European volcanism: Alpine geological processes, or heat from Earth's core?

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University of Durham, UK

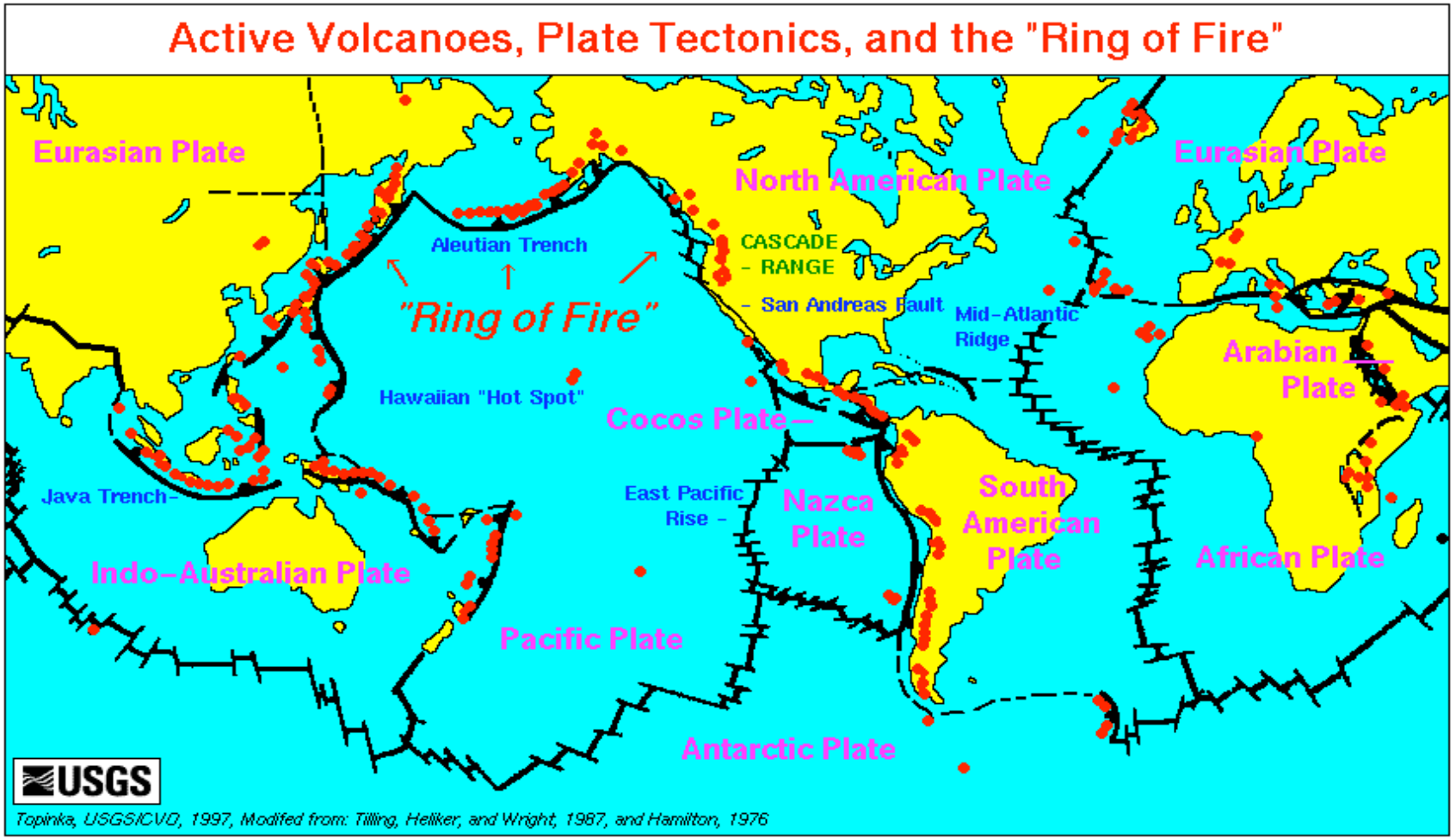
My thanks to:

L'Association Géologique du Luxembourg

Musée National d'Histoire Naturelle, Luxembourg

Volcanoes
&
How We Do Science

- **Plate tectonics**
- Plume
- Plate
- Europe & Eifel
  - Plume
  - Plate



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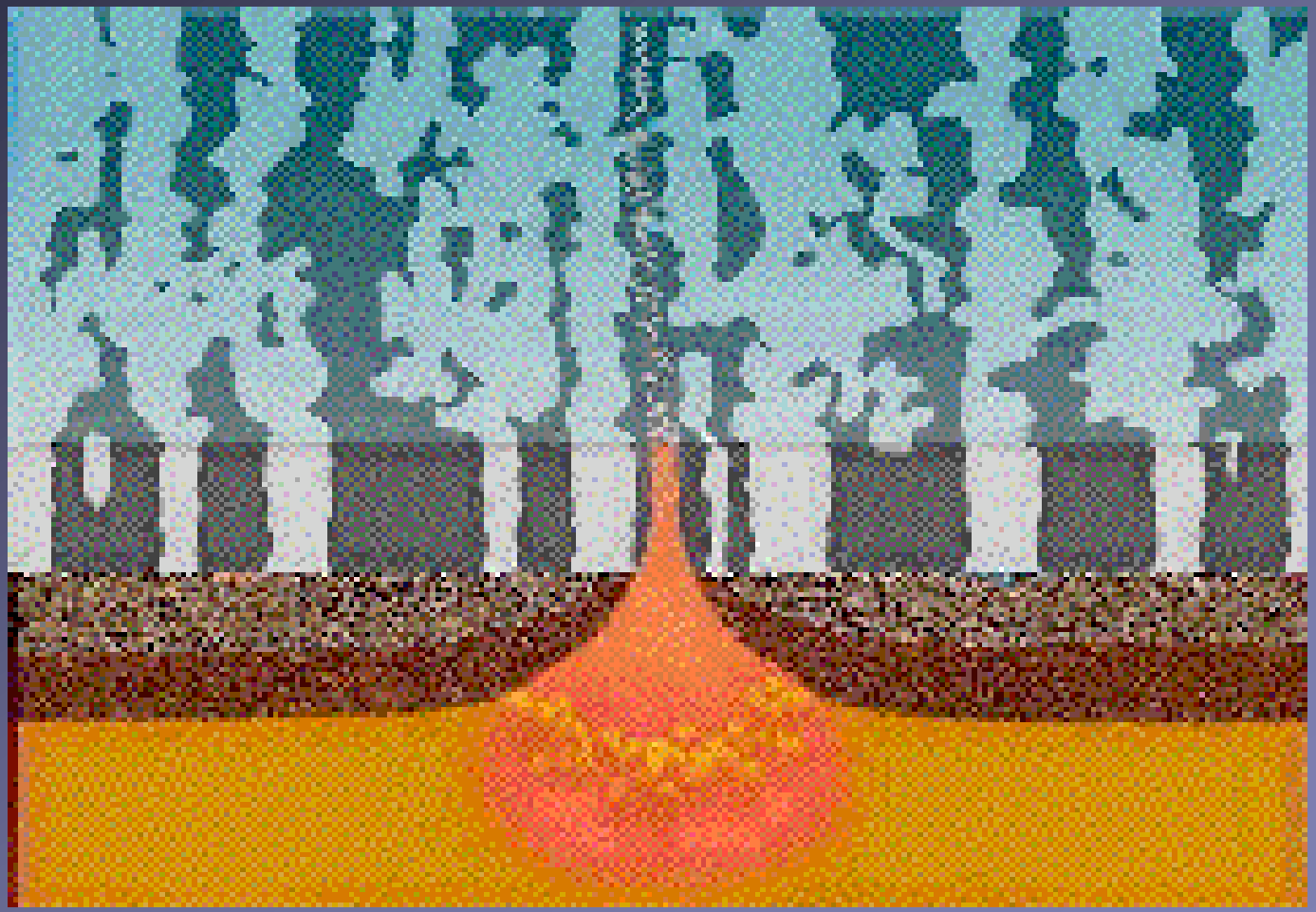

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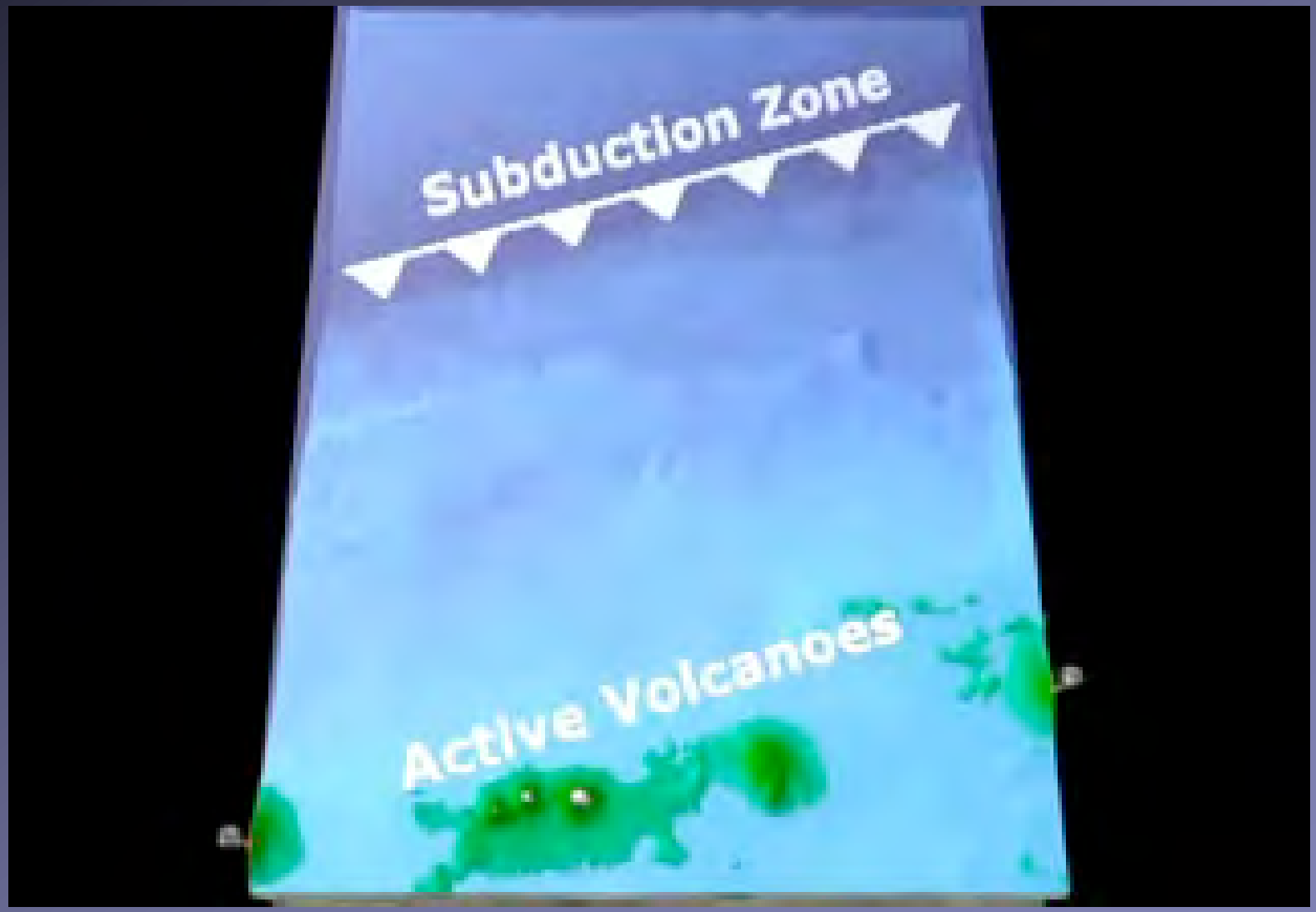

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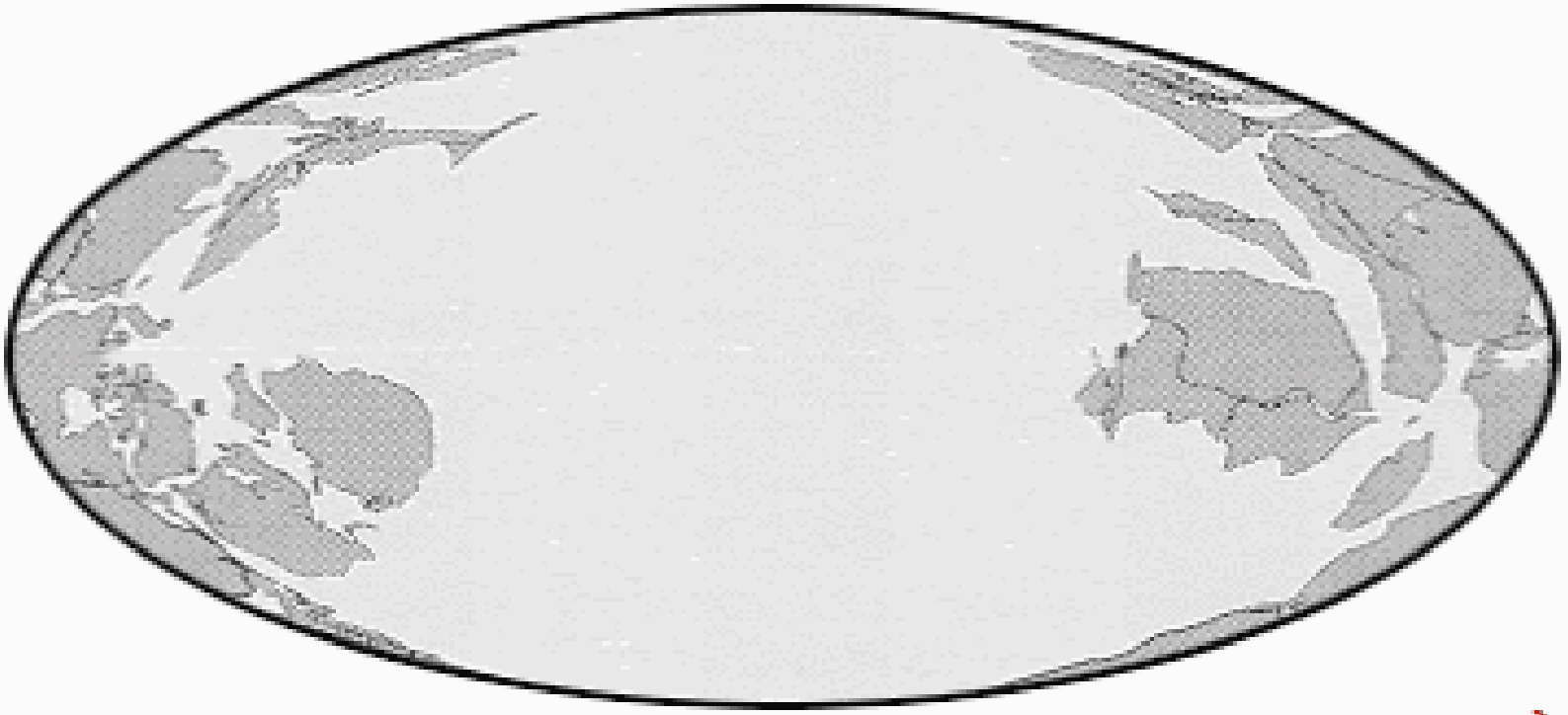

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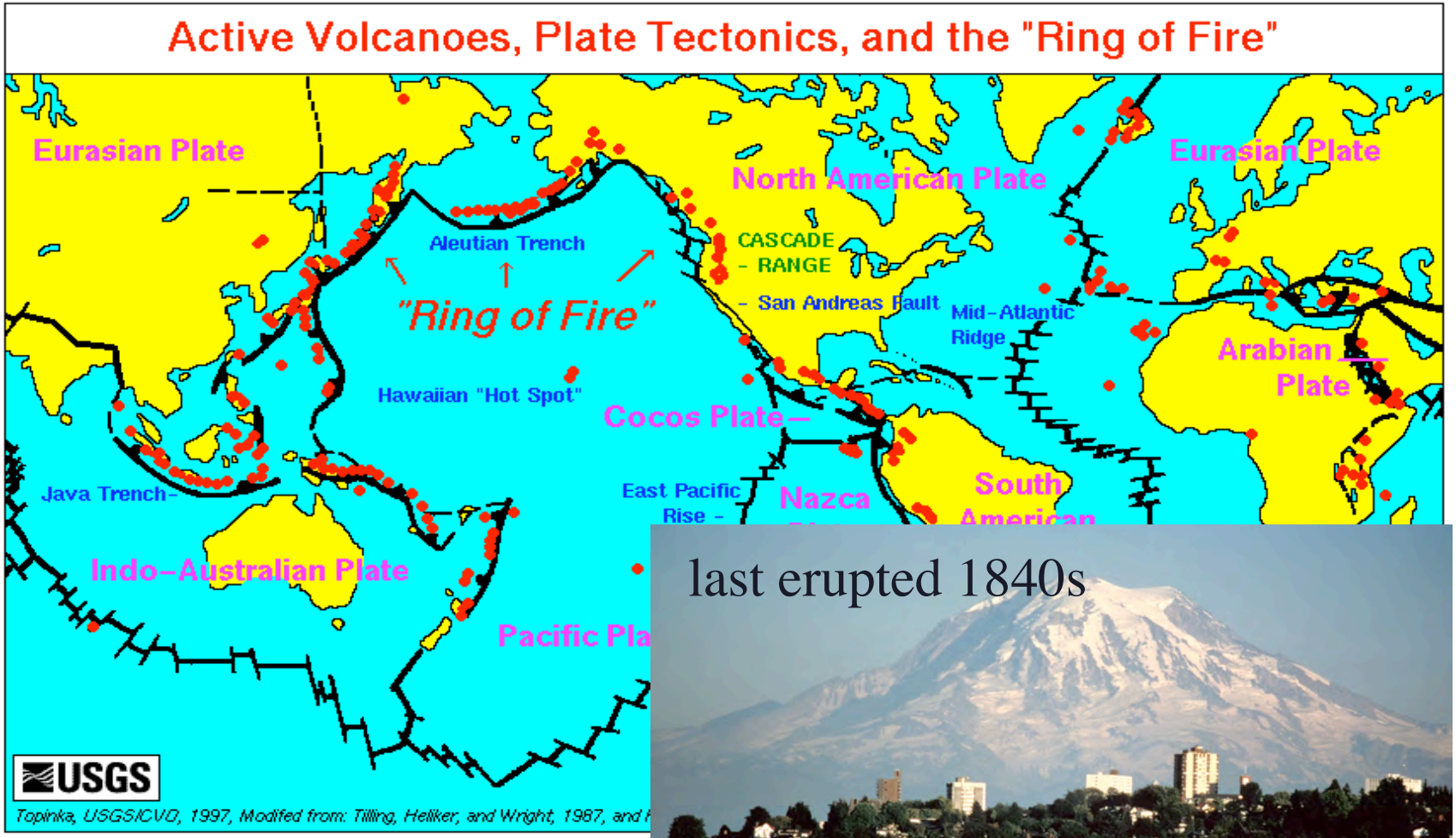

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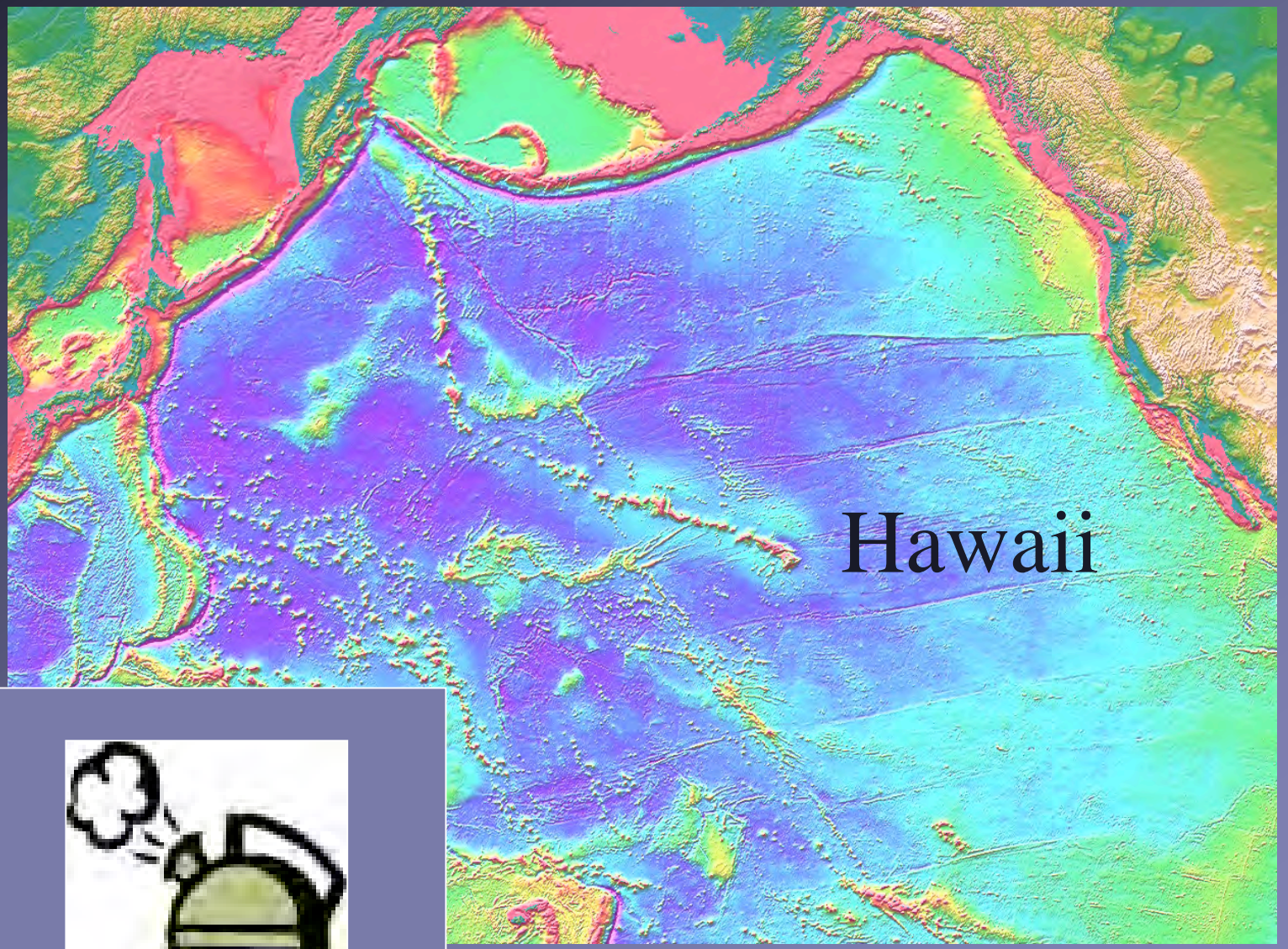

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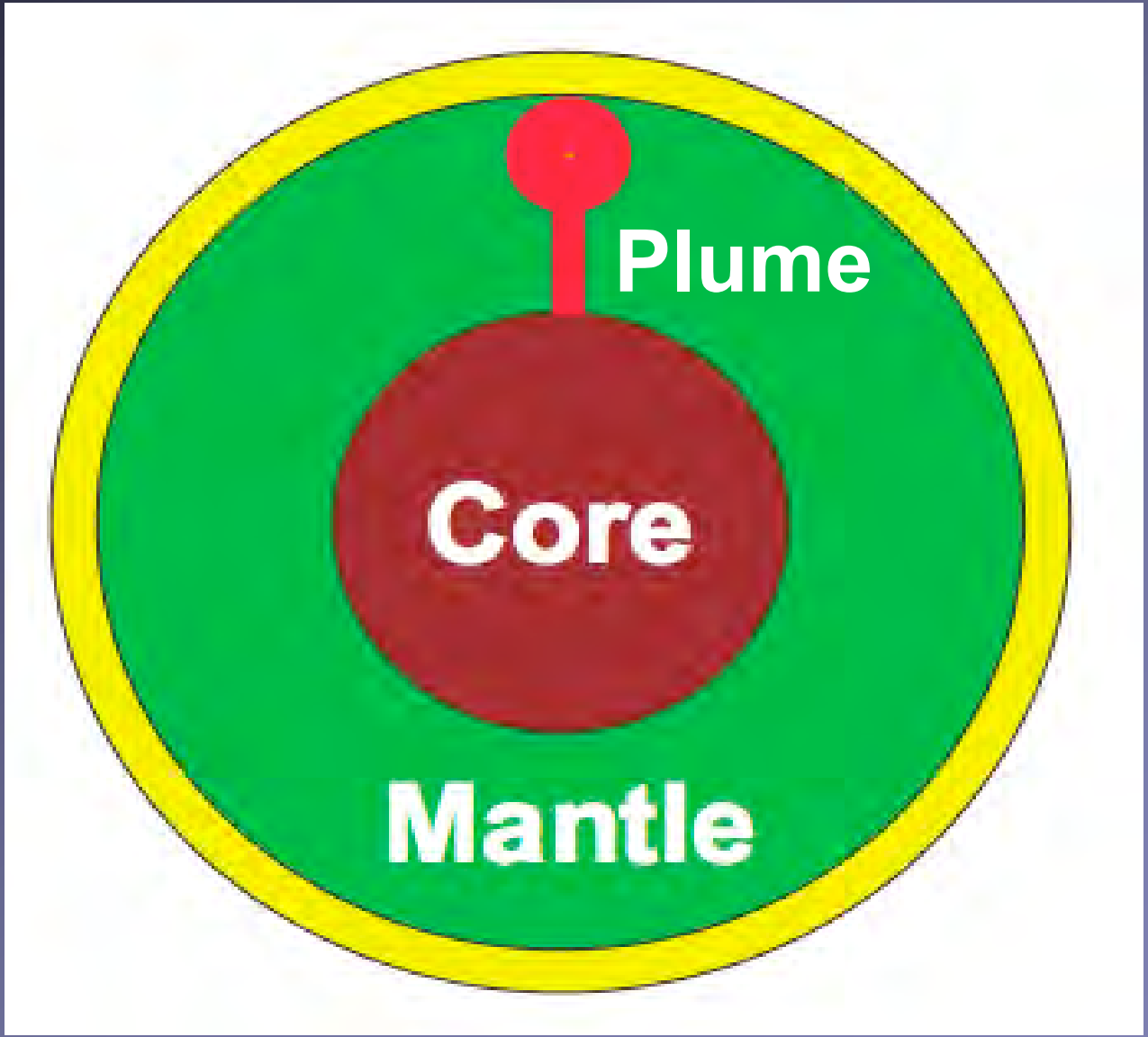

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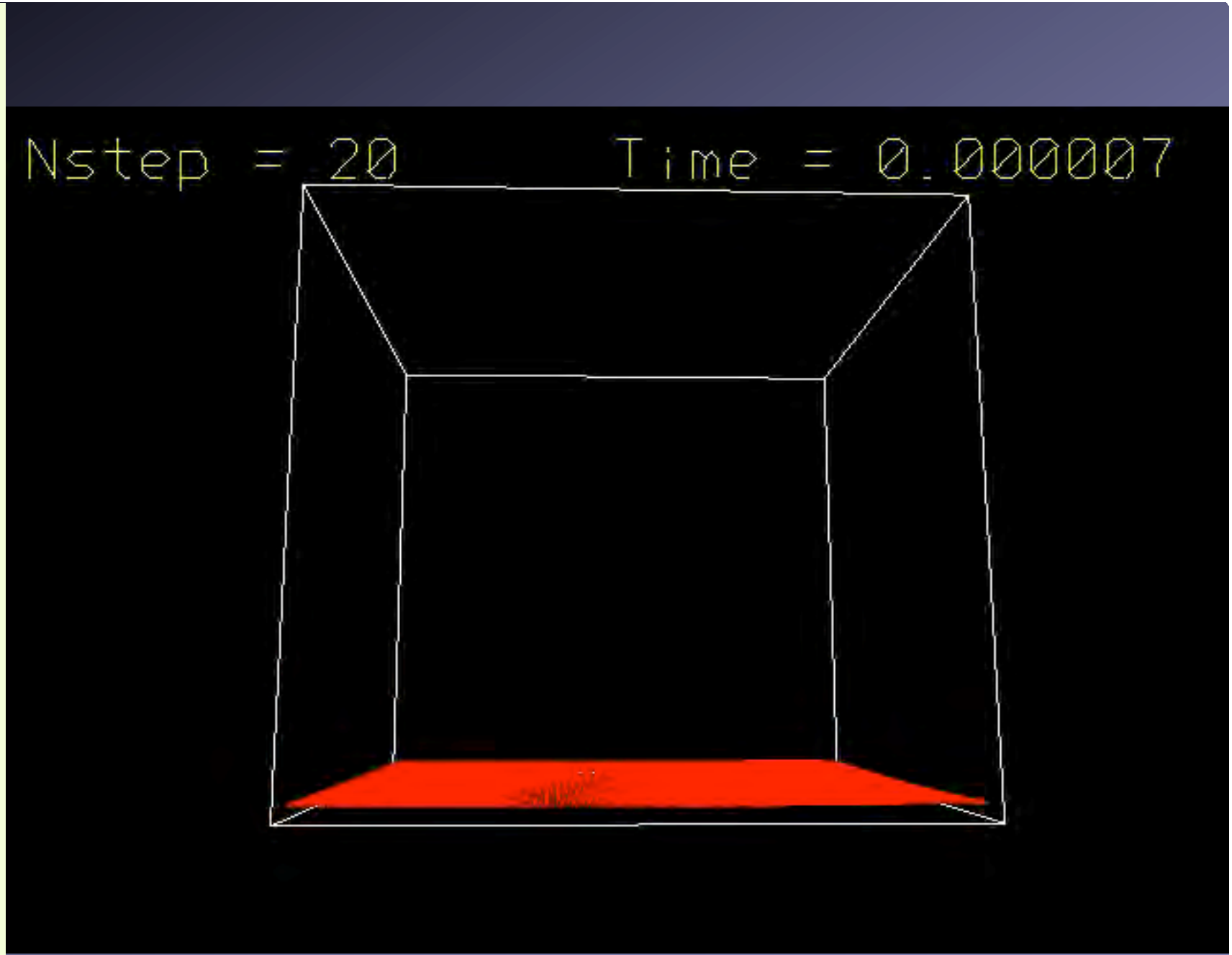

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Plume Predictions

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There are 5 primary predictions

1. Precursory uplift

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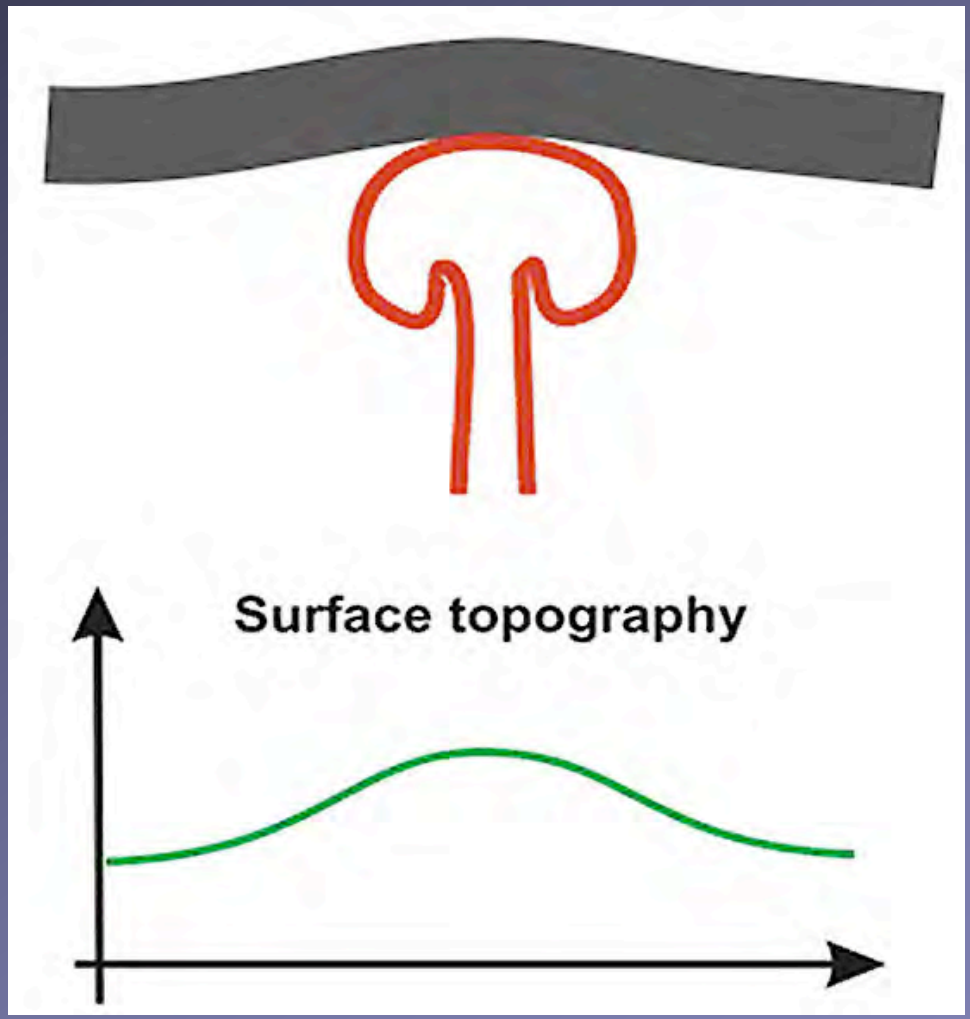

Burov (2005)

2. “Plume head” eruption

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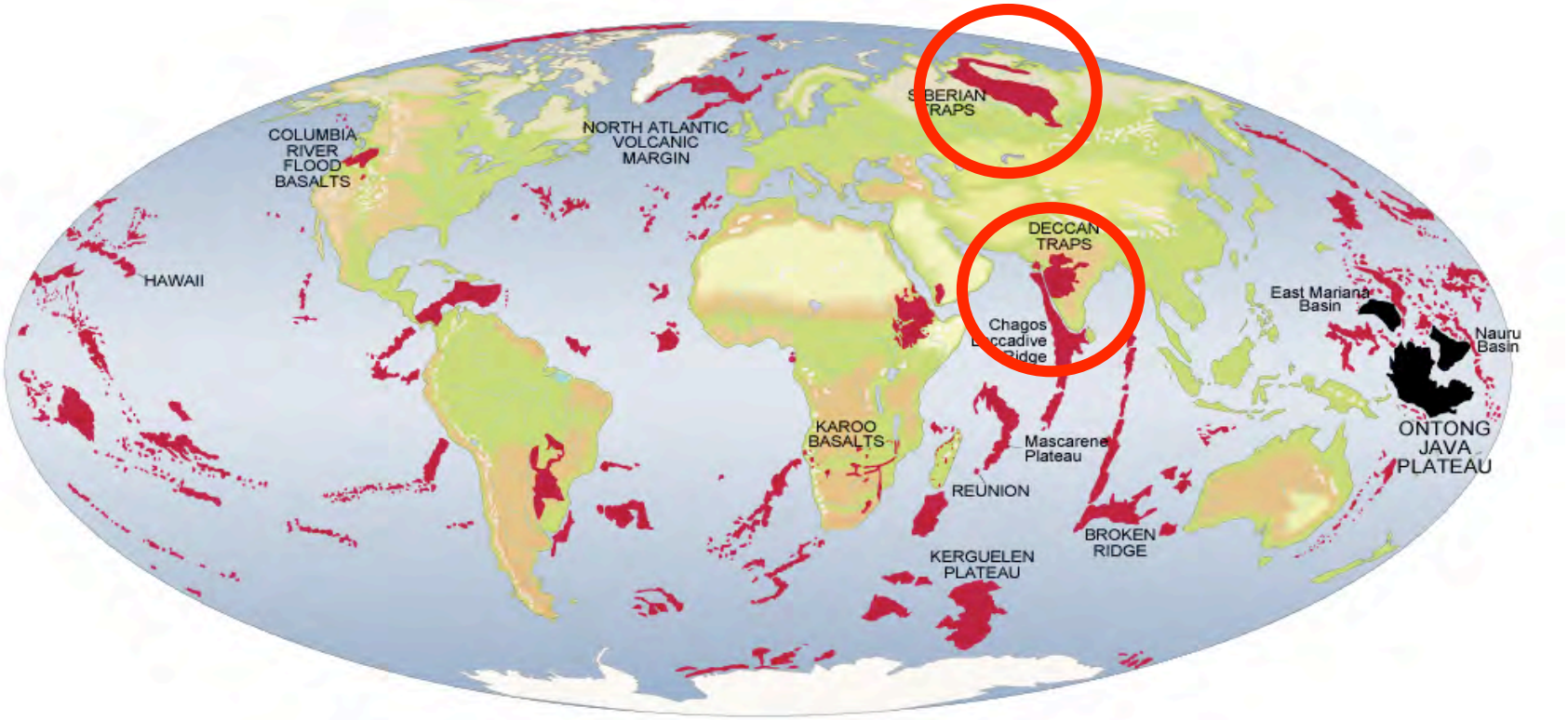

Coffin & Eldholm (1993)

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3. “Plume tail” to the core-mantle boundary

Campbell (2005)

4. Time-progressive chain

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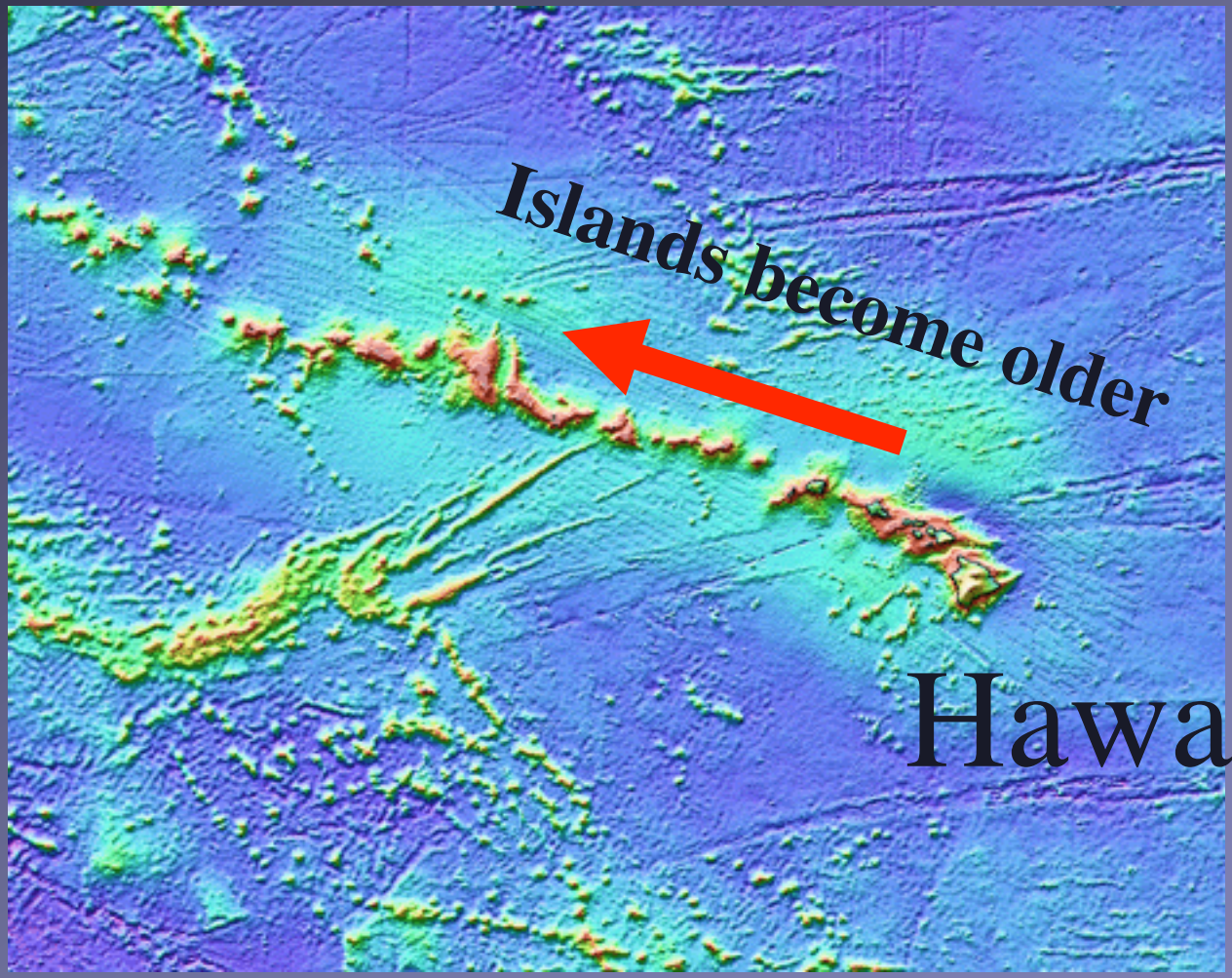

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5. High temperature

Modern plume lists

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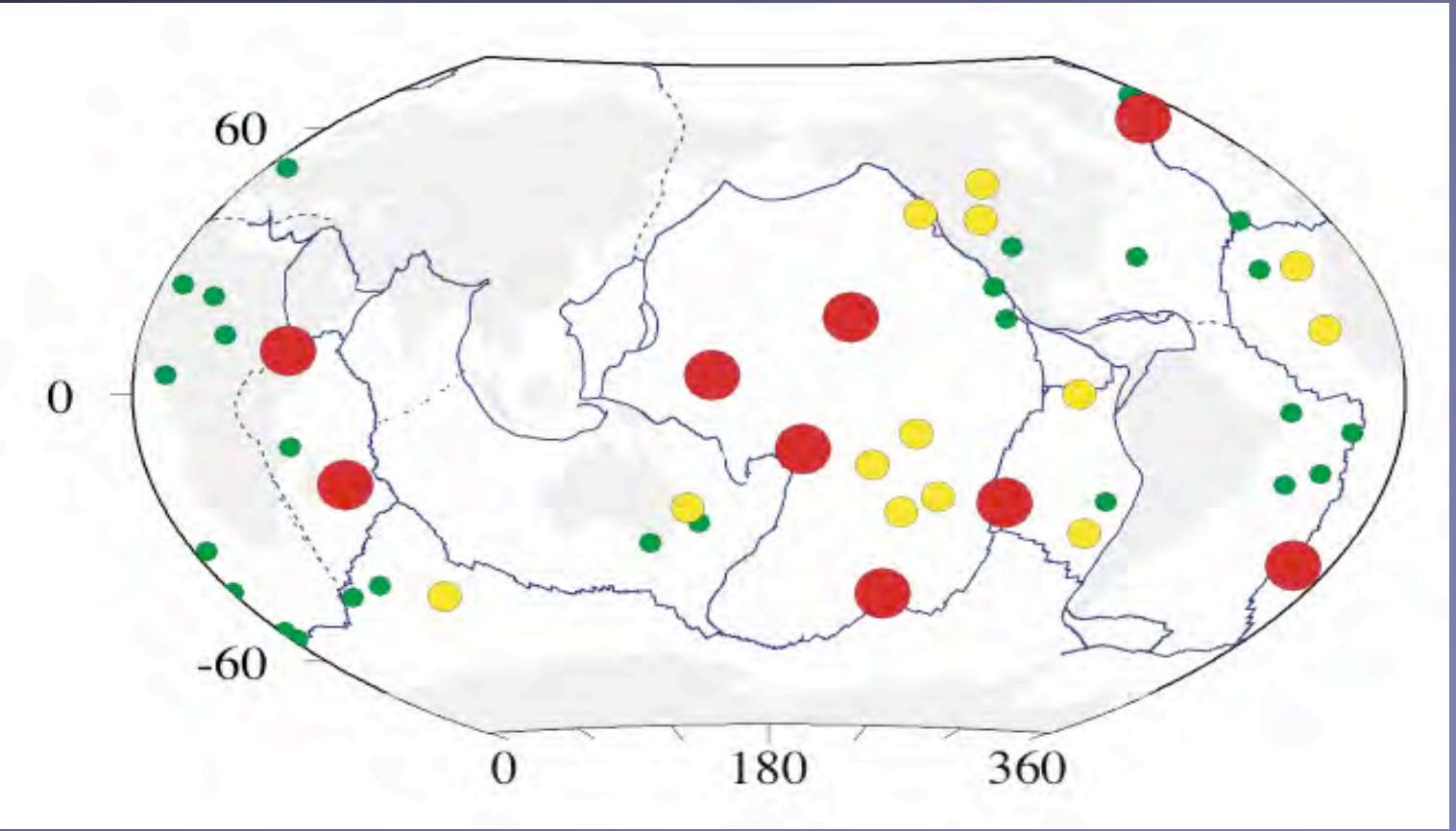

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How successful are the predictions?

Largest flood basalts: No Uplift

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Coffin & Eldholm (1993)

No Plume head

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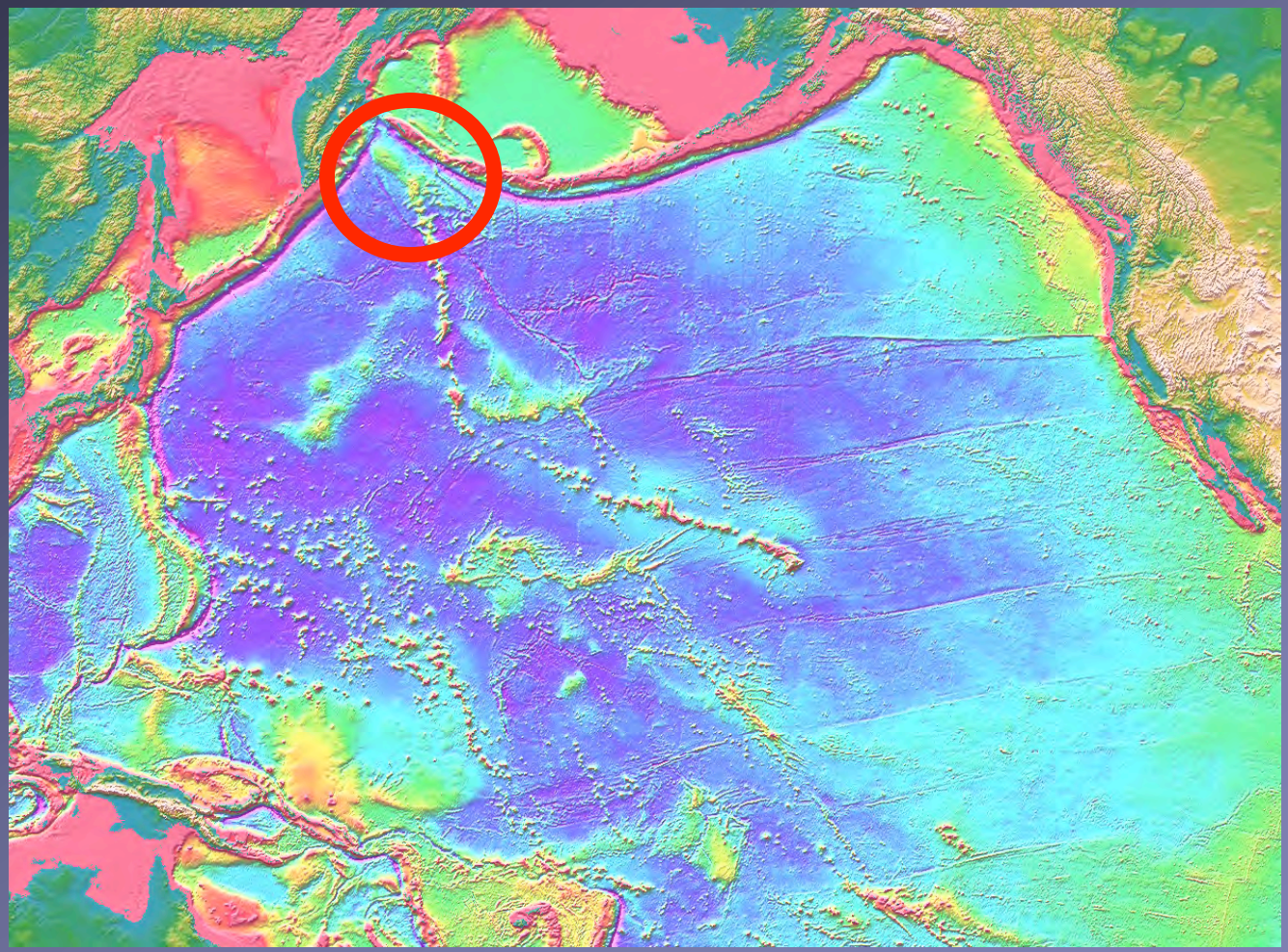
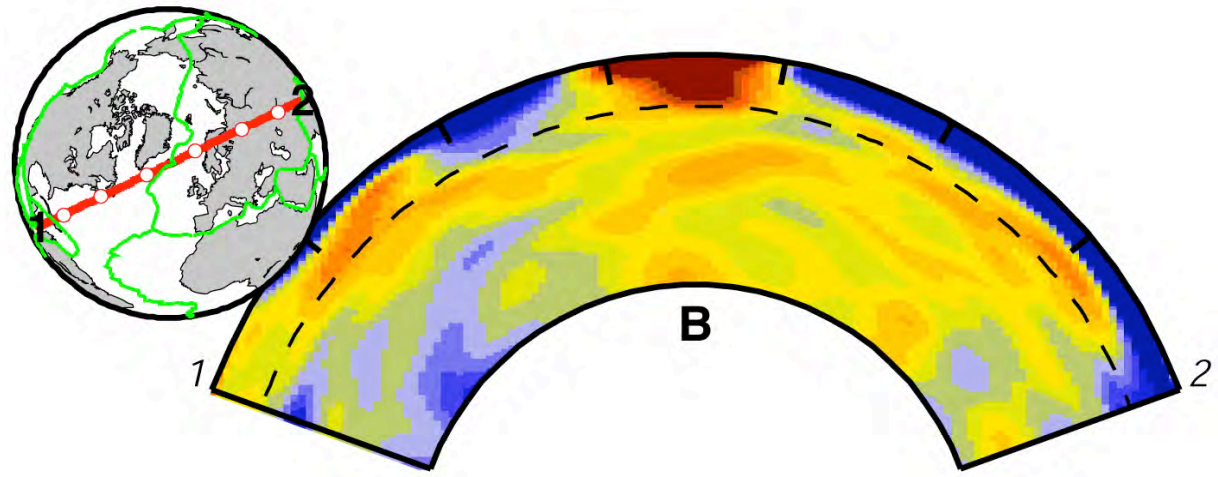


No Plume tail



No Time-Progressive Chain

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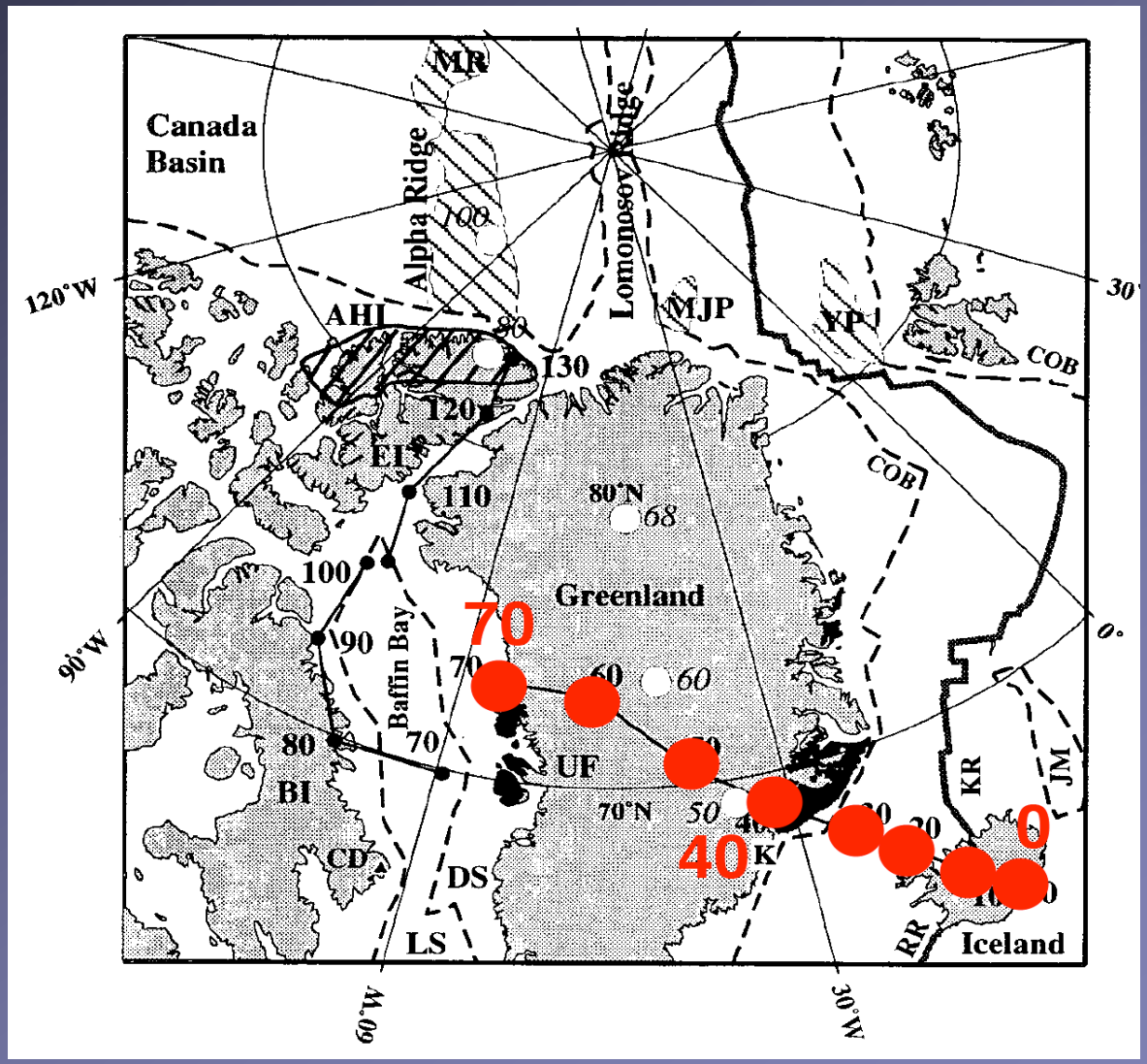

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No High Temperature

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Plate

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Passive extension
+
Source fusibility

Extension

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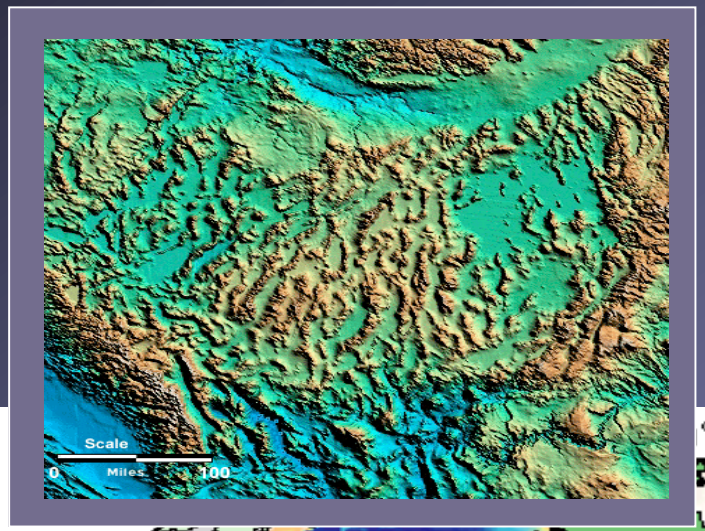

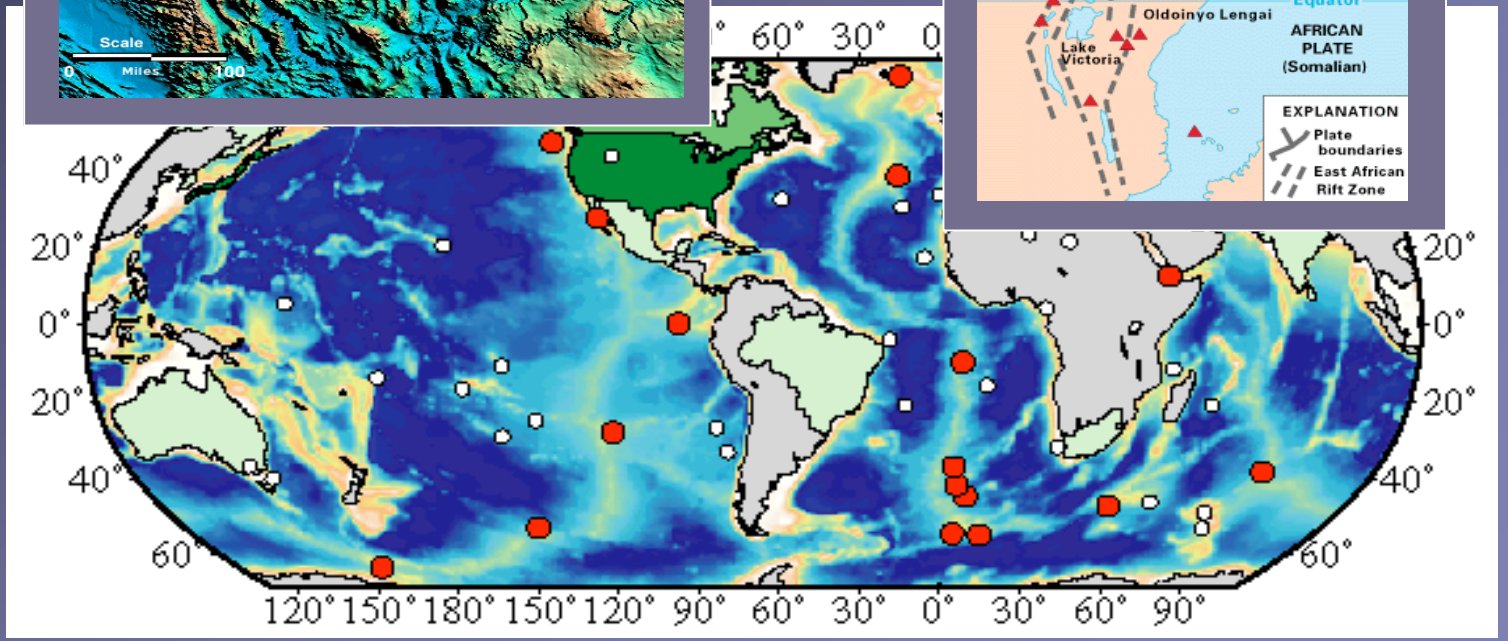

Fusibility

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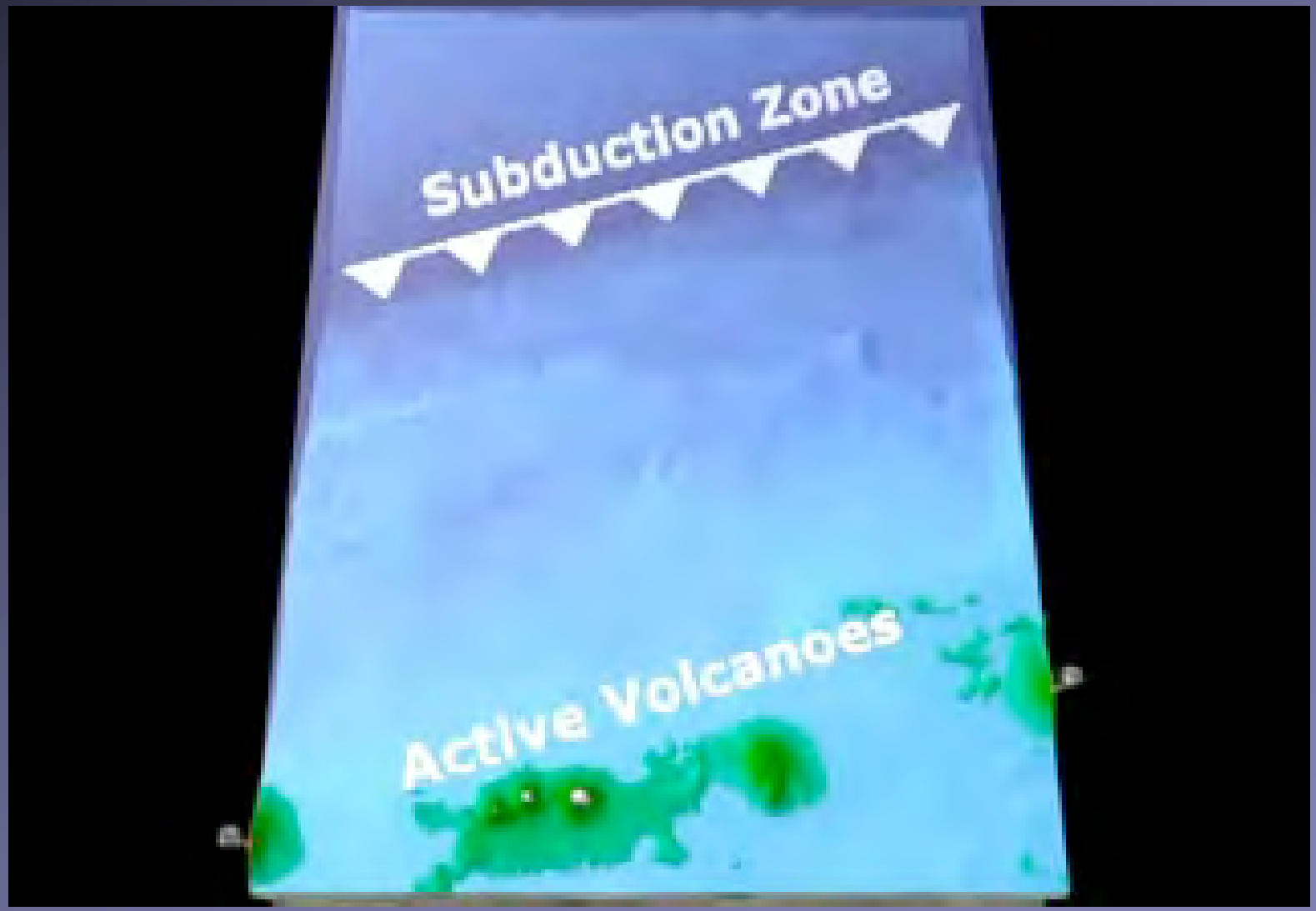

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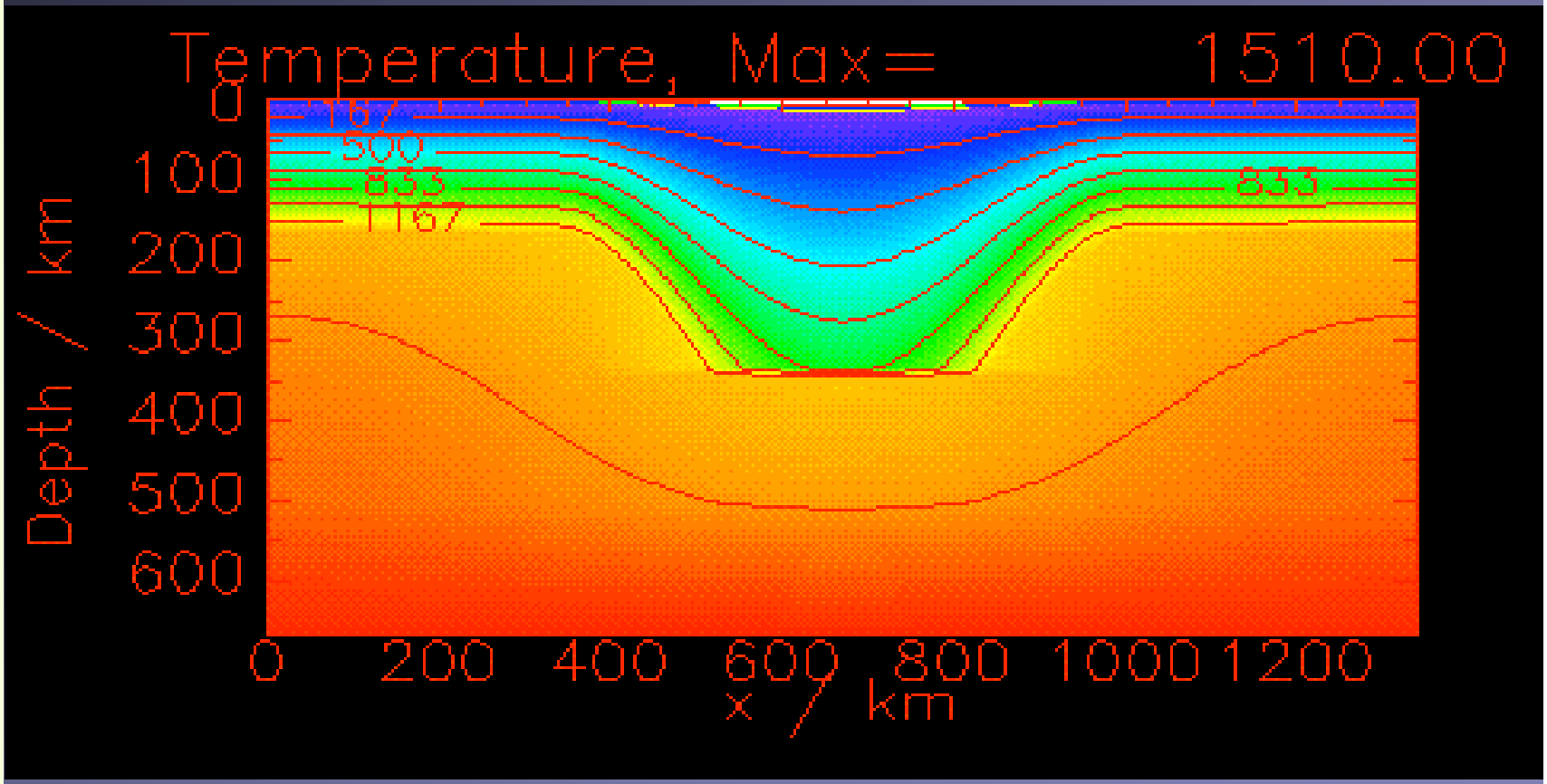
Fusibility



Schott et al. (2000)

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Europe

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Eifel

- Plate tectonics
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Eifel Fieldtrip

Association Géologique du Luxembourg

Eifel Scoria Cones & Maars

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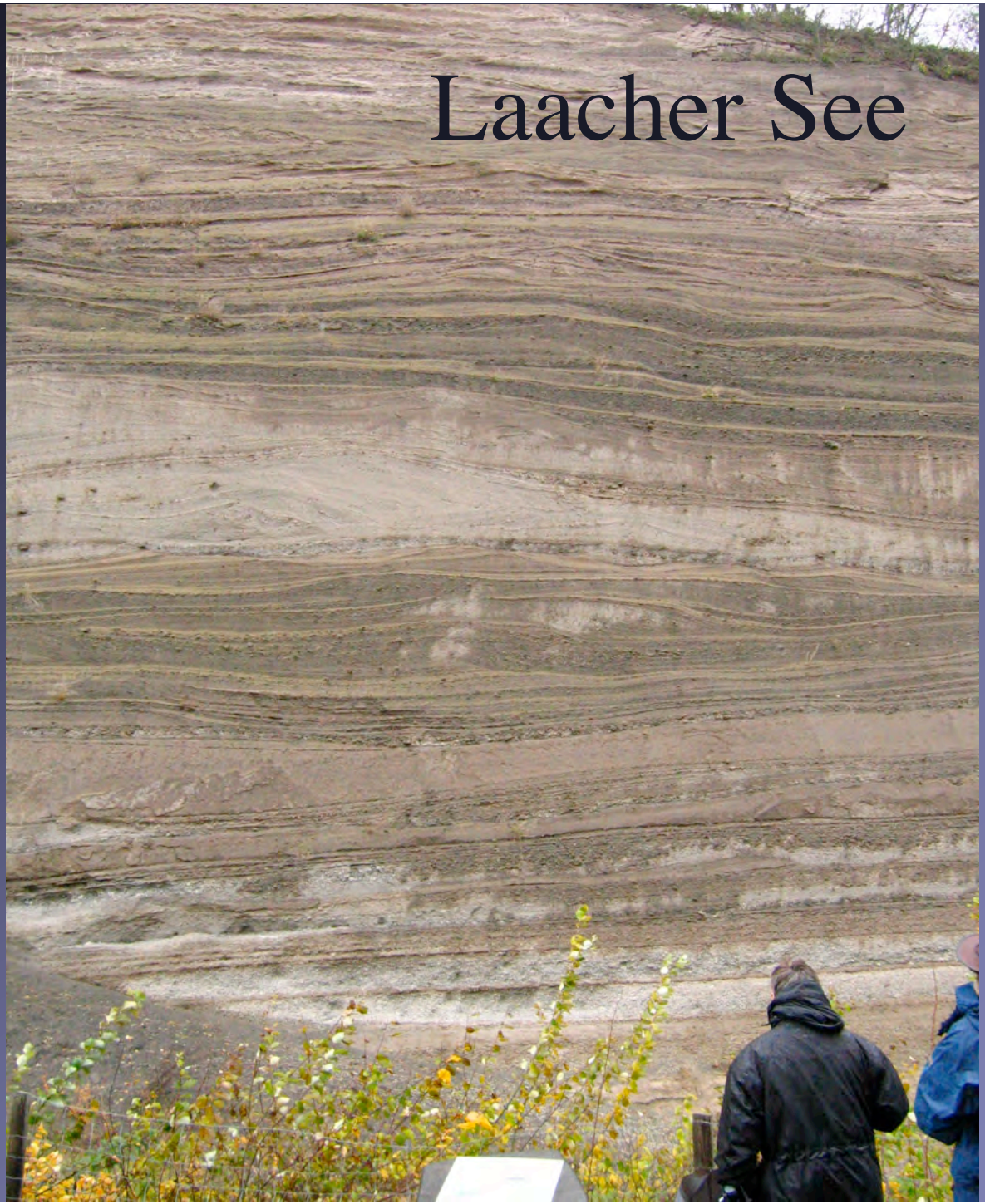
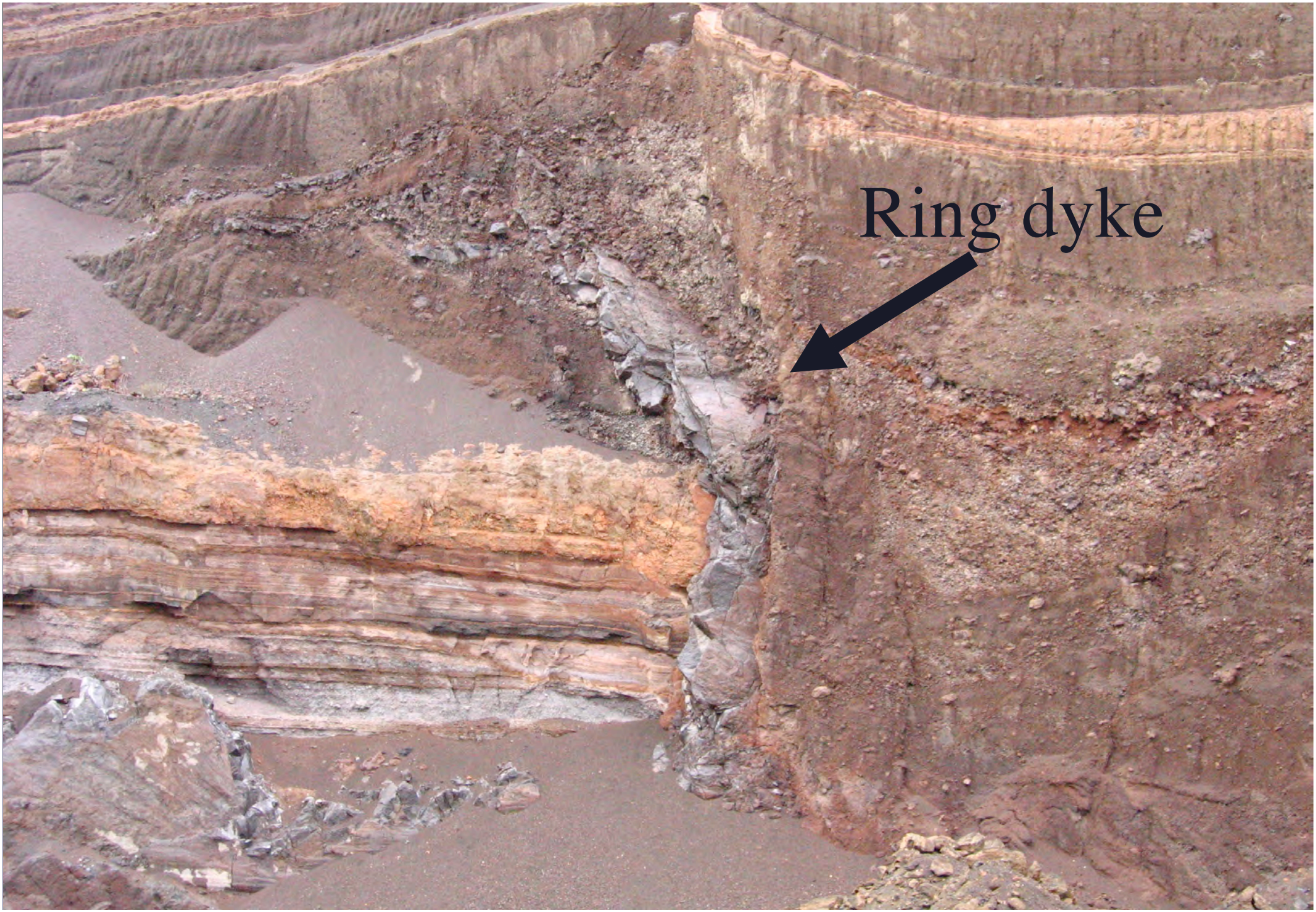
Laacher See

Laacher See



Eppelsberg scoria cone


Ring dyke

Intrusion

Laacher See – Plinian Eruption

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The 5 plume predictions at Eifel

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Uplift

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Eifel Uplift

- Gradual uplift of Rhenish Massif since
  ~ 50 million years ago
- Rapid uplift of Eifel since
  ~ 800,000 years ago
- Main Eifel volcanism started
  ~ 0.5 million years ago

Eifel Uplift

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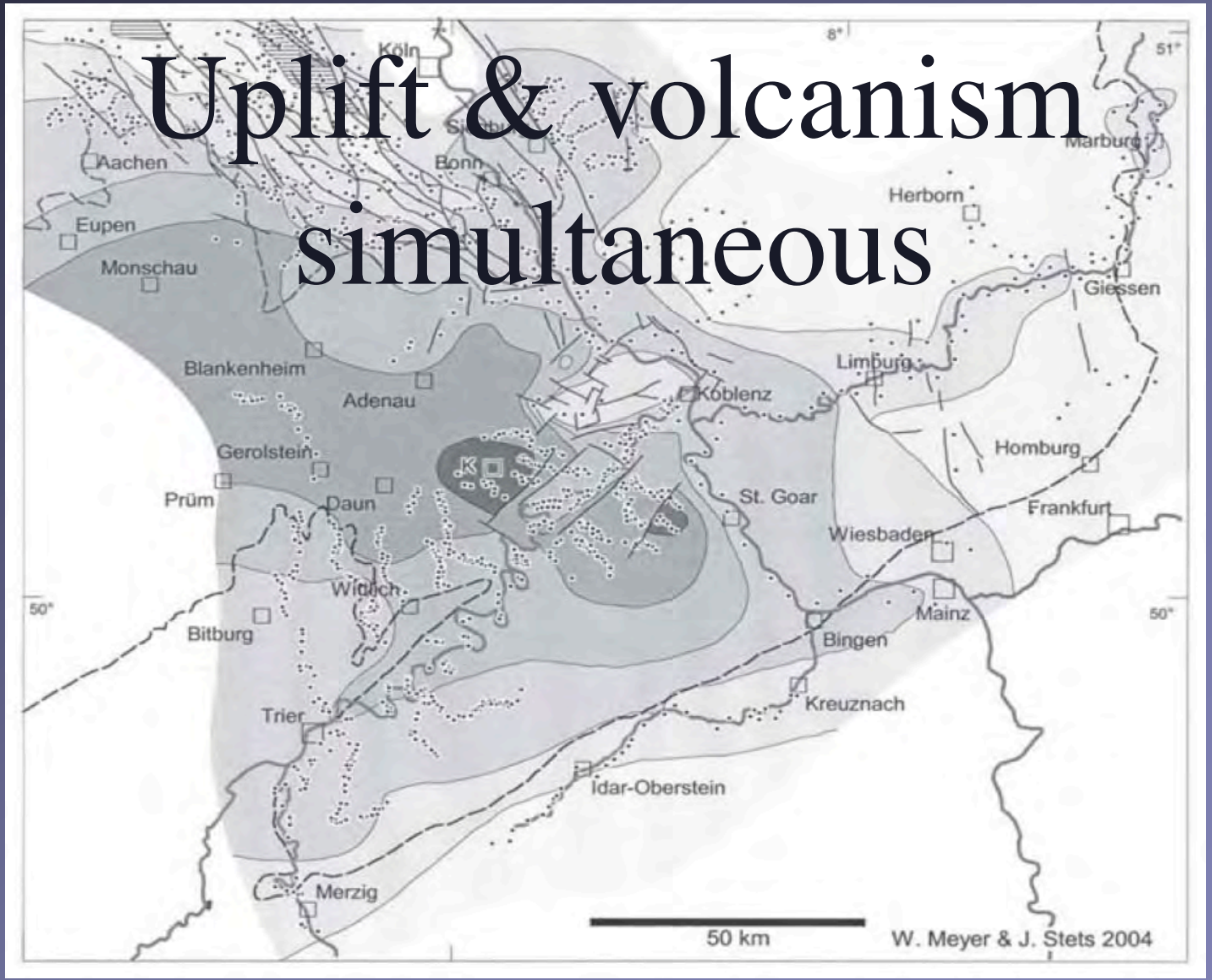

Eifel Volcanism

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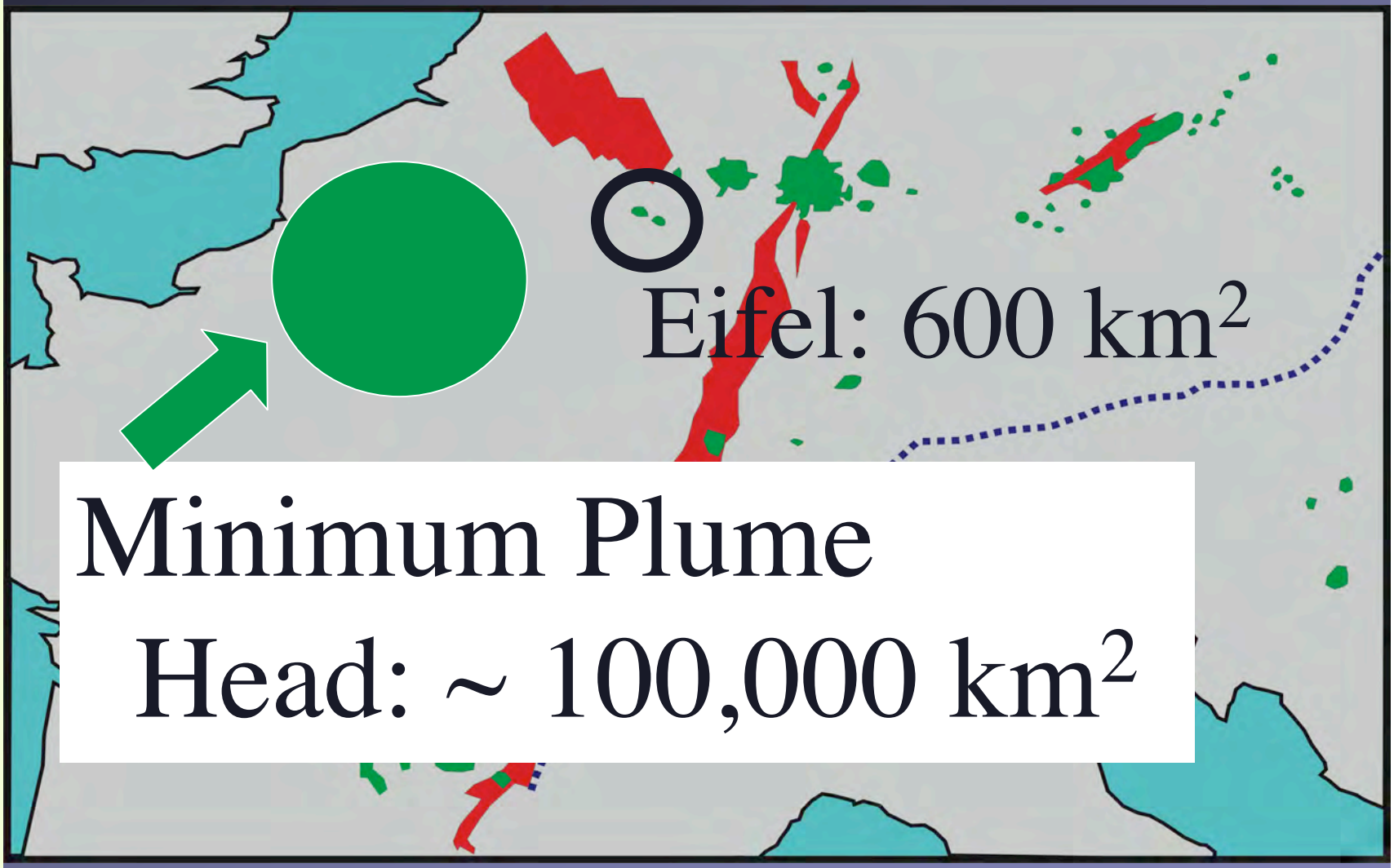

Eifel Plume Tail

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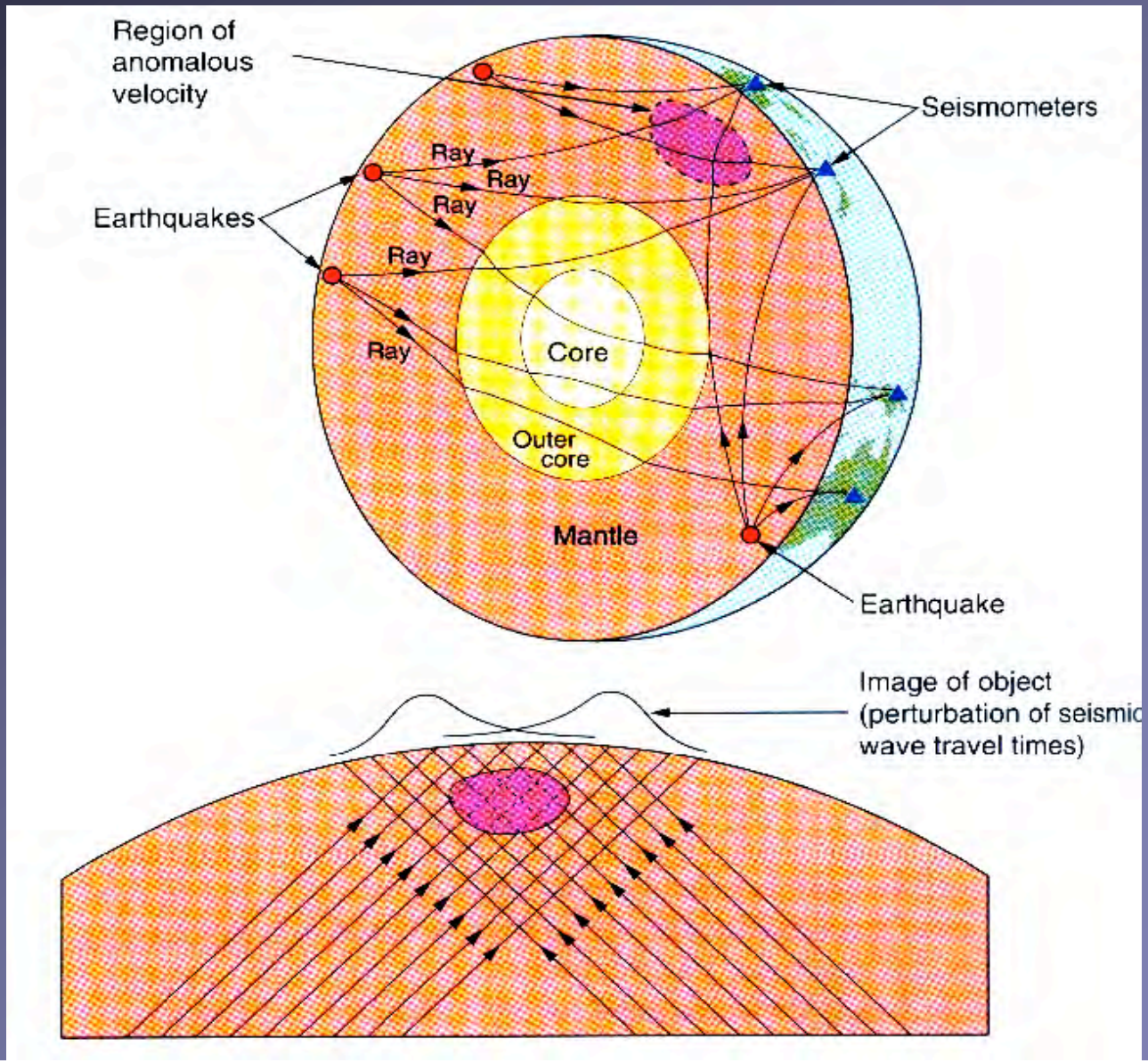

“The Eifel Plume Project”

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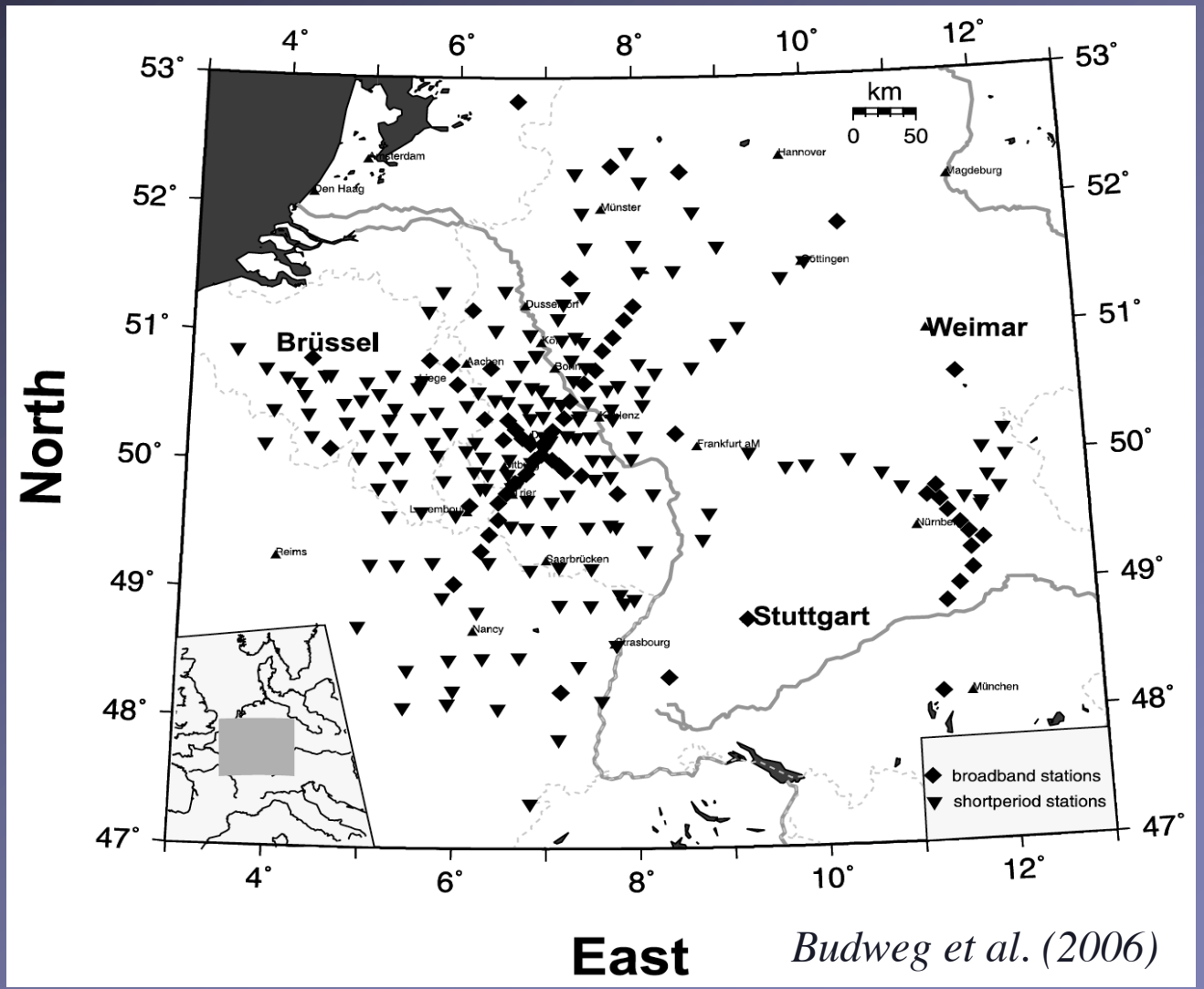

Budweg et al. (2006)

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A plume tail will show:

- A P-wave anomaly
- A stronger S-wave anomaly
- Both extending deep into the lower mantle

P-wave image

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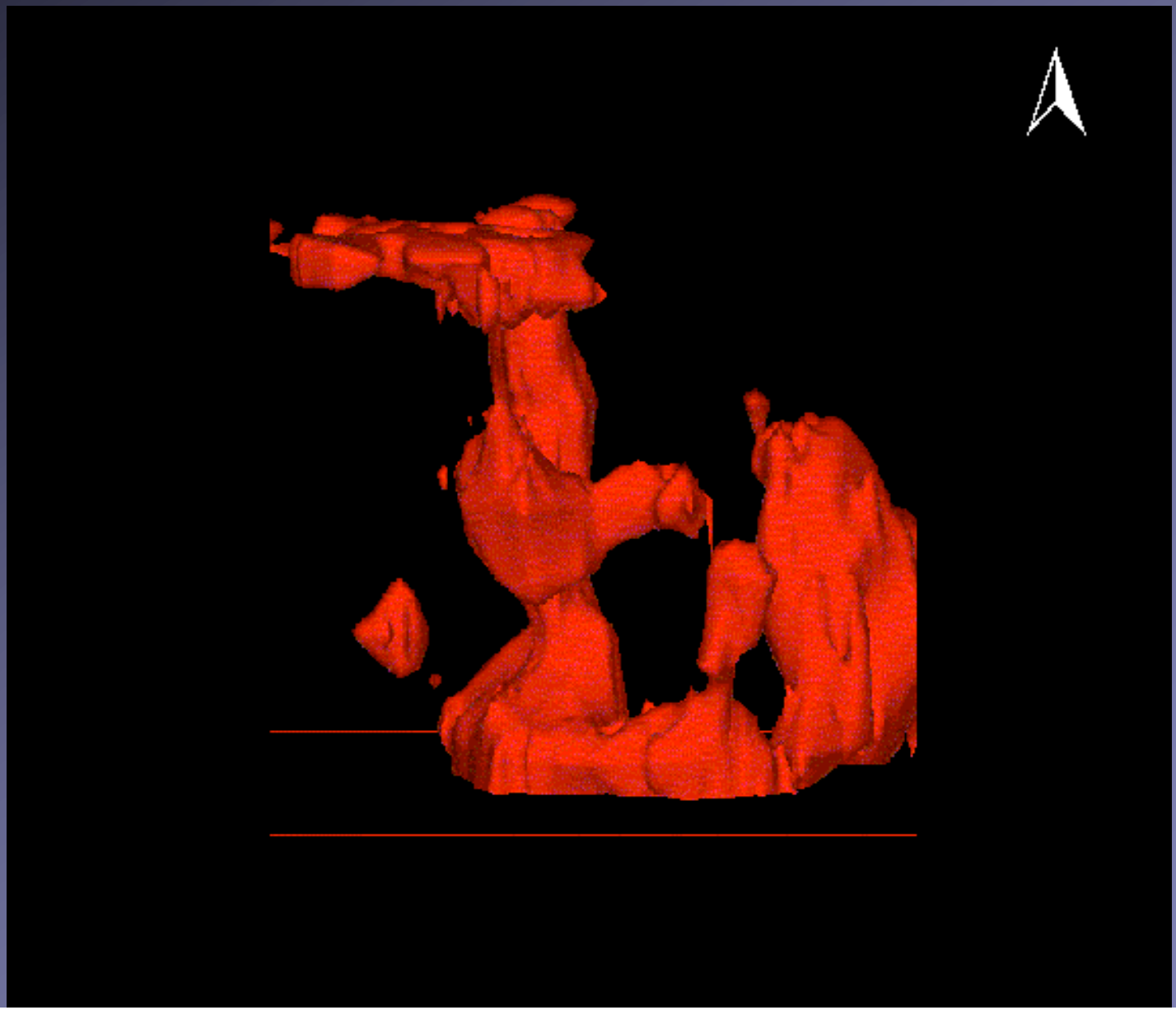

http://www.geo.physik.uni-goettingen.de/~eifel/

S-wave image

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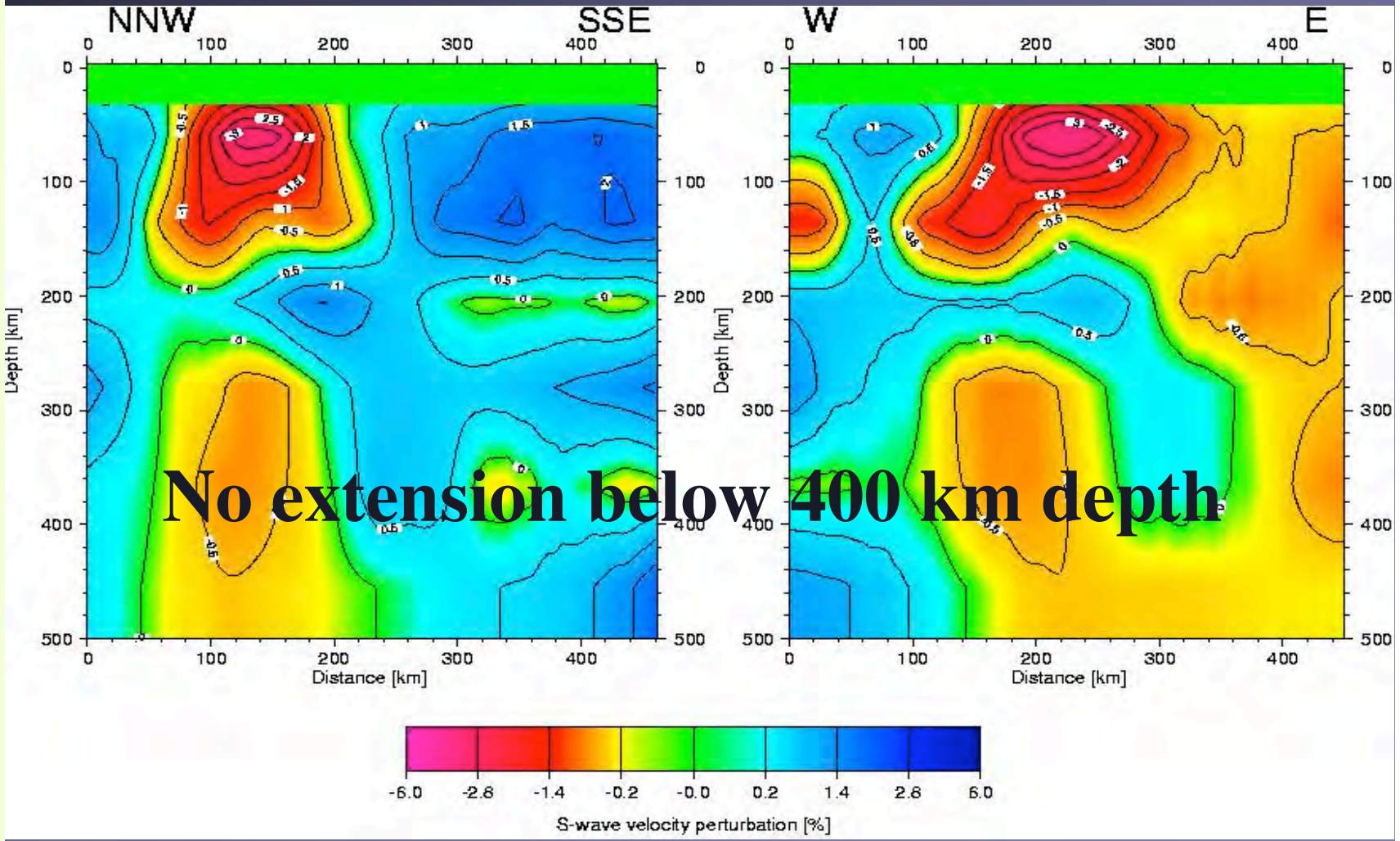

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How to express the results?

A. Our observations …
do not rule out
… processes at larger depth.

B. Our observations
provide no evidence for
… processes at larger depth.

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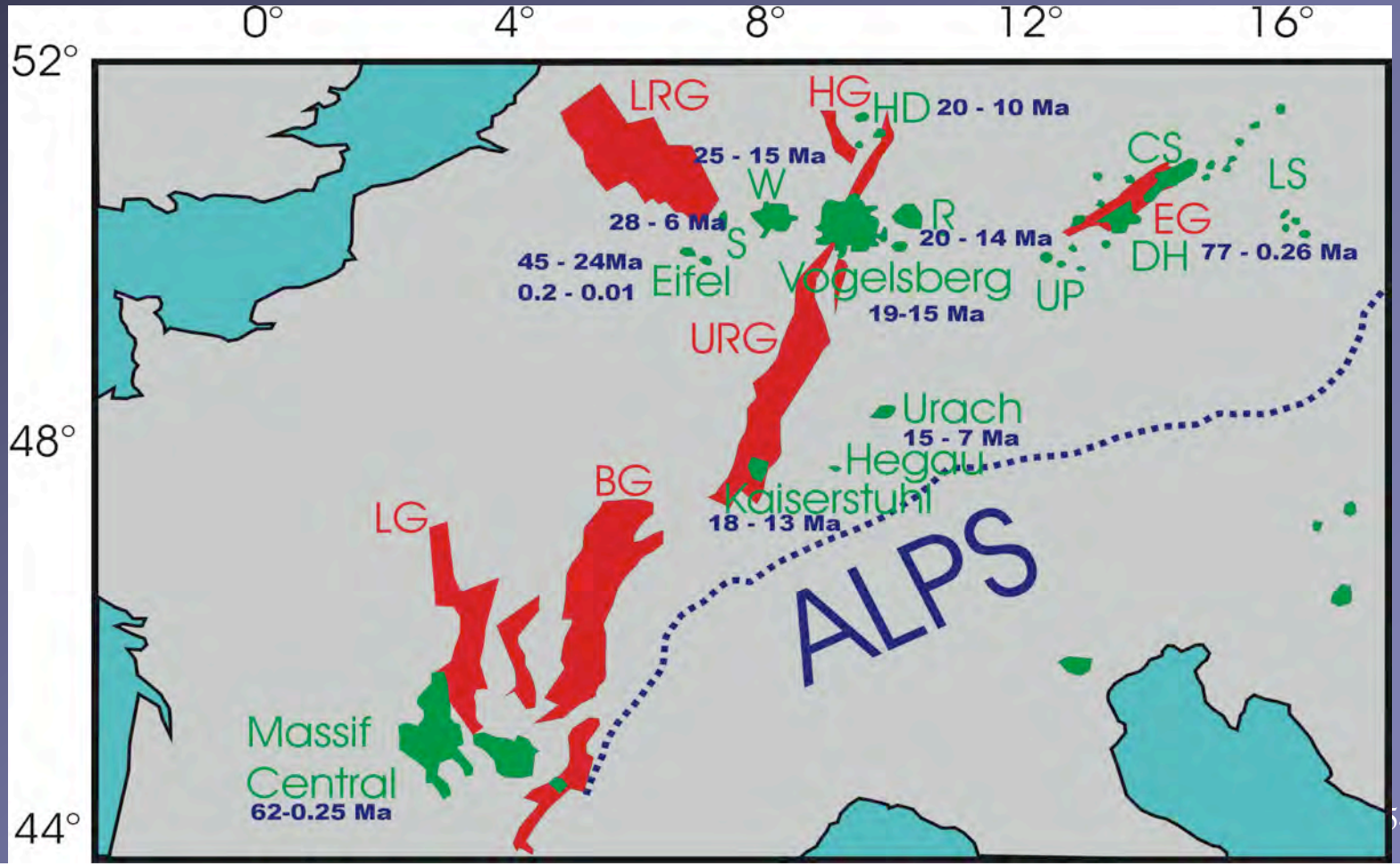
Eifel time-progression

There is none



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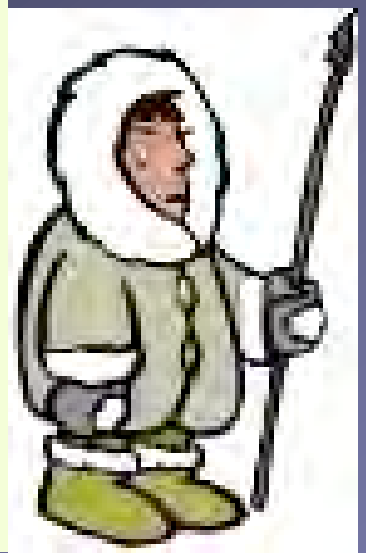
Eifel temperature

No evidence for high temperatures



Eifel Plume?

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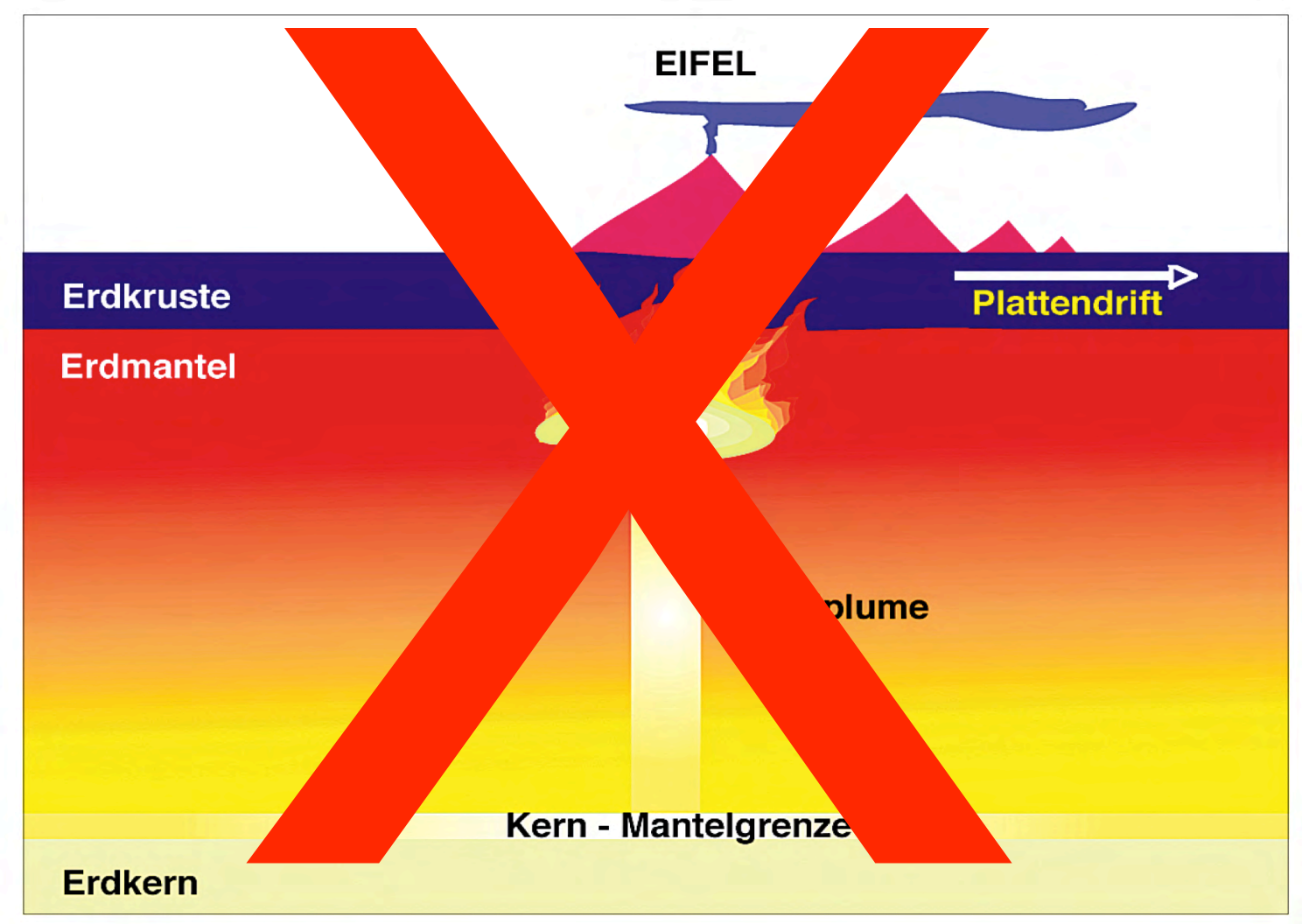

Plate Hypothesis at Eifel

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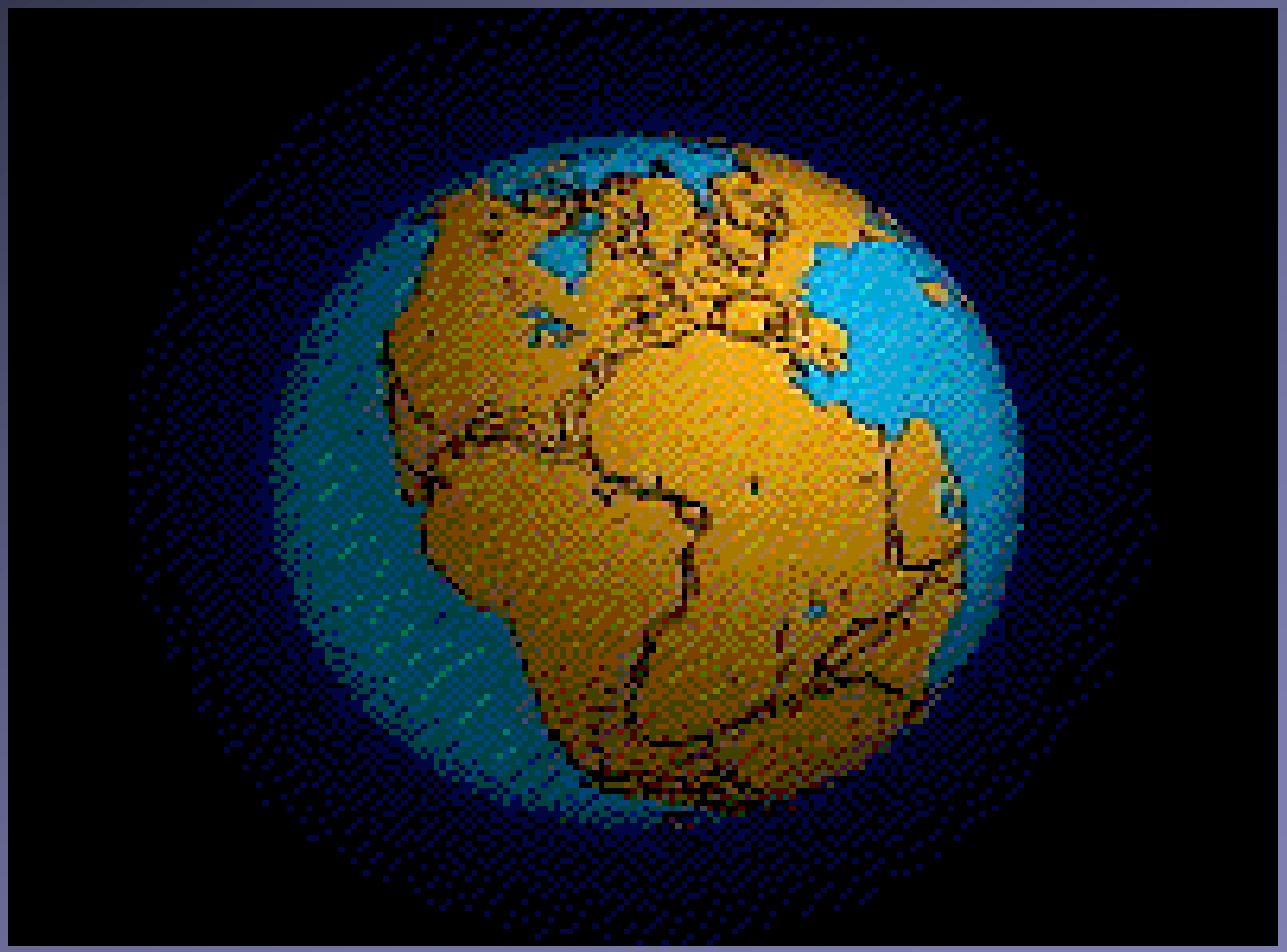

European Rifts & Volcanoes

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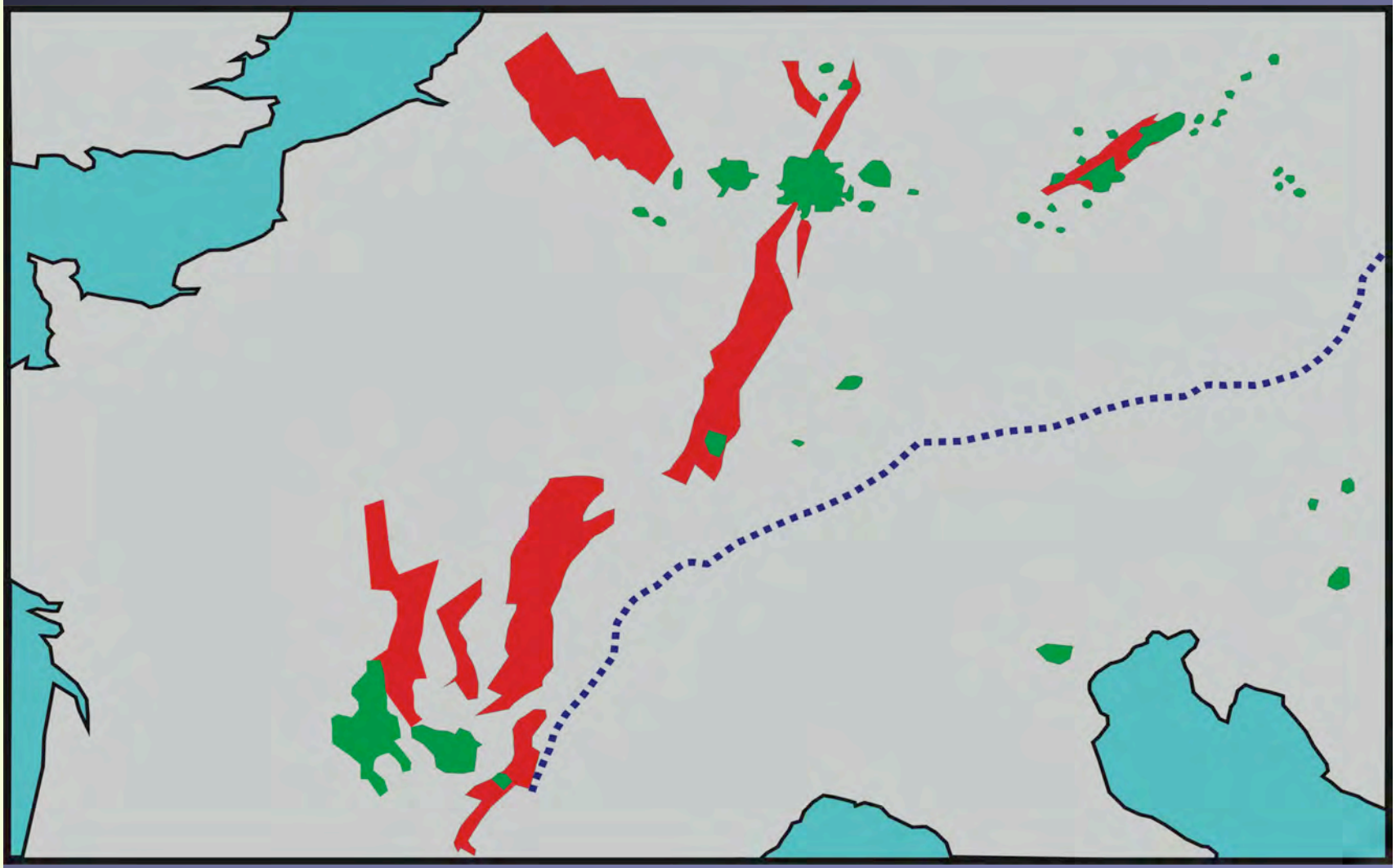

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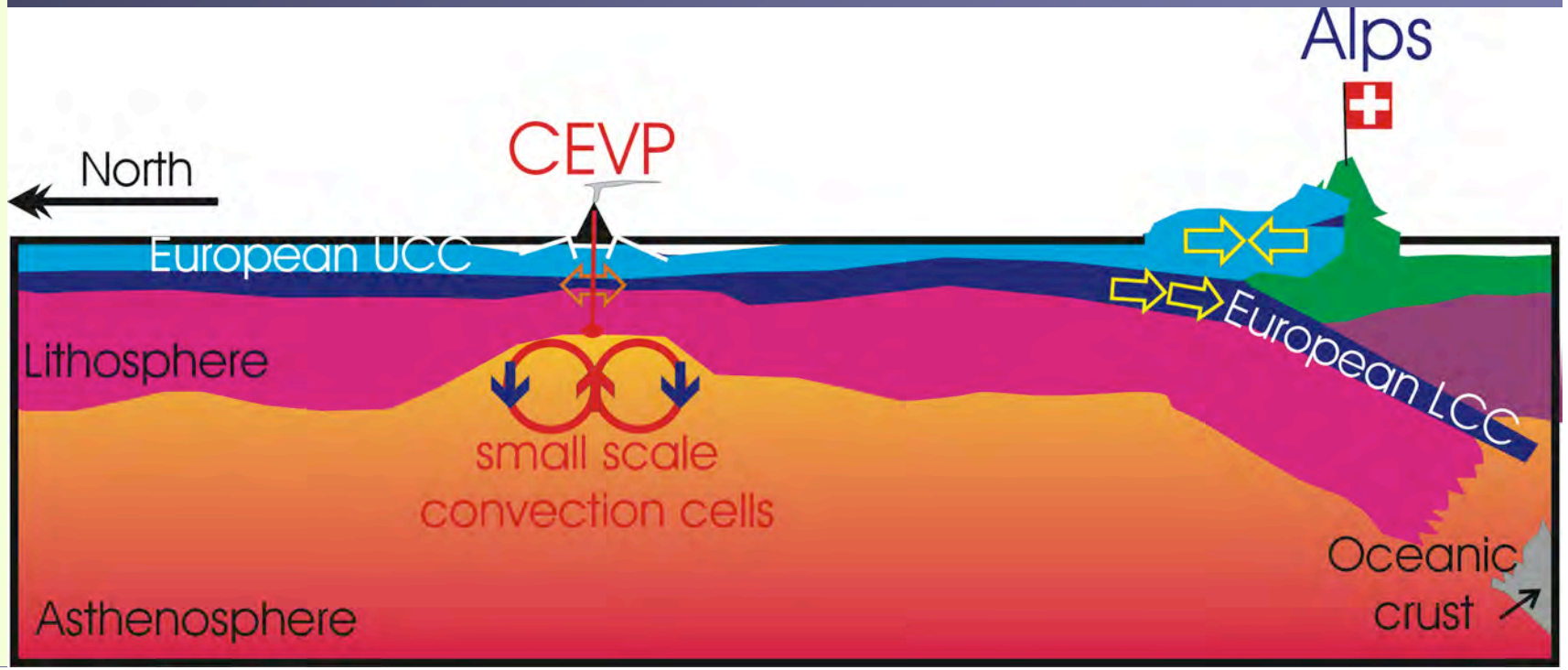
The Rifts

- Subduction beneath Alps
- Stretched lithosphere to north
- Formed Rhine Graben & other rifts



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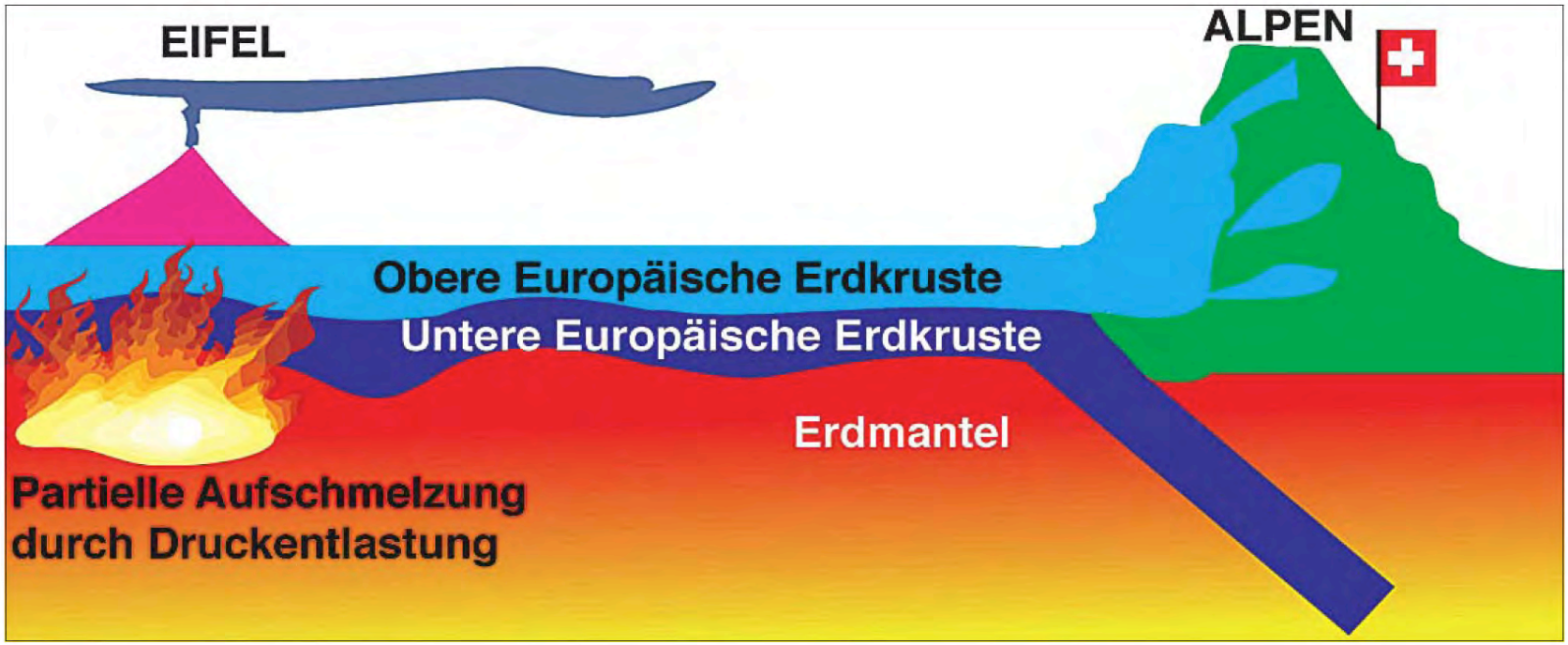
The Volcanics

- Passive rising & melting of mantle
- Small diapiric upwellings



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http://www.mantleplumes.org/

That's all folks