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Towards a quantitative paleogeography calculator

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Studies of paleoclimatology, paleoceanography, paleobiology, and other studies of paleoenvironment require paleogeographic reconstructions that display the past distribution of land and sea, and of bathymetry and altimetry. Quantitative reconstructions of past positions of continents and oceans have been available for decades, and have become easy to access and develop with the advance of GPlates software. Quantitative estimates of bathymetry and especially altimetry and topography, however, are considerably more challenging to develop. First attempts towards a global, quantitative approach towards paleotopography reconstruction were made in recent years. However these models are largely based on present day topography and require extensive manual adjustment for local modification that is subjective and precludes reproducibility. In this project, we attempt to overcome this subjectivity, and develop a quantitative methodology to calculate paleogeography based on kinematic input parameters.

Our aim is to develop 'Paleogeography.org', a free, online paleogeography calculator. This project calculates oceanic bathymetry and continental altitude and topography from plate tectonic reconstructions for various geodynamic settings. The algorithms are based on simple and straightforward dynamic principles: bathymetry of the ocean floor is at first order inferred from its age, and altimetry is based on computing crustal thickness based on shortening or extension reconstructions, assuming isostacy. Distinctions are made between undisturbed ocean floor, oceanic plateaus, trenches, continental rifts and back-arc basins, oceanic and continental volcanic arcs, upper plate orogens (e.g., Andes, Tibet) vs accretionary orogens (Zagros, Himalaya, Apennines, Alps), etc. This allows to calculate a global geography for any given time slice for which underlying kinematic reconstructions are available. These reconstructions are subsequently tested against independent quantitative estimates of e.g., altimetry and bathymetry and iterated where necessary. This approach provides a reproducible, global estimate of paleogeography without input from paleobiological or paleoclimatic indicators, enabling an independent platform for paleo-environmental study. The iteration between prediction and observation, moreover, will provide novel constraints on 4D geodynamic processes.

Code is written mainly in Python, especially using pyGPlates. The calculator will be available as open source code for scientists and other professionals. They can use it to make reproducible paleogeographic reconstructions based on their own plate tectonic reconstructions or on specific moments in time. In addition the output makes appealing pictures of plate tectonic

reconstructions for both scientists and a wider audience.