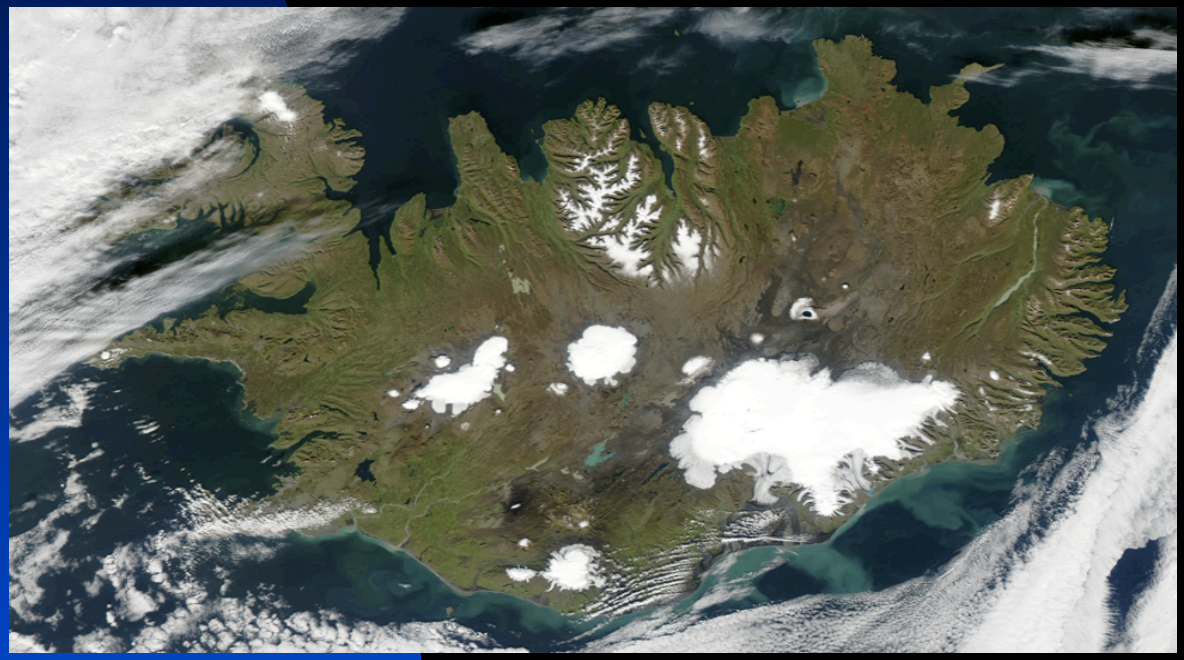
Iceland- Land of "Fire and Ice"

Johkalups and Volcanism- An analysis of the Vatnajokull ice cap and subglacial lake Grimsvotn



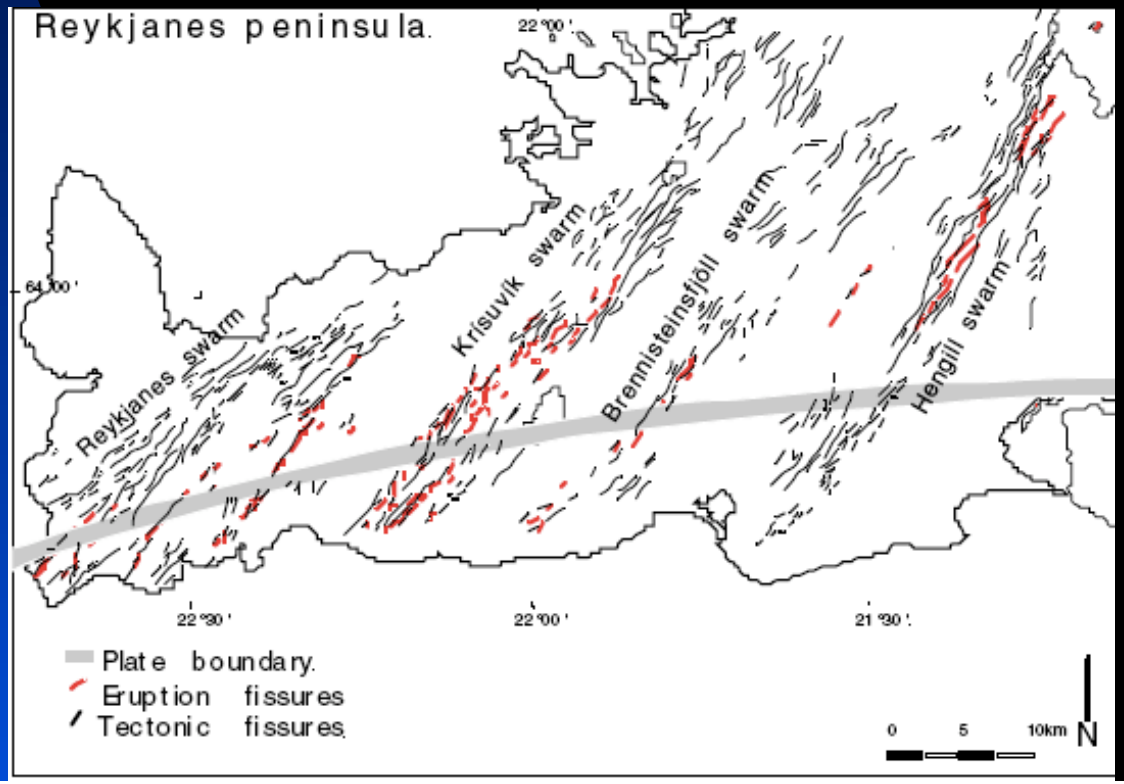
Christopher Lyles ESS 315

Tectonic Setting

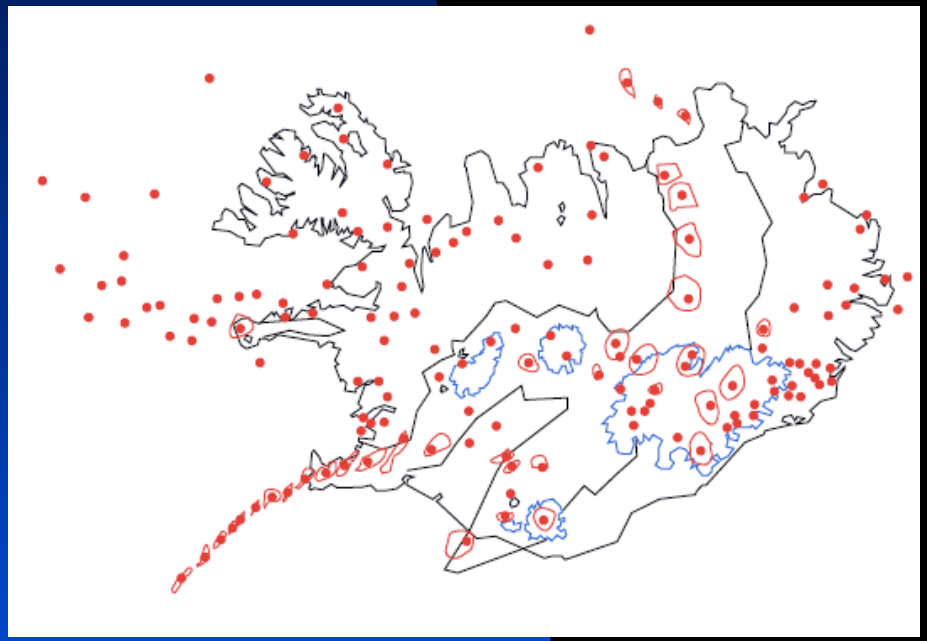
- Iceland- Land of “Fire and Ice”
  - Between the N.A. and Eurasian Plate boundaries
  - Junction of two oceanic ridges, the Mid-Atlantic spreading Ridge and the aseismic Greenland- Faroe ridge
  - Mid- Atlantic ridge has a spreading rate of 1.95 cm/yr
  - 10% of the 103,106 km^2 (39,758 mi^2) surface area is glaciated, some of which overlies volcanoes

Plate Boundary and Swarm intersection

- Plate Boundary runs East to West across the Country
- Swarms Run roughly NE to SW
- Intersection of the two is where the volcanism centers



Volcanism and Glaciers



Kristjansson and Helgason, 1988

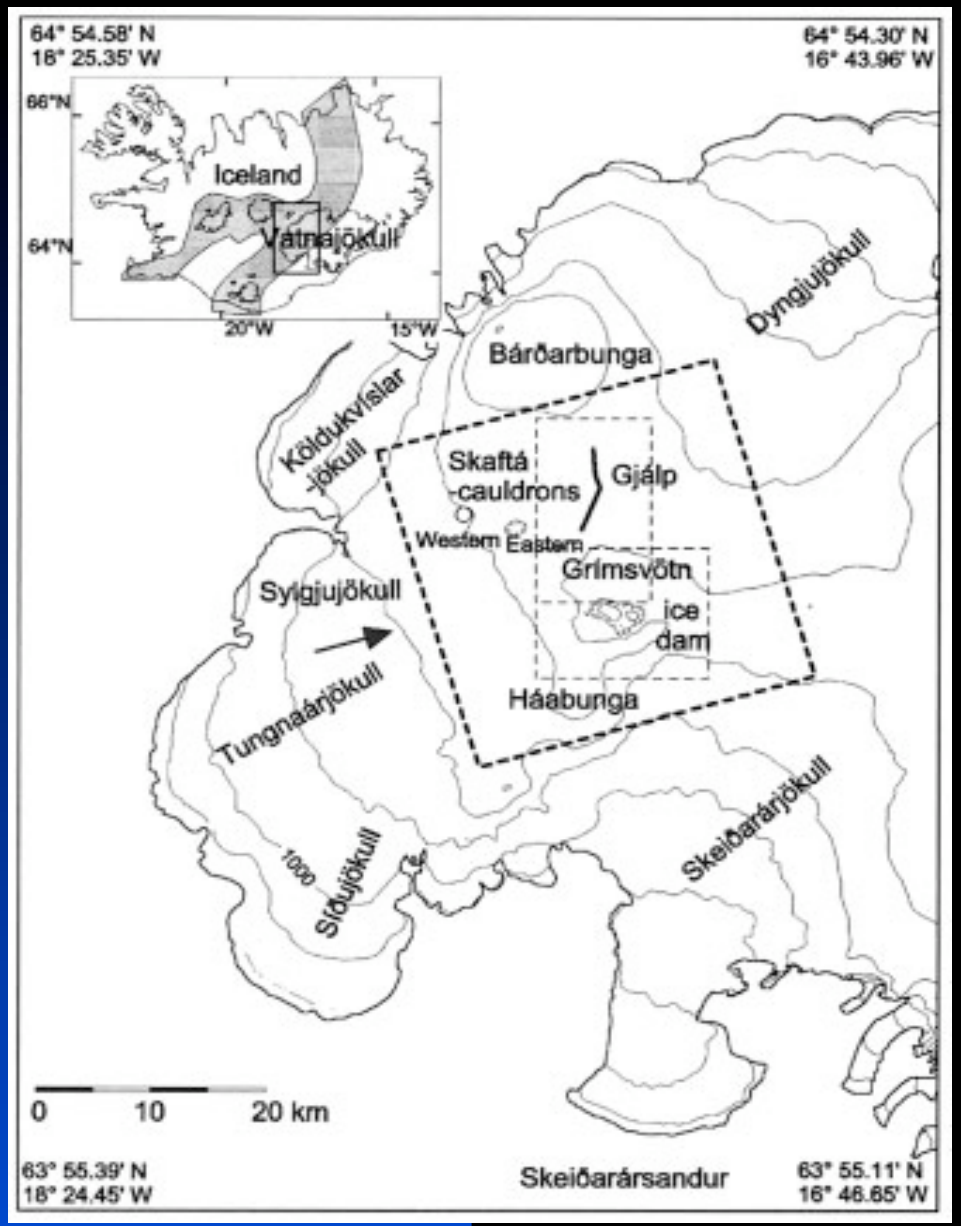
Western Vatnajokull

- Area covering 8100 km^2
- Area of geothermal activity overlain by glaciers
- 80 volcanic eruptions recorded in 800 years of documentation
- Some of which result in periodic Johkalups
- Well known, geothermically active depression called Grimsvotn is area of focus

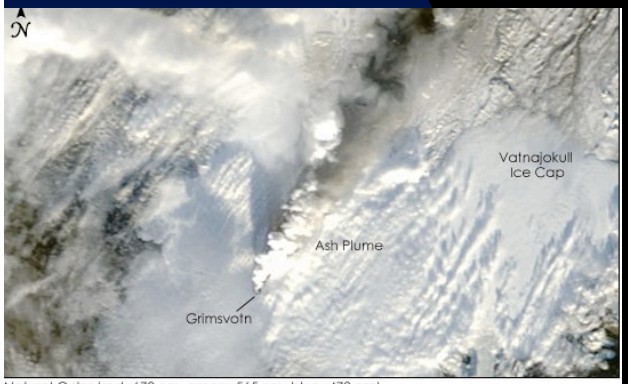
Grimsvotn

- 160 km^2 contributing area
- 0.2 to 0.5 km^3 / yr melted in this geothermally active area
- Meltwater forms a large subglacial lake where the 250 m thick ice is buoyed up by the lake at a rate of 10-15 meters / yr
- 80-110 m of uplift is generally the threshold before an outburst flood releases the stored pressure
- 1-10 year recurrence interval
- Peak discharge of 600-50,000 m^3/sec with a duration of 2 days to 4 weeks

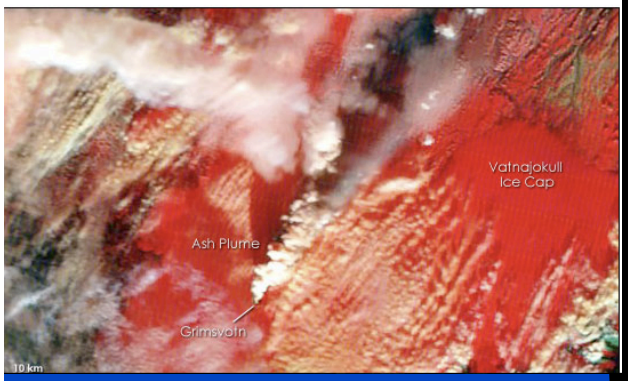
Area of Interest



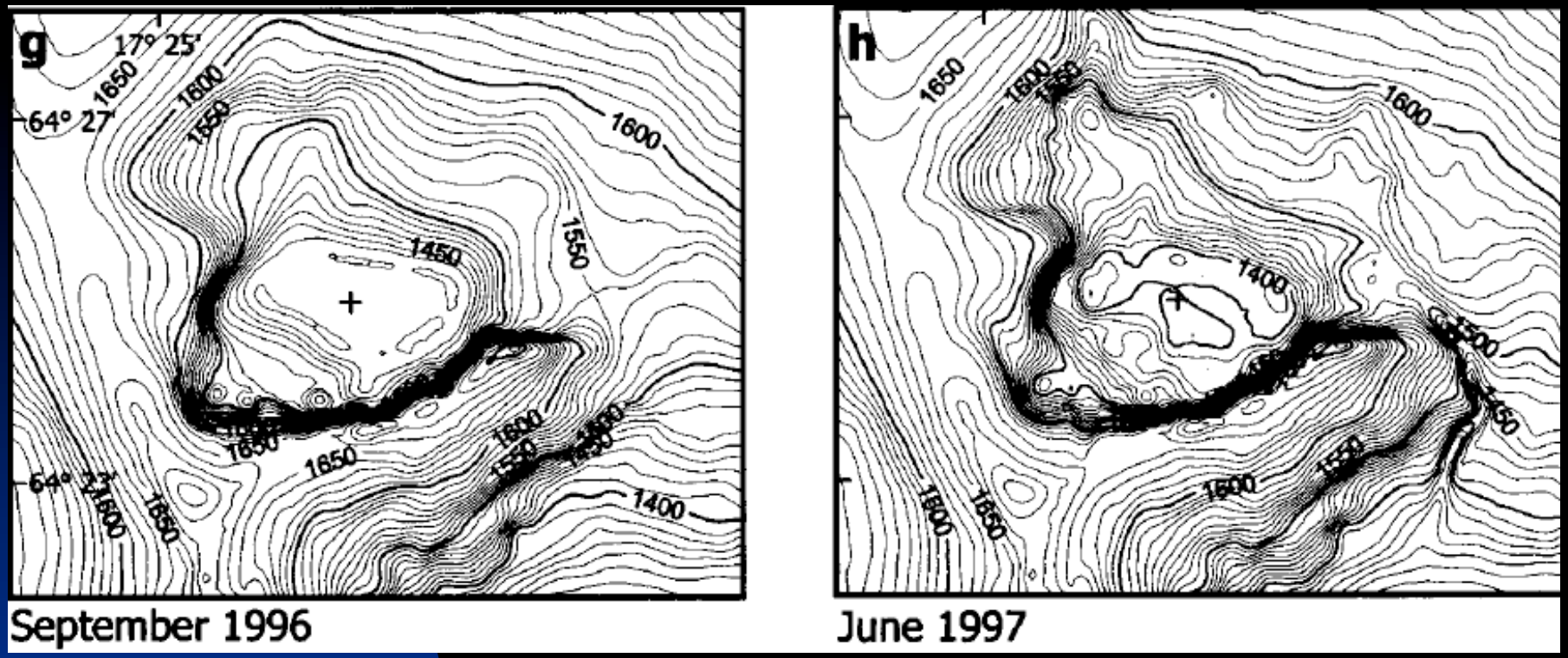
1996 eruption and surface morphological expressions



Natural Color (red=670 nm, green=565 nm, blue=479 nm)



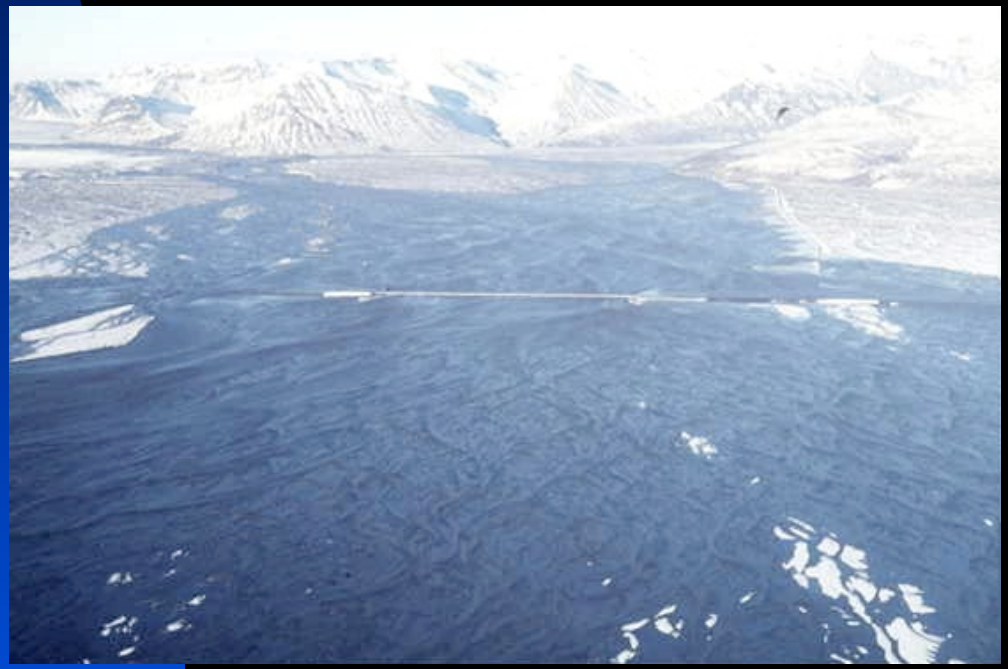
- 13 day duration- Sept 30 to Oct 13, 1996
- Eruption centered along a 6-7 km long fissure
- Occurred beneath 500-750 m of ice
- ~ 3km^3 meltwater drained towards Grimsvotn
- Melting of ice was compensated by inflow of ice
- No large scale basal sliding occurred
- Fissure reached the surface and scoured an ice canyon 60-100m deep



Subglacial Lake formed from the volcanism in Sept/ October and subsequently released in an outburst flood in November of 1996

Most Rapid Jokulhlaup reported from Grimsvotn

- Glacier ice closing the lake lifted Nov 4 and 10.5 hrs later water rushed out from the glacier margin
- Estimated 3.2 km^3 volume of water released



Impacts

- 15 million dollar bridge destroyed
- Dyke protecting the bridge and National Park compromised
- Other bridges, including the ring road and important arteries were damaged
- Fiber Optic and Telecommunications cables damaged
- Commercial fishing halted offshore because of sediment discharge
- Flights halted, rerouted

Historic Lake outbursts

- Laurentide Ice sheet (LIS) breakup placed a freshwater cap on the Atlantic and caused a slowdown in the Atlantic Thermohaline Circulation
- Cordilerrian Ice Sheet (CIS)- glacial lake Missoula outburst flood and creation of channeled Scablands…

Future Jokulhlaups?

- Antarctica- Lake Vostok
- Greenland- SW outlet glacier (unnamed?) subglacial lake
- Alaska- Hubbard Glacier (previously dammed Russell Fjord- became a lake)
- Other Unmapped/ Unidentified lakes?
- Future Heinrich Events?

References

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