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Reconstructing sediment thickness of the ocean basins since the Early Jurassic

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Sedimentation is the second most important mechanism controlling the volume of ocean basins after seafloor spreading, causing sea level variations in the order of 60 m at a rate of 10 m/My. To understand the sediment budget of the ocean basins through time, a synthesis of sediment thickness on presently preserved ocean crust, known through a combination of seismic reflection surveys and five decades of ocean drilling, needs to be complemented by reconstructing sediments on subducted seafloor. This is important not only for constraining long-term changes in eustatic sea level, but also for calculating global carbon budgets. The significantly larger sediment thickness in the Indian and Atlantic oceans compared with the Pacific reflects differences in proximity to passive continental margins, a dynamic parameter reflecting the common conversion of plate margins from passive/transform (high sedimentation rates) to active (low sedimentation rates), and vice versa. To capture the time-dependence of sedimentation on this parameter, we use pyGPlates to compute global grids of oceanic crustal distances to passive margins throughout the lifetime of any piece of ocean crust over the last 200 million years. The mean of these distances for a given parcel of ocean crust is a proxy for the mean exposure of this piece of crust to the deposition of terrigenous, riverine sediments. On average this effect is significant if the mean distance is less than $\sim$2000 km. We develop and apply regression algorithms that are trained using the dependence of observed sediment thicknesses and long-term sedimentation rates on the age of underlying ocean crust and the mean distance to the nearest passive margin, producing global sediment thickness and long-term sedimentation rate grids from 200 Ma to the present at 1 million year intervals. Our modelled mean sediment thickness decreases from $\sim$220 m at 200 Ma to a minimum of $\sim$95 m at 130 Ma, reflecting the replacement of old Panthalassic ocean floor with young sediment-poor mid-ocean ridges, followed by an increase to $\sim$365 m at present-day. This increase reflects the accumulation of sediments on ageing abyssal plains proximal to passive margins, coupled with a decrease by over 700 km in the mean distance of any parcel of ocean crust to the nearest passive margin, and a doubling of the total passive margin length at present-day compared to the Early Jurassic. Mean long-term sedimentation rates triple from $\sim$0.5 cm/k.y. at 160 Ma to $\sim$0.8 cm/k.y. today, caused by enhanced terrigenous sediment influx along a passive margin system increasing in length through time, accompanied by the onset of ocean-wide carbonate sedimentation. Our predictive algorithms coupled to a plate tectonic model provide a framework for constraining the seafloor sediment-driven eustatic sea-level component, which has grown from 80 m to 210 m since 120 Ma. This implies a long-term sea level rise componment of 130 m, partly counteracting the contemporaneous increase in ocean basin depth due to progressive crustal ageing. This methodology forms a starting point for computing the oceanic sedimentary carbon budget through time in the future.