Geomechanical Model For Multiply-oriented Conjugate Deformation Bands

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A unique suite of three superimposed systems of conjugate deformation bands (very thin shear zones) is present in Jurassic sandstones in the southeastern corner of the San Juan basin, northwestern New Mexico. Temporally, the first set of conjugate bands has the normal fault orientation, the second set has the strike slip orientation, and the third and final set has the thrust fault orientation. Deformation bands are important for at least two reasons. First, they often have lower porosity and permeability than the host rock. Second, they are coherent shear strain features and when sense of shear can be determined they have uniquely associated stress orientations. This last feature, allows them to be used with confidence for the reconstruction of the paleostress field orientation. The superposition of 3 such systems of bands would highly compartmentalize a reservoir. A geomechanical model was developed to explain the superimposition of the three systems of conjugate bands. The model is comprised of assumed boundary condition history and a failure condition. Boundary loads change in response to increasing depth of burial and to increasing tectonic loading consistent with the surrounding large-scale structures. The principal axes of the stress tensor are predicted to remain coaxial, but to change in relative magnitudes. This causes the orientations of the band systems to change, from one fault style to the next, discretely in time rather than continuously as would be predicted by some type of posited continuous farfield stress rotation. This model may be applicable to fractures as well as deformation bands, thus solving the problem of having continuous rotation of farfield stress but only discrete sets of fractures.