Katla eruptions

What are eruptions at Katla like?

Although Katla has, on occasion, produced lava flows during fissure eruptions (including the 1934 AD Eldgjá eruption, which at 14 km, is one of the largest lava flows in recorded history, Larson et al., [2001]) and silicic tephas, by far the most common eruption type is explosive subglacial basaltic eruptions from within the ice-cold caldera. This is particularly true for eruptions within the most recent millennia (Larsen, et al., 2005, Cadrin et al., 2008). Consequently, the biggest Katla hazards are tepha dispersion (Fig. 4) and glacial floods (Fig. 5).

Katla 1918

The last eruption of Katla occurred in 1918 (Fig. 6). It was comparable in style to the 2010 Eyjafjallajökull eruption, however it was more powerful (Table 1, Fig. 4). Eyjafjallajökull 2010 produced both an ash cloud (that caused the worst disruption to aviation since WW2) and a jökulhlaup (glacial flood), which destroyed roads in south Iceland (Gjafersson et al., 2013). The 1918 eruption produced a bigger plume, but also one of the world’s largest ever floods (Öjensson and Cotza, 2004). Peak discharge exceeded 300 m³/s more powerful than the Amur River. Within 2 hours it had flooded an area 6 times the size of Paris. Sediment transported by the flood (Fig. 7) extended the coastline by 3 km (Tómasson, 1996).

Is Katla ready to erupt?

Katla (Figs. 1, 2) is one of Iceland’s most active volcanoes. However, she has not erupted since 1918. This is the longest gap in Katla activity within historical records (Sturkell et al., 2005). On average, she erupts every 26 years. In fact, for the past several hundred years, Katla had erupted at the end of the 22nd and 24th decades of every century, or take 5 years… until the 20th century (Thorarinsson, 1960) (Fig. 3).

Katla also seems to have a connection with Eyjafjallajökull. Every time Eyjafjallajökull has erupted within historical records, Katla has erupted within a year or two (Fig. 3). However, there has been only 4 years since the 2008 eruption of Eyjafjallajökull and there still has not been a significant Katla eruption.

Lessons learnt from PhD

My PhD was investigating the role of volcanoes in determining the explosivity of subglacial eruptions at Tófajökull (Fig. 2). We also reconstructed the palaeo-ice thickness for various edifices using dissolved volatile contents (Öjensson et al., 2013, 2014). There was no correlation between ice thickness and eruption style. However, there was evidence for rapid decompression at Dalvikjökull, which seemed to accompany a change in eruption behaviour (Öjensson et al., 2013b). Furthermore, the more explosively formed edifices had significantly higher proportion of mineralogical quartz and showed evidence of closed-system degassing (Fig. 10). By comparison, effusive edifices were water poor and showed evidence of open-system degassing (Öjensson et al., 2013a, 2013b). However, the relationships hold true in basaltic subglacial systems such as Katla?

Preliminary data

The project is in early days but preliminary data showing a high fraction of volatile (Fig. 11) suggests that phreatomagmatic fragmentation may have played an important part in fueling explosivity. Volatile data next...

The project

My aims

I have just started a 2 year project to get under what did she do? What triggers her violent outbursts?

We have collected various samples of 1918 Katla ash (Figs. 8, 9). We shall analyse them in a number of ways to determine:

- Grain size distributions
- Bubble characteristics:
  - Viscosity
  - Vesicle size distributions
  - Bubble number densities
  - Vesicle shape
  - Connectivity
- Mineralogy:
  - Mineral identification
  - Crystal volume distributions
  - Crystal number densities
  - Relationships between bubbles and crystals
- Volatile content
  - Pre-eruptive
  - Melt glass
- Geochemistry
  - Pre-eruptive
  - Melt glass

This will help us answer the following key questions (Table 2)

References

Table 1: Comparing the eruption of Katla 1918 and Eyjafjallajökull 2010

<table>
<thead>
<tr>
<th></th>
<th>Katla 1918</th>
<th>Eyjafjallajökull 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of commencement</td>
<td>25th Oct 1918</td>
<td>14th Apr 2010*</td>
</tr>
<tr>
<td>Duration of eruption</td>
<td>26 days*</td>
<td>10 days*</td>
</tr>
<tr>
<td>Composition</td>
<td>Basalt (66% fayalite), troctolite and trachyte</td>
<td>Basalt (65%)</td>
</tr>
<tr>
<td>Anode ~Lava (kPa)</td>
<td>0.25 (supplied from 2)</td>
<td>0.3 (supplied from 2)</td>
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<tr>
<td>Total erupted volume (10⁶ m³)</td>
<td>3.84</td>
<td>0.25</td>
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<tr>
<td>Ashes particle height</td>
<td>1 km</td>
<td>1.0 km</td>
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<tr>
<td>Volume of lava lakes</td>
<td>0.7 km³</td>
<td>0.2 km³</td>
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<tr>
<td>Area of lava fall or build</td>
<td>12,000 km²</td>
<td>12,000 km²</td>
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<tr>
<td>Thickness of ice over eruption site</td>
<td>0.01 m</td>
<td>0.01 m</td>
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<tr>
<td>Volume of subglacial lava</td>
<td>0.1 km³</td>
<td>0.12 km³</td>
</tr>
<tr>
<td>Time taken to melt-overlying ice</td>
<td>2 hours</td>
<td>4 hours</td>
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<tr>
<td>Jökulhlaup volume</td>
<td>10,000 km³</td>
<td>10,000 km³</td>
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<tr>
<td>Flooded area</td>
<td>350-400 km²</td>
<td>17.5 km²</td>
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<tr>
<td>Jökulhlaup rate (kg-lb)</td>
<td>~100,000 m³</td>
<td>1.000 m³</td>
</tr>
</tbody>
</table>

* From the Icelandic Met. Office. ** K1721

Figure 6-9: Photos of sampling locations (see also Fig. 4).

http://www.birdsinc.org/2013/01/09/fig12.jpg (Credit to the USGS; produced by J. M. Hofmann in 2013)

http://www.isim.umd.edu/gvp/volc/volcanol.html

