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Silicate weathering estimates from paleogeographic and biogeochemical cycling models of orogens and ophiolite obduction during the Phanerozoic

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Collisional settings that terminate subduction are most often associated with orogenesis, and in many cases are also associated with the obduction of oceanic crust into the suture zone. These events are key components of the planetary carbon cycle, where the subduction-related volcanic outgassing is generally shut down, and instead dominated by processes of erosion and silicate weathering and carbon dioxide drawdown. This is particularly intense where silicate rocks are being exhumed, and especially where fresh ophiolitic crust is exposed, to intense weathering in the near-equatorial humid belts.

Here we use a new compilation of Phanerozoic orogens and ophiolites in a (py)GPlates workflow to analyse the distribution of these orogenic and obduction events in time and space. We test different tectonic reference frames, as well as explore different assumptions of the distribution of the near-equatorial humid belt through time. We compare our datasets and analysis with previously published models, and link the time series to the COPSE biogeochemical cycling model. In addition, we evaluate the implications of erosion and weathering from recent global landscape evolution models to explore the role of the near-equatorial humid belt precipitation and mountain areas.

The analysis suggests that large areas of mountains resided in the near-equatorial regions in the late Cambrian to Ordovician, late Carboniferous, the Cretaceous, and in the Neogene. One obvious challenge that emerges is the need to designate actively-uplifting versus inactive orogens, as the paleogeographic reconstructions do not yet discriminate between these categories. However, using our (py)GPlates workflows and other geological data (such as magmatic zircons), we can use the plate tectonic reconstructions to infer which orogens are proximal to plate boundaries and more likely to be actively uplifting, in contrast to mountains that are passively being denuded.

Although this approach sees an improvement to the constraints on the areas of elevated crust for the use in biogeochemical cycling, it remains challenging to infer the paleo-altimetry of these orogens in deep time. In addition, other geological time series inputs require further work (e.g., volcanic and orogenic/metamorphic degassing). Ongoing work is quantifying self-consistent tectonic parameters that can be incorporated into the biogeochemical cycling models to help

improve the constraints on these models. More broadly, this approach provides a pathway towards more robust and geologically-constrained Earth Systems Models that have implications for our understanding of paleo-climate and carbon cycling in deep time.