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Landslide mobilization of particulate organic carbon from an active mountain belt: Western Southern Alps, New Zealand

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The erosion of organic carbon from the continents followed by its transfer to oceans constitutes an important component of the global carbon cycle. The amount of particulate organic carbon (POC) entering the oceans via rivers is comparable to the estimated global CO_2 consumption by silicate weathering. This POC is comprised of modern biogenic, organic carbon (either living biomass or recent, partially degraded material), and fossil organic carbon, derived from sedimentary rocks. Like silicate weathering, the transfer of non-fossil biogenic POC to sedimentary basins will contribute to the drawdown of atmospheric CO_2. High-standing active islands of the Western Pacific are known to transfer a significant proportion of the global riverine POC to the oceans. Rivers draining these active mountain belts have small floodplains, high clastic input to margins and can discharge sediment to the ocean at very high concentrations. These characteristics may promote burial of the eroded POC. It is important to constrain the source of this riverine POC and understand the processes by which POC is routed from upland catchments.

We investigate the routing and transfer of POC from the western Southern Alps, New Zealand using percent organic carbon, nitrogen and stable carbon isotopes. In this active mountain belt, sediment discharge is dominated by landslide-derived material. Samples from landslide debris fans show that landsliding acts to homogenize the geochemically diverse hillslope POC, mixing POC from the standing biomass and soil with the fossil POC from bedrock. As a result, at the catchment-scale, our data show the riverine POC can be explained by a binary mixing of fossil and non-fossil sources, sourced from many landslide deposits. We calculate that non-fossil biogenic POC

makes up 63±7% of the total POC in the suspended load. Therefore we estimate that catchments draining the western Southern Alps transfer on average 39 $tCkm^{-2}yr^{-1}$ of atmospheric CO_2 via the erosion of biogenic POC, which is ∼4% of the net primary productivity. On the million year timescale, if more than 10% of this POC is preserved in sediments then this process will be the most significant way in which the Southern Alps, and similar active mountain belts, consume atmospheric CO_2.