Hydrologic Modeling of Faults in Unconventional, Coal Seam Gas and Mining Projects

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Abstract

Coal mining and coal seam gas developments may impact near-surface groundwater assets such as groundwater-dependent ecosystems, riparian zones, springs, or wetlands. Faults can form clear and tangible flow paths between subsurface developments and groundwater assets.It is vital to recognize that faults are neither singularly sealing nor singularly leaking. Instead, they are a patchwork of cross-fault juxtapositions and fault rock types. Variations in the rock-mass either side of the fault control the fault rock core and damage zone composition, continuity and thickness. Thus to estimate the reduction of permeability across a fault or the enhanced fracture flow parallel to a fault an Allan Map (fault-parallel, cross-section view) may be required. Within Environmental Impact Statements for coal-related developments, there is commonly an insufficient characterization of faults. Advice to Australian government since 2013 shows that more than half of proponents are asked to provide additional justification for their modeling of faults.A conceptual groundwater model is proposed to allow proponents of developments to describe, characterize and stochastically calculate the potential impact of faults on assets.When considering the possible effects of faulting, there are two key aspects that need to be characterized. These are 1) accurate prospect and near prospect scale fault and aquitard geometry, and 2) characterization of the aquifers, aquitards and the fault zone materials. Based on these data, the hydrogeological behavior of any fault-related flow paths between the development areas and groundwater assets can be comprehensively assessed.There are a few summary development scenarios that present specific risks involving coal, faults, and groundwater. Some developments will fall outside of these scenarios, but these scenarios

can still form a framework for comparative risk analysis. The three cases are: 1) One/or many aquitards are thicker than the throw on any faults separating development from an asset. 2) A stack of aquitards and aquifers connects the seam via fault juxtaposition to the asset. 3) There is no significant aquitard separating the development and asset. Additional complexity can result from anthropogenic differential subsidence, particularly in cases where there are thin aquitards and perched aquifers. Typical flow pathways that could connect development with groundwater assets include flow along faults in a fault damage zone, flow across faults (potentially impeded by fault zone rocks), and flow through aquifers and across aquitards. Cross fault flow and flow through aquifers can be effectively modeled or estimated using a Darcy Law treatment, whilst fractured aquifers, and fault damage zones (within aquifers) can be modeled or estimated using Discrete Fracture Network codes based on Snow's law.

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