



University of
BRISTOL



Volcanoes, their eruption and management of risk

Professor Steve Sparks

University of Third Age, Great Malvern, 16 December 2022



Krakatoa December 2018





21 December 2018



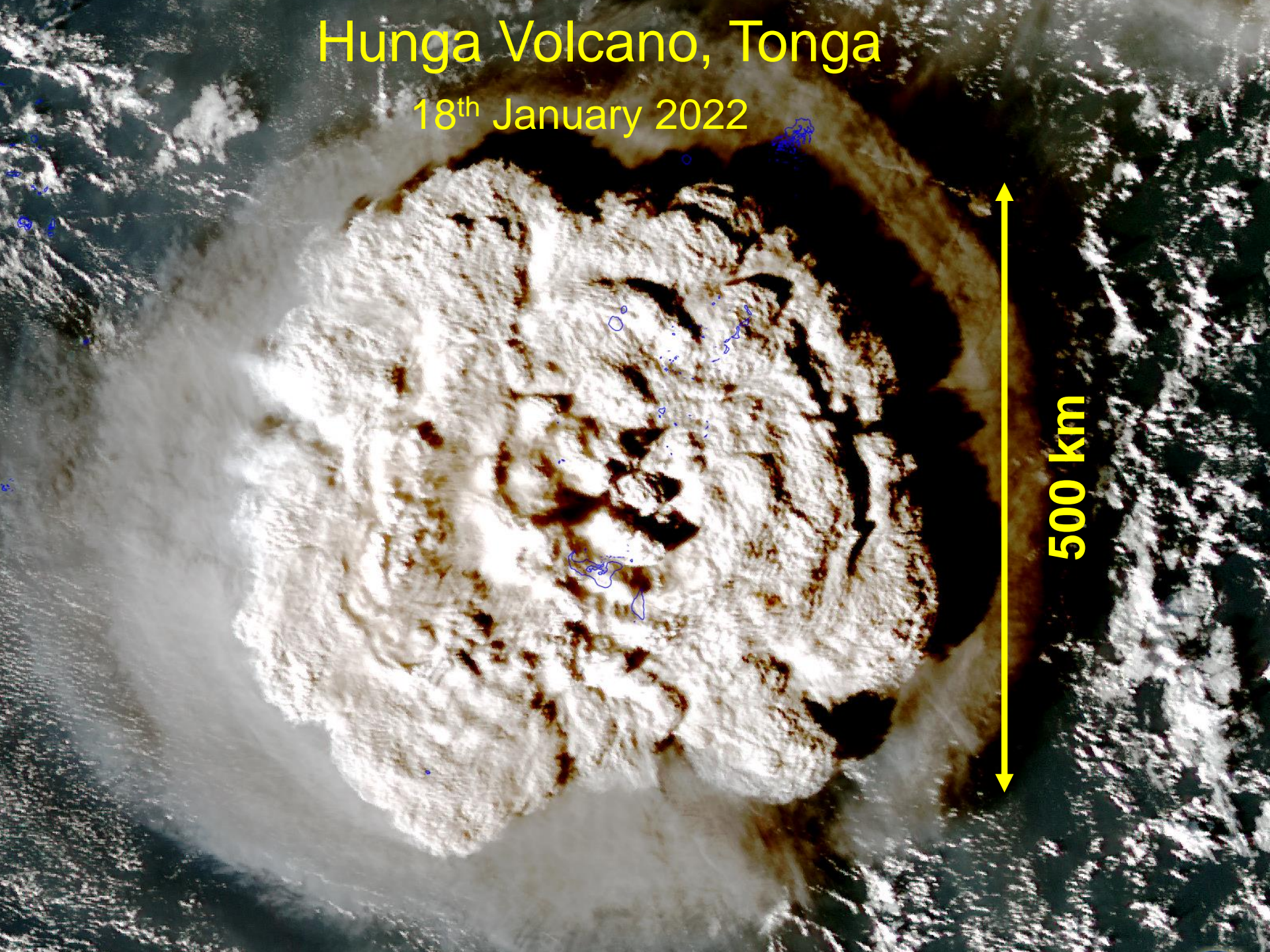
2 January 2019

Cordon Caulle, Chile 2005



Hunga Volcano, Tonga

18th January 2022



500 km

Giant eruptions

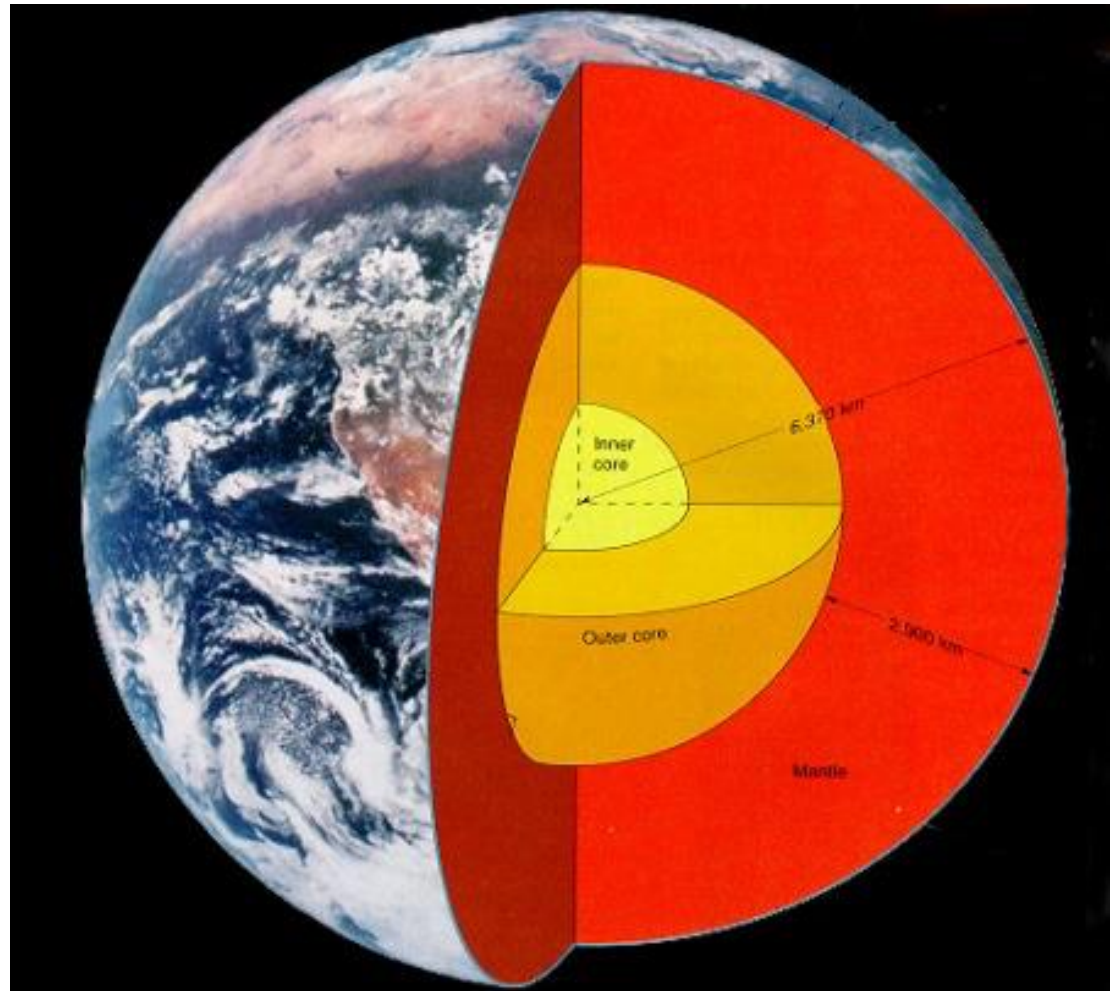


**The Earth is very
hot inside!**

**BUT THE MANTLE
IS SOLID**

**100 km below Geneva
its 1200°C**

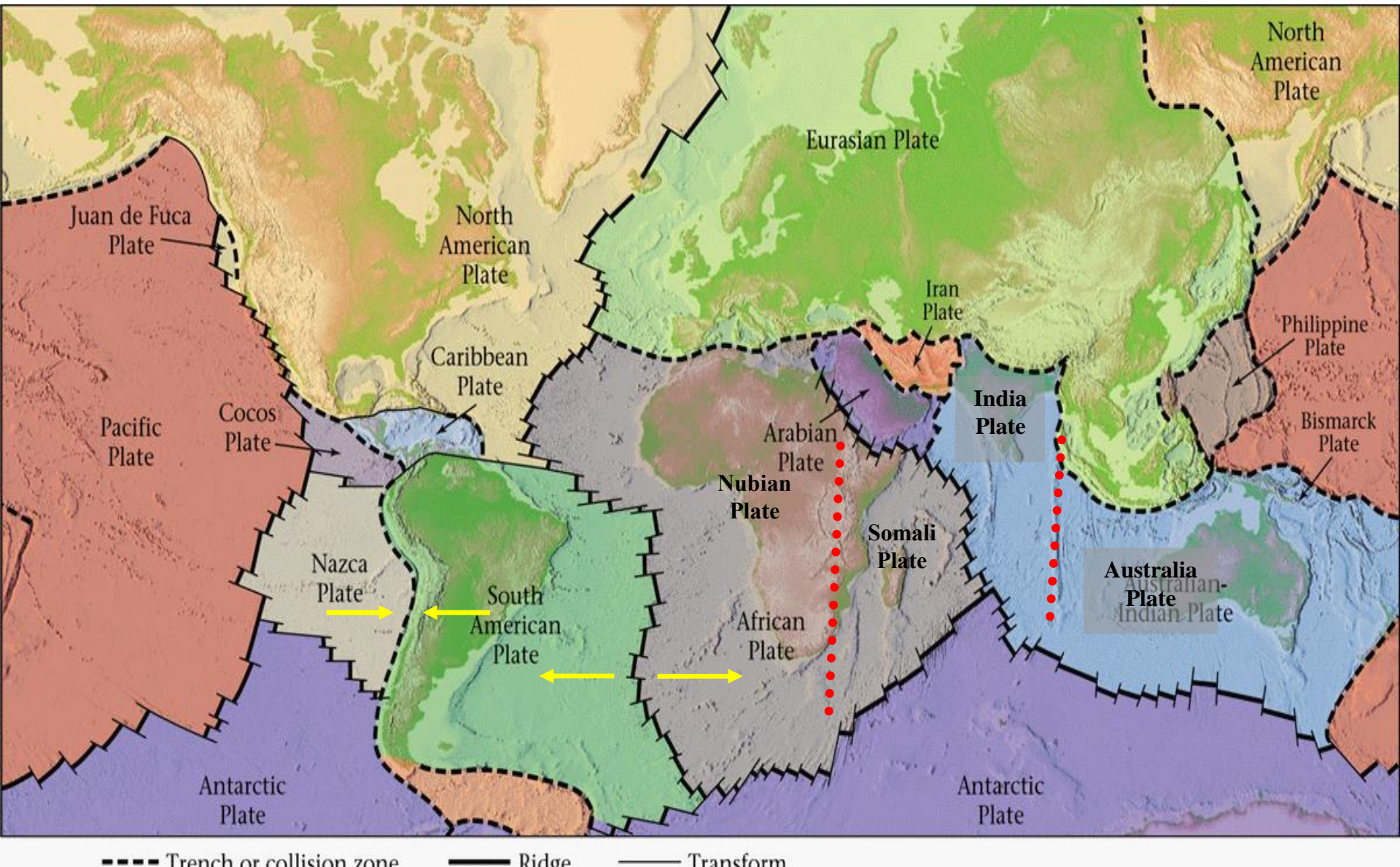
Centre of Earth 5200°C



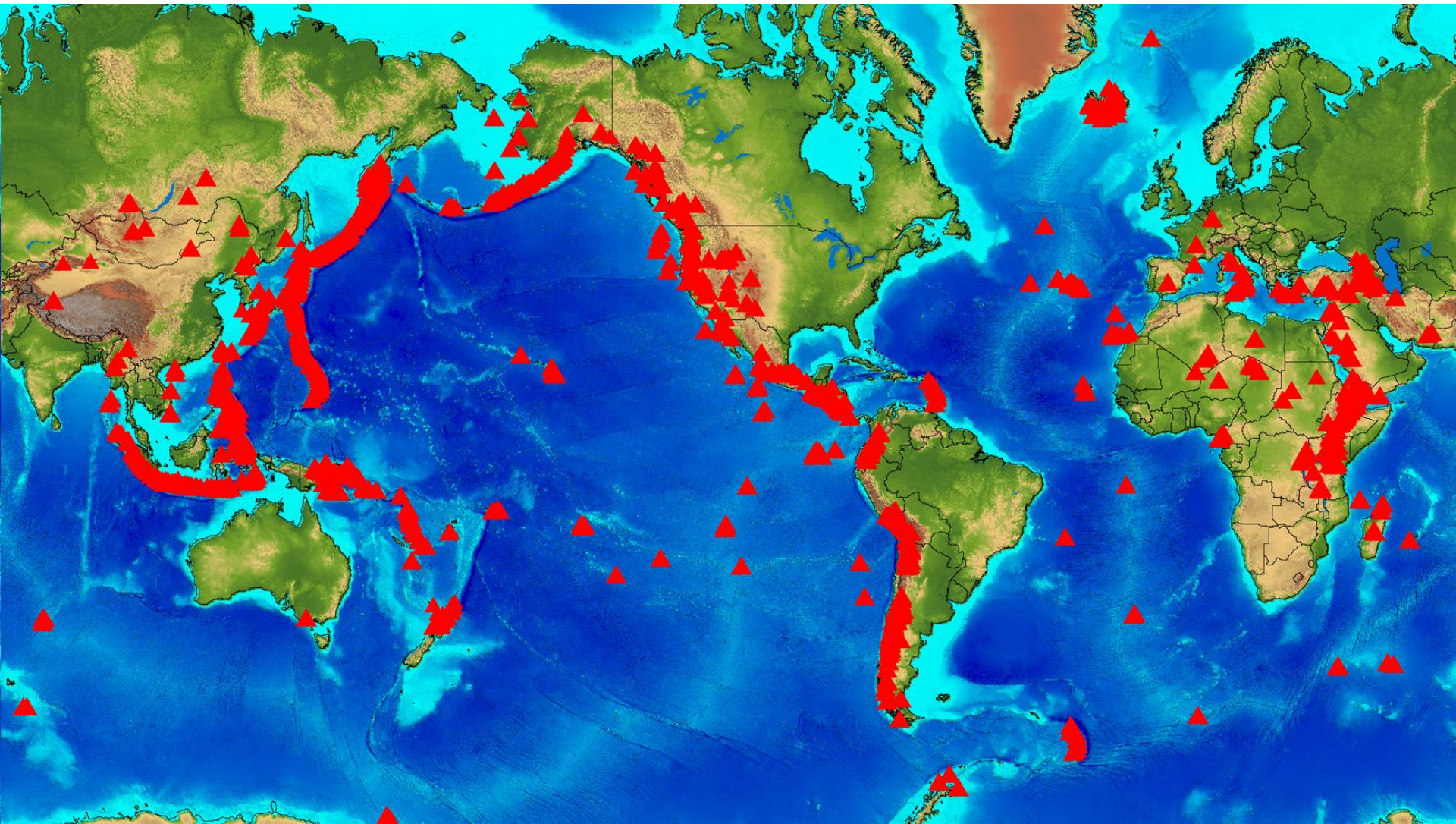
Why Volcanoes?

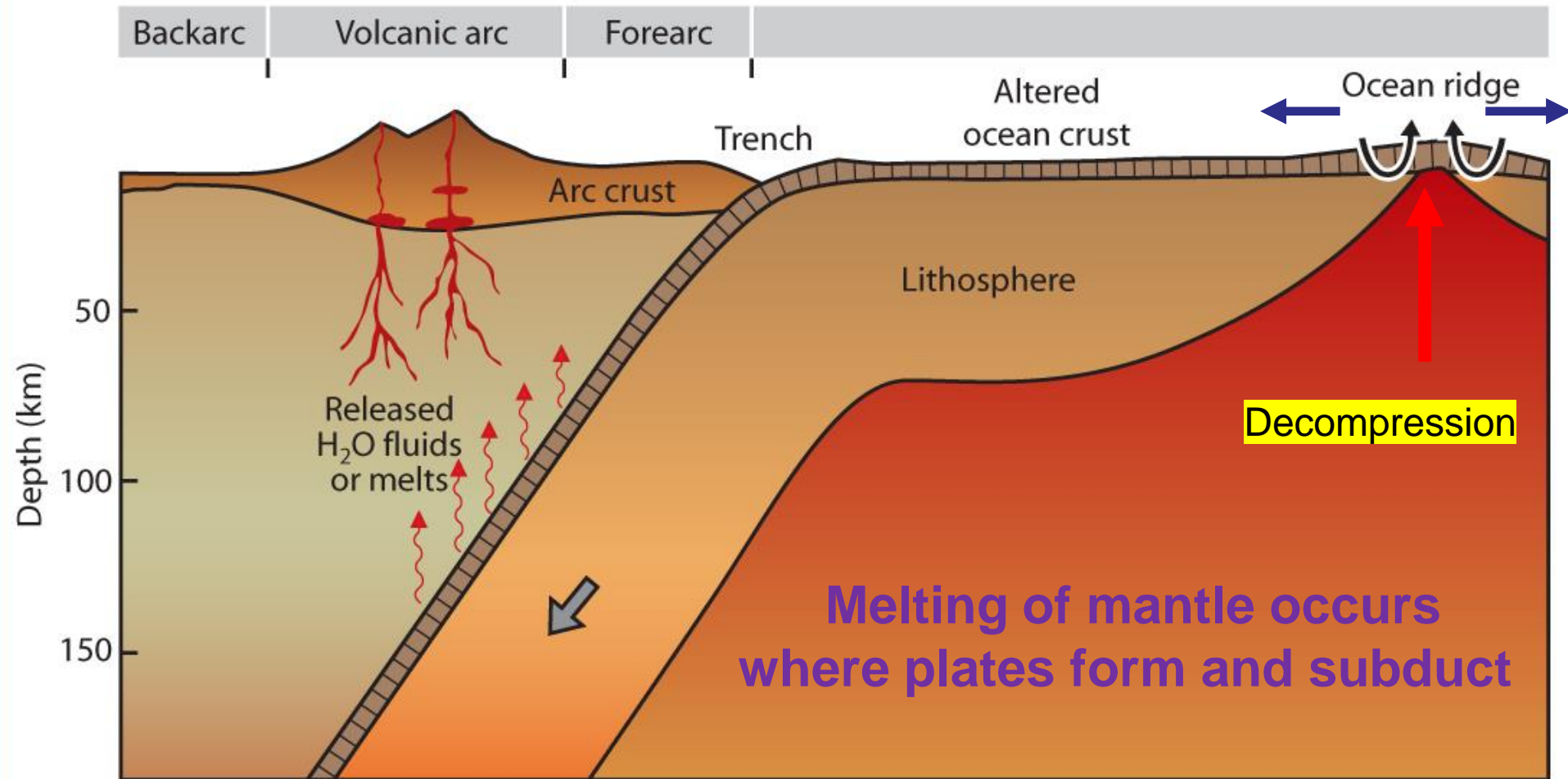
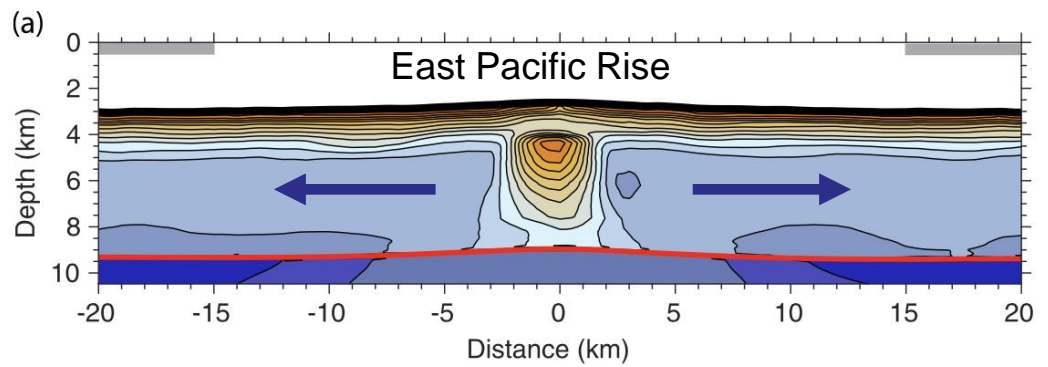
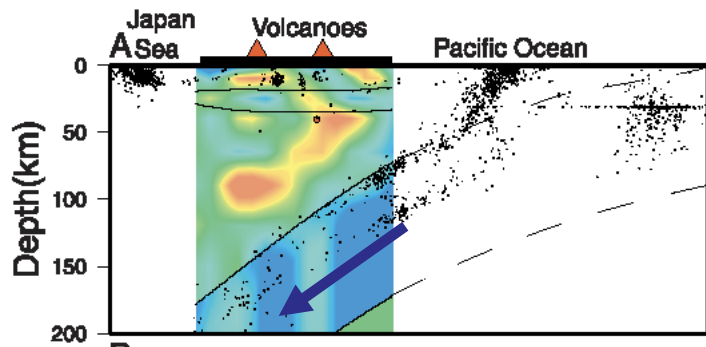
Why Volcanoes on Earth?

Tectonic Plates



Most volcanoes are at plate boundaries



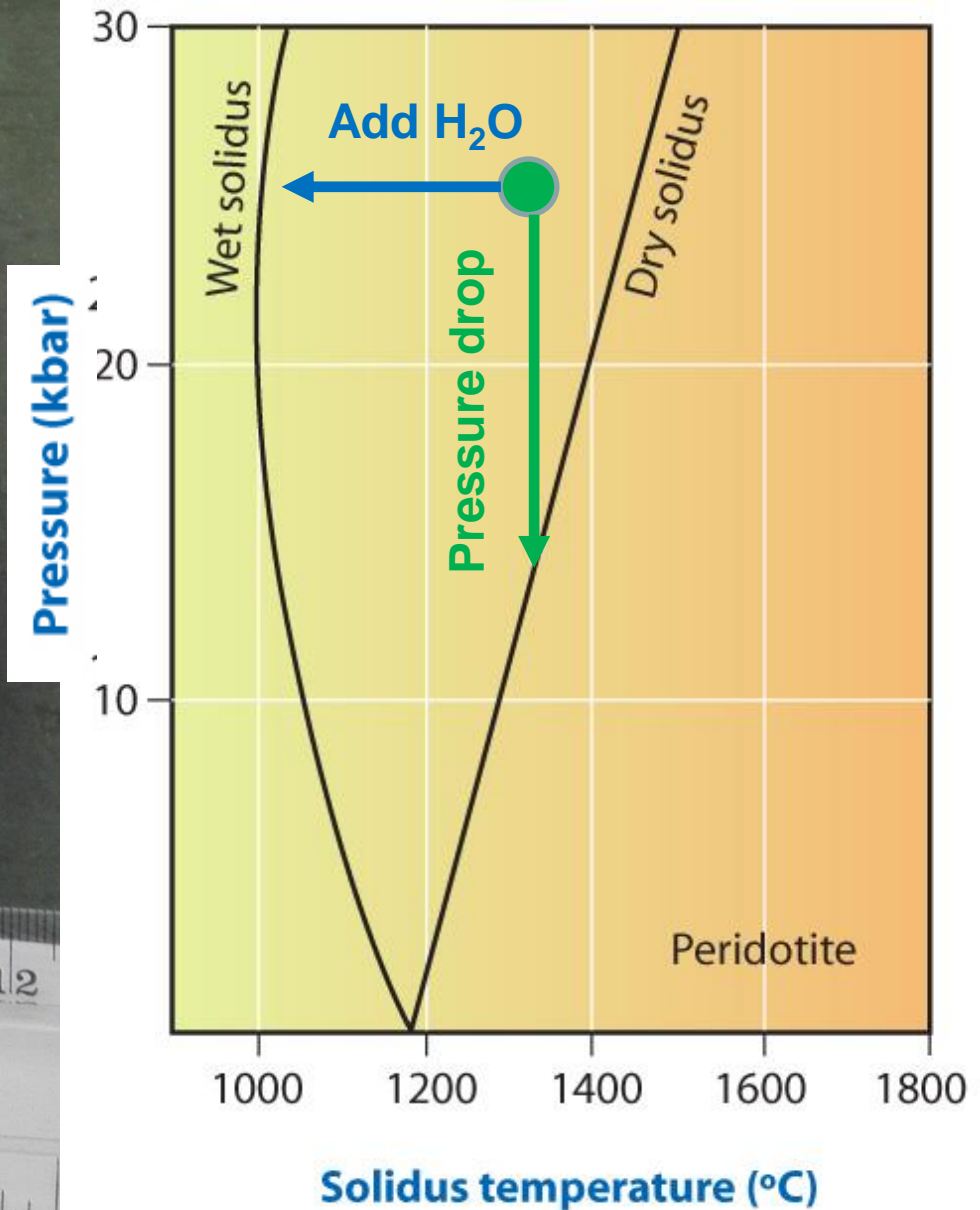


Peridotite
Olivine

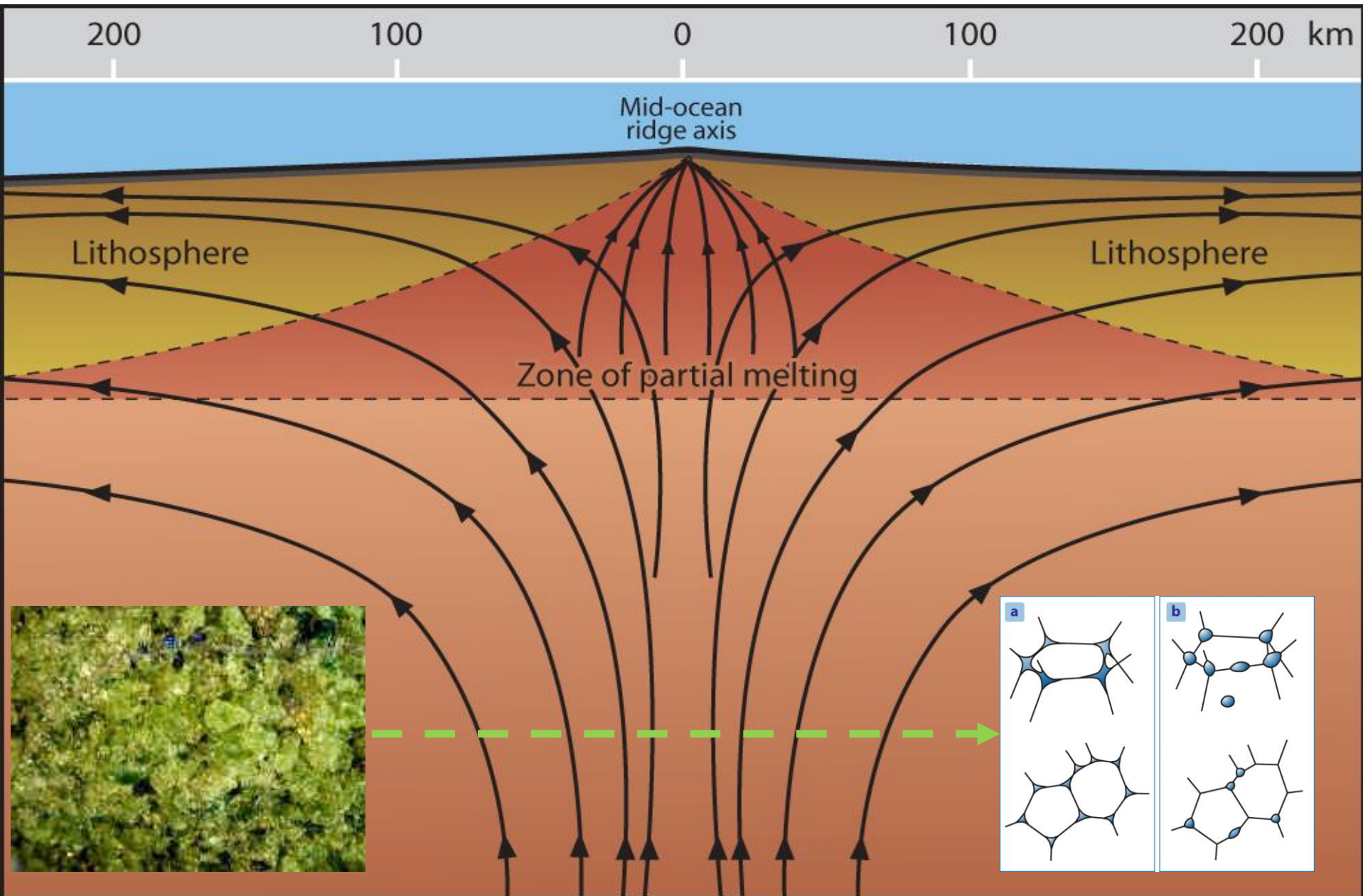


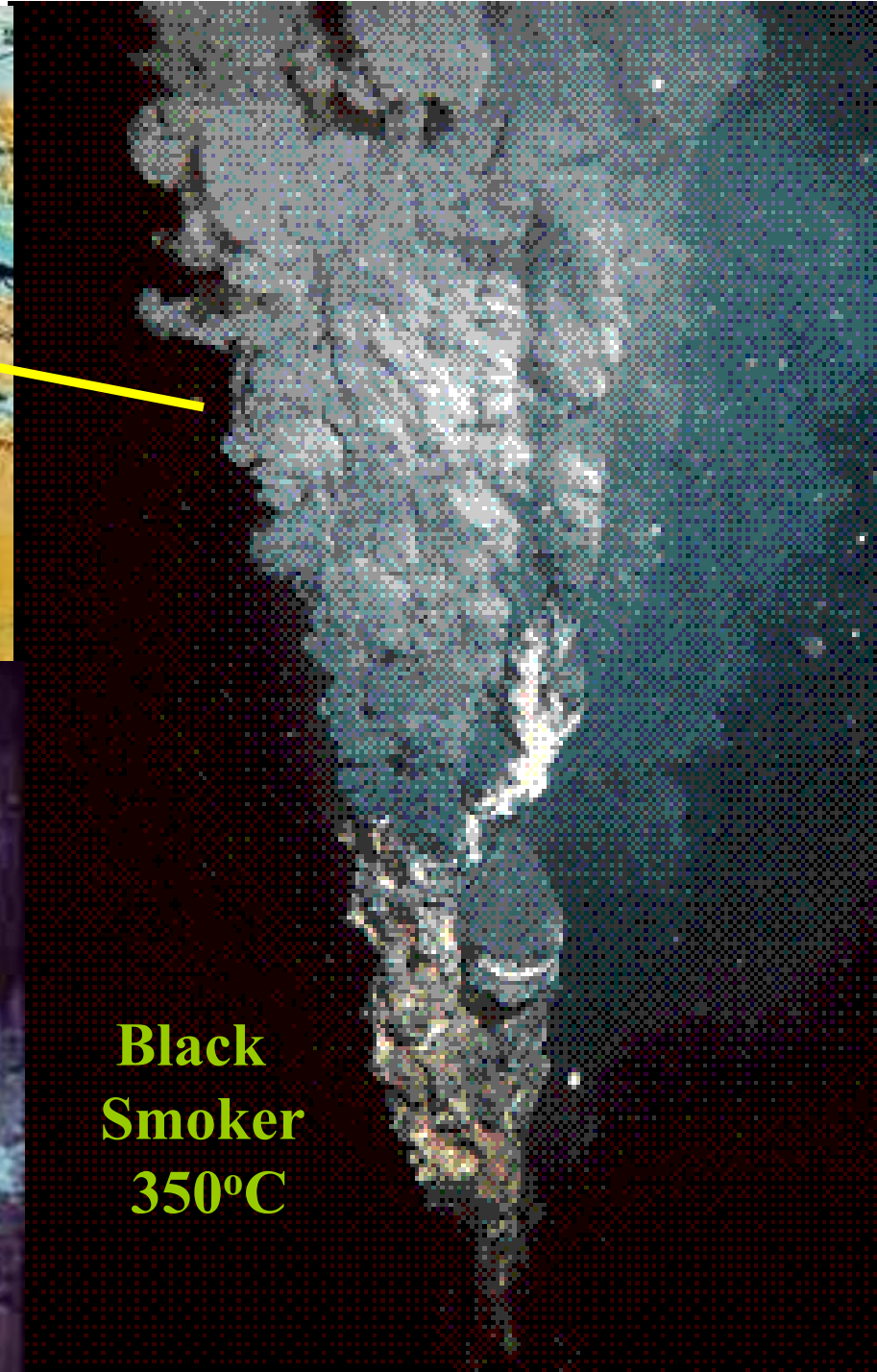
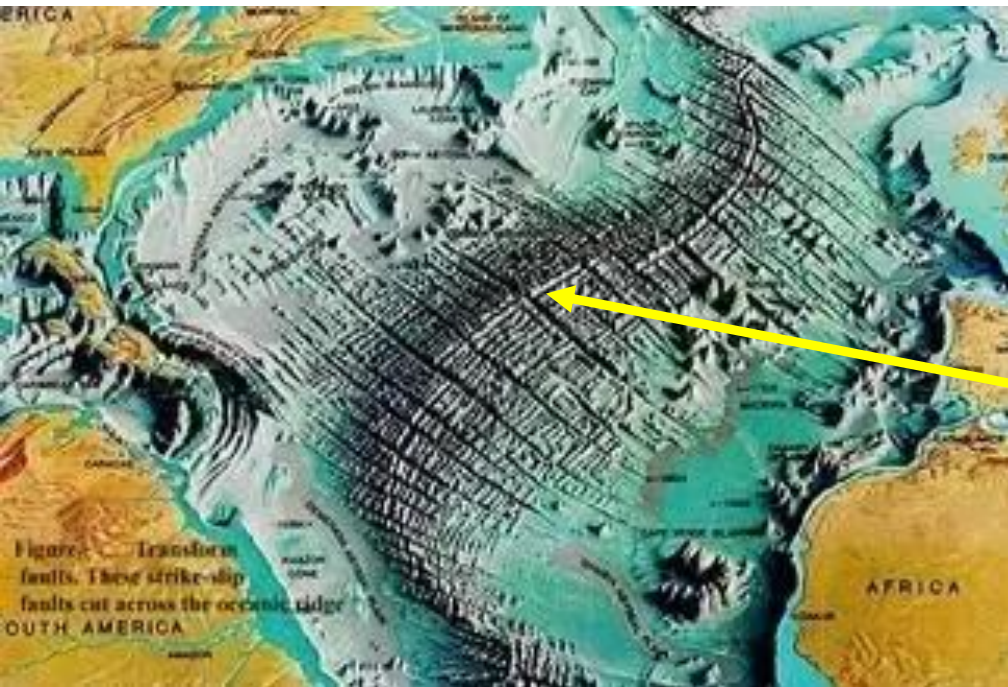
The mantle of the Earth
is solid rock

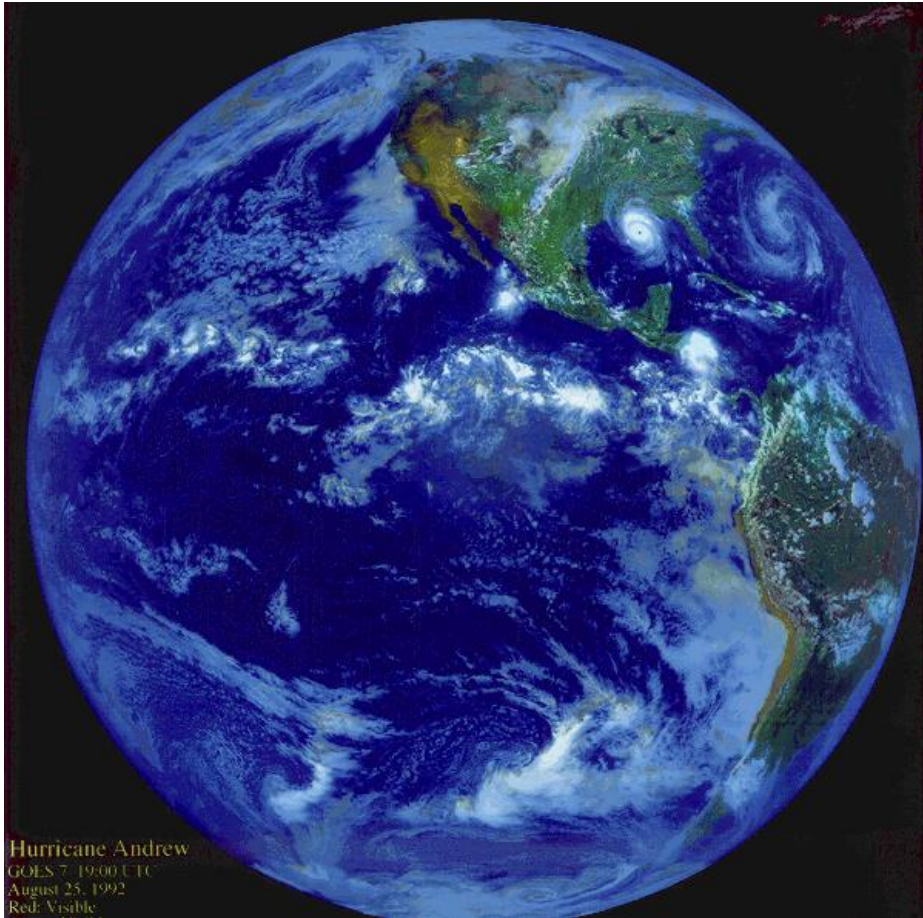
Rising mantle melts
Mantle melts by adding water



Many volcanoes at crest of mid-ocean ridge







551 historically active volcanoes

~ 1500 Quaternary volcanoes

~ 50 eruptions per year

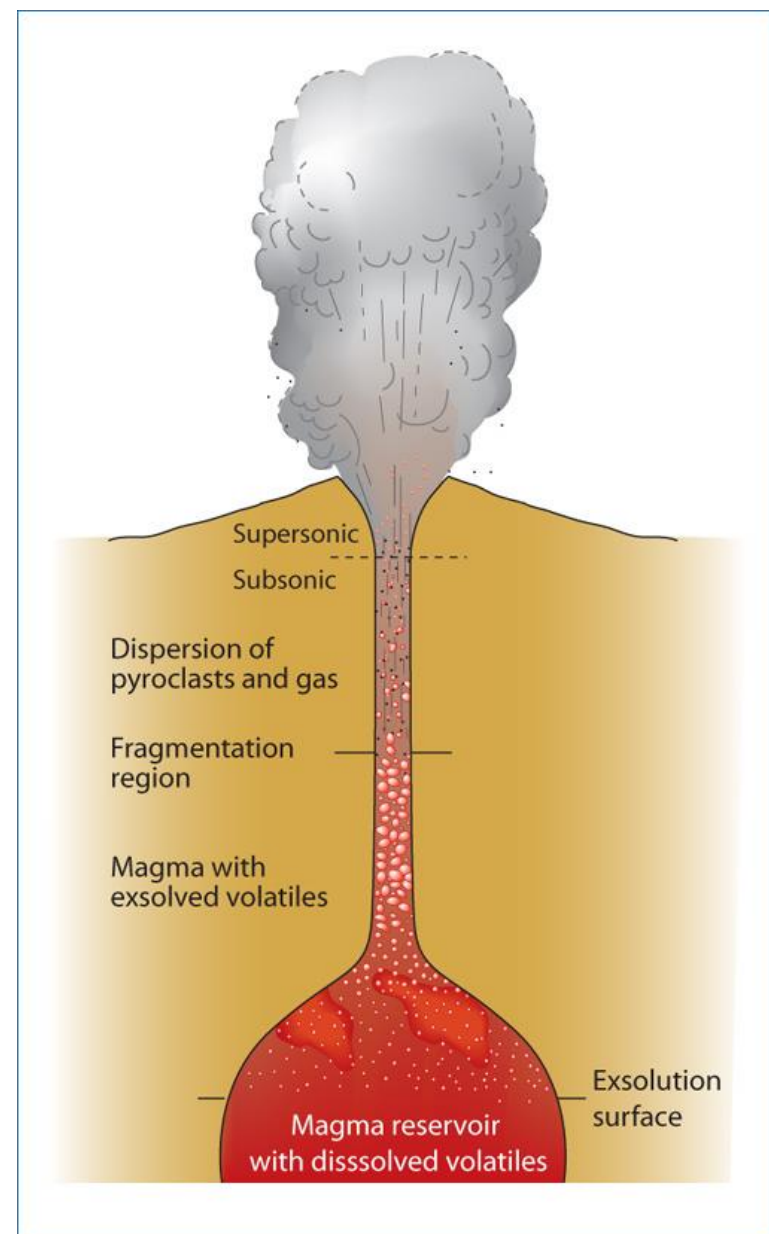
**Large eruptions effect
global climate**

**Global vulnerability increasing
(population and infrastructure)**

Global Volcanism

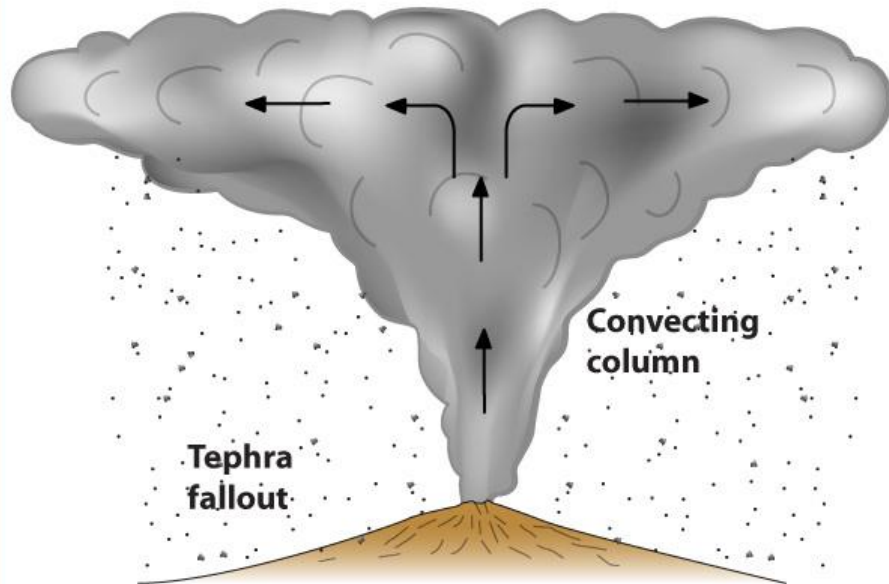


Gas dissolves in magma under pressure
Gas bubbles form in erupting magma
Pressures in bubbles exceed magma strength
Magma explodes

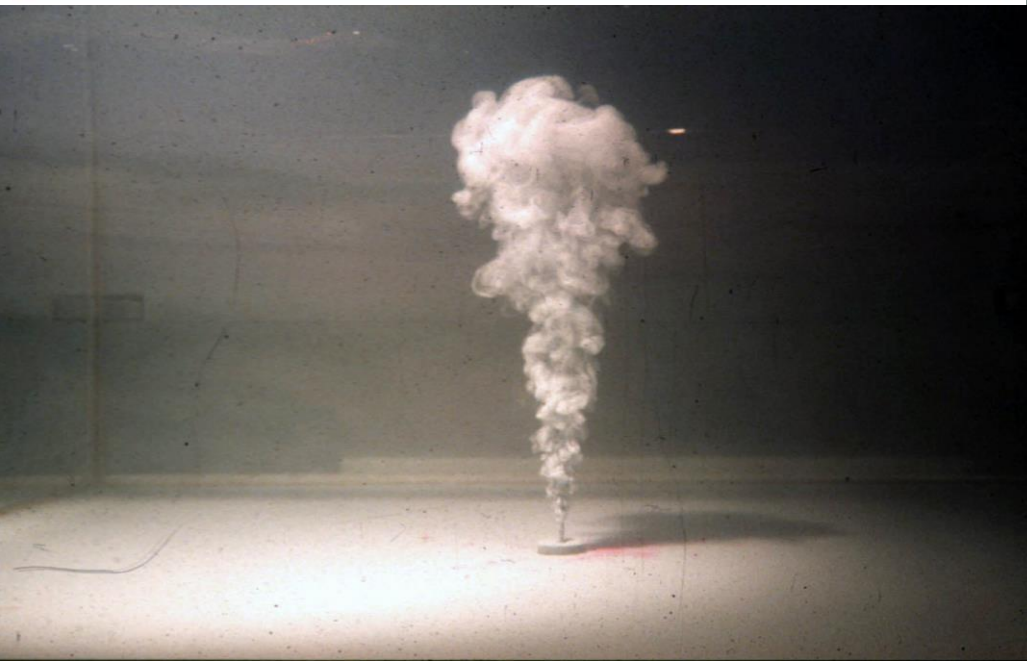


Why do volcanoes explode?

Volcanic plumes

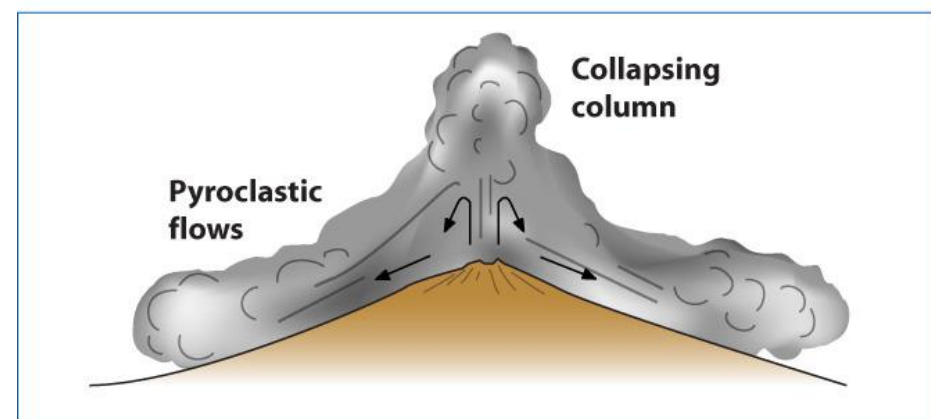


Mount St Helens 1980
10,000 cubic metres per second
0.2 km³ over several hours



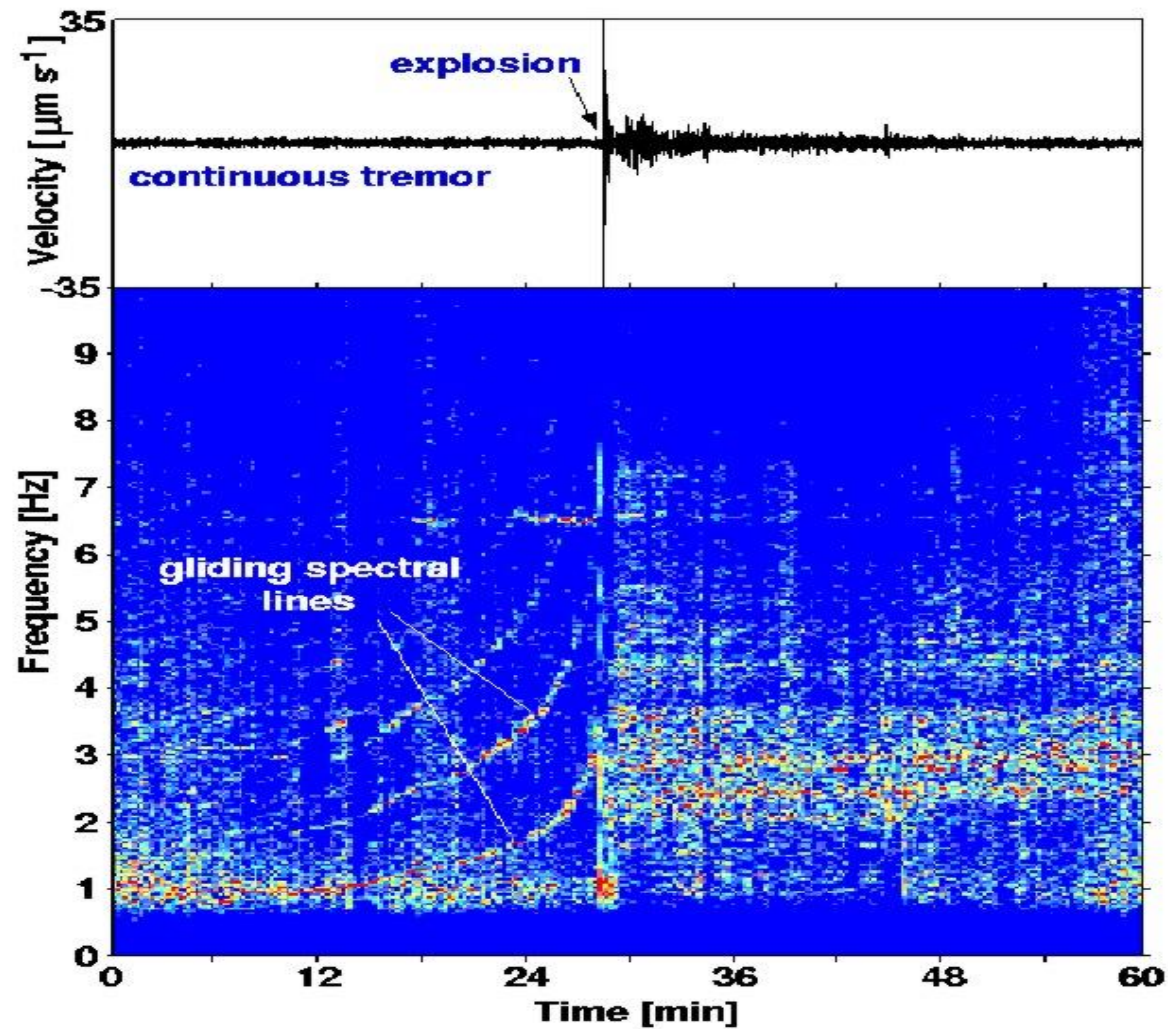
Download from web:

<https://vimeo.com/volfilm/videos>



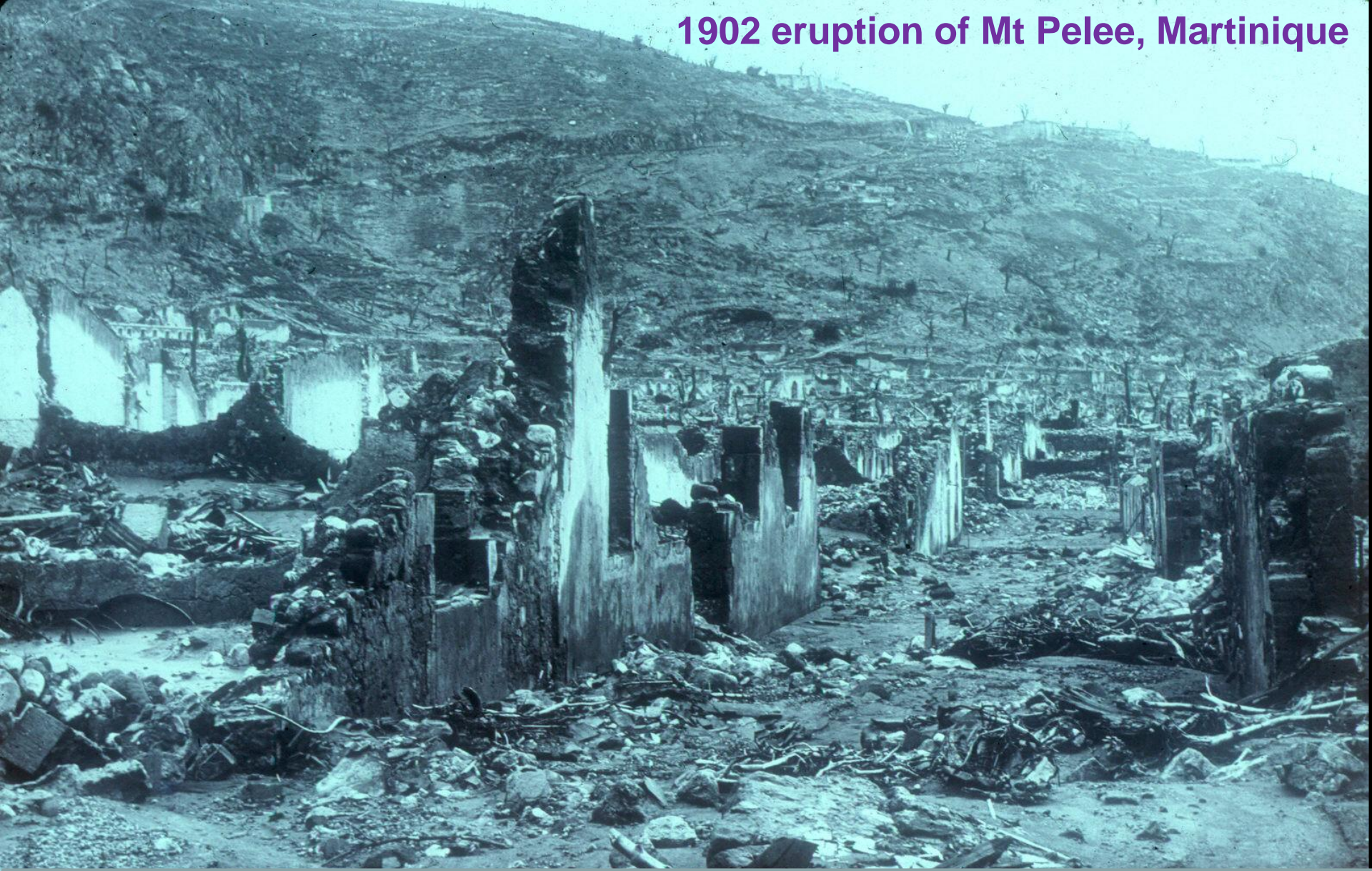
Column collapse
Pyroclastic flows

Download from web:
<https://vimeo.com/volfilm/videos>



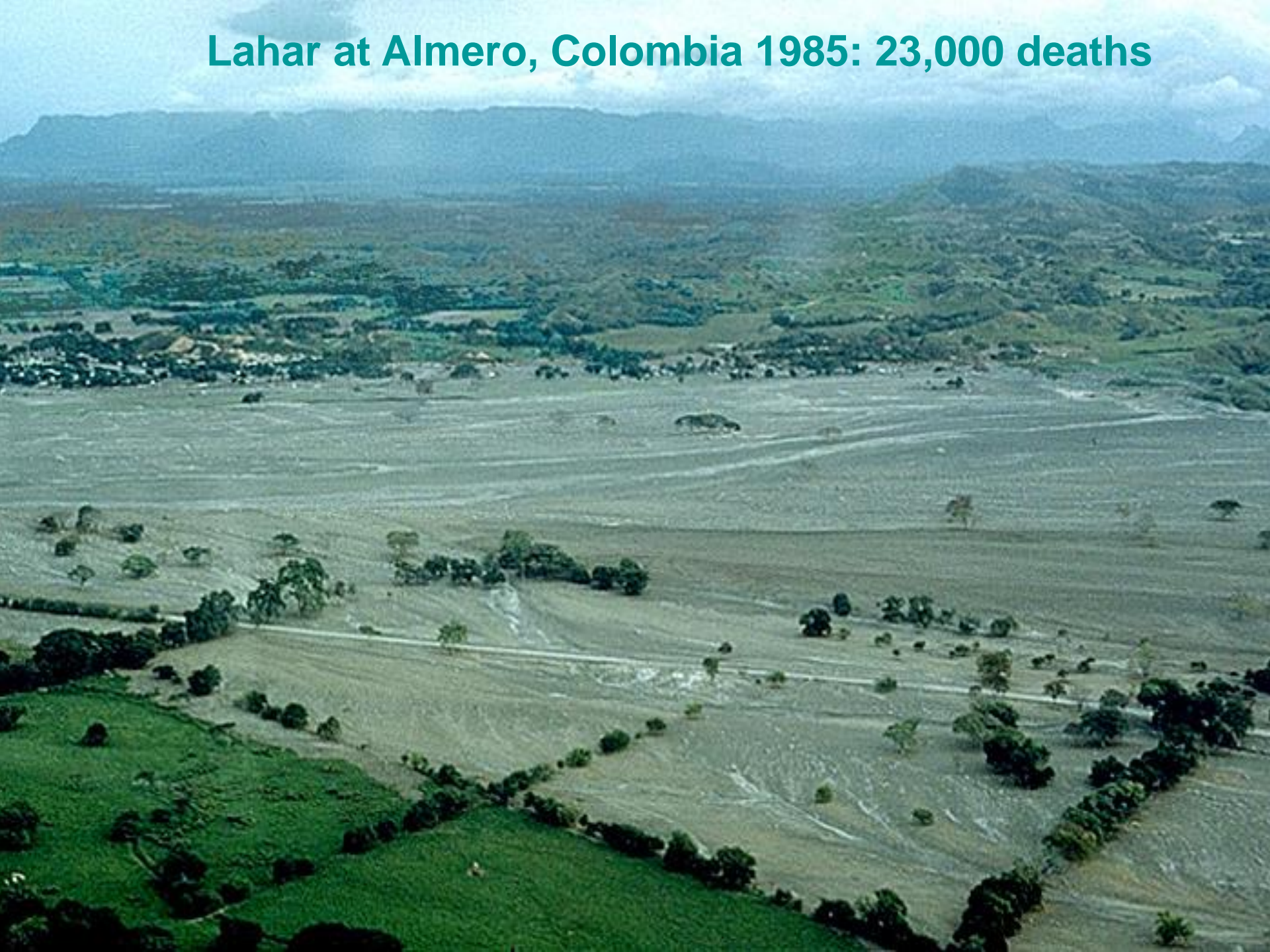
Volcano Monitoring, forecasting and risk management

1902 eruption of Mt Pelee, Martinique



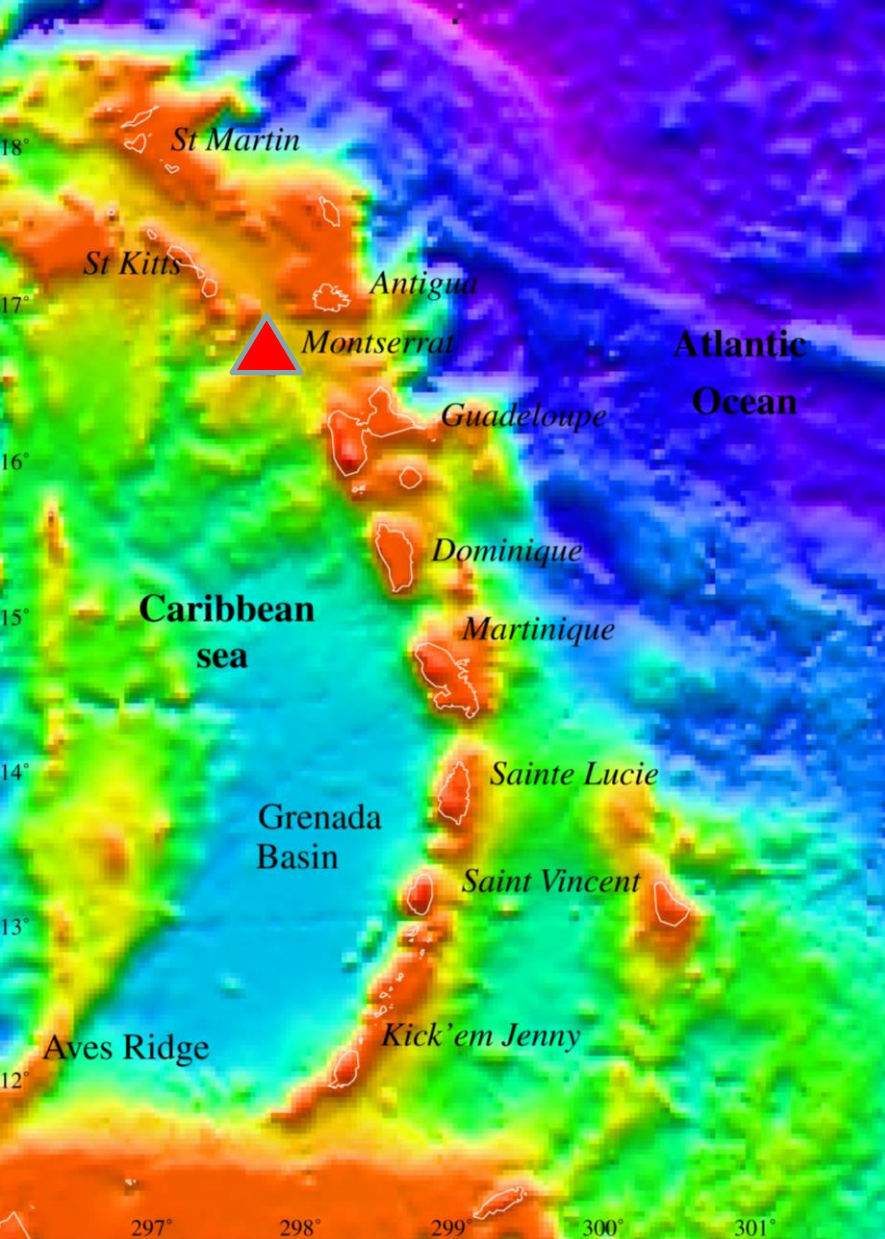
**29,000 people die when political priorities
take precedence over public concerns**

Lahar at Almero, Colombia 1985: 23,000 deaths





Soufriere Hills Volcano Montserrat 1995-2010



Montserrat is part of the Lesser Antilles Volcanic arc

9,000 relocated
> 1 billion \$ losses
~ £30 million per yr

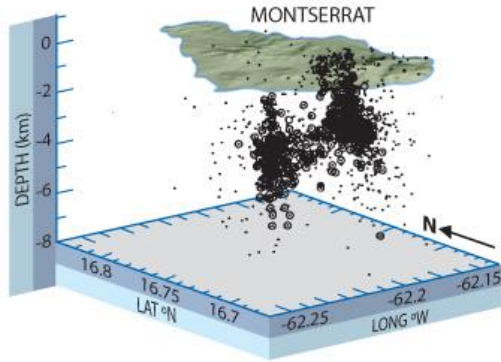


Soufriere Hills Volcano, Montserrat

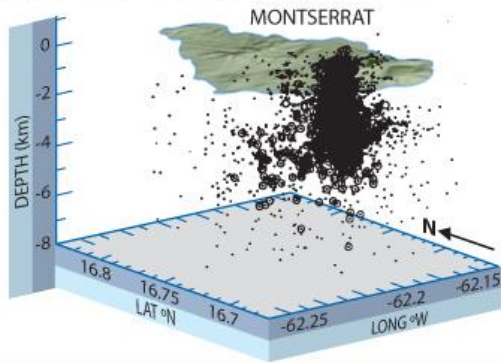
Monitoring volcanoes and magma transport

Earthquakes

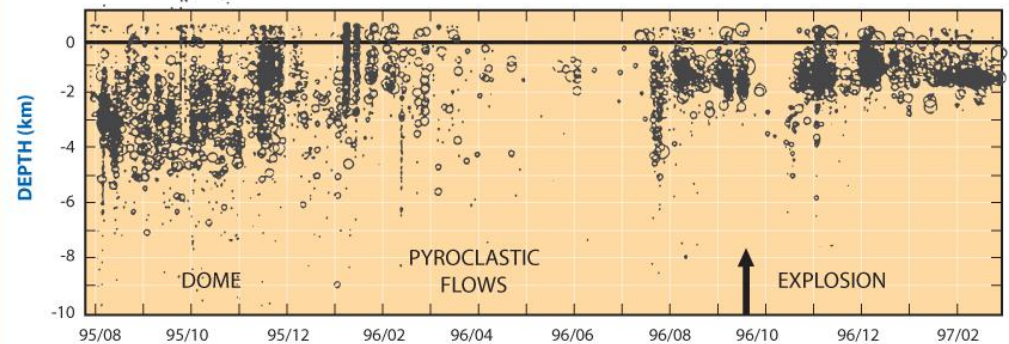
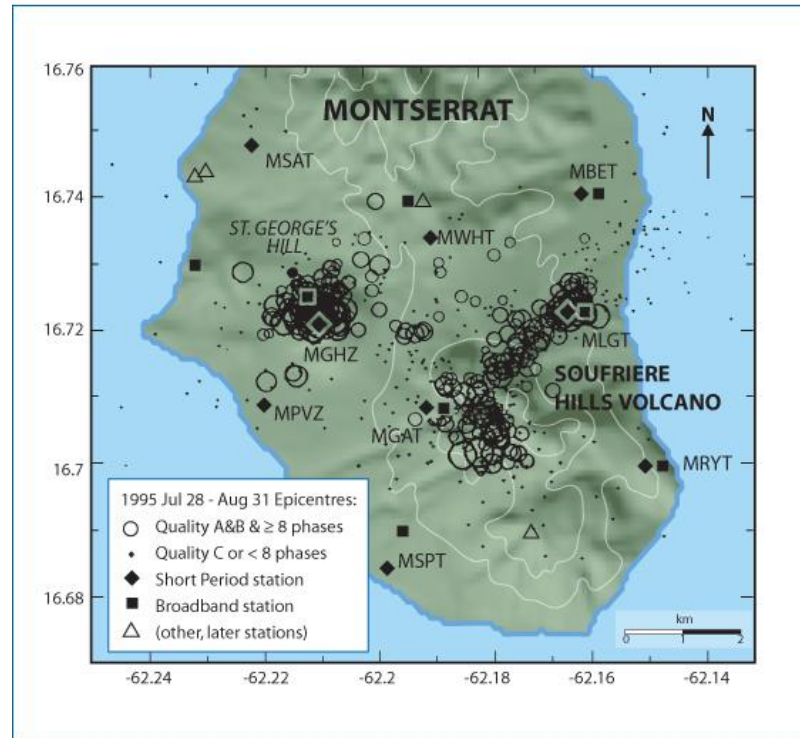
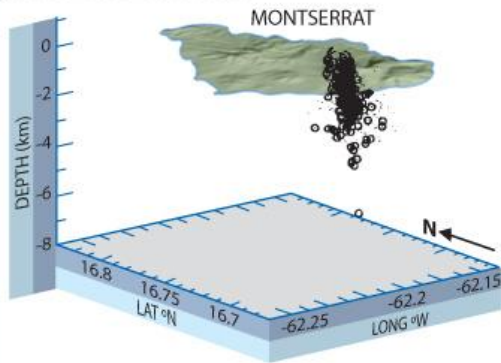
a) 28 JUL - 30 SEP 1995

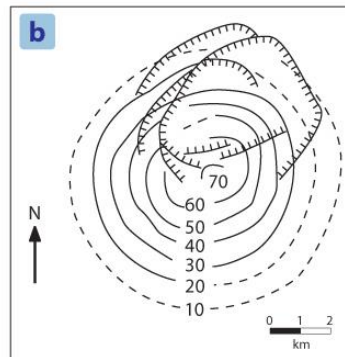
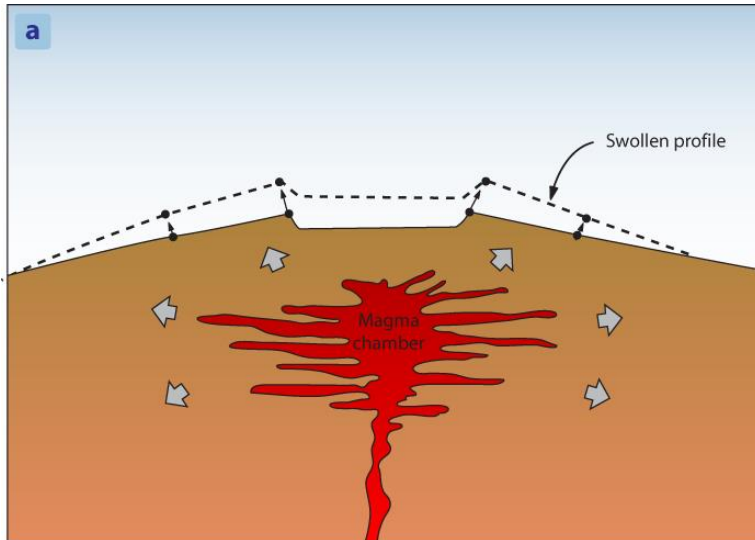


b) 01 OCT 1995 - 31 OCT 1996



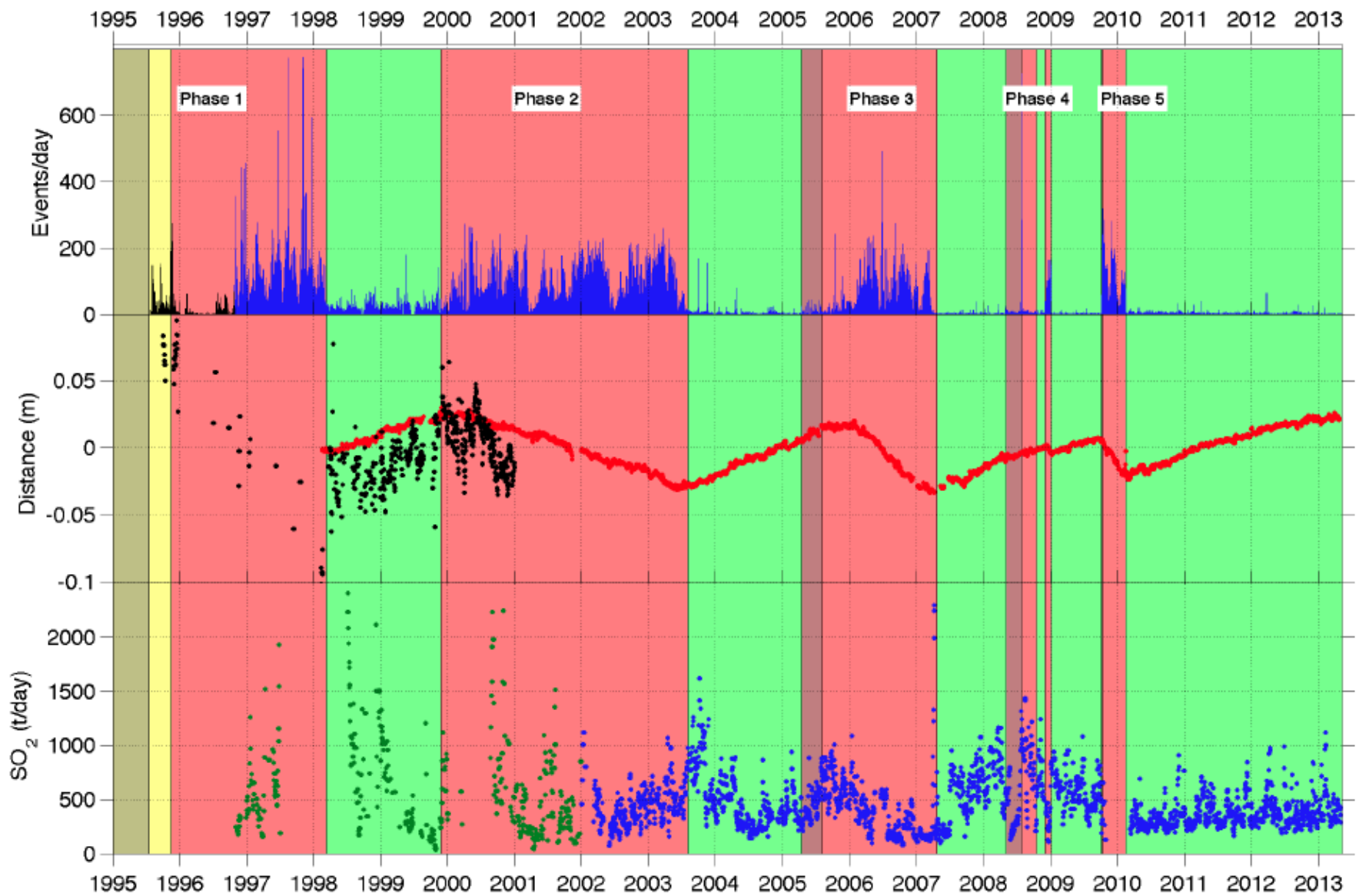
a) 01 NOV 1996 - 28 FEB 1997



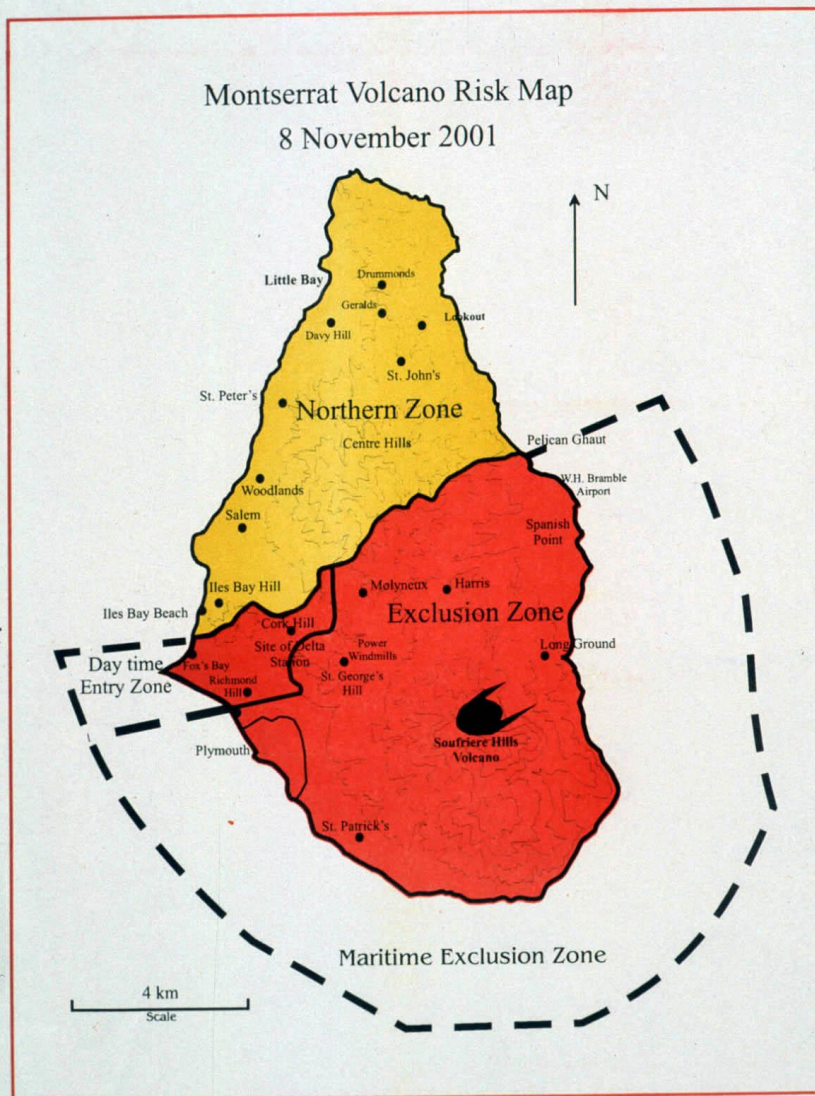


Ground Deformation

Monitoring volcanoes and magma transport



Monitoring establishes systematic patterns to allow forecasting



Simplified risk map July 1997




Volcanic Risk Management



What is the chance that a village 6 km NW of the volcano will be inundated by a pyroclastic flow?

Assessing risk and uncertainty: probabilistic approach



Spine →
(1098m)

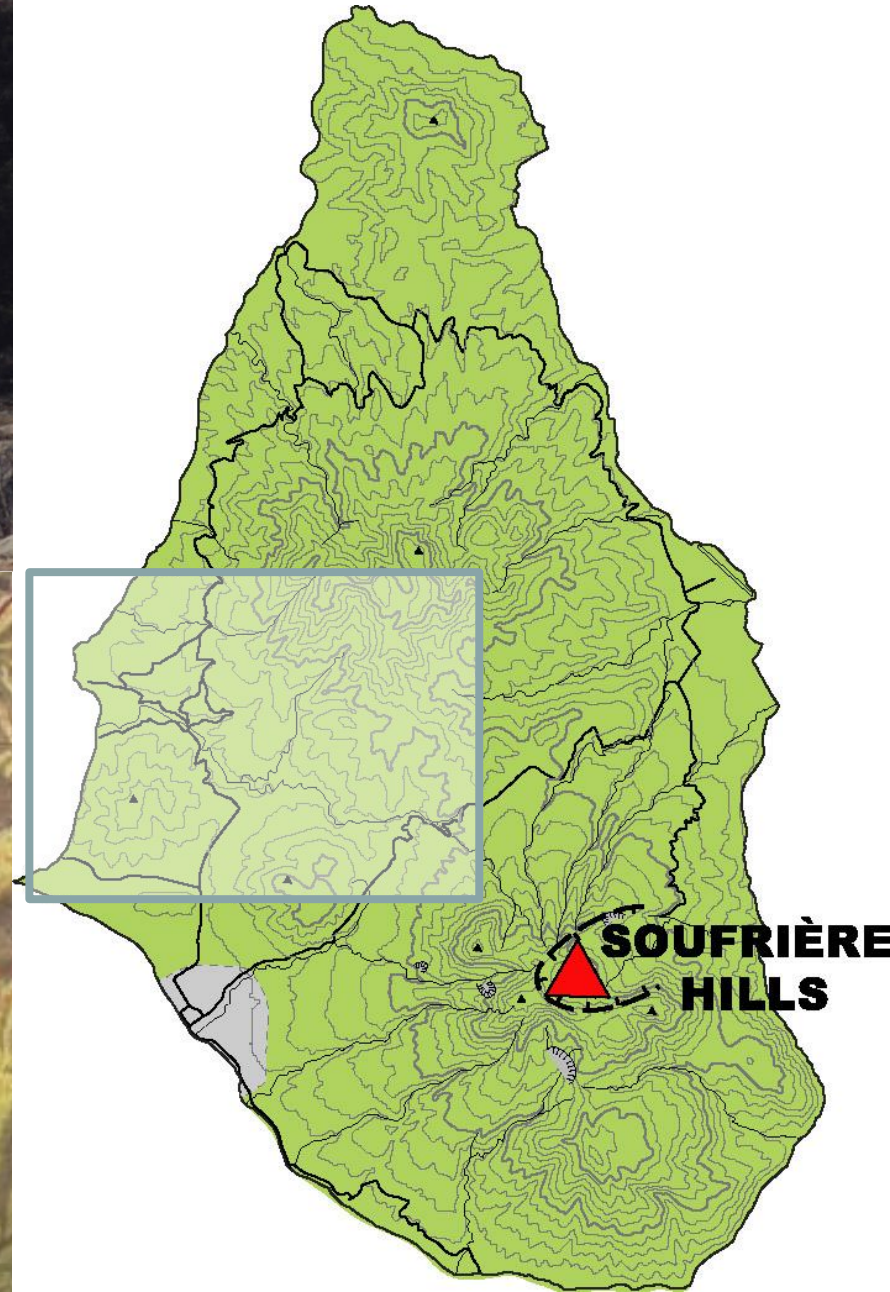
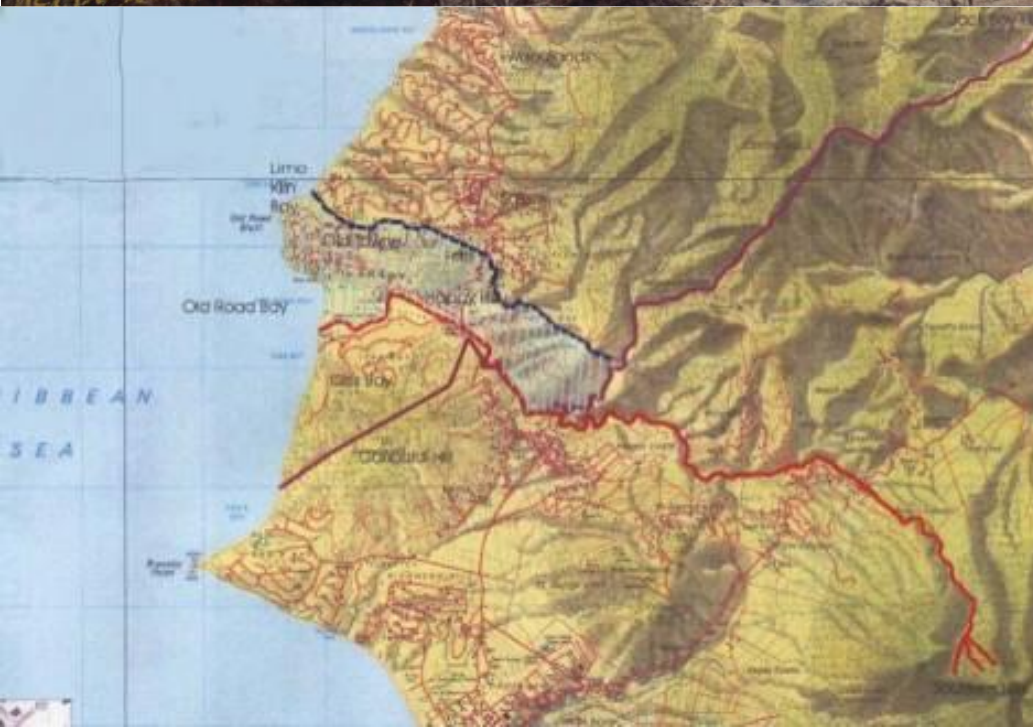
**Tyres
Ghaut** →

to Upper →
Belham Valley

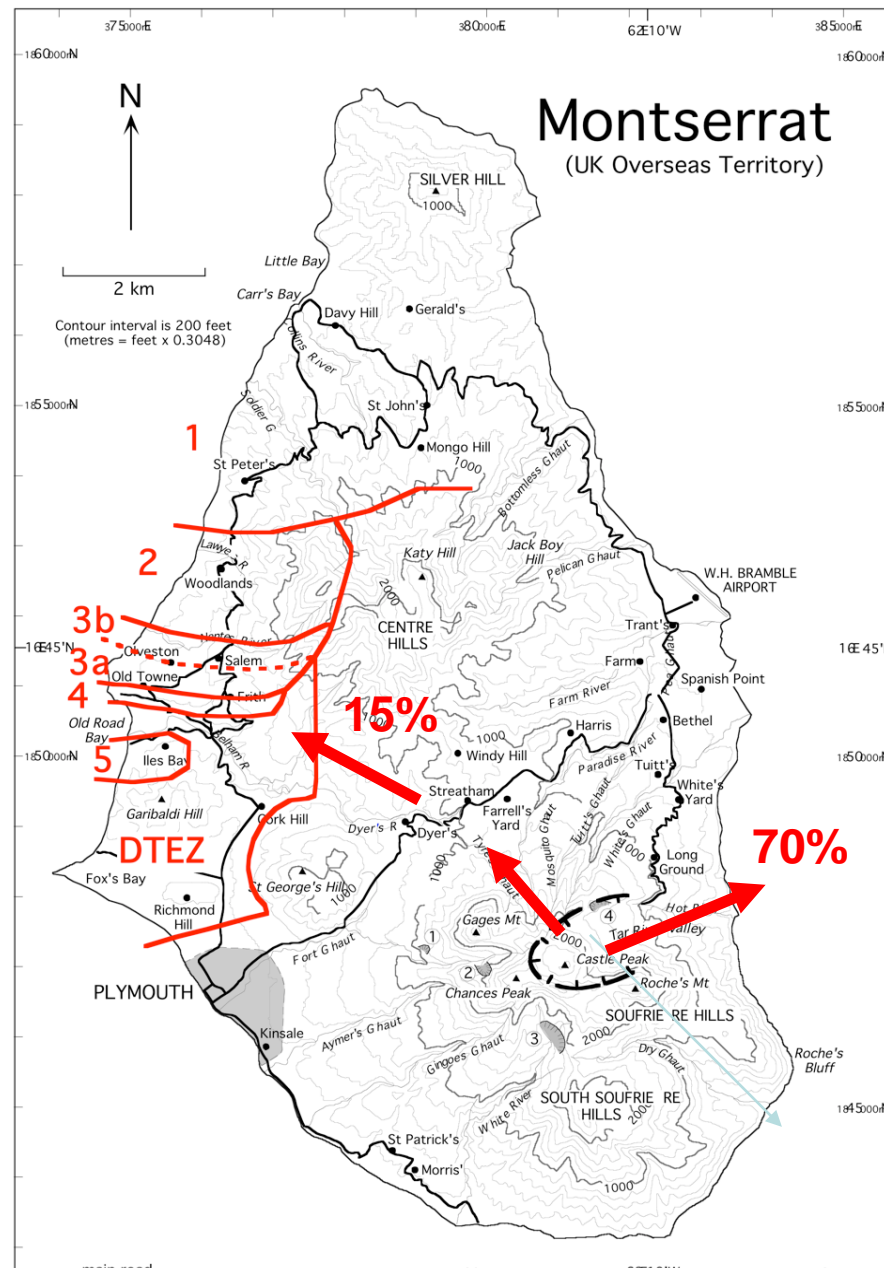
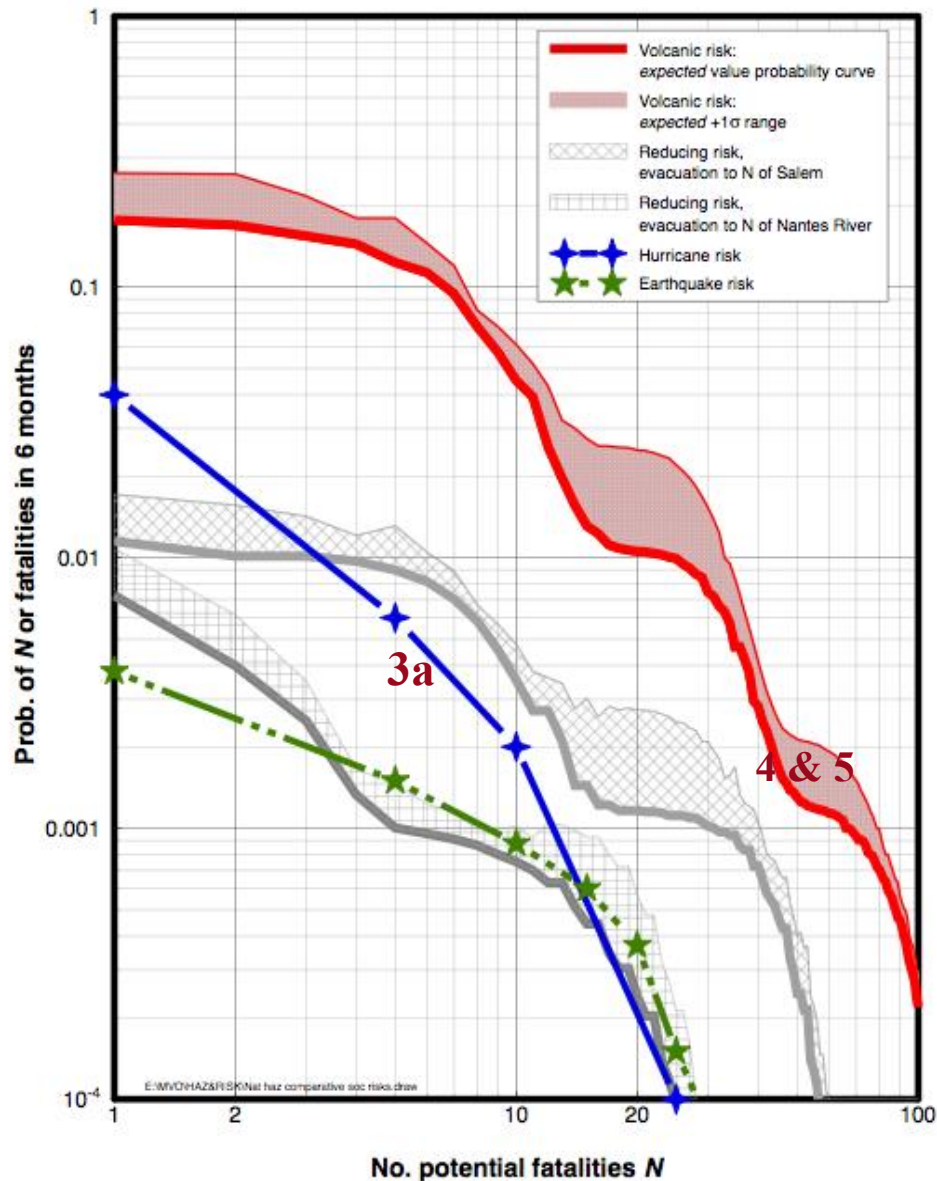
Crisis in July 2003



Lower Belham valley, Montserrat
Evacuated 8 October 2002



Comparative societal risk exposure



12 July 2003

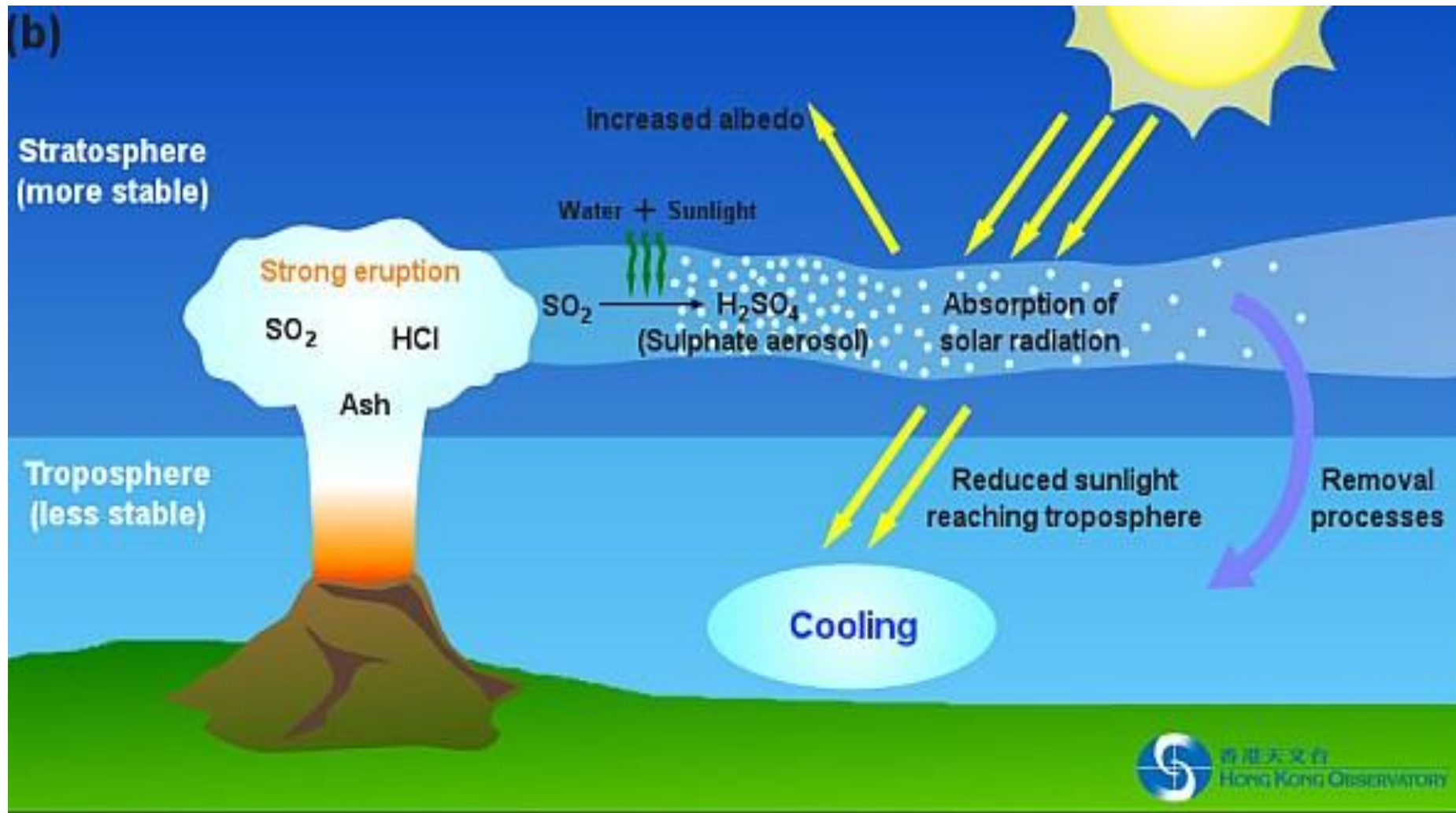
What happened?



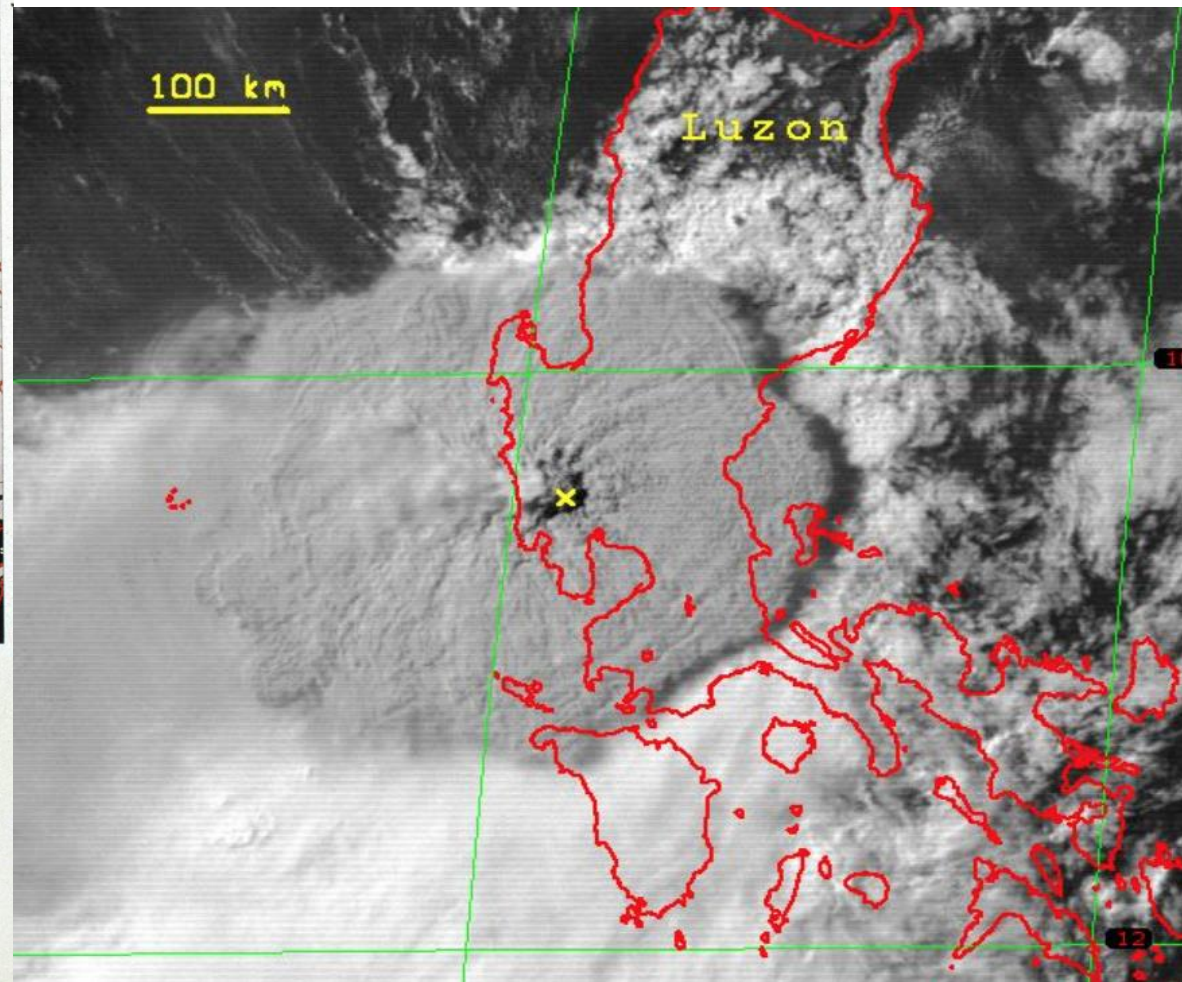
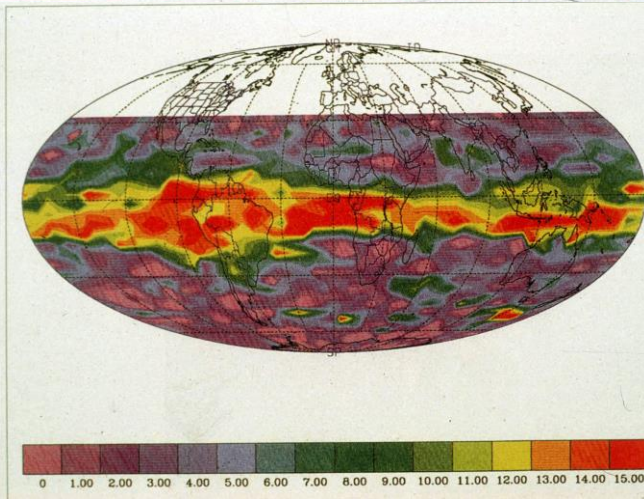
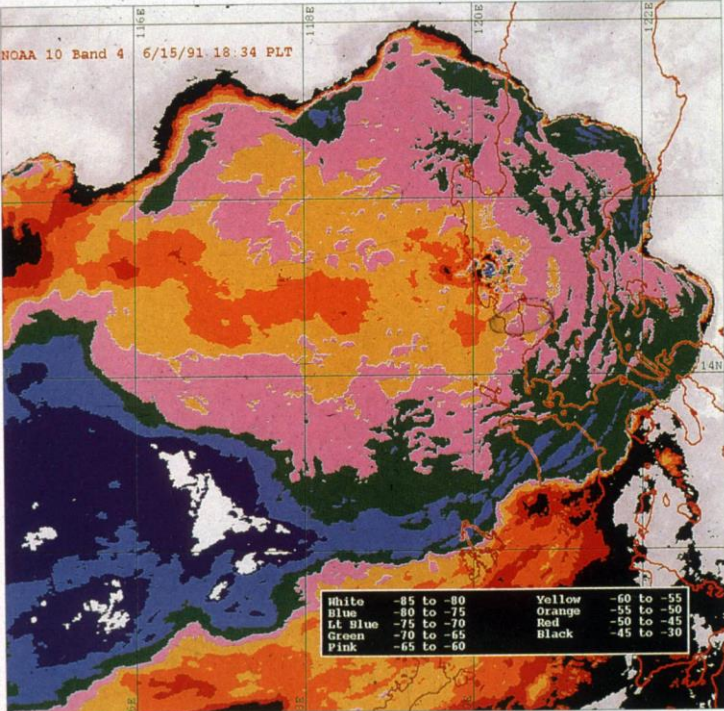
**Largest historic dome collapse
(210 million cubic metres)
on 12th July 2003**

**13th July 2003
Risk reduced!
People moved back**



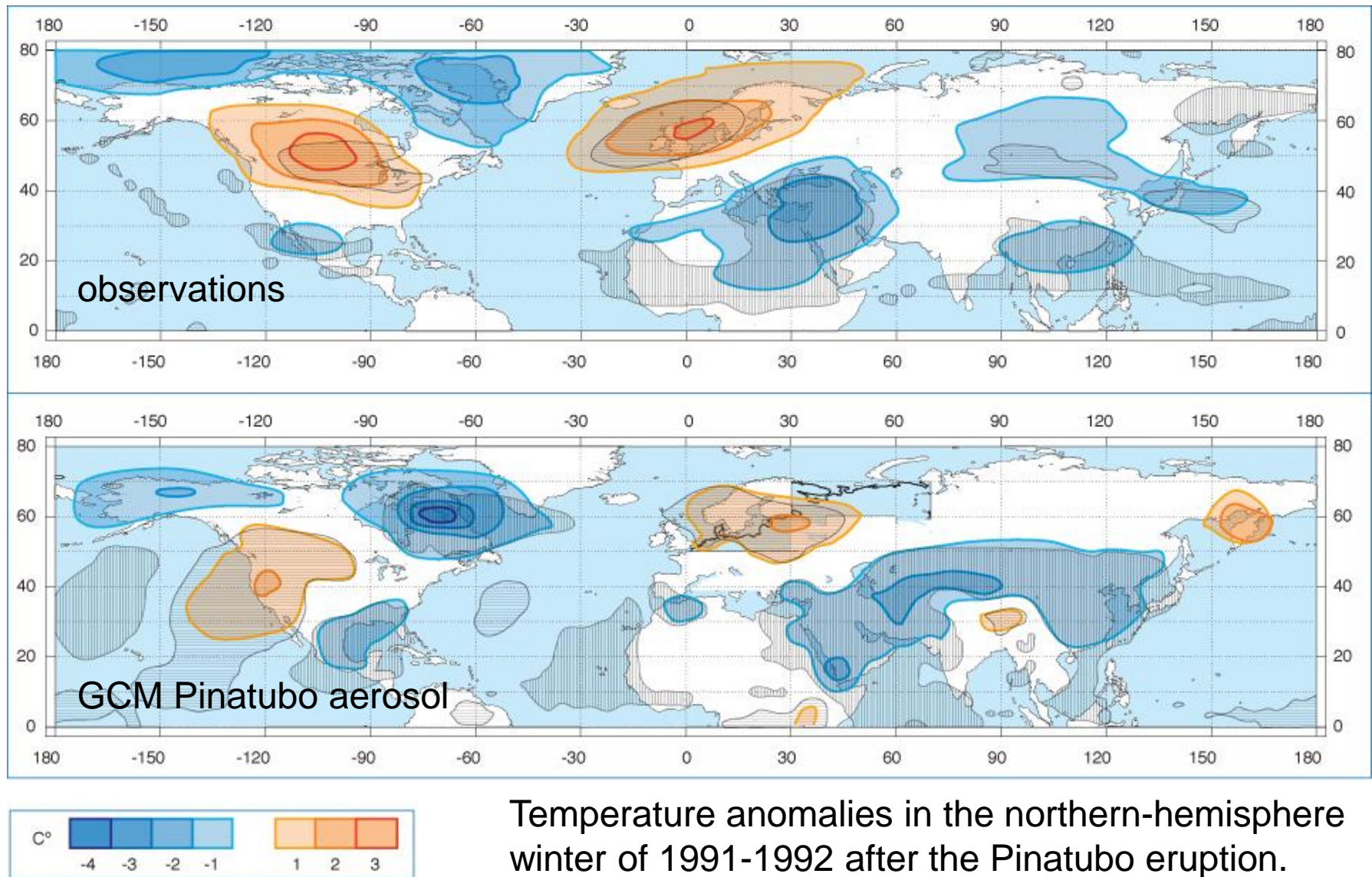


Impact of large volcanic eruptions on climate



Atmospheric pollution; global scale

June 1991 eruption of Mount Pinatubo, Philippines (5 km³)



Comparison of climate model and Pinatubo observations

**1815 eruption of Tambora,
Indonesia ~ 40 km³**



Great Famine of 1816

'Coldest July in a 192 years record.' (Lancashire Plain, UK)

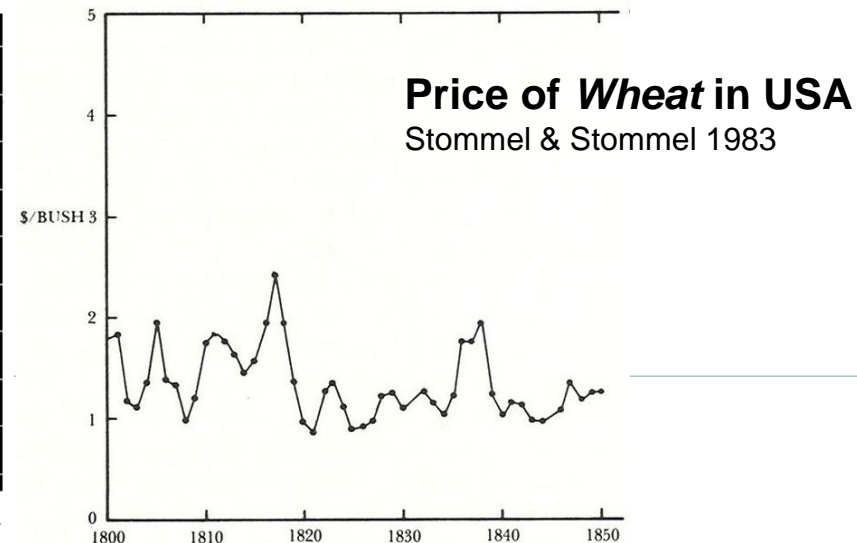
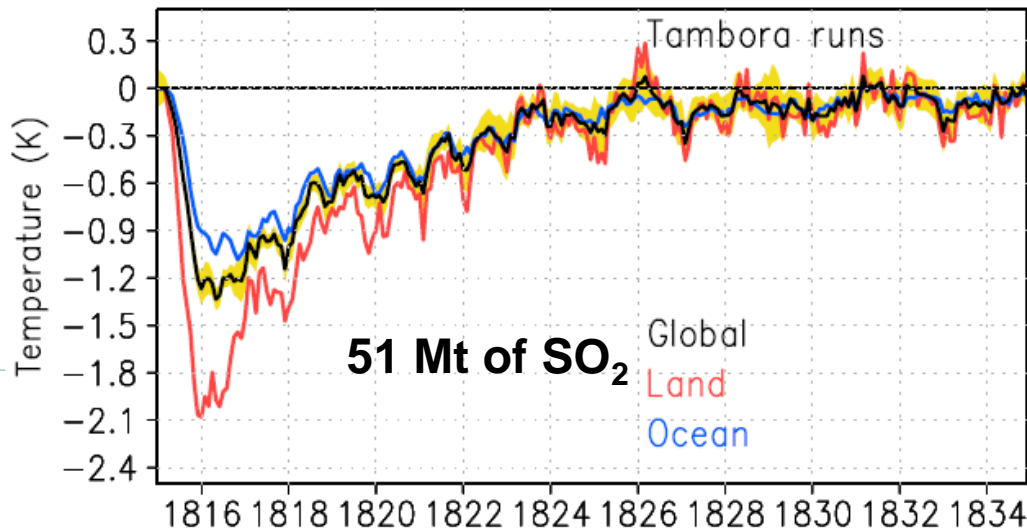
'Coldest summer in 1753-1960.' (Geneva, Switzerland)

'Great frost [in June] – we must learn to be humble.' (Branford, USA)

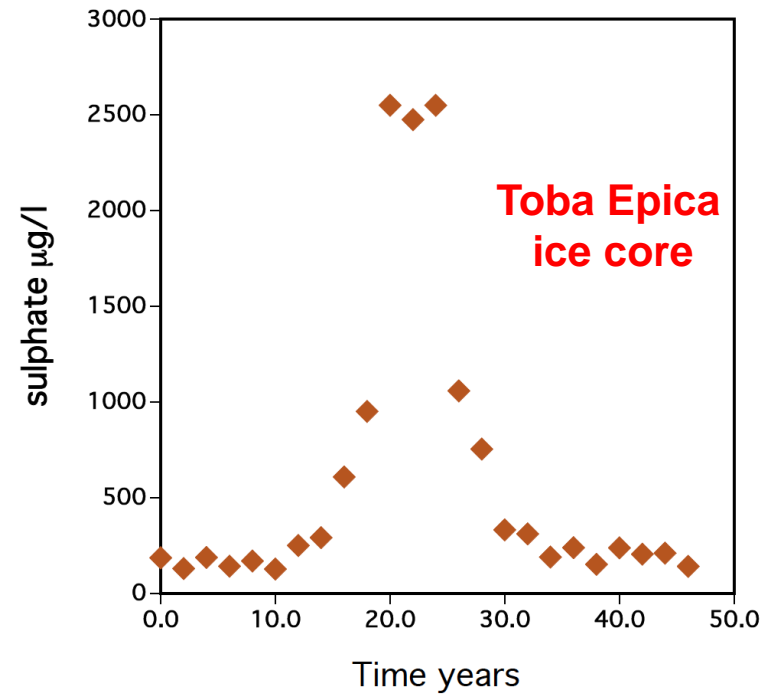
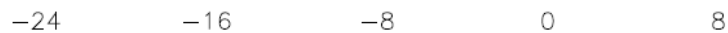
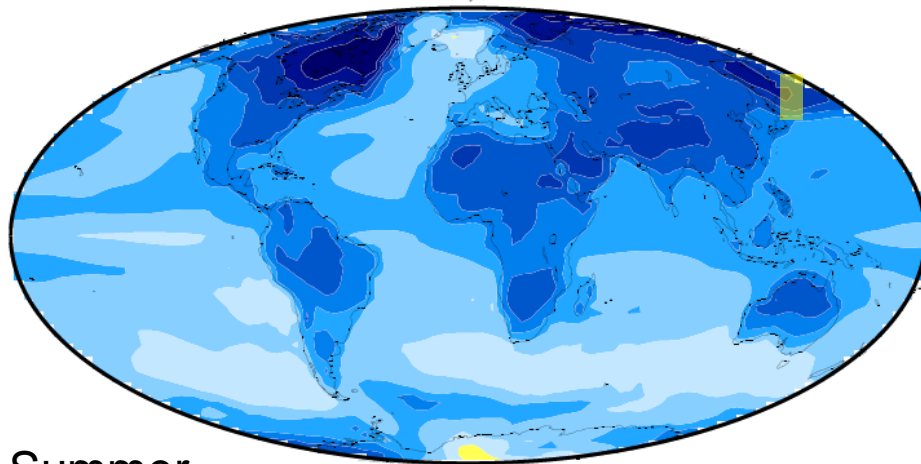
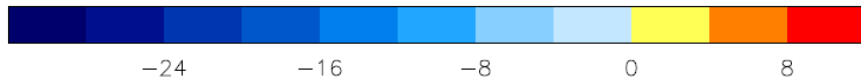
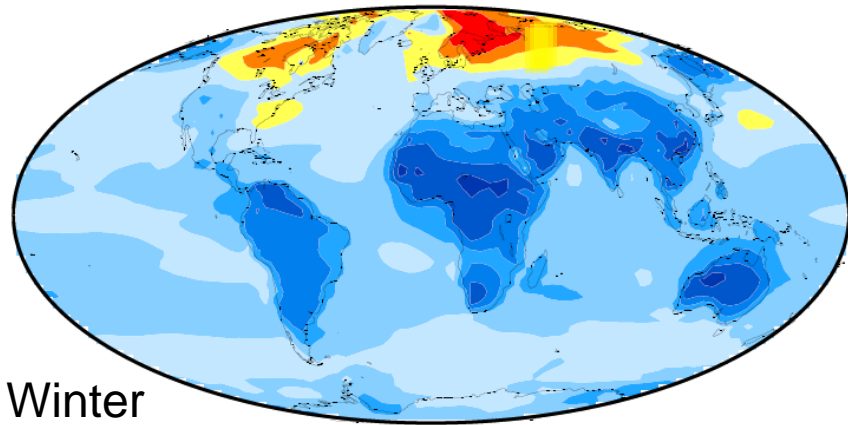
'In July ice froze as "thick as window glass"'. (Maine, USA)

'..for the harvest entirely failed from the badness of the weather.' (Ireland)

a) Surface Temperature Anomaly (K)



Global effects of super eruption



Thank you for listening

Questions?

