

Distributed Strike-Slip Faulting in the Northern Bighorn Arch — A Zone of Distributed Tear at the Northern Edge of the Laramide Orogen?

Aydinian, Karen ^{*1}; Erslev, Eric A. ¹ (1) Department of Geology and Geophysics, University of Wyoming, Laramie, WY.

How do basement-involved, contractional foreland orogens terminate on their margins? Simple shear models invoking crustal and lithospheric detachment suggest that they terminate in tear faults. In contrast, pure shear “squashing models” suggest that shortening just dies out towards orogen margins. This project seeks to define and model the kinematics of the Bighorn arch as part of the Bighorn project, an NSF EarthScope-funded project to image the Bighorn arch using passive and active seismic data and to construct 3D kinematic and dynamic models of the structure. The Bighorn arch is a basement-cored foreland structure at the northeastern margin of Laramide deformation. Several en echelon, east-west-trending zones on the northwest end of the arch, including a larger east-west zone containing many northeast-southwest-trending faults north of Billings, Montana, have east-west-trending folds that curve into northeast-verging thrusts, a more typical Laramide orientation. Little structural relief is present north of Billings. Minor fault and slickenline orientation data were collected from several units around the northern edge of the range. Slip directions were determined using Riedel fractures and fibrous calcite growth, and paleostresses were determined using the Compton ideal stress method. Kinematic data from over 900 minor faults around the northern plunge of the Bighorn arch indicate a compression direction of 065 in the northwest and 042 in the northeast, with no evidence of later extension. Surprisingly, 82% of minor faults in this region are strike-slip (46% dextral, 54% sinistral), unlike the central Bighorn arch where thrust faults make up over 50% of the minor faults, with an average compression direction of 057. On average, left-lateral faults strike 060-105 and right-lateral faults strike 010-060. The unusual dominance of strike-slip faults suggests a large zone of distributed left-lateral shear controlling the northern plunge. The contrast in compression directions between the NW and NE domains suggests an additional component of gravitational spreading, vertical axis rotation, and/or stress refraction. A proposed paleomagnetic investigation will test these hypotheses by determining vertical axis rotations.