HOW DOES METAMORPHIC FABRIC CONTROL EARTHQUAKE RUPTURE PROPAGATION? AN NSF REU FIELD STUDY

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Abstract

The earthquake barrier model provides a framework for understanding fault propagation and geometry, but it is unclear what geologic features may act as earthquake barriers in natural systems. Observations of pseudotachylyte-bearing faults in the 25-km-long Homestake shear zone (HSZ) fault system suggest metamorphic fabric plays an important role in impeding or promoting earthquake rupture. We use high resolution UAS-derived orthophotographs to generate maps with remarkable detail of fault and country rock fabric geometries. Country rock in the HSZ consists of folded gneisses and schists showing variable degrees of transposition into a dominant NE trending foliation. Field mapping defined two fabric domains, one with fully transposed host rock and a second with partially transposed host rock and foliation oblique to the pseudotachylyte-bearing faults in the shear zone. Injection veins and damage zones show a pronounced asymmetry on dextral faults indicating a northeast-directed rupture propagation. Field observations also indicate that ruptures frequently terminate in the oblique fabric domains. Earthquake barriers are known to slow or stop rupture propagation. To evaluate the influence of foliation on rupture velocity, we employ methods based on experimental results that show a relationship between injection vein divergence angle and fault roughness to slip velocity. This study was conducted through an NSF Research Experience for Undergraduates (REU) program using largely open source tools including StraboSpot2 and Strabo Tools to collect and compile detailed observations keyed to digital outcrop images and QGIS to analyze our UAS photogrammetry image orthorectified using Agisoft Metashape.

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