Size distribution of submarine landslides and its implication to tsunami hazards

Co-authors:
Eric Geist, Brian Andrews
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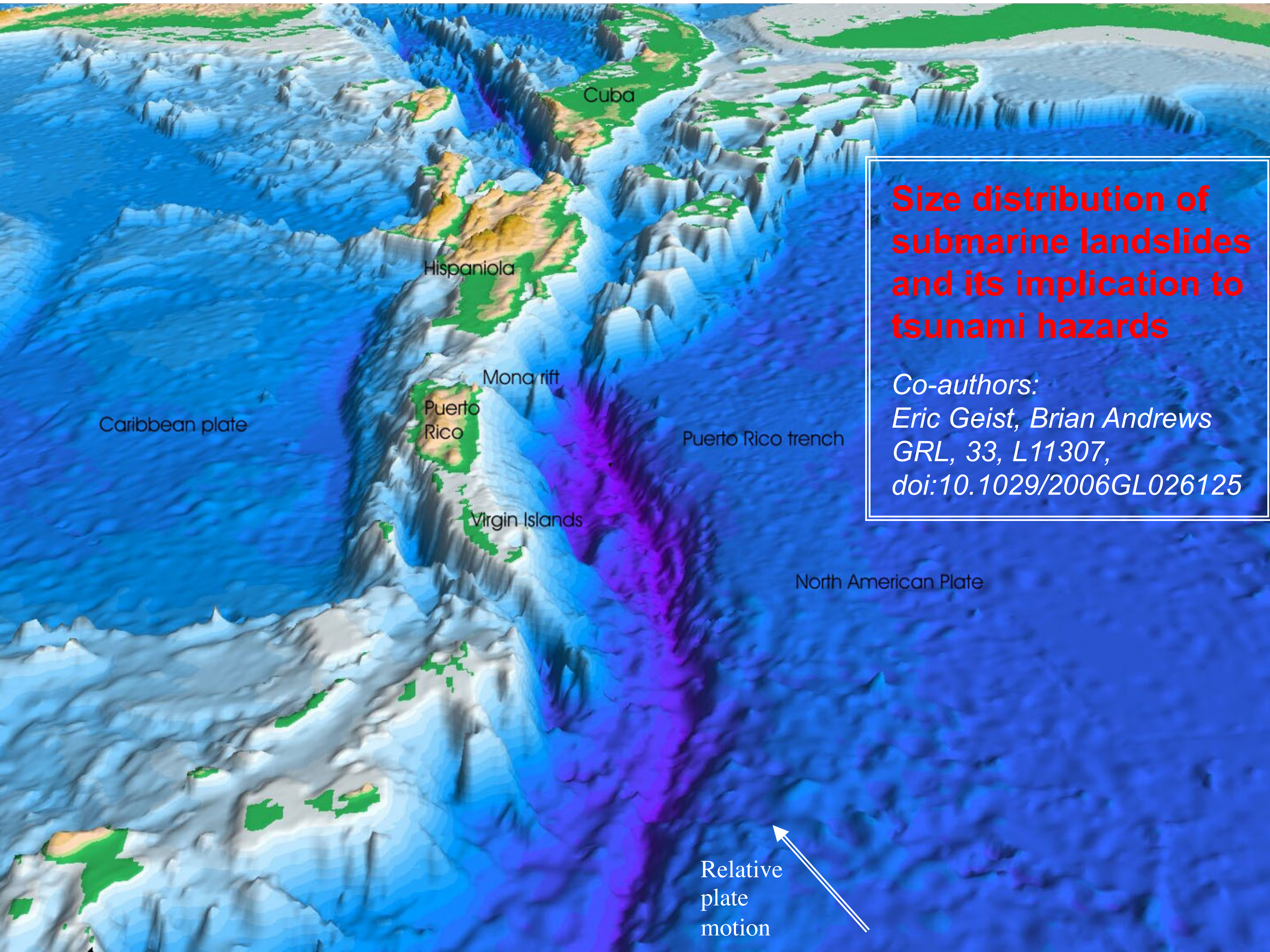
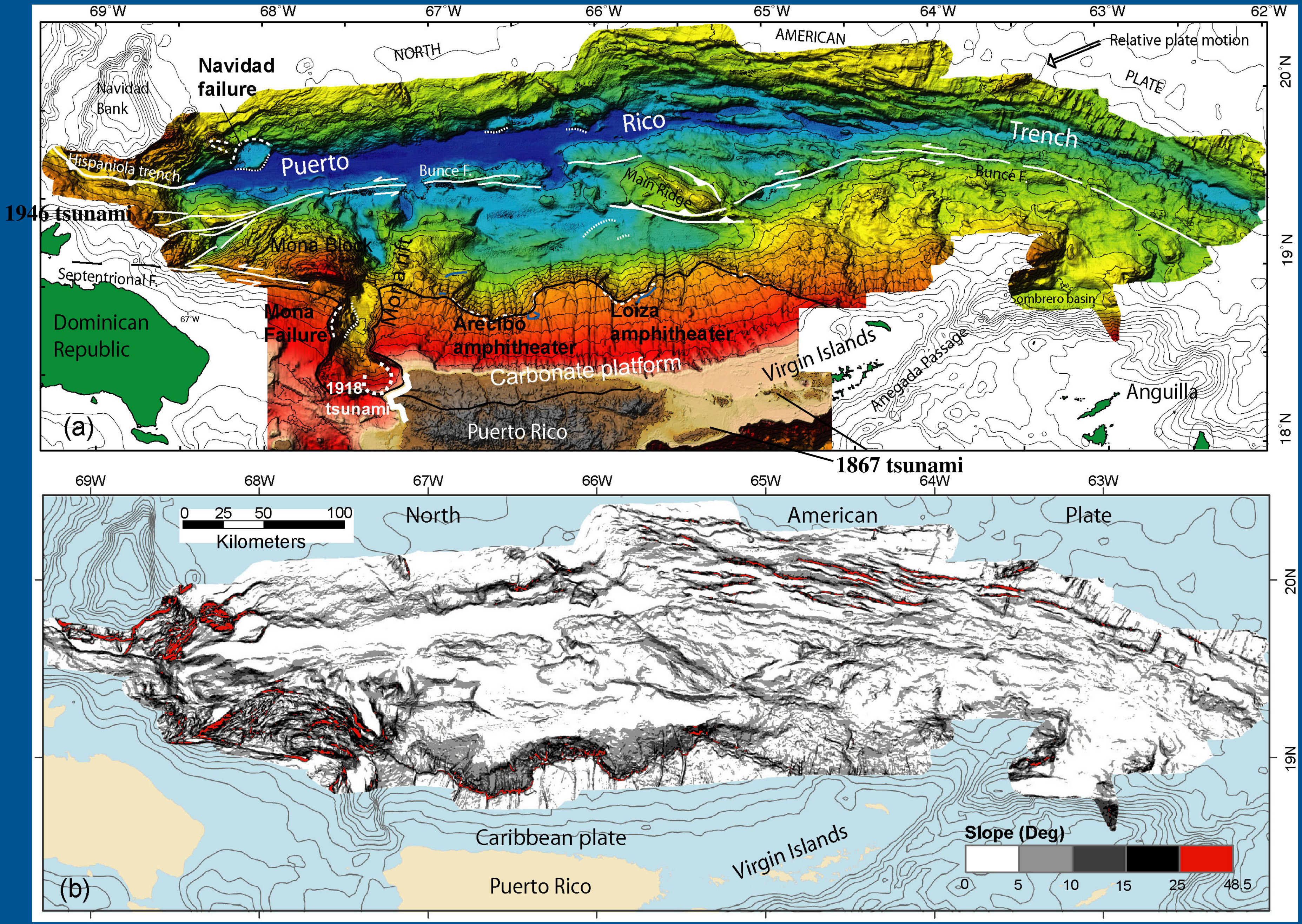
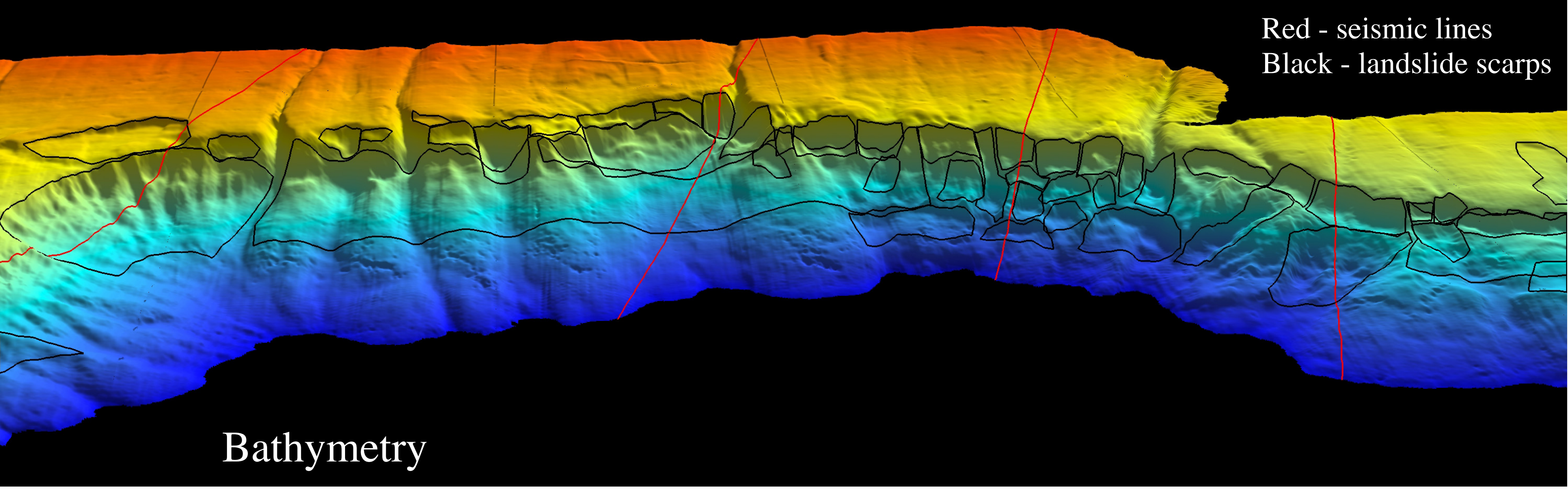
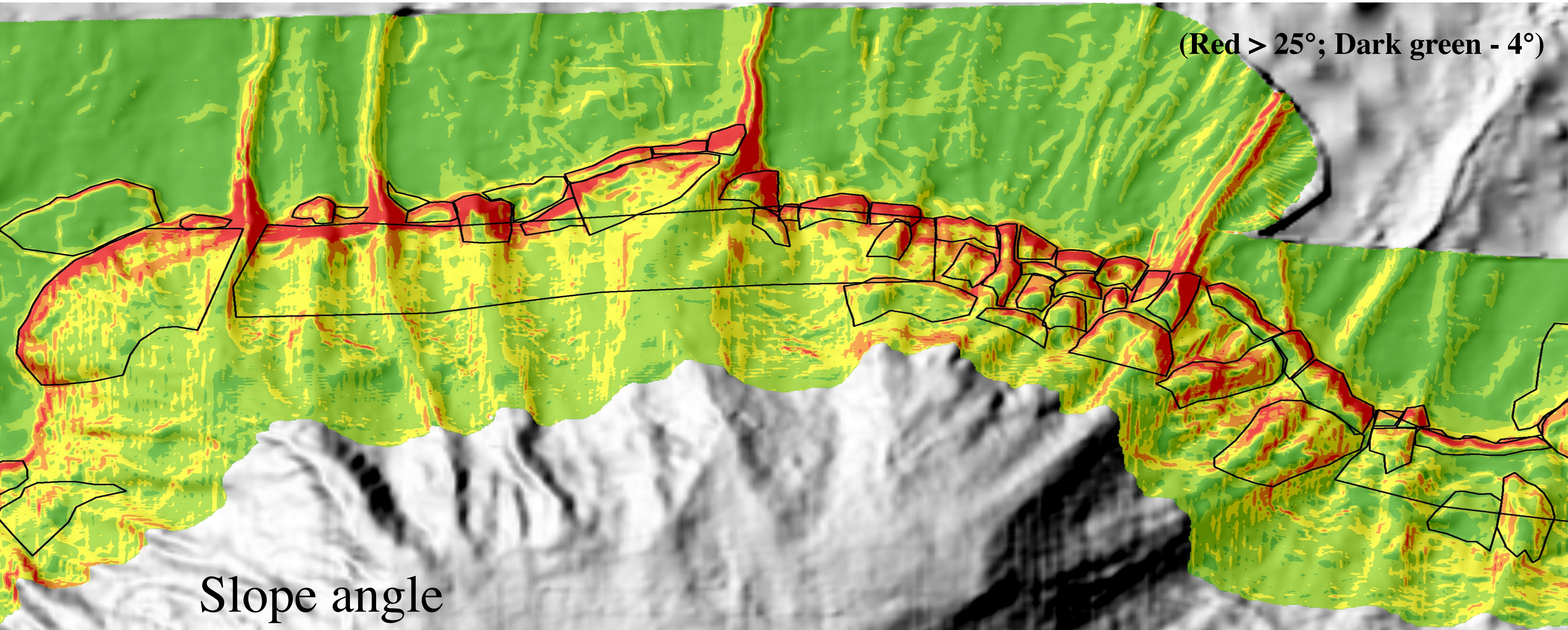
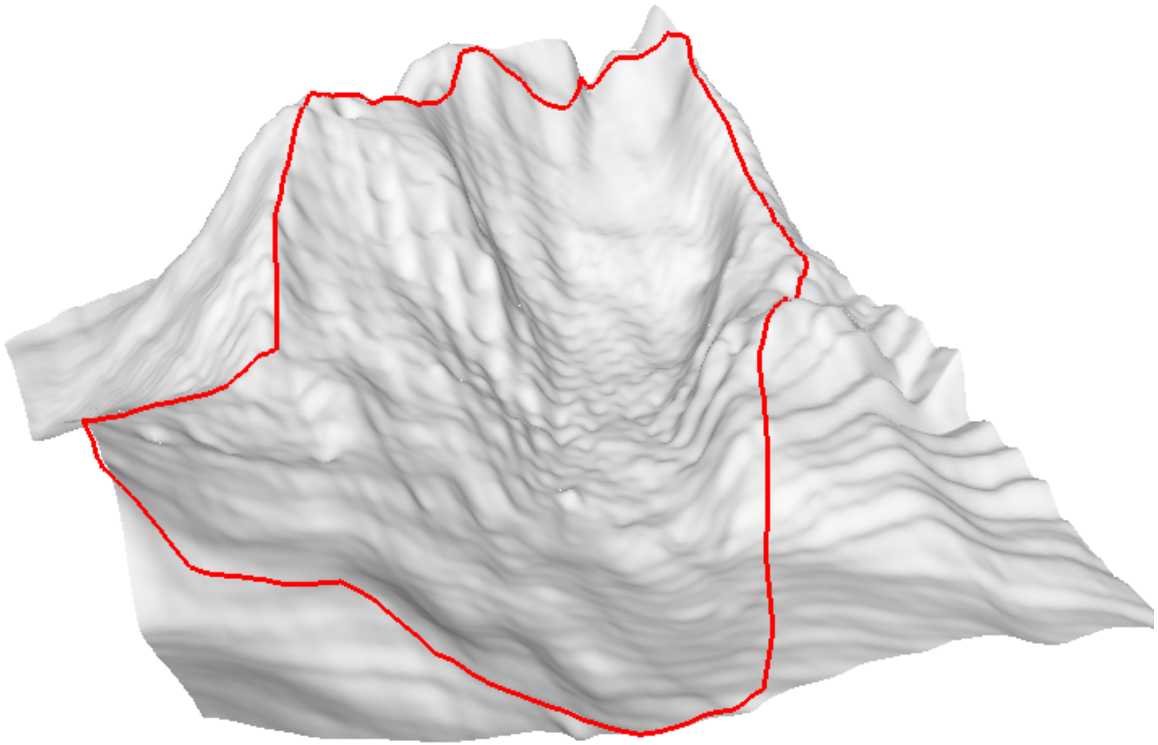


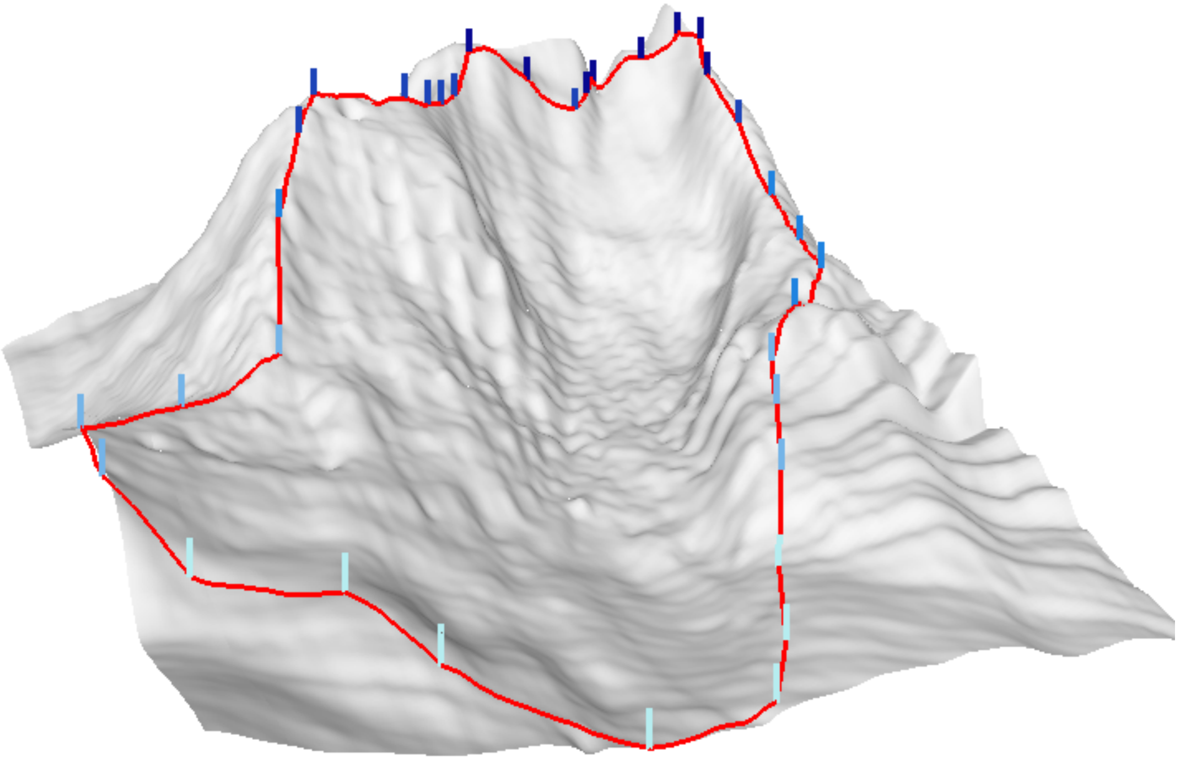
Submarine landslide sources

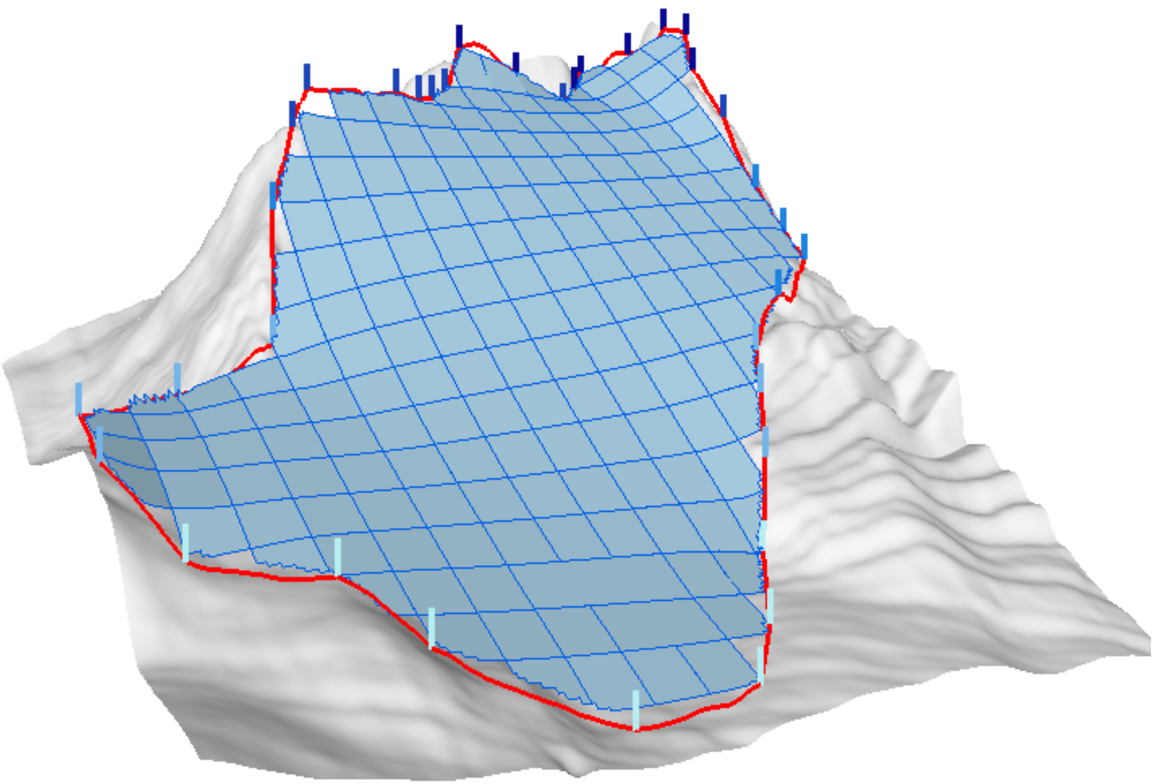


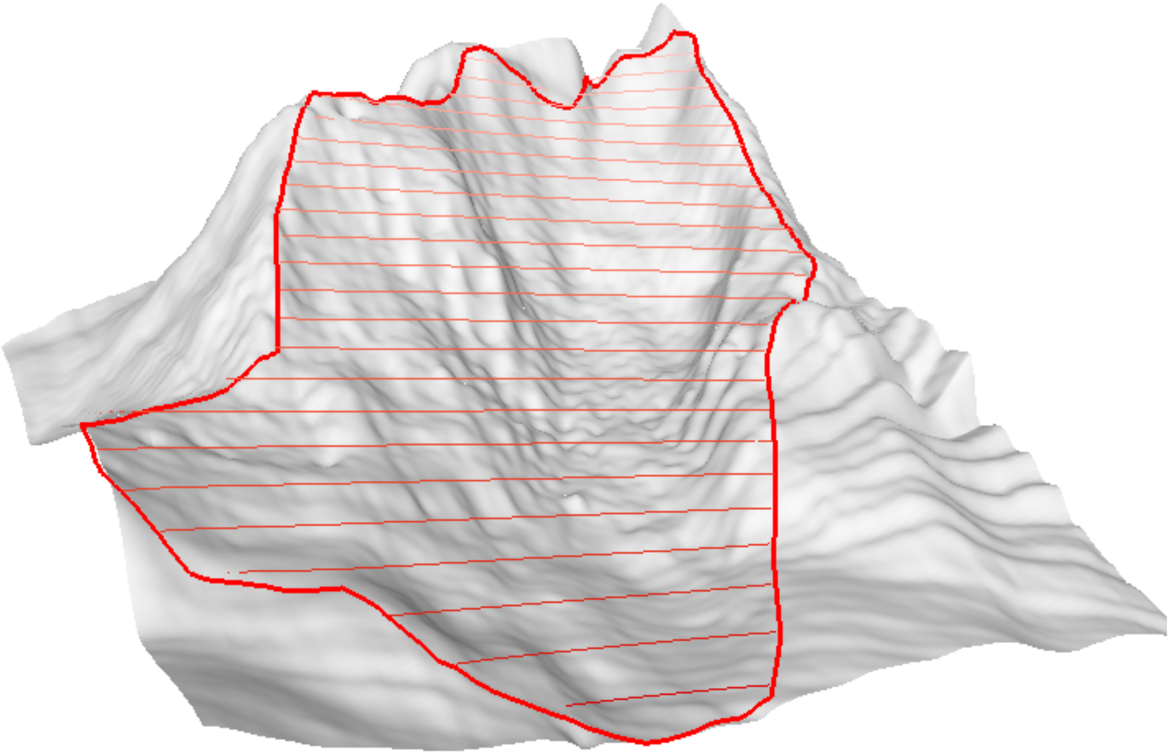

Red - seismic lines
Black - landslide scarps
Bathymetry


(Red > 25°; Dark green - 4°)
Slope angle



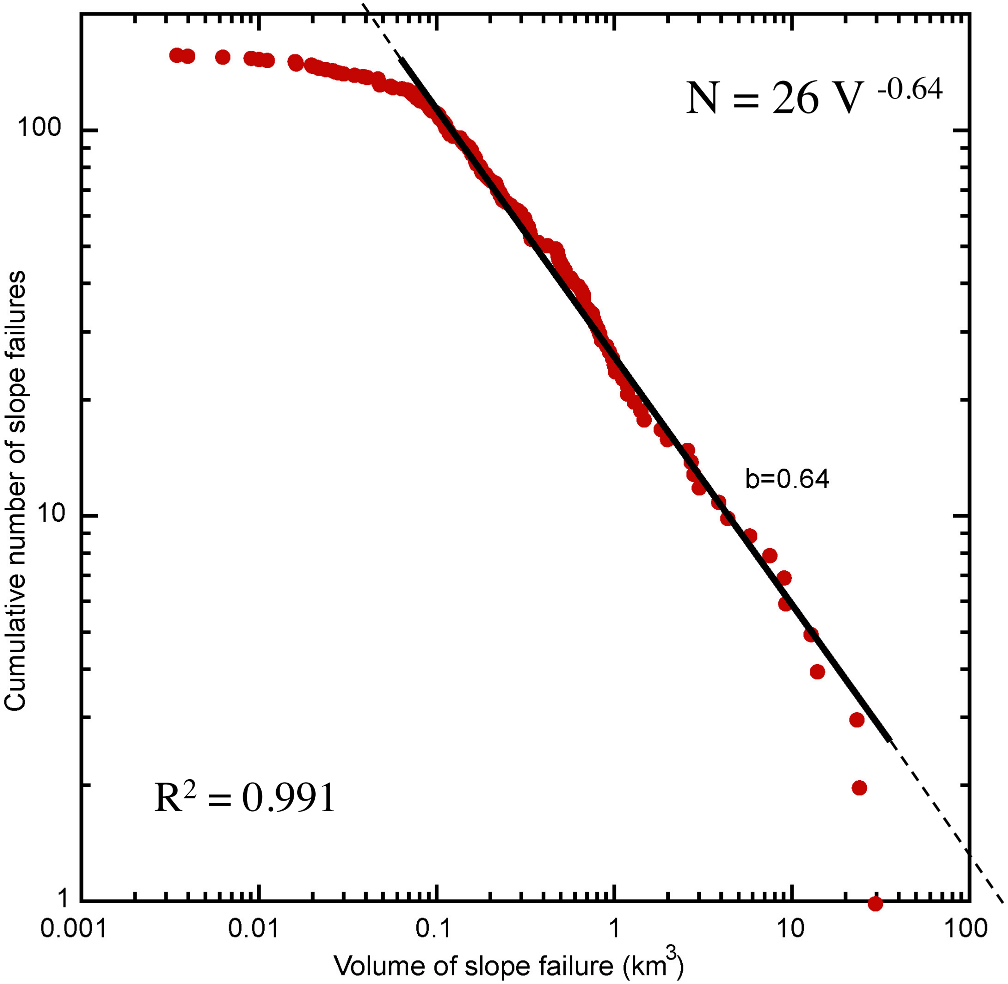


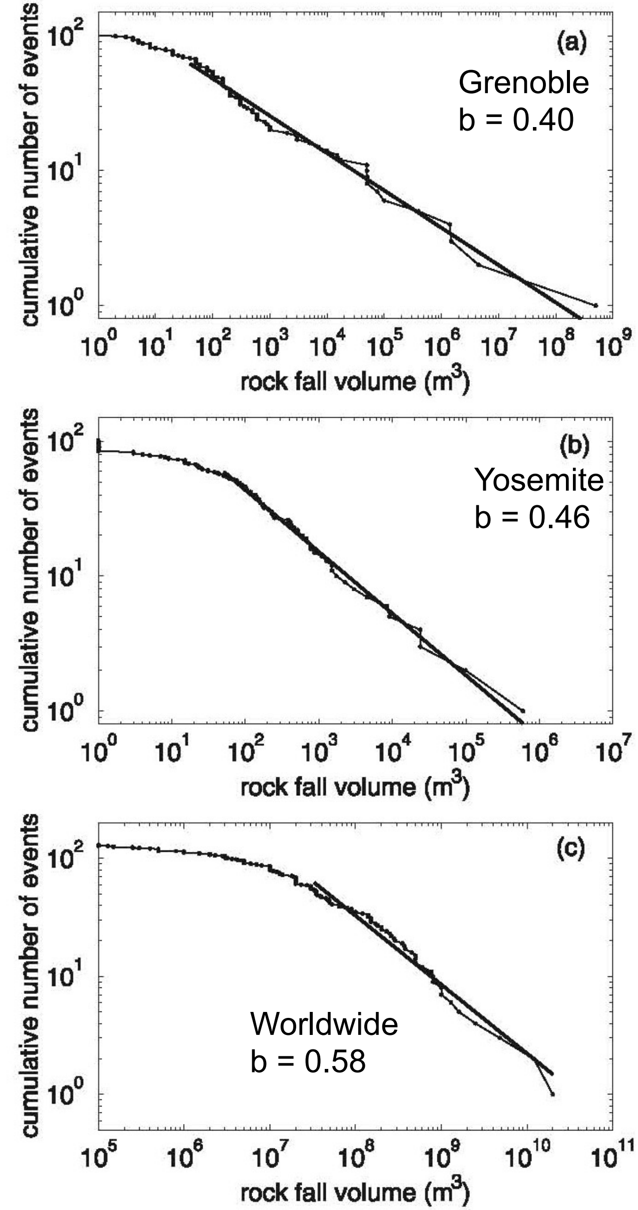




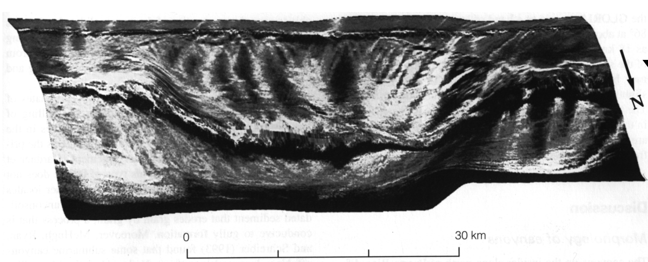
Slides with volume < 0.08 km^3
Contribute < 17 km^3

Cumulative volume of landslides

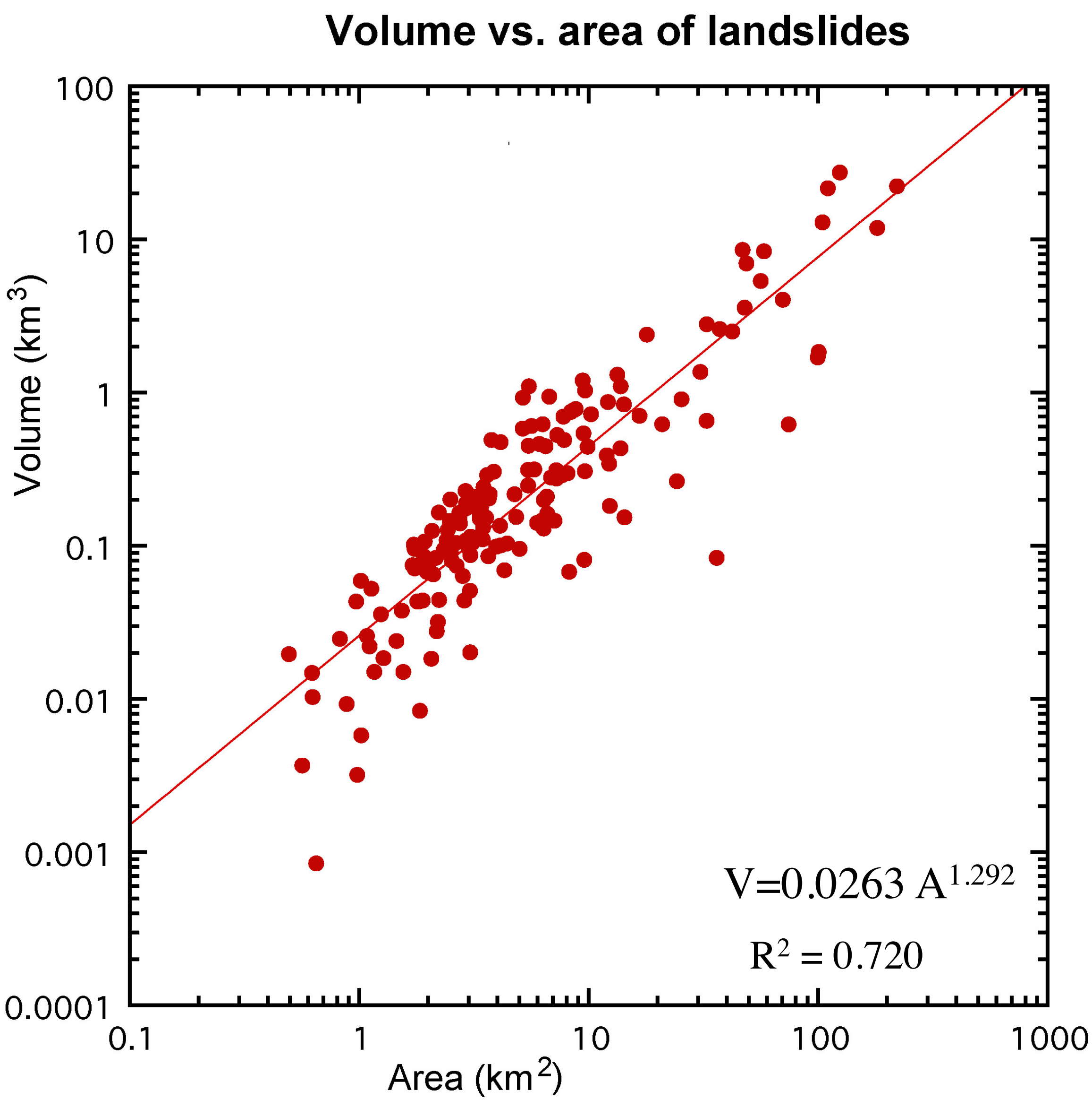




(Dussauge et al., 2003)



Previous estimates
Of 1500 and 900 km^3



On land

Simonett (1967)

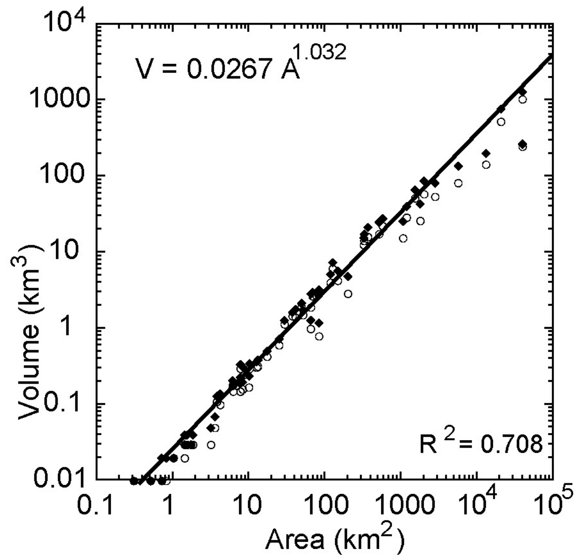
$V_L = 0.024\ A_L^{1.368}$

(Measured 201 slides, New Guinea)

Volume-area ratio of slides in carbonate margins is similar to that on land

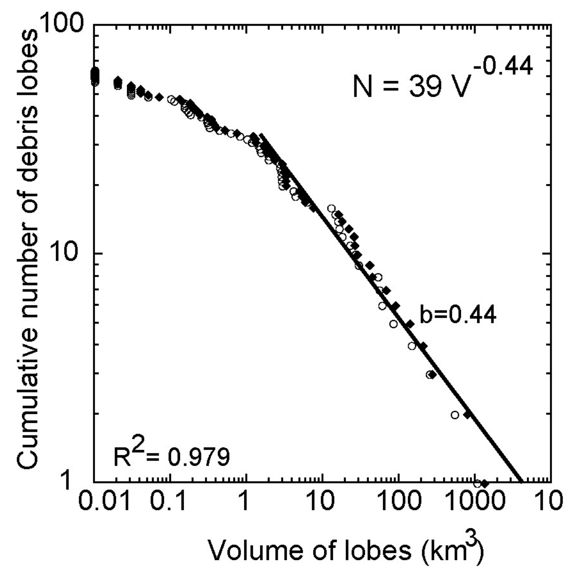
Size-distribution in clay-rich debris flows - Storegga slide

Relationship between volume and area of 63 submarine debris lobes in the Storegga slide (from tabulation by Halfidason et al., 2005).



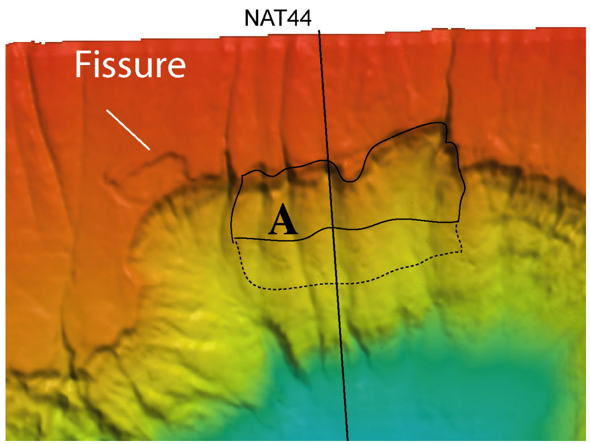
Note volume-area relationship ~ 1

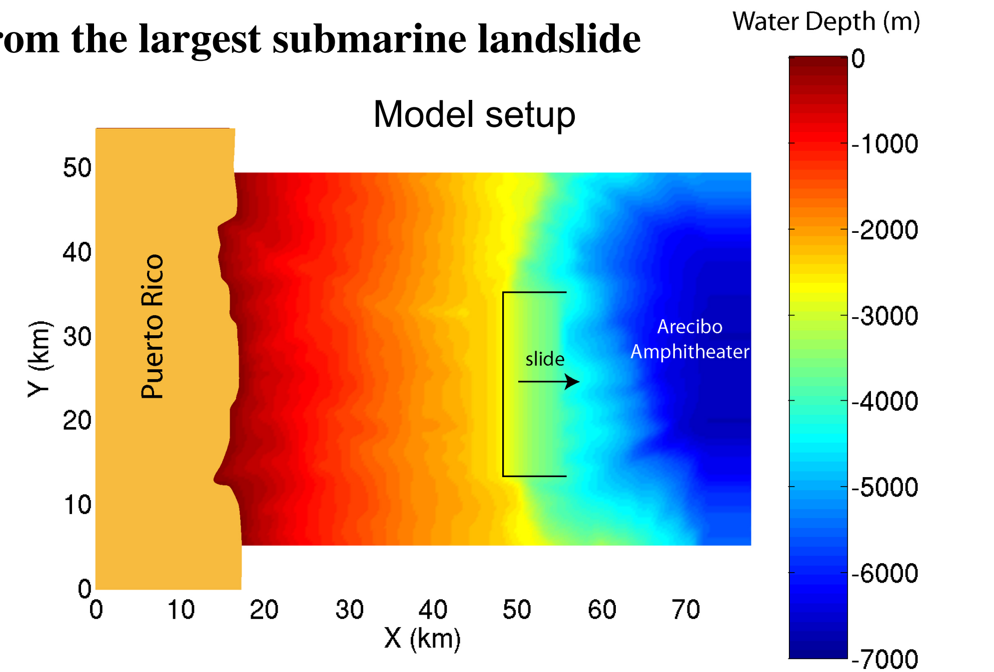
Cumulative volume distribution of the debris lobes.

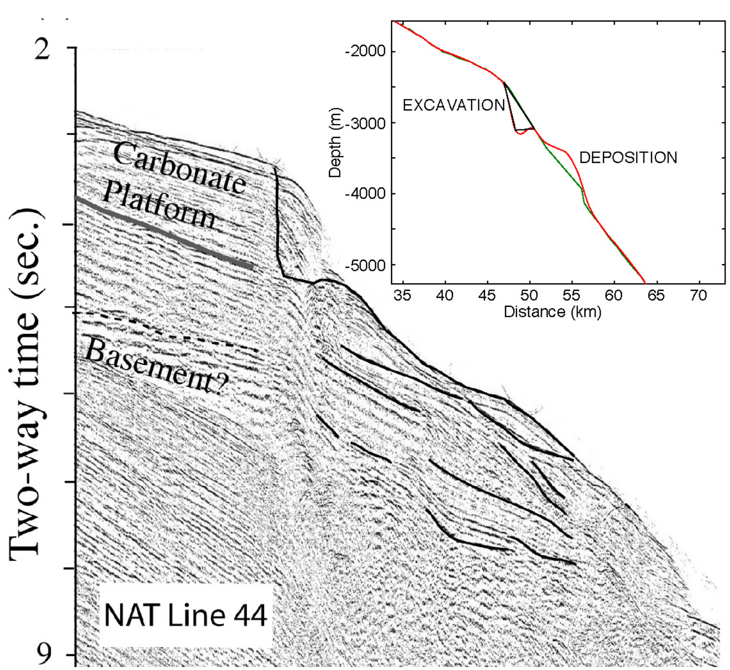


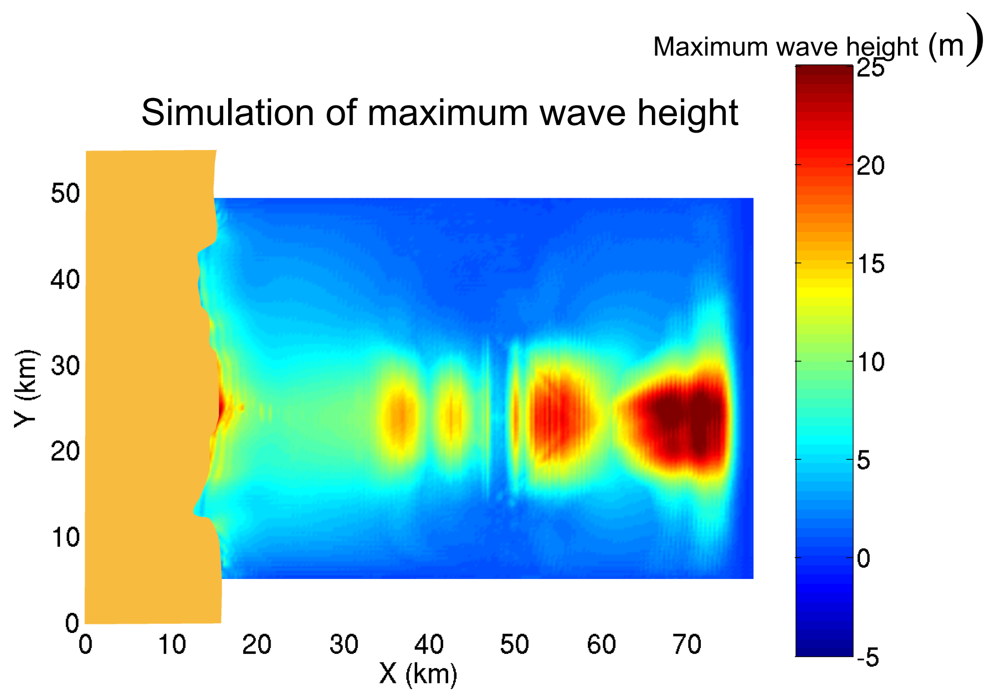
Black diamonds - Maximum volume estimates.
Open circles - Minimum volume estimates.

Hydrodynamic simulation of tsunami run-up from the largest submarine landslide

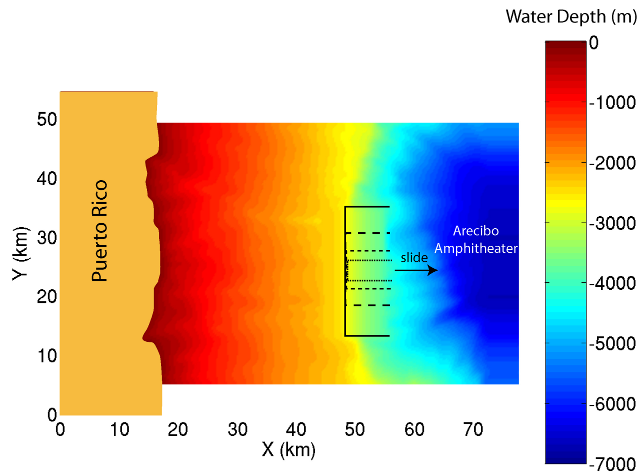


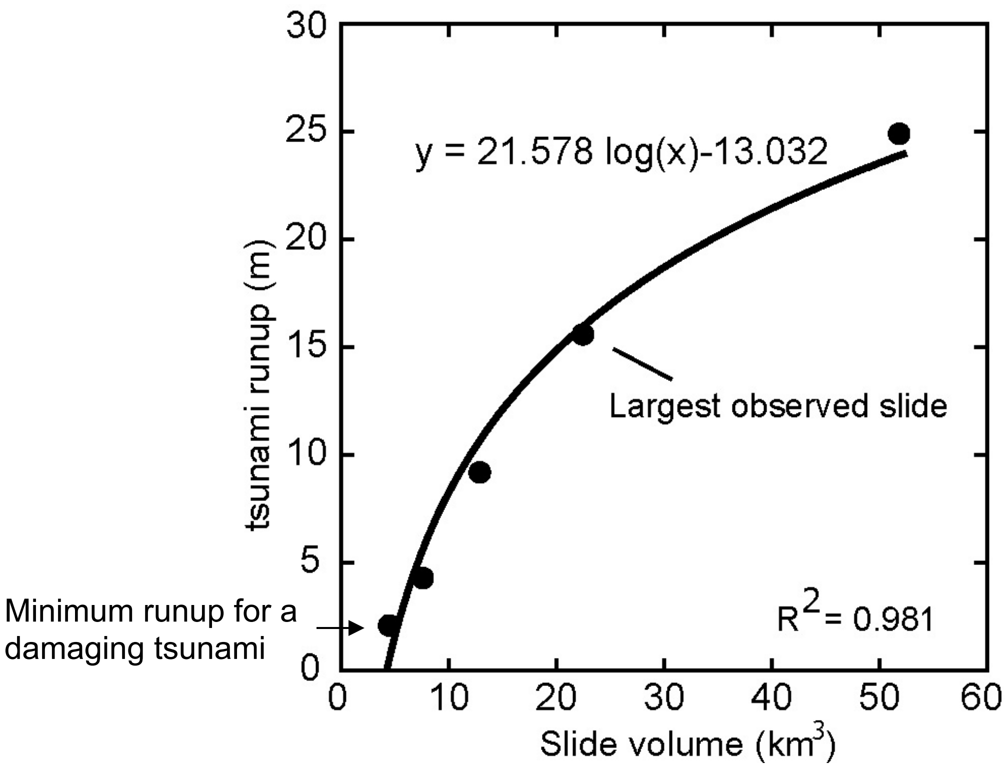


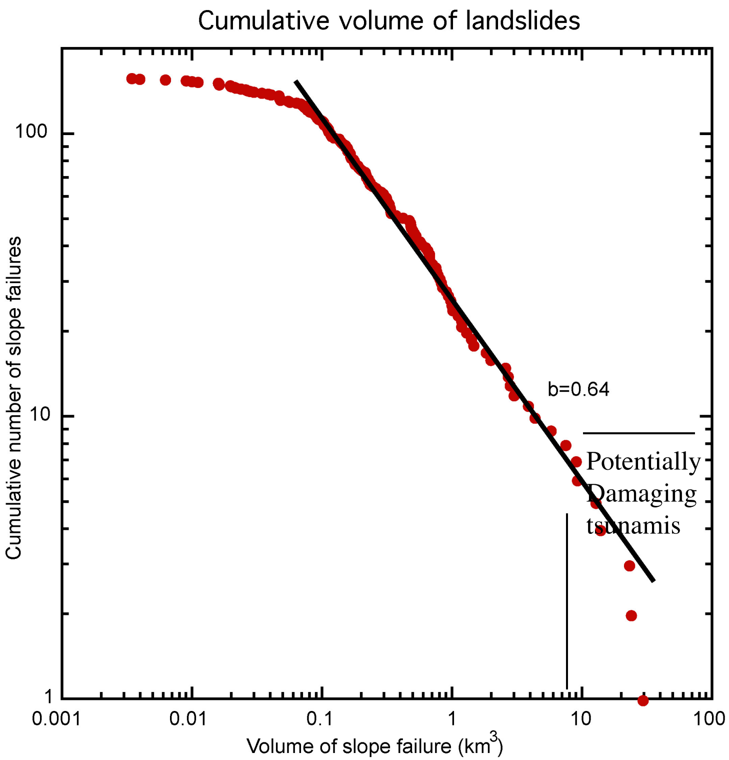




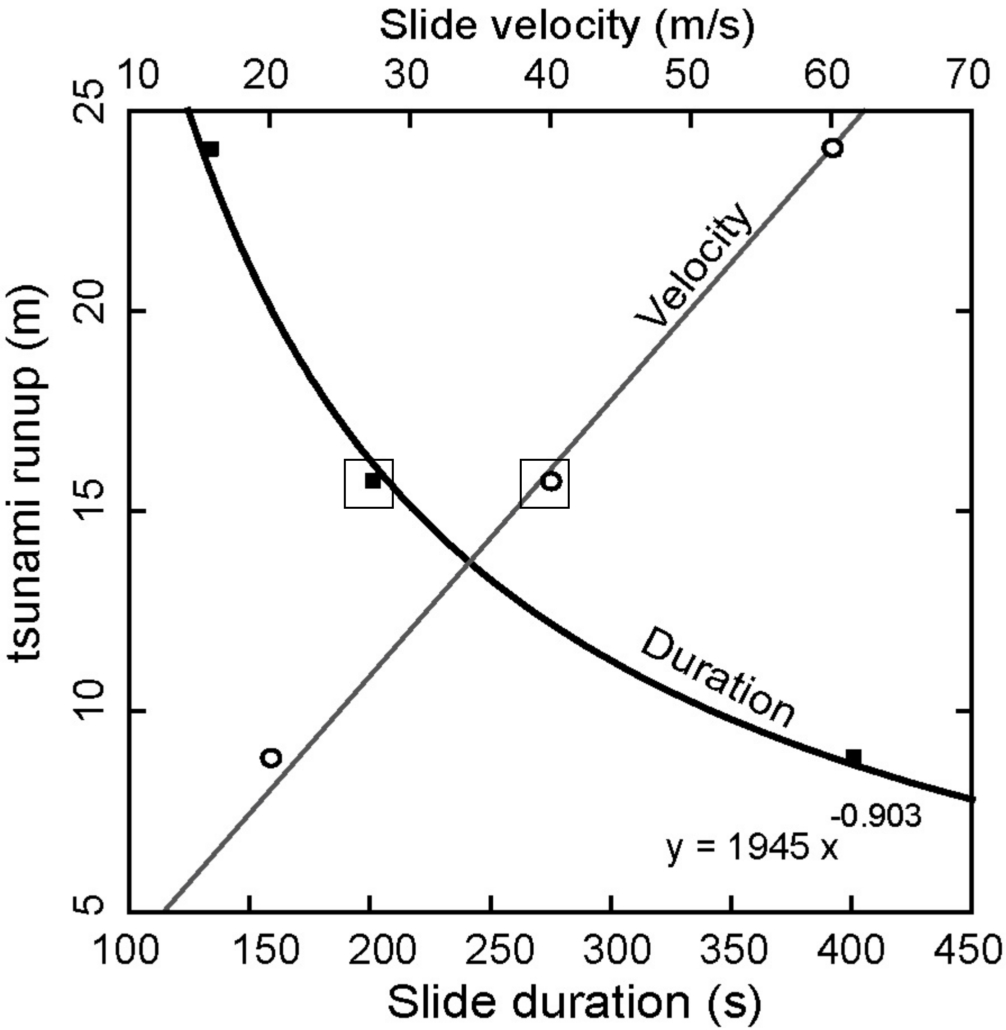
Tsunami runup scales with slide volume







Uncertainty in slide speed --> uncertainty in runup



Tsunami phase velocity at 4000 m water depth = 200 m/s

We have established for the first time the size distribution for carbonate submarine slope failures:

•Volume distribution follows a power law.

•This distribution allows estimates of total volume of slumped material, and indicates that a few largest failures dominate the failure volume.

•Volume-Area relationship and power law are similar to distribution of subaerial rockfalls despite differences in scale, indicating similar processes.

•Different relationships are derived for the clay-rich Storegga debris flows, which likely reflect different processes.

Source size distribution can be applied to estimates of the impact of landslide-generated tsunami:

•The largest mapped slide north of Puerto Rico, moving with an assumed slide speed of ~40 m/s, could have caused 15.7 m high runup.

•Only the largest 9 of 160 mapped slope failures could have caused a tsunami runup higher than 2.5 m.

•Future dating of the failure scarps may allow us to estimate the tsunami recurrence interval north of Puerto Rico.

•The caveat in these predictions that calculated runup is highly dependent on the prescribed duration (or velocity) of the landslide.