



Continental flooding and emergence since the Devonian constrained by paleogeography, paleobiology and geodynamic models

Wenchao Cao (1), Sabin Zahirovic (1), Nicolas Flament (1), Simon Williams (1), Jan Golonka (2), and Dietmar Müller (1)

(1) EarthByte Group, School of Geosciences, The University of Sydney, Australia, (2) Faculty of Geology, Geophysics and Environmental Protection, AGH University of Science and Technology, Kraków, Poland

Paleogeographic reconstructions are important to understand Earth's tectonic evolution, past eustatic and regional sea level change, paleoclimate and ocean circulation, deep Earth resources, and to constrain and interpret the dynamic topography predicted by mantle convection models. Global paleogeographic maps have been compiled and published, but they are generally presented as static maps with varying map projections and spatial resolutions, different time intervals depicted, and different plate motion models that underlie the paleogeographic reconstructions. This makes it difficult to convert the maps into a flexible digital form that can be linked to alternative digital plate tectonic reconstructions. To address this limitation, we develop a workflow to restore global paleogeographic maps to their present-day coordinates and enable them to be linked to different tectonic reconstructions. We use marine fossil collections from the Paleobiology Database to identify inconsistencies between their indicative paleo-environments and published paleogeographic maps, and revise the locations of inferred paleo-coastlines that represent the estimated maximum transgression surfaces by resolving these inconsistencies. As a result, the consistency ratio between the paleogeography and the paleo-environments indicated by the marine fossil collections is increased from an average 75% to nearly full consistency (100%). The paleogeography in the main regions of North America, South America, Europe and Africa is significantly revised, especially in Late Carboniferous, Middle Permian, Triassic, Jurassic, Late Cretaceous and most of Cenozoic times. The global flooded continental areas since Early Devonian times calculated from the revised paleogeography in this study are generally consistent with results derived from other paleo-environment and paleo-lithofacies data and with the strontium isotope record in marine carbonates. We also estimate the terrestrial areal change over time associated with transferring the paleogeography to a different reconstruction, filling gaps and modifying the paleogeographic geometries based on our paleobiology test. The results indicate that the variation of the underlying plate reconstruction is the main factor that contributes to terrestrial areal change, and the effect of revising paleogeographic geometries based on paleobiology is secondary, at least based on the data currently available in the paleobiology database. Our new paleogeographic model forms the basis for understanding plate-mantle interaction processes that have shaped Earth's topography through geological time. Combining the extent of interpreted continental flooding and emergence with models of mantle flow-induced dynamic topography provides an avenue to quantitatively reconstruct Earth's surface in three dimensions – a critical input for models of Earth surface processes, sedimentary basin evolution, past climate and ocean circulation.