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Evolution of Structural Damage—Role of Geomechanical Simulations

As structural traps develop, they acquire a wide range of imposed material discontinuities and surfaces onto which strain is localized. Each such feature has petrophysical properties that will often be considerably different from those of the ''undeformed'' host rock. Predicting these features is one of the big challenges of modern reservoir evaluation. This paper illustrates how geomechanical simulation can improve our understanding of such features, thereby reducing the uncertainties of reservoir characterization and management. The example used for illustration involves the flexural process, where folding of a sequence of rock layers creates spatio-temporal heterogeneities in the resulting deformation. This progressive evolution of damage – and variations that depend on factors like lithological differences, the operation of bedding-plane slip, and the viability of different deformation mechanisms – leads us to develop a process model for flexural-slip folding. Modern geomechanical simulation tools, using material descriptions that produce localizations that are strikingly like faults, allow us to examine the factors that influence the distribution of damage. Natural, experimental, and numerical models of this process each produce a comparable deformation response, suggesting that the mechanical system is appropriately conceptualized by the process model. Using information about how petrophysical properties evolve with deformation, such geomechanical models enable us to develop flow simulations. These can then be used within the current approaches to uncertainty quantification to address the role of structural damage.