RESERVOIR FLOW MODELLING INTEGRATING THE COMPLEX GEOMETRY OF NATURAL FRACTURE SYSTEMS

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In order to develop a methodology for reservoir flow modelling that takes into account the complexity of natural fracture systems in reservoirs, high-quality fracture datasets were first collected at different scales in a well-exposed clastic formation at Tayma, Saudi Arabia. Using this information a multiscale fracture model, incorporating large-scale faults and medium- to small-scale fractures (joints), was conceptualized and numerically simulated. Flow modelling was then conducted for three scales of permeability within the multiscale fracture organization; namely matrix, joint and fault permeabilities. The model results show that flow tends to become directional when joint permeability is one order of magnitude higher than matrix permeability. On a local scale the maximum directional flow is always horizontal, fluctuating along a NW-SE direction, which is the direction of the systematic joint set. Vertical flow is only possible where joints and bedding planes have permeability ratios between 0.1 and 10 to 1. An attempt to upscale the flow properties of the model to simulate the entire reservoir was made by combining the flow properties of the jointed matrix with those of the large-scale fault system in a dual-permeability system. Faults were modelled explicitly and the jointed matrix was represented by an equivalent permeability tensor. Simulation of a pumping well illustrates the hydraulic response of the multiscale fracture system according to different permeability ratios between faults and jointed rock matrix. The influence of the fault system begins to be visible at a permeability ratio of 100 to 1. At a ratio of 10,000 to 1, the hydraulic potential field is controlled by the fault system, fault planes becoming isopotential lines of the hydraulic field. This multiscale fracture flow simulation procedure, which combines the hydraulic effects of small- to medium-scale fractures and large-scale faults, could be very helpful in predicting flow responses in dual-permeability reservoirs.