Geophysical Research Abstracts
Vol. 16, EGU2014-9549, 2014
EGU General Assembly 2014

Limited climate control of the Chugach/St. Elias thrust wedge in southern Alaska demonstrated by orogenic widening during Pliocene to Quaternary climate change

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Critical taper wedge theory is the gold standard by which climate control of convergent orogenic belts is inferred. The theory predicts (and models reproduce) that an orogenic belt narrows if erosion increases in erosion in the face of a constant tectonic influx. Numerous papers now argue on the basis of thermochronologic data that the Chugach/ St. Elias Range (CSE) of southern Alaska narrowed as a direct response to Quaternary climate change because glaciers dominated erosion of the orogenic belt. The CSE formed in response to collision of a microplate with North America and is notable because glacial erosion has dominated the CSE for the past 5 to 6 Ma. An increase in sediment accumulation rates in the foreland basin over that time suggests that glacial erosion become more efficient. If correct, it is possible that glacial erosion outpaced rock influx thereby inducing a climatically controlled narrowing of the orogenic wedge during the Quaternary. Growth strata preserved within the wedge provide a test of that interpretation because they demonstrate the spatial and temporal pattern of deformation during the Pliocene to Quaternary climate transition. A thrust front established between 6 and 5 Ma jumped towards the foreland by 30 and 15 km at 1.8 and 0.25 Ma, respectively. Distributed deformation within the thrust belt accompanied the thrust front relocations. Continuous exhumation recorded by low-temperature thermochronometers occurred contemporaneously with the shortening, parallel the structural not the topographic grain, and ages become younger towards the foreland as well. Interpreted in terms of critical wedge theory, continuous distributed deformation reflects a sub-critical wedge taper resulting from the combined effects of persistent exhumation and incremental accretion and orogenic widening via thrust front jumps into the undeformed foreland. Taper angle varies according to published cross-sections and ranges from 3 to 9 degrees. If the wedge oscillated about critical taper, a pore fluid ratio between 0.7 and 0.97 is suggested by range of taper angles. Thus, the thrust belt response to Pliocene to Quaternary climate change and a likely increase in glacial coverage is in fact the opposite of the expected response of a critical-taper wedge to an increase in hinterland erosion rate. The CSE hovered near critical taper throughout the Quaternary and the tectonic influx equaled or exceeded the erosional efflux, implying that glacial erosion was paced by, not independent of, tectonic rock uplift rate.