Subglacial Eruptions, effects of ice-volcano interaction on eruption style and edifice form

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Subglacial eruptions are presently an important part of volcanism in Iceland and have been the dominant style of activity during Pleistocene glaciations. Deposits of subglacial eruptions are also found in high latitudes in both the southern and northern hemisphere and ice-volcano interaction occurs on several strato-volcanoes around the world. Recent eruptions in Iceland have provided new data on eruptions in temperate ice caps. The most important of those is the Gjalp eruption in 1996, but an eruption in Grimsvotn in 1998 and subglacial activity in Myrdalsjokull in 1999 have also provided new insight. In most subglacial eruptions it seems that the surrounding ice acts as a mould, resulting in the formation of steep-sided piles of volcanic material. Ice thickness is a major factor in determining the response of a glacier to a subglacial eruption. When the glacier is thin (<200 m) the ice is relatively stiff and ice flow towards the vent is limited. In such cases eruptions quickly become subaerial and preatomagmatic. In contrast, ice flow towards vent under thick ice is much greater, delaying the onset of a subaerial phase as the loss of ice by melting is partly compensated by inflow of the surrounding ice. Observed heat flow rates suggest that fragmentation of magma is very common and probably dominant for eruptions under ice up to 500-600 m thick. Subglacial water pressure is most influential in controlling the style of activity. In most cases basal water pressure is similar to ice overburden load. However, ice disruption, fracture, deformation and subsidence may decrease the water pressure locally. Subsequent drainage of meltwater may also decrease water pressure at the vents. This is a major difference when compared with eruptions occurring in lakes and on the ocean floor where water level remains stable. In most observed cases, more or less continuous drainage of meltwater has occurred. Drainage is predominantly along the base of the glacier. The commonly observed forms of volcanic edifices created in subglacial eruptions are steep-sided ridges and tuyas. This seems to apply to large ice caps and ice sheets where surface and bedrock slopes are small. Where slopes are greater a large part of the erupted material may be transported with the meltwater.