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Climate-tectonic interaction in the Chugach-St. Elias Mountains: insights from sediments of the deep sea Surveyor Fan, Gulf of Alaska

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The Chugach-St. Elias Mountains, highest coastal mountain range on Earth, experienced a complex history of tectonic and glacial interaction during the last 8 Ma. The relative impact of tectonics and climate on the evolution of the orogen are controversial and need to be determined in detail. The proximity of the orogen to the ocean and missing onshore sediment traps allowed the transfer of the onshore sediments into the Surveyor Fan, Gulf of Alaska. IODP Expedition 341 drilled 5 sites in the Surveyor Fan recovering Miocene to Pleistocene sediments. We present a single-grain provenance study, using zircon LA-ICP-MS U-Pb and (U-Th)/He geochronology, REE, and laser ablation Hf isotope analysis, amphibole and garnet geochemistry, Ar/Ar dating of amphibole and mica and point counting of heavy minerals on two IODP 341 sites on the distal and proximal Surveyor Fan (sites U1417 and U1418, respectively).

Two zircon U-Pb age components around 50 Ma and 70 Ma and single Precambrian ages characterize all age spectra. The 50 Ma component matches the metamorphic rocks of the Chugach Metamorphic Complex (CMC) and the intrusions of the Sanak-Baranof Plutonic Belt (SBPB). The age distribution of all older grains strongly resembles the non- or low-grade metamorphic rocks west- and southward of the CMC. Geochemical compositions of amphibole and garnet imply source rocks of mostly amphibolite facies metamorphic conditions together with igneous and greenschist facies metamorphic input, supporting a Chugach-Prince William and Yakutat provenance. Dominance of a 50 Ma zircon age component, the abundance of metamorphic zircons and homogeneous amphibole and garnet compositions favor a CMC/SBPB dominated provenance in the Miocene predating glaciation. Thermochronological data show constant exhumation rates for the Miocene. In the Pliocene, amphibole and garnet spectra reflect more diverse lithologies and the abundance of metamorphic zircons decreases. Both register an increase of input from low-grade metamorphic units on the mountain slopes closer to the coast. This change of erosion centers was connected to the transition from alpine glaciation to tidewater glaciation at the Miocene/Pliocene boundary. During the Pleistocene, all data point again to a dominance of sources within the CMC and some contribution from the surrounding areas. We infer exhumation rates in the CMC to have been very high because of effective coupling of tectonic uplift and strong glaciation. The provenance signal stays relatively constant over the Middle Pleistocene transition giving no evidence for changes through the intensification of glaciation.

We conclude that the Chugach-Prince William and Yakutat terranes form the main and longstanding sediment sources for the Surveyor Fan sediments. Tectonics appear to be the prevalent factor in determining the main erosion center in the CMC, which persist since the Miocene. During times of strong glaciation, glaciers occupied essentially the same regions as today. In times of beginning or reduced glaciation erosion focused on the higher mountain areas. This changed to erosion also of downslope areas when glaciation intensified and tidewater glaciers formed. The volume and rate of input from these areas are modulated by strong interaction of glacial and tectonic processes.