Potential links between onshore tectonics and terrestrial organic carbon delivery to distal submarine fan environments: IODP Site U1417, Surveyor Fan, Gulf of Alaska

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LITHOLOGY OF U1417

Figure 1. Graphic lithology depth and time constraints of units at Site U1417. The units are defined at Site U1417 and boundaries are based on facies associations, and include subunits for I and V.

Figure 2. Interpreted tectonic and depositional setting for 2.6–0 Ma. This stage marks the onset of shelf wide marine glaciation. Tidewater glaciation transported sediment from the continental margin of south-central Alaska through the Surveyor Channel and related sediment pathways, levees, and overbank systems.

Figure 3. Interpreted tectonic and depositional setting for 11–24 Ma. This stage marks a regional increase in sediment delivery to offshore environments as well as deposition and possibly early tidewater glaciation along the southern margin of Alaska. This results in transport of material from the onshore Neogene thrust belt and the older uplifted parts of the Mesozoic continental margin to the distal submarine fan system.

Figure 4. Interpreted tectonic and depositional setting for 28–36 Ma. This stage represents non-glacial sediment delivery to offshore environments related to regional shortening associated with the emplacement of northward transport of the Yakutat Terrane, which is interpreted to have generated uplift and erosion of the eastern Cordilleran Tulsequah terrane, and eroded Kalatheth Formation.

Figure 5. Chronogram of samples from terminal formations of the Yakutat Terrane. Samples were pyrolyzed at 800°C, 3 sec before gas transfer to GC-MS. (a) Samples from the Poul Creek and Yakataga Formations. Differences in relative abundance and presence/absence of compounds highlighted in gray. (b) Coal from the Kalatheth Formation.

Figure 6. (a) The active margin carbon cycle. Accretion, uplift, and erosion of sedimentary rocks on the continent bring previously buried OC to the surface. If mass wasting is sufficiently rapid, as in the case on these margins, the exposed fossil carbon is recycled into the sedimentary system thereby avoiding notation in subsurface systems. This recycled fossil carbon is blended with younger material as sediments move across the surface. (b) Downcore total organic carbon (wt%), measured aboard the IODP Resolution. (c) Total organic carbon (wt%) plotted against carbon isotope composition (δ13C, %) for terrestrial samples from the Poul Creek, Yakataga, and Kalatheth Formations.

CARBON CONNECTIONS

Lithofacies of Site U1417 can be divided into 3 sedimentary packages that we interpret as linked to the tectonic convergence of the Yakutat Terrane with, and onset of tidewater glaciation along, the continental margin of northwestern Canada and southern Alaska (Figs. 2, 3, 4). Based on previous studies linking the movement of the Yakutat Terrane and the development of the Cordilleran Ice Sheet to the development of the Surveyor Fan System (Reece et al., 2011), we hypothesize biogeochemical variations in the deposited sediments as a result of changing provenance.

Tectonic processes on active margins are intrinsically coupled to the transport of sediment and associated organic matter. Over geologic time scales (>1 Ma), uplift and mass wasting of sedimentary rock from uplifted accretionary wedges inject recycled organic C (e.g. kerogen), along with modern material into the marine environment (Fig. 6).

- Differences in compound abundance and presence/absence will allow for biogeochemical distinction between material sourced from the Poul Creek and Yakataga Formations. Delivery to the Surveyor Fan was likely dominated by each formation at varying points during tectonic transport. Fingerprinting of coal from Kalatheth Formation will allow for comparison with coal fragments recovered from Unit V.
- Total organic carbon (OC) measurements collected shipboard indicate steady but low input of OC from the late Pliocene to present, which consistent with input from a tidewater glaciation environment. During the Miocene and early Pliocene OC concentrations are generally greater, with some particularly notable intervals. This may be related to a more significant input of material from the coal-bearing Kulthieth Formation.
- Bulk geochemical analysis (Fig. 6c), coupled with detailed biomarker analysis (Fig. 5) and end-member modeling will allow for the better determination of provenance through time at Site U1417.