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Lithological and erosional controls on orogen width in the Bolivian Andes

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Orogen fold-and-thrust belts (FTBs) often have a tapering wedge geometry in cross section, which develops as a result of the balance between stresses acting along the detachment fault beneath the wedge, its internal strength, and the average slope of the surface topography from the back of the wedge to its toe. The geometry of these critical wedges is thus sensitive to changes in factors that influence stress along the wedge base or the surface slope, including changes in the mechanical strength of the detachment fault or variations in surface erosional efficiency. The Andes of eastern Bolivia have differences in the basal detachment strength, resulting from a thinning of the weak Paleozoic sediments that host the basal detachment, and average annual rainfall north and south of the bend in the orogen at $\sim 18^{\circ}\text{S}$. In addition, the orogen and active Subandean FTB are $\sim 50\%$ narrower in the north, where both the detachment layer strength may be higher and the average annual rainfall is around eight times that in the south. This raises the question: What controls orogen width in the Bolivian Andes?

We explore the effects of variations in the mechanical strength of the basal detachment and surface erosional efficiency on FTB width using 3D numerical geodynamic models with lateral variations in these parameters along strike. Our numerical experiments calculate the orogen geometry using the DOUAR geodynamic modelling software (Braun et al., 2008) coupled to the FastScape surface process model (Braun and Willett, 2013). The model design includes an elevated plateau region that is thrust over a weak frictional plastic detachment layer, resulting in growth of an orogenic wedge at the distal plateau margin. The plateau geometry is also bent, including a 40° change in margin orientation along strike; changes in the erosional efficiency and detachment strength are varied on either side of this bend. We find that changes in detachment strength result in significant differences in FTB width, while changes in erosional efficiency have little effect. Increasing the detachment strength by two results in limited forward propagation of the thrust front and a reduction in the FTB width by roughly 50% compared to the weaker side of the model. In contrast, increasing precipitation by a factor of three (as a proxy for enhanced erosional efficiency) does not significantly effect the FTB width. These results compare well with the observed variations in orogen width in the Bolivian Andes, suggesting the FTB width may be controlled by the detachment strength, while variations in erosional efficiency have a limited effect. Ongoing work is exploring how changes in detachment strength and erosional efficiency may affect thermochronometer ages predicted from the numerical experiments, and how the

predicted ages compare to ages observed in the Bolivian Andes.

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