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PRELIMINARY STUDIES ON DIVERSE THEMES

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REVISIONAL PRELIMINARY STUDY ON THE LOCAL AND GLOBAL IMPACTS OF ERUPTION FAIL LAKI FAILURE IN THE PERIOD FROM 1783 TO 1784 IN ICELAND.

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Abstract

In the years 1783 to 1784, for eight consecutive months, the famous eruption of the Laki fault (or Skaftár Fires) occurred in Iceland. This had a real impact on people who lived throughout the Northern Hemisphere during the later years, although the direct impact of the eruption on Earth's climate remains a much-discussed and researched subject.

Keywords: Laki; Skaftár Fires; Eldgjá; Eyjafjallajökull

I - Introduction

From 1783 to 1784, the famous eruption of Laki's fault (or Skaftár Fires) - certainly one of the largest volcanic eruptions in recorded human history - occurred for eight consecutive months in Iceland. It was not a Plinian eruption as many people associate with giant eruptions, nothing like the eruption of Tambora or Krakatau. However, this had a real impact on people who lived throughout the Northern Hemisphere during the later years, although the direct

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impact of the eruption on the Earth's climate remains a much-discussed and researched subject. This is a review study that provides an overview of the eruption and why it is such an important eruption (in terms of Icelandic volcanism and global impact).

II – Characteristics of the evolution of Laki and Grímvötn volcanism.

The eruption of the Laki fault was not a single event, but rather 8 months of lava flow and explosions that released between 333 and 14.7 km^3 of basaltic lava that came out of a number of 140 openings along a set of fissures with 23 km long and cones (figure 01).

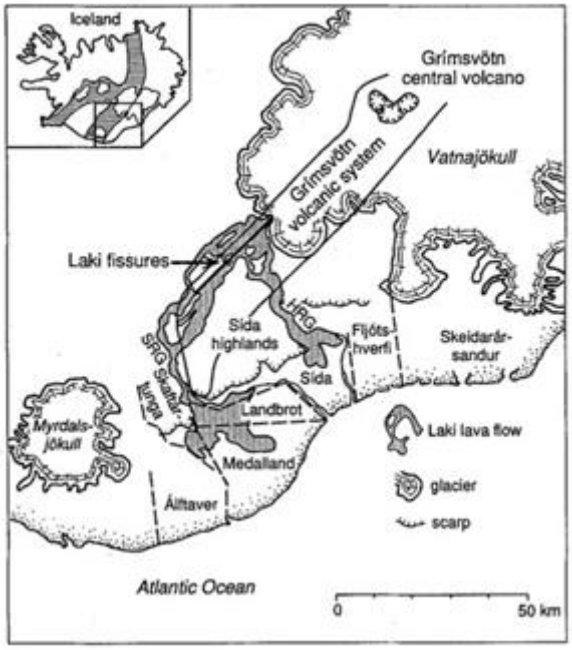

Figura 01: **Geological map of eruptions region (source *Thordarson, T., Self, S., 1993)***

This was the second largest basaltic eruption in recorded human history. Iceland had an even larger basaltic eruption in 934 AD (the Eldgja eruption that produced almost 20 km^3 of lava and Kilauea in Hawaii, USA, one of the most active volcanoes on Earth, erupted releasing 3 to 4 km3 of basalt since 1983. This means that in its eruption Laki released 3.6 times more lava in 8 months than Kilauea released in the last 40 years. This does not even take into account that while Laki's eruptions were occurring, Grimvötn's also erupted, possibly up to 8 times between May 1783 and May 1785. These two events are thought to be related in a single "volcanic-tectonic" episode that suppressed the flaws of Laki and Grímvötn from magma.

III – Global consequences and impacts

Like most volcanic eruptions, the Skaftár Fires (Icelandic name) began with a series of earthquakes 3 to 4 weeks before the eruption began on June 8, 1783. There were probably smaller, deeper earthquakes that preceded the earthquakes that were senses on the surface, but by the late 1700s, there were no seismographs to record minor earthquakes. Iceland is currently connected to seismographs to detect these intrusions probably long before any eruption occurs and if the eruption of Eyjafjallajökull is considered a valid scenario, these earthquakes can start

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months to years before a rash. However, in 1783, only the earthquakes they felt could be recorded - and on May 29, they could feel strongly in the cities, 50 km from the eventual eruption site.

Once the eruption events began, each pulse of the eruption followed a similar sequence: earthquakes, new fissure, short explosive eruption, violent outbursts of strombolas / subplains and Hawaiian eruptions (lava flows). Some of the explosive components of the eruption produced plumes that reached 15 km (~ 50,000 ft) high, while lava fountains were 800-1400 meters high. Once lava flows began to flow from a new crack (usually within a few days of crack opening), some of the eruption rates were remarkably high (up to 3 ~ 8,600 m^3 / s). This is close to the average ebb flow of the Ohio River (USA), but in the form of basaltic lava flow. This is why the eruptions of the Laki fault are considered to be close to a small eruption of basalt and flood with high rates of eruption.

Approximately 90% of most lava flows erupted in the first 5 months. It can be said that more than half of the lava erupted in the first 48 days of the eruptions of Laki's fault. The eruption probably occurred as a series of lava "commotions," where 1 to 2.5 km^3 of lava flows flowed in a matter of days and flowed through the river channels up to 35 km in the period of 1 to 2 days (which means that these flows were moving at a rate of 15 to 17 km / day (very fast for a basaltic lava flow). These flows help to define 10 episodes of eruptions over a period of 8 months in which the openings in the Laki's failure were active (Thordarsson, 1993).

Now, the eruptions of Laki's fault had an amazing effect on Iceland itself, largely due to the volcanic gases released in the eruption and not the lava itself. Sulfur dioxide (SO_2) released by lava flows remained close to the ground (within 5 km) in Iceland, creating acid rain that was strong enough to produce holes in the leaves, kill trees and shrubs and irritate the skin. The eruption released 8 Mt of fluorine, so that fluoride was established and incorporated into grasses, grazing cattle obtained fluorosis. Sixty percent of all grazing animals died due to the effects of Laki's fault eruptions. Haze Famine, as it is called in Iceland, killed more than 10,000 people (~ 22% of the population) from hunger and disease.

Of the 122 Mt of sulfur dioxide (SO_2) released in the eruption, 95 Mt reached the upper troposphere and the lower stratosphere, then this contaminant entered the jet stream and circulated throughout the northern hemisphere. The fog quickly reached the European continent and, until July 1, 1783, the fog was noticed in China. There are not many North American historical records mentioning the arrival of the Laki fog, but records of tree growth rings in northern Alaska suggest that from July to August 1783 the weather was very cold. The average temperature in northern Alaska is 11.3 °C, but the average temperature recorded in May-August 1783 was only 7.2 °C. Russian traders in Alaska noticed a decline in population in the years after the eruption, while the Inuit oral histories refer to a "summer that did not come" that could correlate with the eruption of Laki's fault as well (JACOBY, G.C., WORKMAN, K.W., D'ARRIGO, R.D., 1999).

Overall, these 95 Mt of sulfur dioxide (SO_2) reacted with atmospheric water to form 200 Mt of sulfuric acid aerosol (H_2SO_4). Almost 90% of this sulfuric acid was removed as acid rain or mist, while 10% remained in the ground for more than a year. This may explain why Northern Hemisphere temperatures were 1.3 °C below normal for a period of 2 to 3 years after the eruption. Thordarson and Self (2003) created a diagram to show how sulfur aerosols were dispersed during the eruption (Figure 02), where 80% were part of the explosive phase of the eruption and launched 10-15km in height, producing distant haze.

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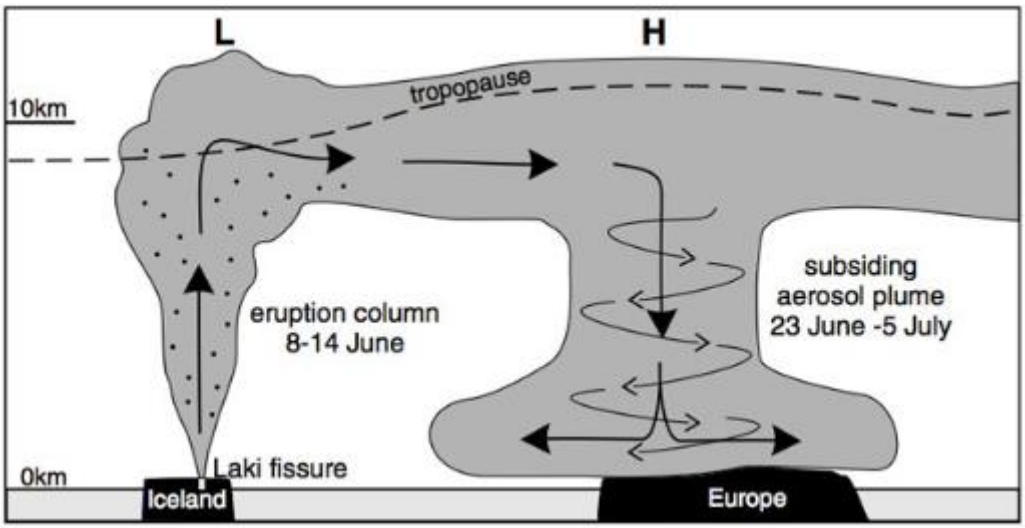

Figure 02: Simplified cross section from Iceland to mainland Europe showing the dispersal and development of the Laki plumes in the first 3–4 weeks of the eruption. Eruption columns produced by explosive activity at the Laki fissures carried ash, SO_2, and other gases to altitudes of 9–12 km. The sulfur-rich plumes (shaded) were dispersed eastward over Europe by the polar jet stream. Due to convergence of airflow at the tropopause level, the Laki aerosol cloud was sucked into a large quasistationary high-pressure cell (H) located over Europe at the time and reintroduced into the lower atmosphere by the subsiding air masses, spreading in a spiral-like fashion across the continent. The arrows indicate subsiding air within the core of the anticyclone from mid or upper tropospheric levels. (source: Thordarson, T., Self, S., 2003)

While 20% came directly from the lava flows, then this stream remained near the ground to produce the local fog in Iceland. Sulfuric acid was even harmful to crops in Europe, where ears and frosts formed (sulfur precipitates). Ash from the eruption was noted as far as Venice, Italy and many places in between.

V - Conclusions

It is certainly difficult to scale the magnitude of the eruption of Laki / Skaftár Fires flaws (both in terms of the amount of lava that erupted and the impact on Iceland and elsewhere). Imagining what the impact would be if such an eruption were to occur today is difficult, but we expect a few years of cold weather and potentially a dramatic and negative impact on air travel across the northern hemisphere, not to mention potential crop failures due to acid rain in Europe and Russia. The impact of the eruption on forests in Alaska shows how widespread and global this impact is for these colossal eruptions that release hundreds of millions of tons of volcanic aerosols. It is possible that modern volcano monitoring techniques can give us warnings in advance (maybe months) before this event begins, but even then it would be difficult to escape the consequences of such an eruption.

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