The Subduction Margin Carbon Cycle: A Preliminary Assessment of the Distribution Patterns of Multicycle Carbon (NSF, OCE-1144483)

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Over geologic time scales, the burial of organic carbon in sediment plays an important role in global carbon and oxygen cycling. The burial of carbon in active margins is of particular interest for several reasons. When compared with passive margins, active margins are particularly efficient in the burial of organic carbon due to the close proximity of highland sources to marine sedimentary sinks and high sediment transport rates. Of particular interest is the ancient (rock) carbon, also known as kerogen, which comprises 25 – 45% of the organic carbon buried on active margins (Blair et al., 2004). The sequestration of organic carbon on active margins can provide a record of the terrestrial environment spanning millions of years. Differences through time in the volume and nature of exported organic carbon from terrestrial environments have implications for the regulation of the carbon cycle and can also provide information on storm frequency, sea level, precipitation regimes, vegetation type, erosion rate, climate shift, and tectonic movement/uplift. As part of the Alaska and Aleutian Subduction Zone (AASZ) Primary Site of the Subduction Cycles and Deformation (SCD) Initiative, the Southern Alaska Margin represents an ideal active margin system in which to study the relationship between tectonic and glacial changes and organic carbon.

To investigate these relationships, we use samples from Site U1417 of Integrated Ocean Drilling Program (IODP) Expedition 341. Located in the distal portion of the Surveyor Fan and extending into the Miocene, this core allows for the investigation of sedimentary and organic carbon provenance over broad tectonic and

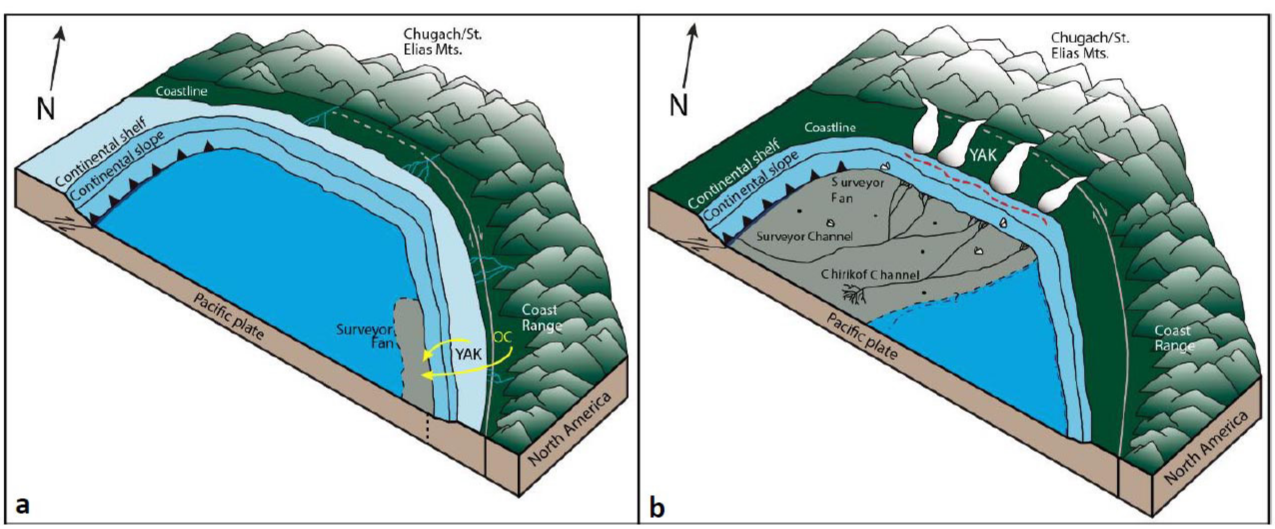

Figure 1. From Reece et al. (2011) (modified), schematic illustration of the southern Alaska margin sedimentary evolution from (a) ~20 Ma, first terrigenous sediment deposition to (b) ~1 Ma, glacial intensification following tidewater glaciation. Yakutat terrane (YAK), organic carbon transport (yellow), glacial restriction to terrestrial carbon export (red dashed line).

climate dynamics. Initial interpretations of core material from Site U1417 suggest at least three distinct sedimentary packages linked to the tectonic convergence of the Yakutat Terrane and the onset of glaciation (Expedition 341 Scientists, 2014). Observations of discrete coal and plant fragments, coupled with initial shipboard measurements, imply good preservation of a traceable terrestrial organic carbon signal at this site (Jaeger et al., 2014). Variations in the volume or nature of kerogen input could indicate an altered terrestrial erosion pattern, which is likely driven by a combination of tectonics/uplift and glacial incision of bedrock in the Southern Alaska Margin. Furthermore, interpretation of organic carbon sources downcore and into the Miocene will be an important component in the source-to-sink study of connections between glaciation, climate change, and tectonic uplift.

To assess connections between the marine and terrestrial environments Site U1417 sediments and rock samples of the Yakutat Terrane, including the Kulthieth, Yakataga, and Poul Creek Formations (Perry et al., 2009), were analyzed for carbon concentration and stable carbon isotope values by elemental analysis – isotope ratio mass spectrometry (EA-IRMS) and compound specific hydrocarbon analyses (polycyclic aromatic hydrocarbons [PAH], alkanes) via coupled pyrolysis-gas chromatography-mass spectrometry (pyr-GCMS). Elemental, isotopic, and hydrocarbon data from rock samples of the Yakutat Terrane provides a valuable constraint on the biogeochemistry of the terrestrial end member(s). Principal component analaysis of data from the three primary terrestrial formations clearly distinguishes the oldest formation (Kulthieth), from the younger, partially reworked formations (Poul Creek, Yakataga) by carbon content and alkane chain length.

Recorded at Site U1417 in the organic carbon record are important changes in the tectonic and erosional dynamics of the landscape. Through the Miocene, sediment and associated organics are erosionally derived from the tectonic uplift and transport of the Yakutat Terrane. During this period, records in the Surveyor Fan are higher in organic carbon concentration and isotopic values are consistent with Yakutat/Coastal Range derived material (Fig. 1a). Following the onset of regional glaciation near the Pliocene-Pleistocene boundary, a dramatic shift in erosional patterns is recorded in the organic carbon record of the Surveyor Fan. As tidewater glaciation progressed to more intensive regional glaciation (Fig. 1b), the source and/or volume of material eroded from the margin transformed. Previous sediment delivery by river systems from the Yakutat Terrane/Coastal Range sources was restricted by glaciation, greatly diminishing terrestrial organic carbon export and preservation in the Surveyor Fan.

References

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