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Surface ruptures in the western St. Elias Orogen, Alaska: Seismogenic gravity collapse sachung vs fold-growth related scarps

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Collision between the Yakutat microplate and North America occurs at one of the highest continental convergence rates on earth, yet surface ruptures that are unambiguously caused by active faulting are scarce. This originates in part from erosion by active glacial systems which obscure many Quaternary deformational features However, large areas of the orogen have not been glaciated since the LGM and surface ruptures associated with active deformation should be preserved. One such area lies between the Copper River and the Bering Glacier where hundreds of scarps are present. If all of these scarps were tectonic they would imply high rates of deformation, but many probably originate by hillslope collapse, presumably triggered by high ground acceleration during earthquakes.. We systematically examined many of these features during field work in 2005 and recognized 5 general classes of scarps: 1) extensional fissures from 1cm to 5m wide with strike-lengths of less than a ~100m that record extension within landslides; 2) valley-side down scarps with curvilinear traces that locally cross-cut bedding and are located at headwalls of existing or developing landslides; 3) ridge-parallel, uphill-facing scarps that typically, but not invariably, form by bedding-parallel slip and can be traced for hundreds of meters; 4) scarps oriented at high-angle to ridge crests with normal-slip offset on surfaces that typically parallel bedding planes-many of these scarps can be traced for only a few hundred meters but some scarps extend across valleys and across adjacent ridge-crests with a total strike-length of 1-2km or more; and 5) scarps that can be traced for 10km or more along known faults. Type 1 and 2 scarps are mass wasting features and type 5 are almost certainly tectonic, but types 3 and 4 are problematic. Type 3 scarps are most abundant and fit many of the characteristics of "sachung" that are ascribed to gravity spreading along ridges during large earthquakes. Their similarity to, and close association with, type 4 and type 5 scarps, however, suggests they may be tectonic and created by flexurally-driven extension within actively growing folds located beneath elongate hills. A circular arc bending model suggests that the total extension across each individual hill could be produced by about 30-50 m of horizontal shortening. This model requires only 3-5mm/yr of orogenic contraction per feature if the deformed land surface is ~10ky in age; i.e. a fraction of the 50-60mm/yr of total convergence in the orogen. This folding, however, is geometrically complex because the rocks contain pre-existing folds, and thus, the inferred active folding is being superimposed on previously tilted and faulted beds. The folds originate as the microplate is accreted into southern Alaska, and becomes incorporated into the upper plate of the Aleutian mega-thrust.