Geophysical Research Abstracts
Vol. 18, EGU2016-4038, 2016
EGU General Assembly 2016

A Double-Porosity Model for Pumping Test in a Fractured Formation of a Large Dip Angle

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A Cenozoic sandstone fractured formation is found to have a dip angle, θ, as large as 47 degree. Assuming the dip angle creates a uniform regional flow in the fractured formation, the flow field due to pumping is no longer radially symmetric with respect to the pumping. Instead, a capture zone will appear in the neighborhood of the pumping well. A double porosity model is developed for the problem of interest, where the matrix flow is taken into account by the distributed parameter approach. Neglecting fracture storage, there are three hydrogeological parameters in the model; namely, fracture transmissivity T_f, matrix hydraulic conductivity K_m, and matrix storage coefficient S_m. A Laplace-domain solution is determined, and its large time asymptotic solution analytically inverted, which indicates that the drawdown variation of large times exhibits a straight line in a semilog plot. When the dip angle is known, the slope of this straight line can be used to determine T_f, and the intercept of the logarithmic time axis can be used to estimate S_m. The remaining K_m can be uniquely determined by the curve-matching method for drawdown of small and intermediate times without difficulty. The larger the dip angle, the closer the stagnation point to the pumping well, and the smaller the capture zone. An overestimate of T_f by a factor of $\cos\theta$ results if the dip angle effect is neglected. However, neglecting the dip angle has less effect on the estimates of K_m and S_m.