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Application of Discrete Fracture Network Models to Coalbed Methane Reservoirs in the Black Warrior Basin

Landowner concerns related to coalbed methane operations in the Black Warrior basin of Alabama include contamination of shallow sources of domestic groundwater by hydraulic fracturing and drawdown of shallow groundwater by withdrawal of water from deep coal zones. Although no claim of contamination or drawdown has been substantiated, new regulations intended to address these concerns have placed a hardship on gas producers. To help determine if coalbed methane operations can affect shallow aquifers, we are developing discrete fracture network flow models of coal-bearing strata in the Black Warrior basin using FracMan software.

Discrete fracture networks are stochastic models of fracture architecture that incorporate statistical scaling rules derived from analysis of fracture length, height, spacing, orientation, and aperture. Once a structural model is built, hydrologic data can be incorporated, and flow solutions can be obtained using a finite element method. Basic data on fracture systems in coalbed methane reservoirs of the Black Warrior basin were derived from core and outcrop, and hydrologic data were obtained from well records. These reservoirs contain orthogonal joint and cleat systems, as well as normal faults and fault-related shear fractures. The orthogonal fractures are mainly stratabound, thus hydrologic connections between beds are mainly near the tip regions of the fractures. Aperture width in sandstone and shale obeys a power-law distribution. This distribution dictates that flow is concentrated in relatively few fractures and that connectivity among beds is limited. Therefore, the possibility of contamination or drawdown of shallow aquifers by coalbed methane operations is remote.