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Why does a trench advance or retreat?

Insights from numerical and laboratory experiments

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The variety of tectonic styles on the surface of the Earth is impressive as some trenches advance while some others retreat. In particular, the actual motion of the Earth’s trenches is equally partitioned between trenches that advance and trenches that retreat.

As a direct consequence, subducting lithosphere shows a wide range of possible shapes and geometries. Some slabs show a flattened shape with various dip angles or a roll-over structure.

To gain understanding of what is controlling trench dynamics, two complementary approaches are used: the numerical and analog ones. Exploitation of the advantages involved by the combination of numerical and laboratory models provides us with a powerful tool to study the dynamics between material properties and present-day observables. Numerical models allow the investigation of a wide range of parameters; while, laboratory ones overcome the computational limitations necessary to simulate three dimensional (3-D) geological features using complex rheology. Therefore 3-D numerical calculations are performed with the finite element code Citcom solving the equations for conservation of mass, momentum, composition and energy for an incompressible, viscous Cartesian box.

3-D laboratory experiments are as simple as possible: a viscous plate is positioned in the center of a large tank full of honey, and subducts under its own negative buoyancy once a small instability at the plate edge is created.

Varying thickness, width, density, and viscosity of the plate and mantle in both numer-

ical and laboratory models, the modes of subduction are investigated and compared to natural cases.