

Atmospheric processes affecting the separation of volcanic ash and SO₂ in volcanic eruptions:

Inferences from the May 2011 Grímsvötn eruption: Supplementary Material

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1 Supplementary Photographs

A series of photographs taken from the ground and from aircraft flights during the initial phase of the Grímsvötn eruption are included here. The photographs are annotated with interpretations of notable features.

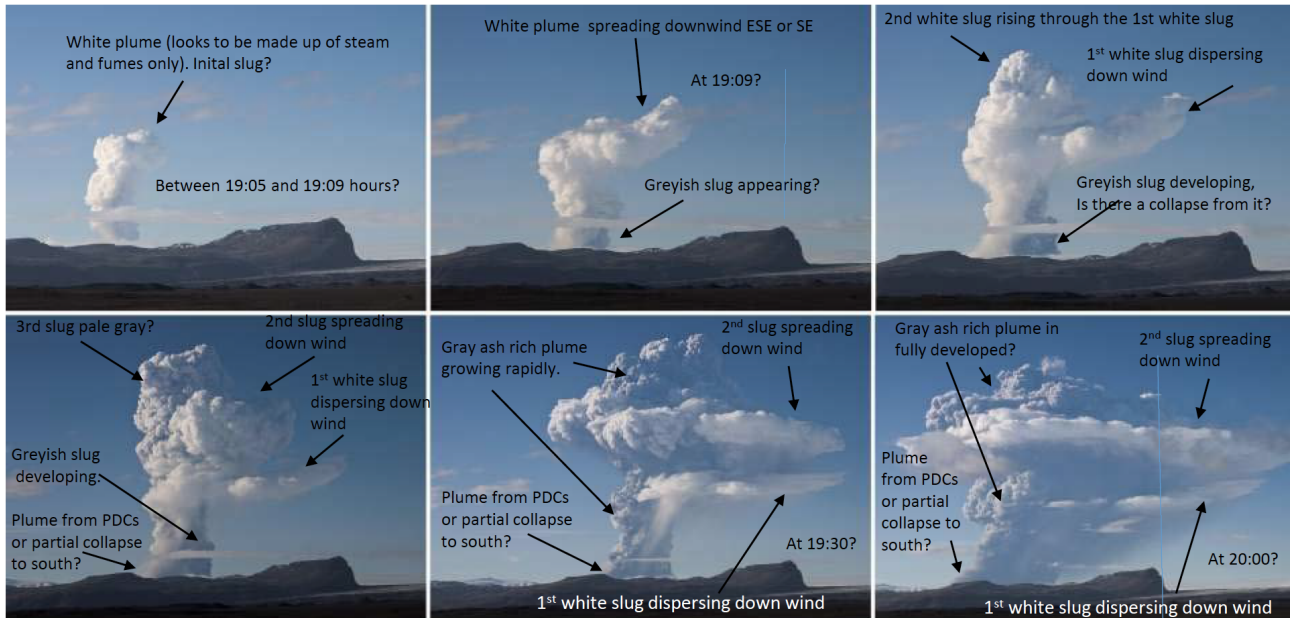


Figure P1. This series is very revealing about the early development of the plume. It appears to start as a white (i.e. steam+gas rich) slug rising to ~ 8 km before beginning to disperse down wind (2nd panel). There appears to be a greyish coloured slug appearing at the base of the plume (lower arrow). On the 3d panel, a 2nd white slug punches through the first increasing the plume height by one third, the greyish slug is present at the base of the plume and may be revealing a partial column collapse (lowest arrow). The 4th panel shows what appears to be the 3rd slug, slightly greyer than the first two (possibly containing tephra/ash). A darker column, containing more solid material, at the base and a possible partial collapse to the south from the lowest part of the plume (alternatively, this could be cloud rising from directed PDCs). The 5th panel shows that the grey (tephra-rich) plume has taken over and reaching full heights (~ 20 km) at $\sim 19:30$ UTC. The 6th panel features the maintained 20 km high plume that appears to be broadening, induced by gravitational instabilities and or wind shear. Photographs acquired from the real-time webcam– no times were available.

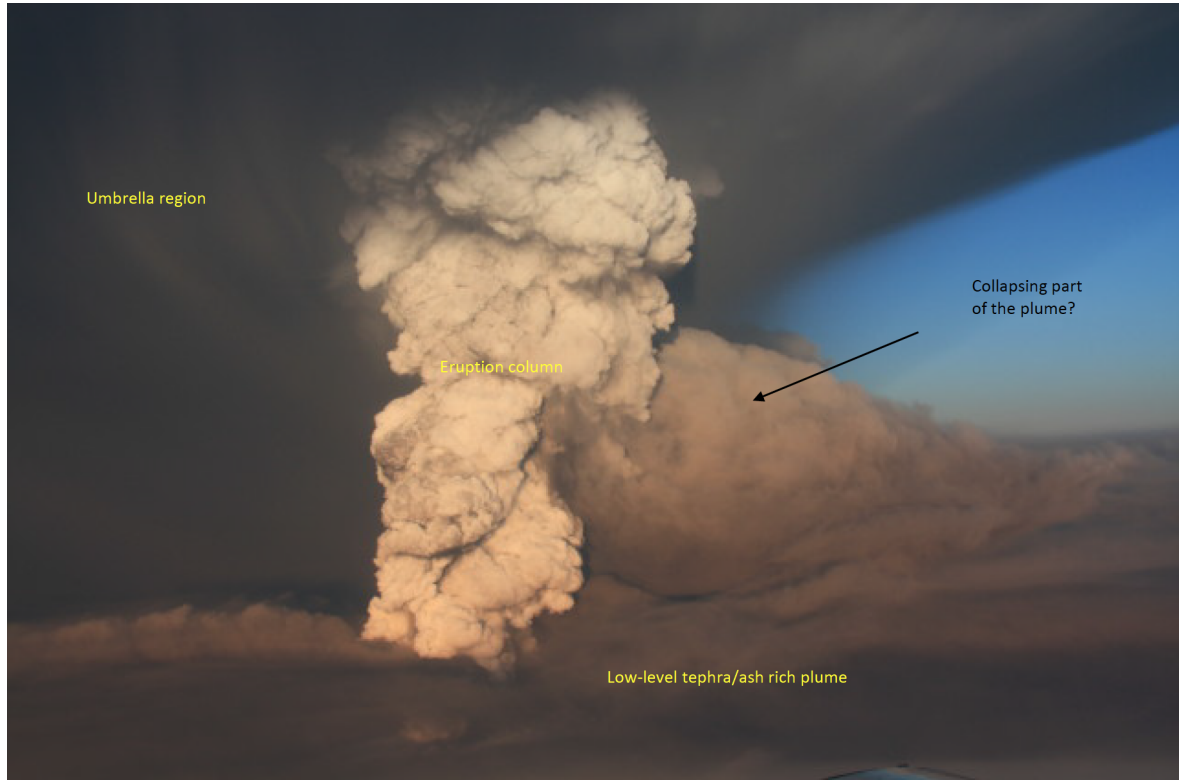


Figure P2. Aerial photograph taken on 21 May at 22:37 UTC showing a possible partial collapse of the column. Photo courtesy of Þórdís Högnadóttir.

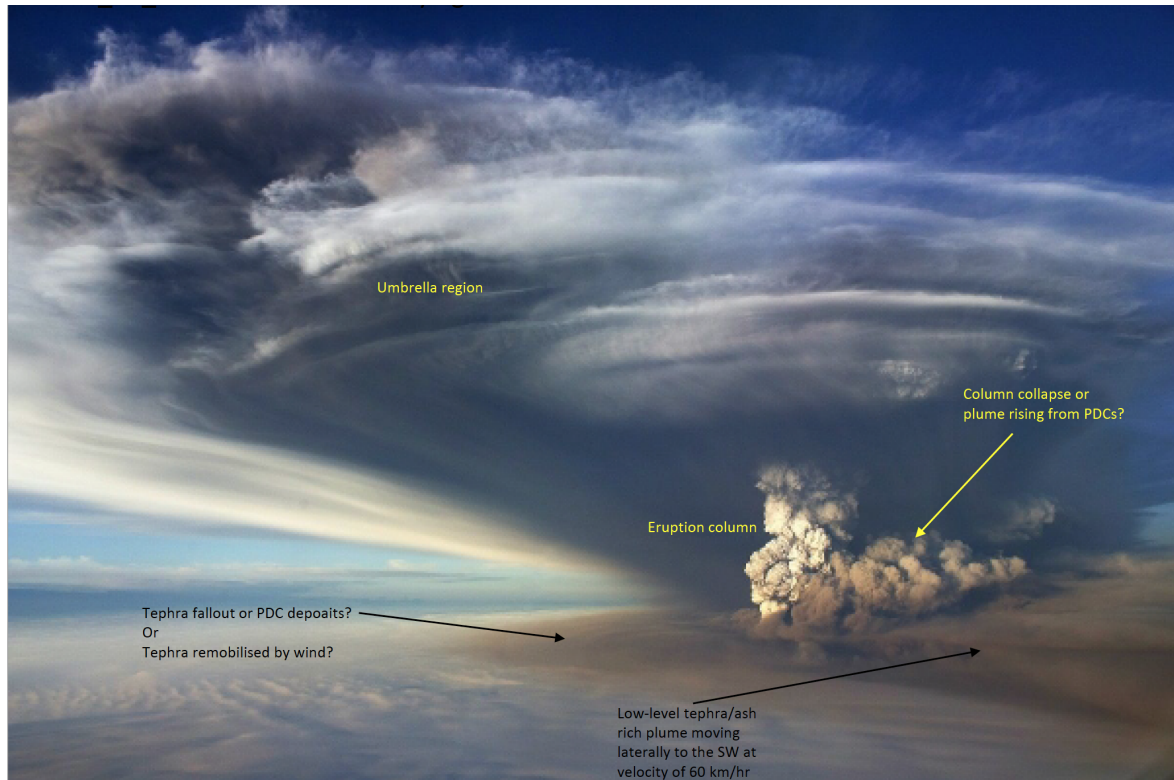


Figure P3. Aerial photograph taken on 21 May (no time supplied) showing a possible partial collapse of the column or perhaps a plume rising from a PDC. Photo courtesy of Egill Aðalsteinsson.

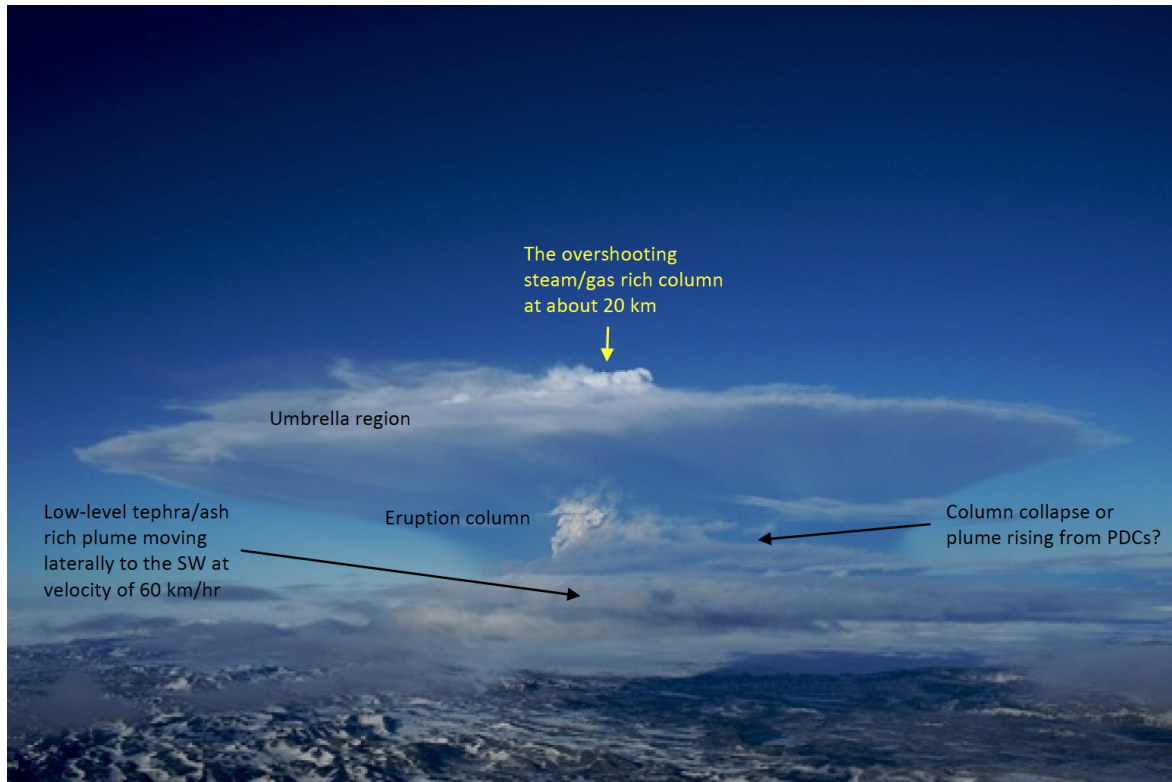


Figure P4. Aerial photograph taken on 21 May at 20:16 UTC showing the structure of the rising plume, the spreading of the high-level umbrella and low level tephra/ash rich plumes moving laterally. A possible partial column collapse is also indicated on the photo. Photo courtesy of Ólafur Sigurjónsson.

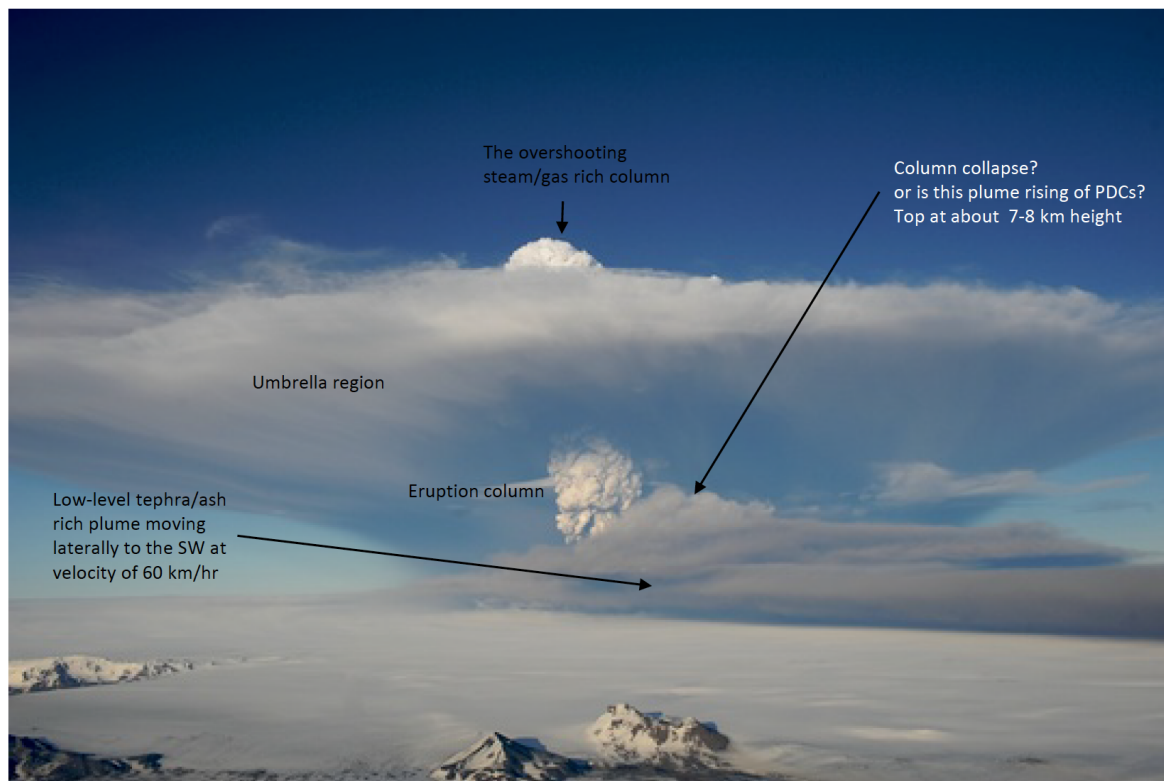


Figure P5. Aerial photograph taken on 21 May at 20:23 UTC, 6 minutes after the photo shown in Fig. P4. The direction of view is to the east and the low-level plume top height is estimated to be $\sim 7-8$ km. Photo courtesy of Ólafur Sigurjónsson.



Figure P6. Photo from the aeroplane TF-SPA flying between the umbrella cloud and the lower level tephra-rich plume on 21 May at 20:58 UTC. The separation of the upper- and lower-level plumes is clearly evident. Photo courtesy Andri Orrason.

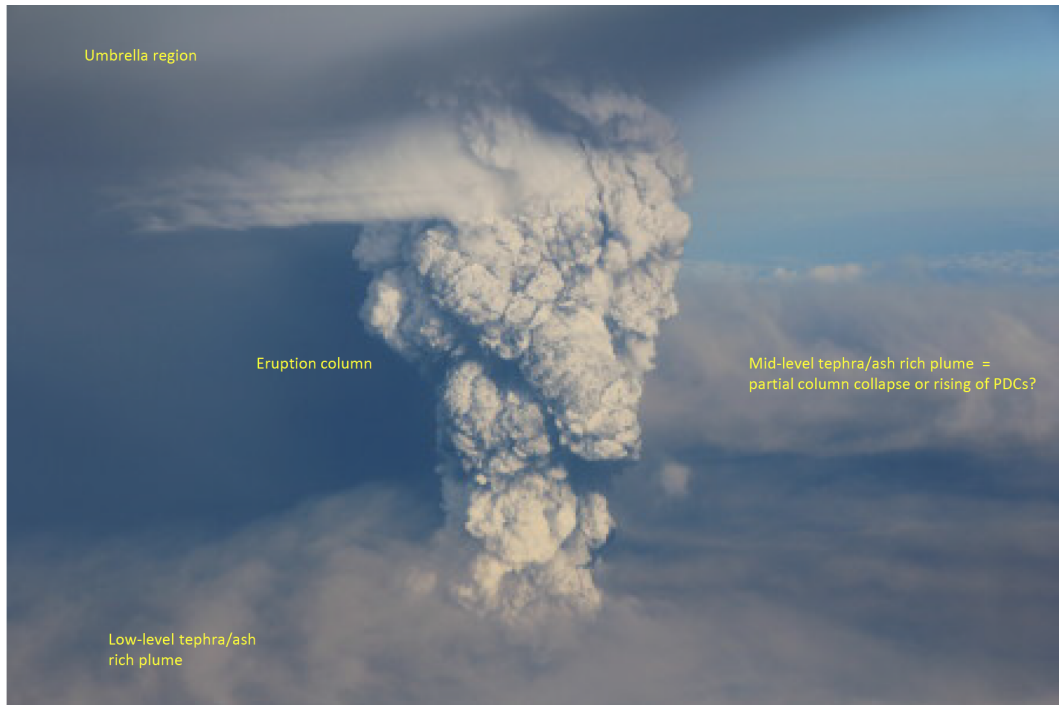


Figure P7. Aerial photo taken on 21 May at 21:03 UTC showing the lower-level tephra/ash rich “skirt” possibly generated by a partial column collapse. Photo courtesy of Björn Oddsson.

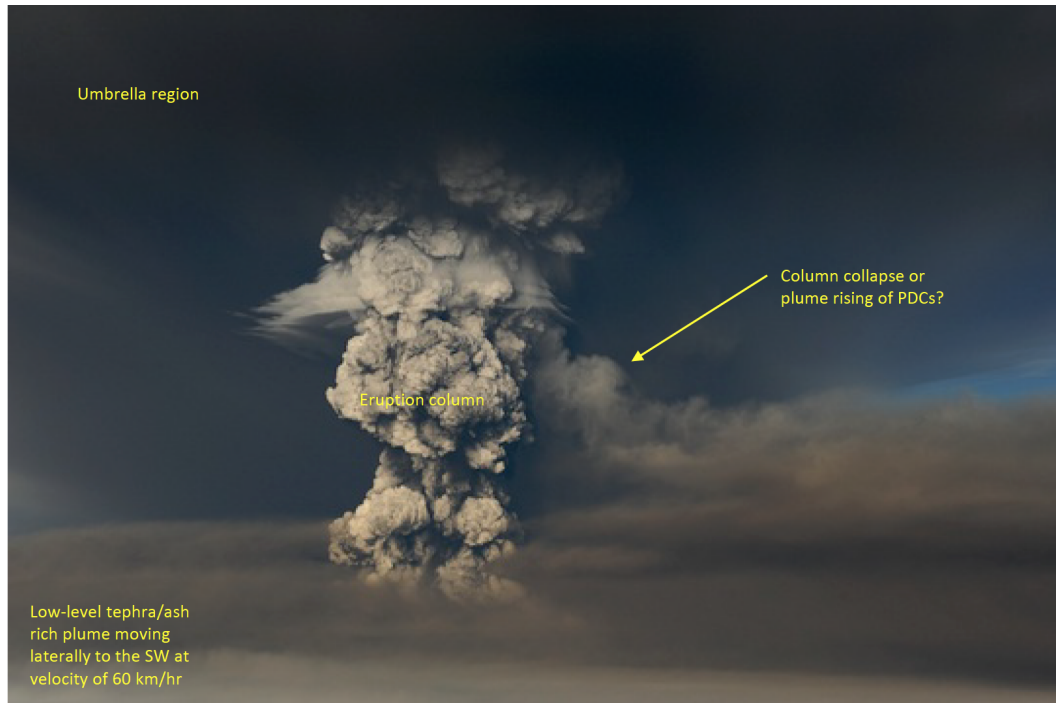


Figure P8. Closer aerial view of part of the column showing mid-level ash. The lateral velocity of the low-level tephra/ash rich plume is estimated to be $\sim 60 \text{ km hr}^{-1}$. Photo taken on 21 May at 21:04 UTC . Photo courtesy of Andri Orrason.

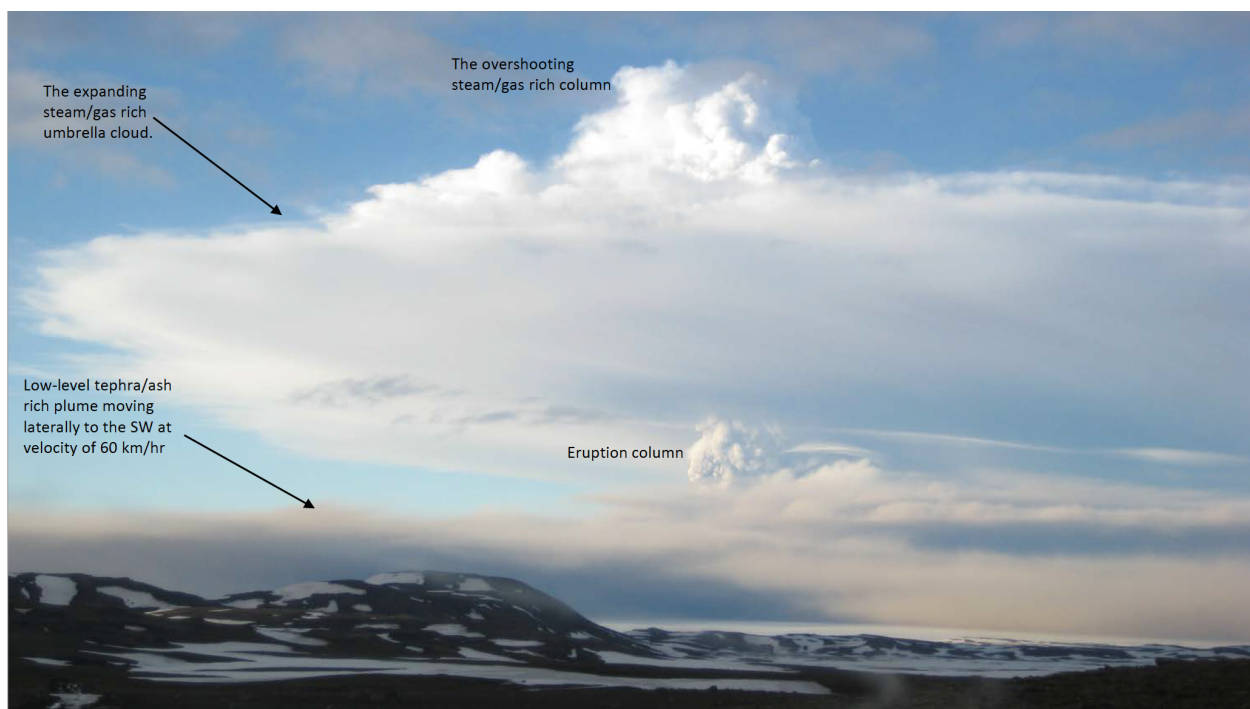


Figure P9. Ground-based photograph taken from Laki-Blágil intersection (~60 km southwest of Grímsvötn) on 21 May at 21:19 UTC showing the lower-level ash-rich “skirt”. Photo courtesy of Kári Kristjánsson.

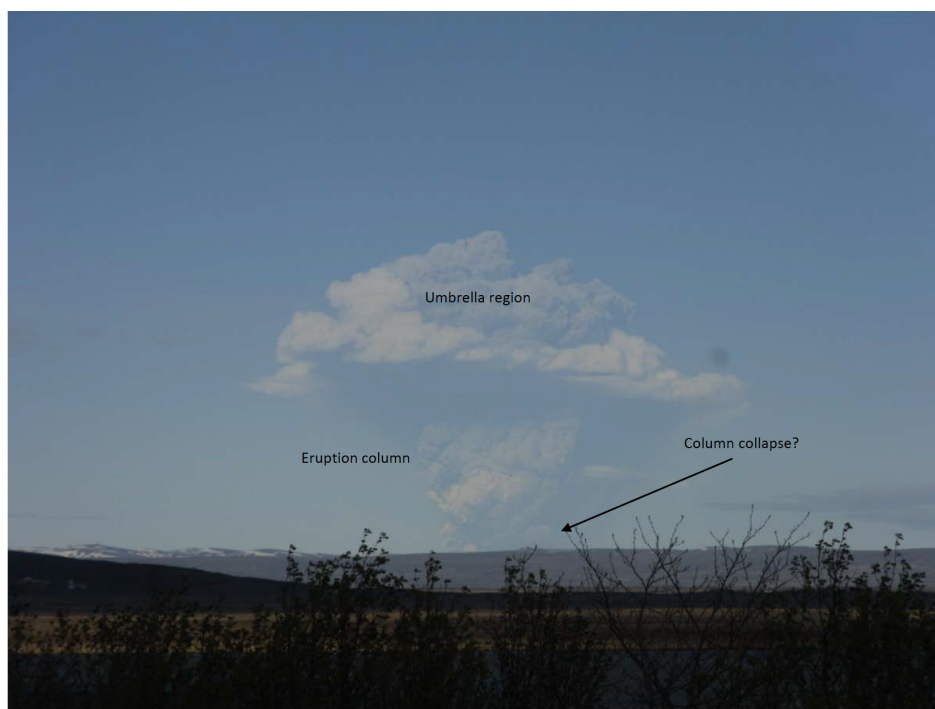


Figure P10. Ground-based photograph taken from Laugarvatn (~160 km west of Grímsvötn) on 21 May at 21:52 UTC. The location of a possible partial column collapse is indicated to the right of the column. Photo courtesy of Þórður Sævarsson.

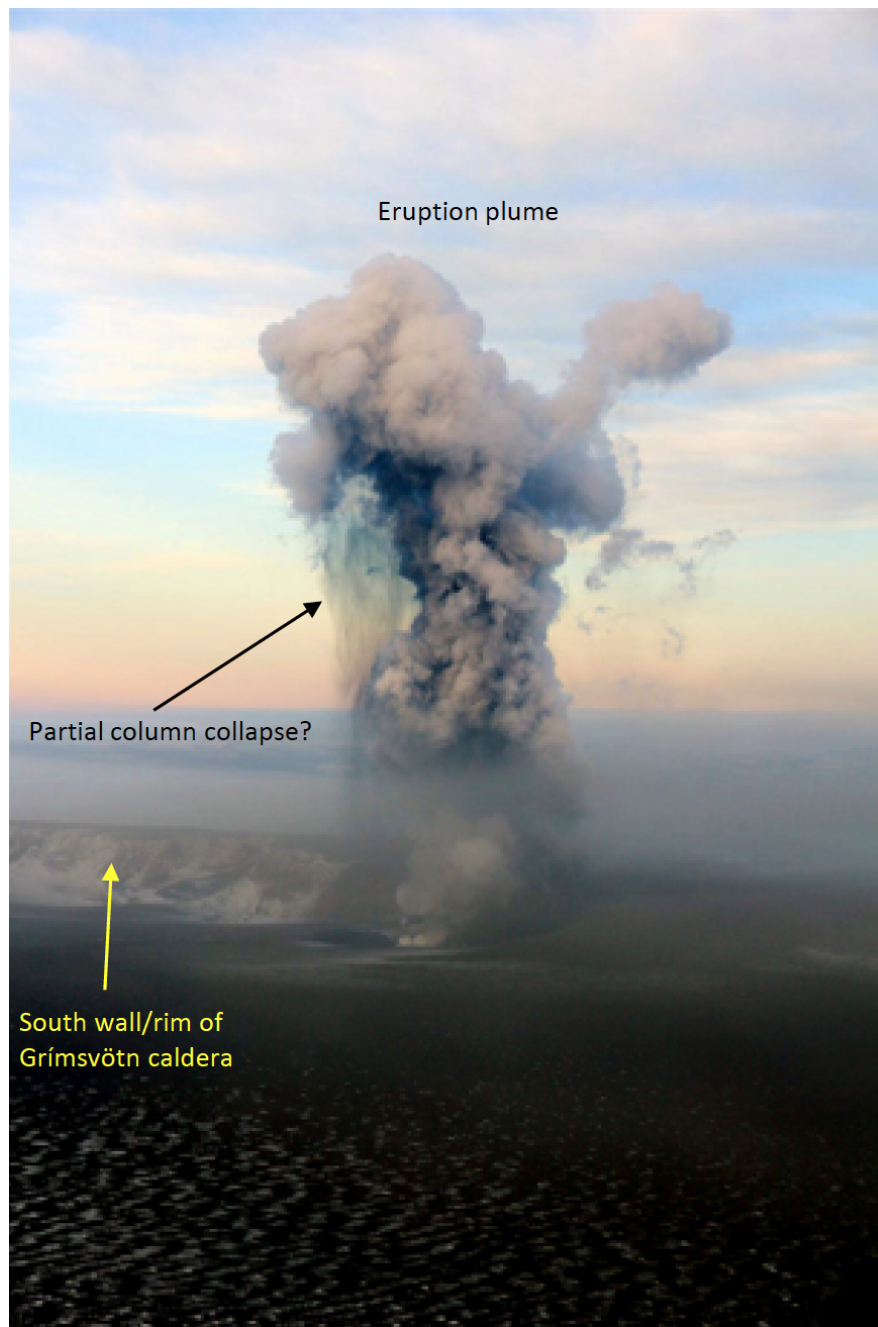


Figure P11. Partial column collapse of the Grímsvötn column photographed on 24 May at 09:16UTC. Photo courtesy of Björn Oddsson.