system and is dated by Hjartarson (1988) to 8,600 BP and can be tied to the enhanced activity in the aftermath of the glaciation. This lava flow is the largest fissure eruption during the Holocene with a total volume of 25km^3 (Halldorsson et al., 2008). It originates from the Bardarbunga volcanic system - the most productive part of the eastern volcanic system during the Holocene (Halldorsson et al., 2008). Two other fissure eruptions in the eastern volcanic zone which have occurred in historic times are the Eldgja eruption 934-940 AD and the Laki eruption 1783-84. Eldgja produced 19.6 km^3 and the Laki eruption 15.1 km^3 (Thordarson and Self, 2003). Despite the slightly less material produced, the Laki eruption had the most devastating impact on population and environment. The Laki eruption emitted 122 megatons of SO_2 into the atmosphere; this resulted in a sulfuric aerosol hanging over the northern hemisphere for more than five months (Thordarson and Self, 2003). Large Plinian eruptions, often silicic, also take place in Iceland despite its location on a mid oceanic ridge. By volume, the basaltic eruptions are the largest and can impact a large area occasionally with ash and aerosols, but the explosive intermediate and silicic eruptions can disperse ash widely. One type of large silicic eruption take place in volcanoes with a developed shallow magma chamber, which is given time to differentiate and can result in an explosive eruption. It can be triggered by an intrusion of basaltic magma. Those explosive eruptions can be followed by the formations of a caldera. Several calderas have been formed in the Holocene, both the largest and the most recent can be found in the volcano Askja (northern Iceland). The largest with a diameter of 8 km formed in the beginning of Holocene producing a silicic (pumice) layer. The most recent caldera formation started 1875 with an explosive eruption ejecting 2.5 km^3 dense-rock equivalents (DRE), and it took thirty years until the present day caldera (4.5 km in diameter) reached its present shape. The pumice from the 1875 eruption devastated a farming district in eastern Iceland and the ash spread to Scandinavia. The internationally best-known Icelandic volcano (until 17th April when Eyjafjallajökull started) with a name that is easier pronounced is Hekla. It is currently one of the three most active volcanoes in Iceland with twenty summit eruptions. The first traces of Hekla as an evolved volcanic centre (erupting basaltic andersite to rhyolite) probably occurred in early Holocene time (Sverrisdottir, 2007). The explosive magmatism in Hekla has produced several distinct silicic ash layers. The largest of these silicic ash layers are named H5, H4 and H3. These conspicuous ash layers are easy to recognize by their white color. They are wide spread and are excellent marker horizons. The first recorded

silicic eruption in Hekla is H5, with a volume of 0.7 km^3 DRE, and it is dated to roughly 7,000 years ago. The H4 ash layer has a volume of 1.8 km^3 and is dated to 4,200 BP. The most voluminous silicic ash from Hekla is the 3,900 BP old H3 layer with 2.2 km^3. All the volumes and datings above are taken from a compellation done by Sverrisdottir (2007). Despite all the large explosive silicic eruptions, no caldera has been formed in Hekla. A deep-seated magma chamber under the volcano can explain this. Hekla has a characteristic pattern, as the longer response time between eruptions the more silicic is the initial products in the explosive phase of the eruption. This is attributed to differentiation in a magma chamber, the longer time the more silicic material accumulated at its top. The response time of the most recent eruptions has been ten years giving pathetic eruptions with a short duration and low initial silicic contents. The next major eruption expected is a phreatomagmatic eruption in Katla that most likely will produce material in the cubic kilometer scale.

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