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What controls the explosivity of subglacial rhyolite in Iceland?

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The eruption controls of subglacial rhyolite are poorly understood but this is of key importance in mitigating hazards. In subaerial rhyolite eruptions the pre-eruptive volatile content and degassing path are considered to be the primary controls of explosivity, but is this also the case when rhyolitic eruptions occur under ice? We present the first pre-eruptive volatile content and degassing path data for subglacial rhyolite eruptions, comparing three edifices of contrasting eruption style from the Torfajökull complex in South Iceland[1]. Volatile concentrations were measured using infra-red spectroscopy (FTIR) and Secondary Ion Mass Spectroscopy (SIMS).

SE Rauðfossafjöll is a large volume ($\sim$1 km3) explosively erupted tuya, Dalakvísl ($\sim$0.2 km3) is an entirely subglacial edifice that has both explosive and effusive deposits and Bláhnúkur is a small volume (<0.1 km3), effusive and entirely subglacial edifice[2]. High pre-eruptive H_2O contents can be linked with the eruptions of SE Rauðfossafjöll and Dalakvísl whilst Bláhnúkur contains H_2O-poor melt inclusions. Furthermore, there is variation in the eruptive products of Dalakvísl, with the explosive deposits containing a slightly higher pre-eruptive H_2O content than the effusive deposits. In terms of degassing paths, SE Rauðfossafjöll and the explosive deposits on Dalakvísl show evidence of closed system degassing whilst Bláhnúkur and the effusive deposits on Dalakvísl show evidence of open system degassing. It therefore appears that the explosivity of subglacial rhyolite eruptions is primarily controlled by the pre-eruptive magma volatile content and degassing path, rather than ice thickness or meltwater hydrology, as previous speculated[3]

[1] McGarvie (2009) JVGR, 185(4): 357–389
[2] Owen et al. (in review) Bull Vol.
[3] Tuffen et al. (2007) Ann Glac, 45(1): 87-94