Biodiversity and the Evolving Earth: New Data, New Methods, New Insights

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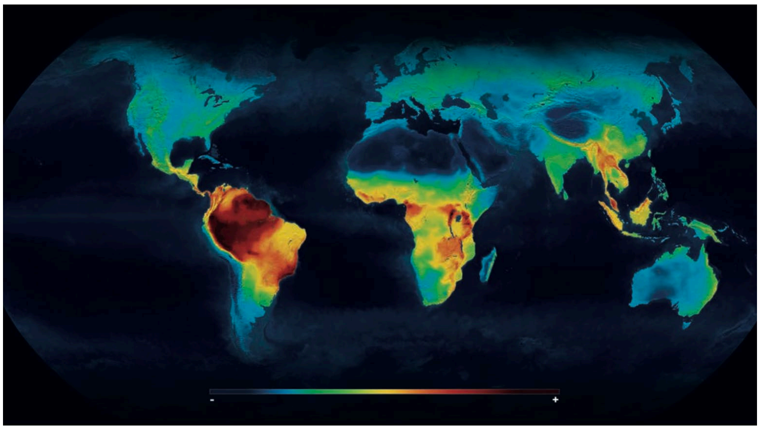
In this project, new computational tools will be developed and applied to understand what drives evolution of life and landscapes on Earth. We will examine how biodiversity is generated and how it relates to the evolution of topography. A key question we will address is: To what extent does topography (and its history) drive terrestrial biodiversity?



Modern biodiversity of terrestrial vertebrates, red/blue = high/low concentration of diversity. Based on data from Clinton Jenkins.

Understanding the history of life on Earth and evolution of its topography has recently become significantly more tractable for three principal reasons. First, thanks to the efforts of the biological, palaeontological, and geochemical communities we now have access to gigabytes of information about nearly all life and many environmental processes that have ever been recorded on Earth. These inventories contain records acquired in more than 100 years of scientific research. Detailed records of the proliferation and extinction of biota now exist for almost all of the Phanerozoic Eon (last 541 million years). Secondly, thanks largely to the space industry, nearly all of Earth's modern topography and environments have been mapped with metre-scale resolution. These data, combined with even more detailed mapping using drone technology, allow us to reconstruct Earth's topography and climate from individual riverbeds to continental scales. In some places, ancient landscapes have been mapped beneath Earth's rocky or icy surfaces and the history of Earth's surface can be reconstructed from relict landforms. Finally, rapid advances in understanding how to date, interpret and mathematically model biotic and landscape evolution, at least at large scales, have matched these advances in data acquisition and compilation. These observational and theoretical advances have changed the way we think about evolution, as well as longevity and preservation of geological and biological processes at a range of scales. It impacts our understanding of how life and landscapes respond to external processes, which is an important step towards reliably predicting the response of the solid Earth and biosphere to external pressures, such as climate change. However, we currently lack a framework that allows us to understand how processes operating at different spatial and temporal scales combine to generate Earth's history of life and topography. This project will address that problem, via new observations, and developing mathematical and computational tools (e.g. spectral analysis) to understand how physical, climatic and geochemical processes combine to generate topographic and biotic evolution on Earth.

The project will suit an Earth scientist, biologist, macroecologist, physicist or applied mathematician who wants to work on a multidisciplinary project that will enable them to develop data analysis, computational and mathematical skills. They will be able to apply those skills to exciting problems at the interface between geology, biodiversity and ecology. The successful candidate will join a group of PhD students and postdoctoral researchers with broad interests across the Earth and Physical Sciences.

Further reading

Antonelli, A. et al. Geological and climatic influences on mountain biodiversity. Nature Geoscience, doi: 10.1038/s41561-018-0236-z.

Badgley, C. et al. Biodiversity and Topographic Complexity: Modern and Geohistorical Perspectives. *Trends in Ecology & Evolution*, doi: 10.1016/j.tree.2016.12.010.

Roberts, G. G., P. Mannion, Timing and periodicity of Phanerozoic marine biodiversity and environmental change, *Scientific Reports*, doi: 10.1038/s41598-019-42538-7.

Roberts, G. G., Scales of Similarity and Disparity Between Drainage Networks, *Geophysical Research Letters*, doi: 10.1029/2019GL082446.

Roberts, G. G., N. J. White & Lodhia, B. H., Generation and Scaling of Longitudinal River Profiles. *Journal of Geophysical Research*, doi:10.1029/2018JF004796.