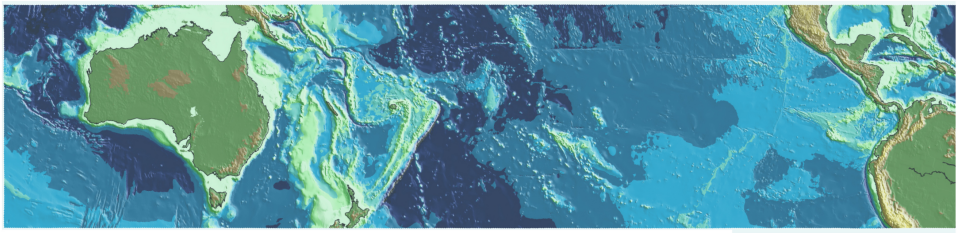
Understanding how subduction has shaped Circum-Pacific tectonics using 3D numerical models

Supervision: Saskia Goes(IC), Gareth Roberts (IC)

Background:
The main driving force for plate tectonics is provided by cold and dense plates that subduct into the mantle, for example along the Pacific "Ring of Fire". Subduction zones control the formation of mountain chains like the Andes and new ocean basins like the Philippine Sea and have shaped the Earth's surface through geologic time. They are also the site of the largest earthquakes and tsunamis. Understanding the balance of forces that determine the observed variability in subduction style through space and time is therefor crucial, but this has been a challenging problem.

Rationale:
The subduction balance of forces is a delicate one, and plates change their motions and shape in response to variations in density and strength of the two converging plates, as well to viscous resistance of the surrounding mantle. Only recently have models been developed that are able to solve this dynamic interplay, including work by our group. The first set of models, where plates are treated as constant density and strength bodies, have already yielded a wealth of new insights, for example into why some subduction episodes have been very fast and what governs sea-ward (basin-forming) or landward (collisional) plate boundary motions.



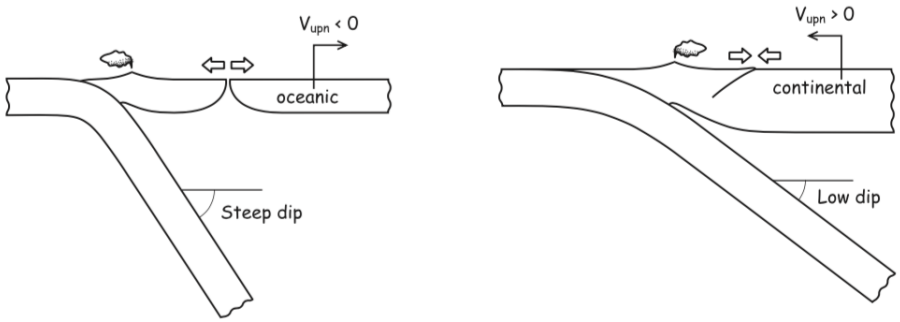


Illustration of the difference in upper plate deformation on the western (extensional) and eastern (compressional) Pacific rim and a proposed correlation [Lallemand et al., 2005] with differences in present-day subduction dip and upper plate motion.

This project:
Subducting plates are however not constant in density or strength, due to lateral variations of plate age and the presence of submarine ridges or plateaus. Aim of this project is to extend the previous (thermo-) mechanical models of subduction to a systematic investigation of the effect of lateral variations in subducting plate strength and density on subduction motions and geometry. The results will be compared with observations of the variable subduction behaviour found around the Pacific.

Our Team:
The work would be supervised by Saskia Goes, who has studied subduction numerically and observationally for over 20 years, and co-supervised by Gareth Roberts who uses geological and geophysical data to study how the Earth's surface responds to tectonic forcing. The student would join the Imperial Plates & Mantle group consisting of 5 academic staff, 9 other PhD students and 2 postdocs, working on shallow and deep geophysical imaging, geochemistry and mantle dynamics.

Student Profile: We are seeking a highly motivated individual with a background in geophysics, physics, or geology with a strong quantitative foundation. The successful candidate will be able to work independently, and have a keen interest to do interdisciplinary work on the dynamics of the deep Earth. Previous experience with numerical (fluid dynamical and/or solid-mechanical) modelling is highly desirable. For more information on this project please contact Saskia Goes (s.goes@imperial.ac.uk).

Application: This project is advertised through the NERC Science and Solutions of for a Changing Planet DTP, and also available for students who apply for other Imperial or international scholarship schemes. For more information on the project please contact Saskia Goes at s.goes@imperial.ac.uk or Gareth Roberts at gareth.roberts@imperial.ac.uk.

References and further reading

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