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### Subducting Carbon: Heterogeneity Rules

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#### Abstract Text:

The subduction of carbon and recycling to volcanoes affects planetary scale processes that set the composition of Earth's surface and mantle environments. The largest flux of surficial carbon that subducts at trenches globally is sedimentary. This is paradoxical, as most carbonate dissolves and organic carbon oxidizes in the ocean before reaching the deep seafloor. Nonetheless, different events conspire to deliver variable fluxes of carbon, some of them large, to different trench sectors. Thus, sedimentary carbon subduction is not a global phenomenon – it is a regional one where heterogeneity rules.

Here we have calculated the flux and isotopic composition of both incoming sediment and trench fill for organic and inorganic carbon at the world's trenches. Our calculations are at the scale of kms along the trench, and so make predictions relevant to individual volcanoes as well as entire arc segments. A useful comparative metric is the carbon flux delivered by altered oceanic crust (AOC), which is a less variable input of largely inorganic carbon to all subduction zones. In some regions, subducting sedimentary carbon is much less than in the AOC unit subducts, for example, along the ~ 2000-km Tonga-Kermadec trench. Given the very high convergence rate, this region constitutes a large flux of carbonate with  $\delta^{13}\text{C}$  heavier than the mantle. At the other extreme, downgoing plates with km-thick turbidites deliver terrestrial organic carbon with  $\delta^{13}\text{C}$  lighter than the mantle. Trench segments that subduct >4X AOC carbon in sediments include the Nicobar Fan off Sumatra and the Aleutian and South Chile trenches. Regions with high biological productivity (Central America) and shallow seafloor (Hikurangi) supply large sedimentary carbonate fluxes with  $\delta^{13}\text{C}$  heavier than mantle. In addition to enormous isotopic heterogeneity (spanning from -25 to +1 per mil  $\delta^{13}\text{C}$ ), bulk sediments also span a wide range in oxidation capacity, from carbonate to organic carbon. These highly heterogeneous point- and regional-sources of carbon fluxes, isotopes and oxidation states provide natural laboratories to study recycling efficiencies at subduction zones and the creation of diamonds, carbonated melts and other carbon heterogeneities in the mantle.