BRIDGING THE GAP USING ALSM DATA AND INVERSE THEORY TO CONSTRAIN MODELS OF THRUST FAULTING AND FOLDING AT RAPLEE RIDGE, UT

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Constitutive equations relate kinematic quantities (strain or rate of deformation) and kinetic quantities (stress), thereby defining the mechanical behavior of rock. Used, for example, to eliminate stress from the equations of motion, constitutive equations facilitate solutions to initial and boundary value problems that model tectonic processes and their structural products with a complete mechanics. A common criticism is that the loading conditions and constitutive behaviors of rock during ancient tectonic events are not known, so mechanical modeling often is too ill constrained to be useful. We show how inverse theory may be used to deduce loading conditions and constitutive properties for such events using Airborne Laser Swath Mapping (ALSM) data to accurately define the geometry of folded strata at Raplee Ridge in southeastern Utah. This fold has been interpreted as forming due to slip on an underlying blind thrust fault during Laramide contraction. The fold is roughly monoclinal in cross section with a width of ~3 km, length of ~14 km, and amplitude of ~0.5 km. The fold geometry was used to infer the fault geometry, tectonic strain loading conditions, and Poisson's ratio based on linear elastic models. Monte Carlo Markov-Chain methods provide probability density functions that reveal the most likely fault geometry, loading conditions, and Poisson's ratio along with their uncertainties. Because displacements scale inversely with the elastic shear modulus, we cannot

uniquely infer the shear modulus and remote stress. Poisson's ratio, on the other hand, does create spatially varying differences in the calculated displacements and can be deduced. Despite restrictive assumptions of this simple model (homogeneous linear-elastic half-space), the deflections of the strata are matched remarkably well. We propose that similar methods may be used with models that include more complicated constitutive laws as well as more realistic heterogeneous and anisotropic material properties to approximate the sedimentary sequence and basement rocks at Raplee Ridge and elsewhere. This methodology opens the door for using modern high-resolution data sets such as ALSM and a complete mechanics (of which kinematics is an integral part) to model tectonic processes.