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From Forest to Fan: Woody Debris Reshapes Organic Carbon Burial Estimates in the Nitinat Fan, Cascadia Basin

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Submarine fans represent some of the largest sedimentary carbon reservoirs on Earth, yet organic carbon (OC) burial estimates for these systems remain systematically underestimated due to their heterogeneous sedimentary architecture, the inherent difficulty of coring sand dominated turbidite bodies, and the convention of restricting geochemical analyses to fine-grained fractions, which neglects the coarse particulate organic matter (>2mm) delivered during turbidite emplacement. The Nitinat Fan, Cascadia Basin, provides a well-constrained case study to quantify this bias and trace the land–sea transfer of terrestrial carbon along an active convergent margin. We analyzed turbidite samples from ODP Leg 146, Site 888B, across fine (<2 mm) and coarse (>2 mm) fractions in both wood-bearing and non-wood-bearing layers. Stable carbon isotopes, elemental ratios, and Raman microscopy confirm a gymnosperm source for coarse woody debris, establishing a clear land–sea carbon pathway to deep basins driven by turbidity current transport. Wood-bearing turbidite layers contain on average six times more OC than non-wood-bearing fan sediments, with 77% of that OC stored in the coarse fraction, identifying the Nitinat Fan as a discrete carbon hot spot within the Cascadia margin system. We calculate an OC burial flux of 0.4 MtC yr^{-1} and estimate that the fan has sequestered ~1,200 MtC since the mid-Pleistocene, approximately 50% more than fine-fraction-only approaches would suggest. These findings highlight coarse woody debris as a disproportionately large and systematically overlooked component of marine carbon budgets. Incorporating the full grain-size spectrum into OC burial estimates is necessary to accurately constrain land–sea carbon fluxes and the contribution of submarine fans to long-term carbon storage.