Large-scale failures on domes and stratocones situated on caldera ring faults: sand-box modeling and natural examples from Kamchatka, Russia

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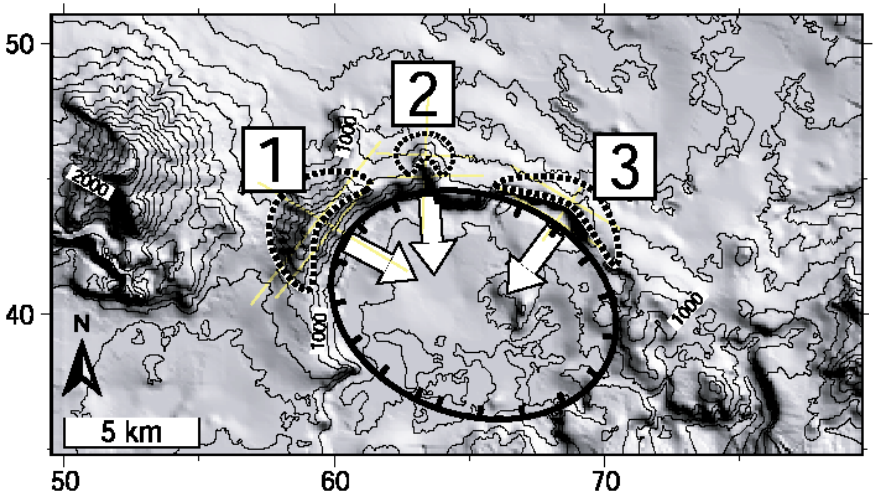
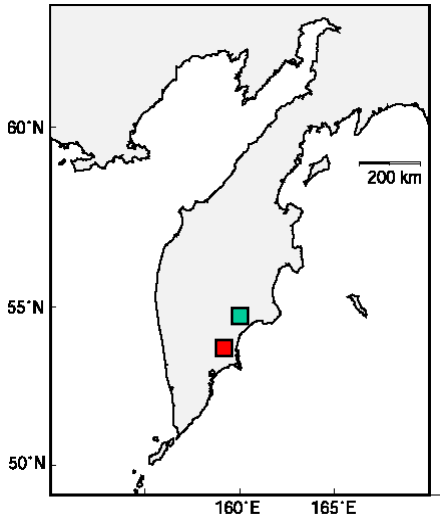
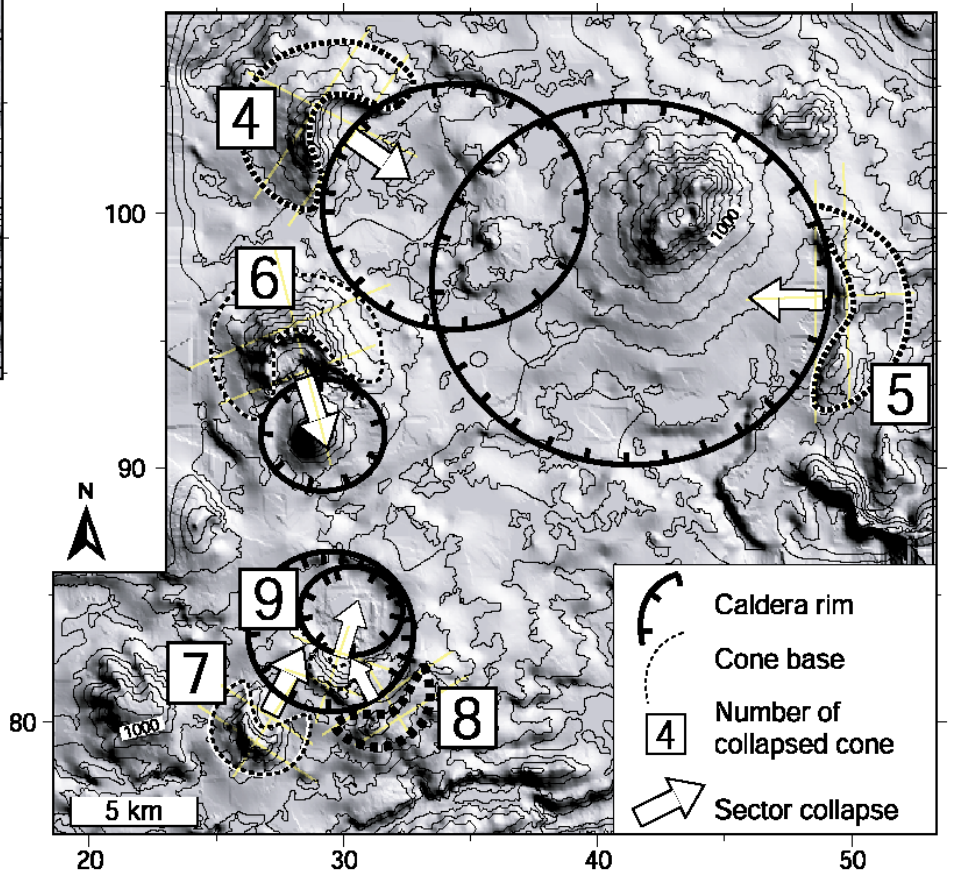
Bezymianny volcano

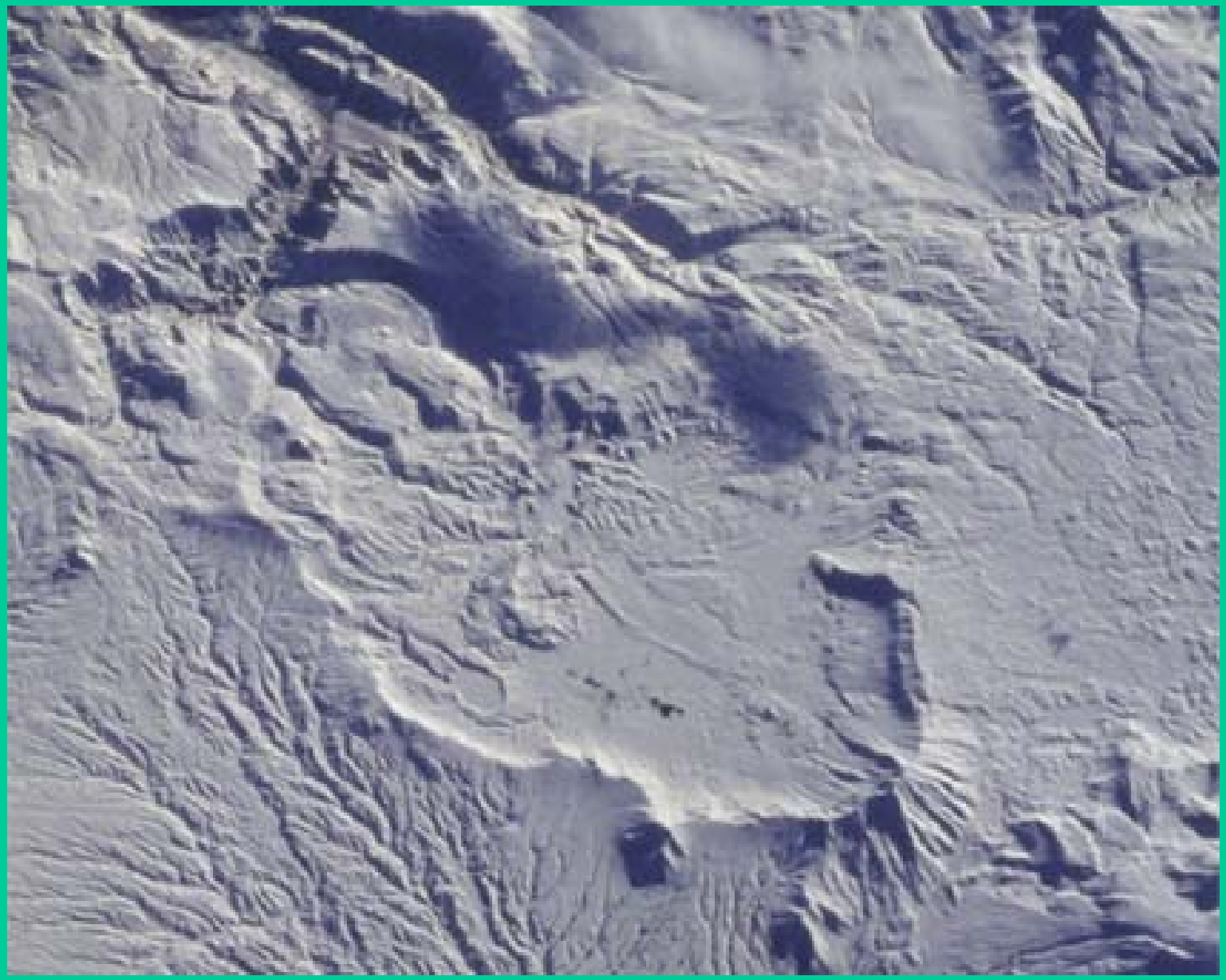
Uzon caldera





Karymsky group of volcanoes and calderas





Uzon caldera

Uzon caldera

Karymskoye lake caldera

Karymskoye lake caldera

Fisher caldera (Alaska)

Questions

- Why horseshoe-shaped volcanic edifices are common on the boundaries of large calderas?
- Can caldera subsidence cause large-scale failure of neighboring volcanic cones? If so, how does the process occur?
- What will be geological consequences of such failures?

Methods

- Analogue sand-box modeling of interaction of caldera subsidence and volcanic cone.
- Comparison of the modeled and natural morphologies of volcanic cones affected by caldera subsidences.

Previous works

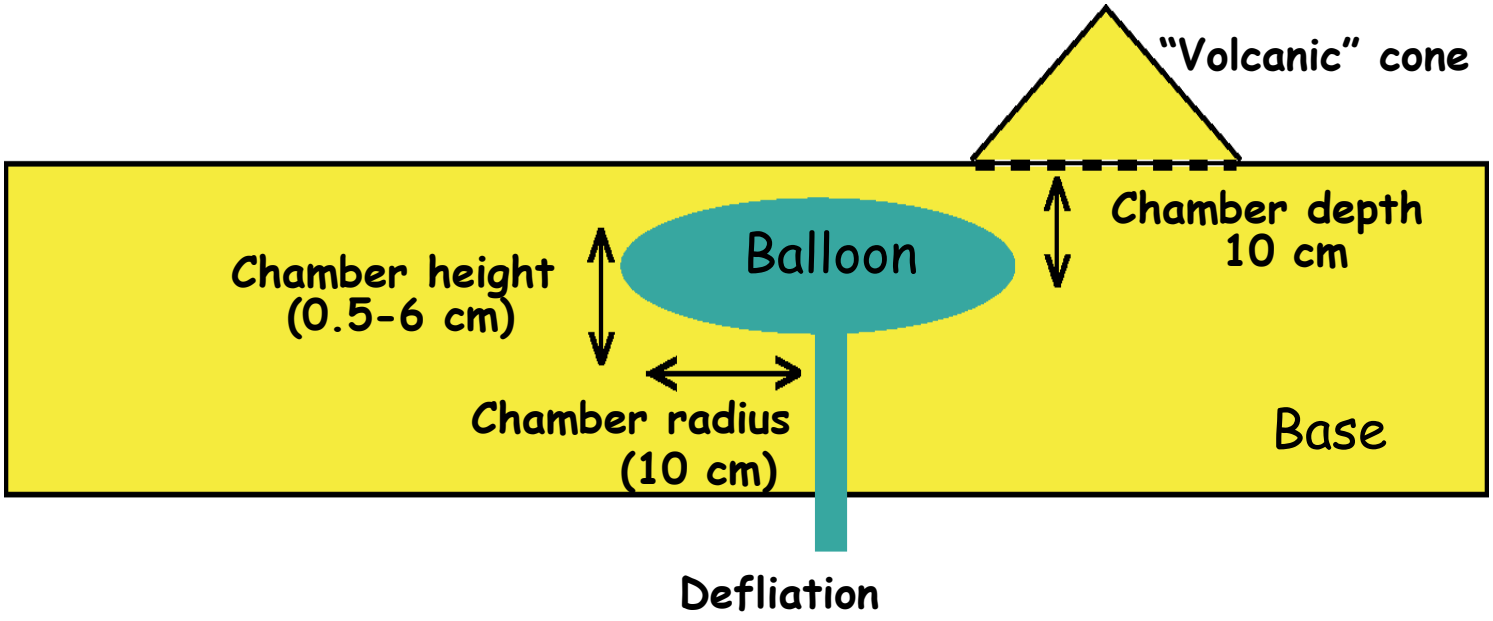
Modeling of caldera subsidence

Caldera subsidence occurs mainly along outward-dipping ring faults that allow subsidence of the central caldera floor either as a piston, trapdoor, funnel or in piecemeal fashion (Komuro 1987; Marti et al. 1994; Branney 1995; Roche et al. 2000; Walter and Troll 2001; Acocella et al. 2001 and Troll et al. 2002)

Modeling of volcanic cone / tectonic fault interaction

Movements along tectonic faults in the substrate could lead to failure of a volcanic cone (Vidal and Merle 2000).

Experimental set-up

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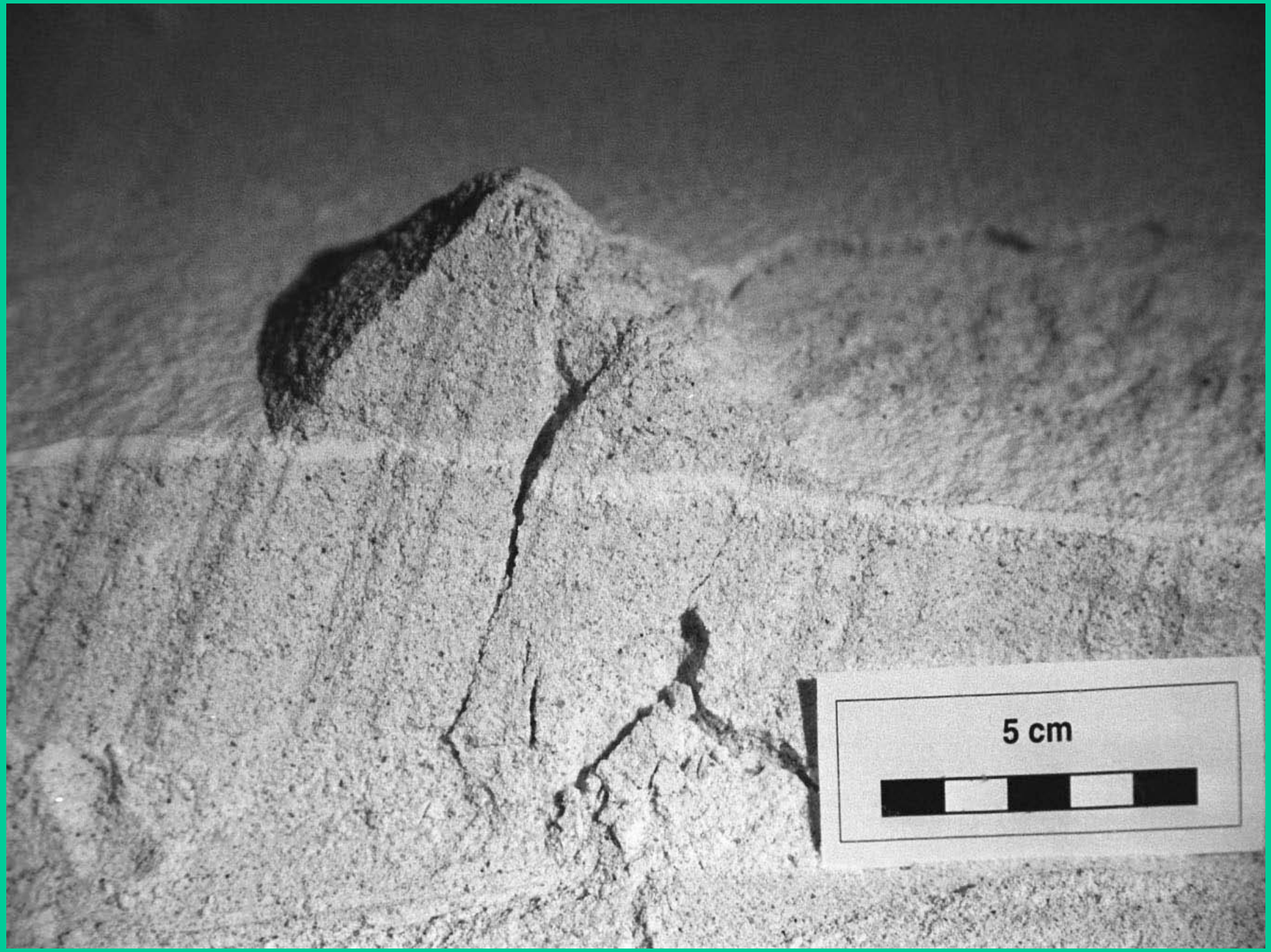
5 cm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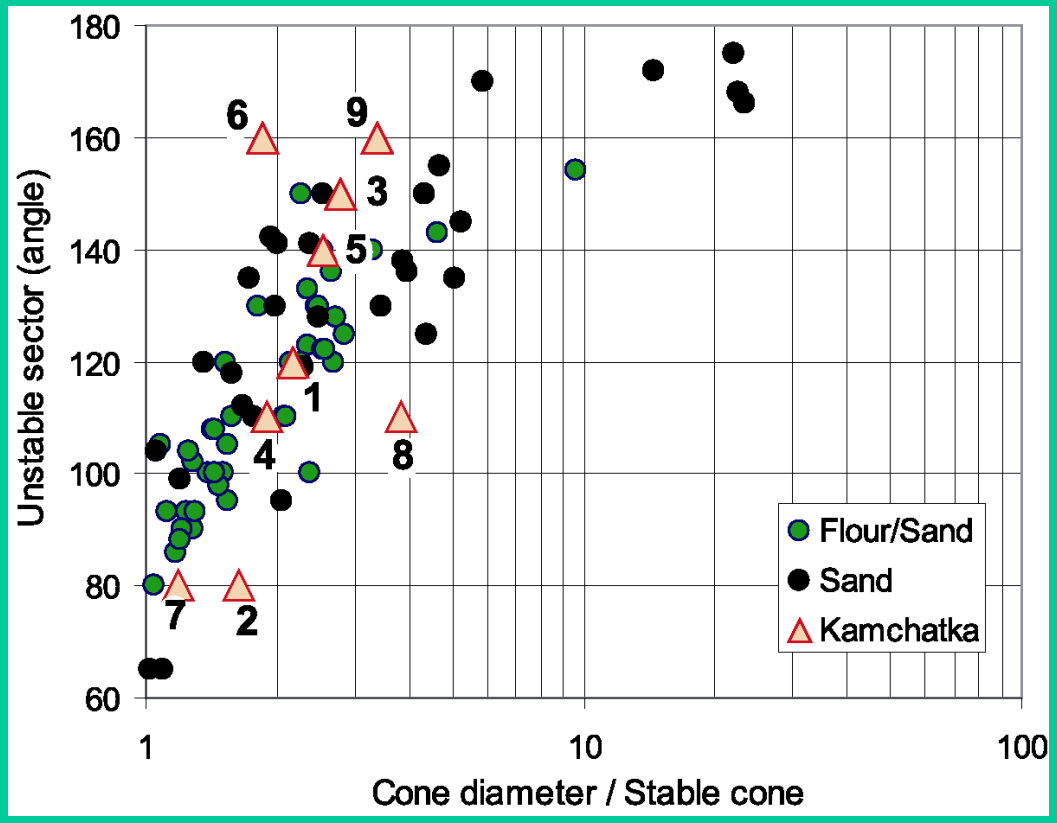
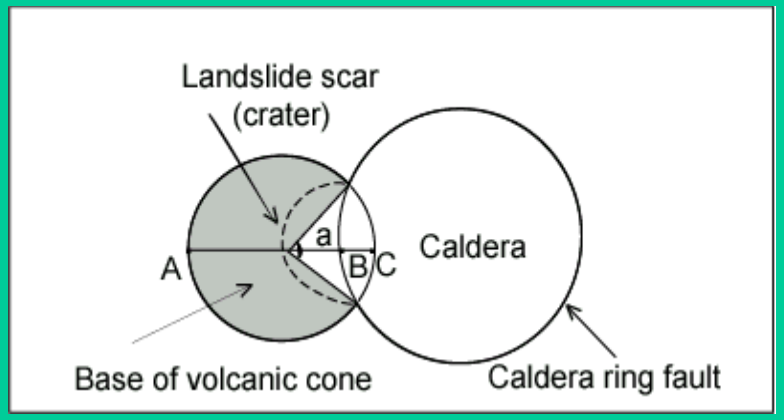
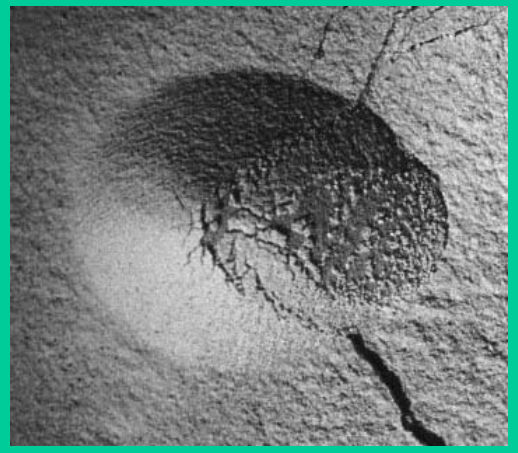
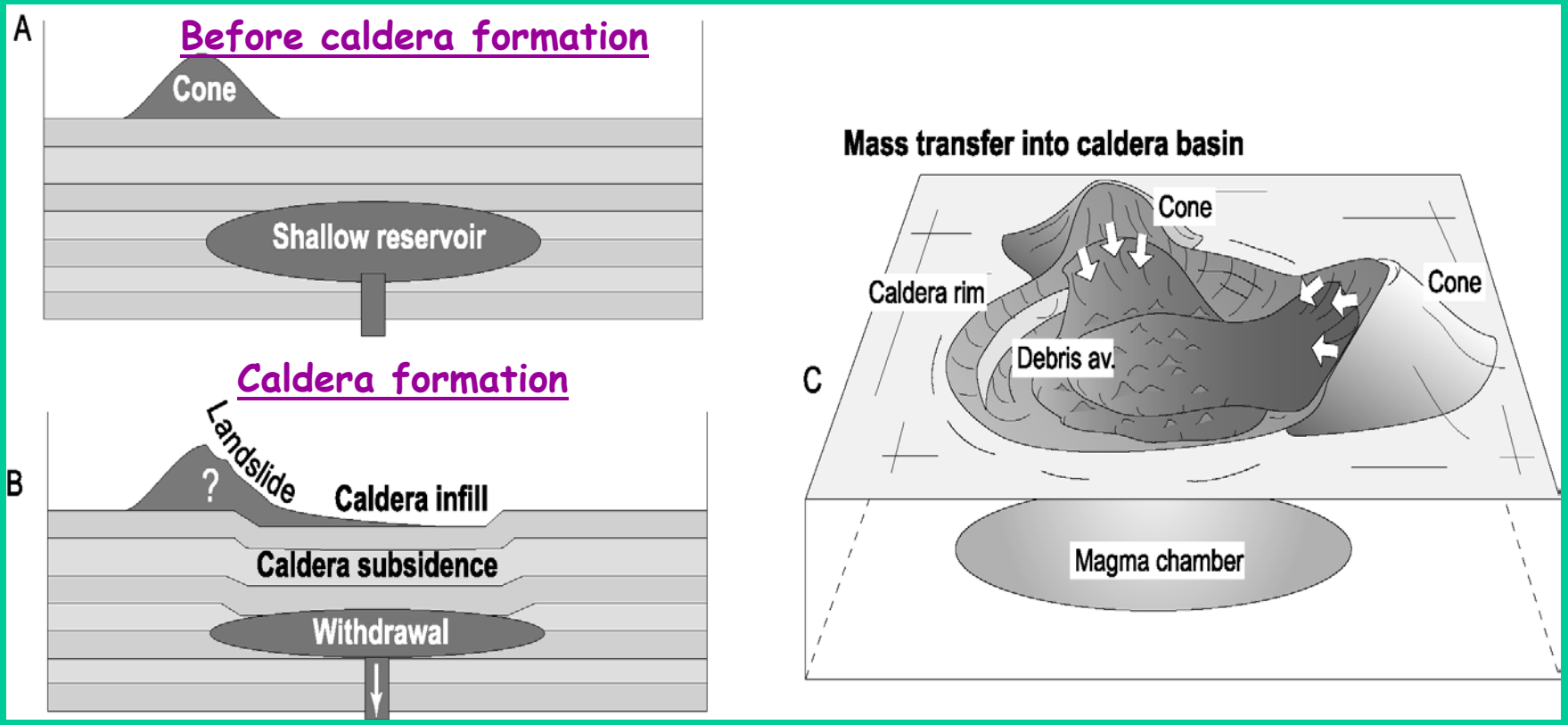
Comparison of modeled and natural examples







Processes of caldera subsidence and destabilization of volcanic cones situated on caldera ring faults

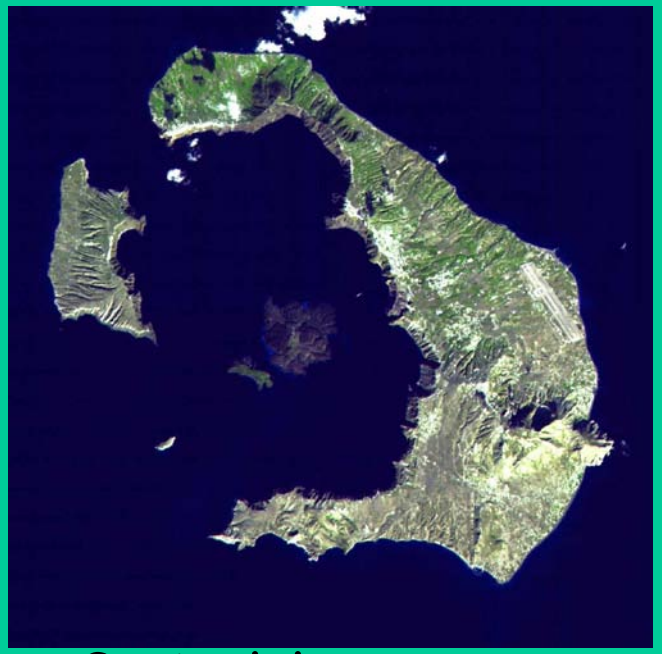


Conclusions

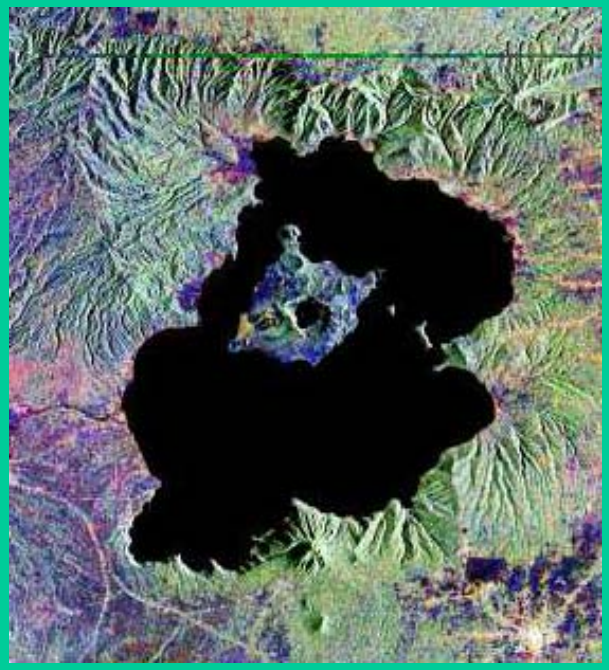
- Caldera subsidences destabilize nearby volcanic cones, formed above the magma chambers in the pre-caldera periods of volcanic activity. This process leeds to large-scale failures of the cones with formation of horseshoe- shaped craters.
- Although vertical movements of blocks dominate in caldera-forming processes, horizontal transport of material is also important in the cases, where large cones were destabilized by caldera subsidences.
- The found relationship between position of a cone relative to the caldera fault and the resulting angle of landslide scar can be used for evaluation of volume of material, which slid in caldera basins.

Main conclusion

Scalloped appearance of boundaries of many calderas can be explained by influence of topography on the process of caldera formation; no need to speculate about complex geometries of magma chambers, several episodes of caldera-forming eruptions or modification by post-caldera erosion in these cases.



Santorini



Taal