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Experimental, Numerical and Observational Models in Geodynamics

Carolina Lithgow-Bertelloni
Department of Earth Sciences University College London, Gower Street, London WC1E 6BT UK
(c.lithgow-bertelloni@ucl.ac.uk)

Geodynamics, the study of the forces that drives all Earth's processes is a rich field that deeply connects all aspects of geological and geophysical studies, from surface observations of the sedimentary record to knowledge of deep Earth structure from mineral physics and seismology. In the context of the solid Earth geodynamics primarily focuses on lithosphere and mantle dynamics, while core dynamics is the purview of geomagnetism. I will focus this talk on the former, its historical context and future developments.

We have known the equations of motion and mechanics for ∼200 years, but only relatively recently can they be solved with enough accuracy and resolution to do geology. We have made great strides since Arthur Holmes conceptual models of mantle flow, thanks to computational and experimental advances. We can know model plate boundaries globally with resolutions in the order of a few kms and image temperature and velocity simultaneously in the laboratory in 3D and non-intrusively. We have also learned a great deal about the physics of the Earth, from composition to rheology. New theories on plate boundary rheology are paving the way for self-consistent generation of plates from mantle flow. New computational methods allow for adaptive meshing, fabric development and history, so we can study deformation and compare directly to geological observations in mountain ranges and continental rifts. We can use ever more sophisticated images of mantle structure from seismic and other geophysical data to probe the relationship between melting, flow and dynamical processes. We can reconstruct landscapes and relief, plate motions and sedimentation and ask how much the mantle has contributed to drainage reversal, sedimentation and climate change.

The future of the field is ever brighter.