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Role of discontinuities on hydro-mechanical properties of shale caprock overlying steam assisted gravity drainage

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Steam assisted gravity drainage (SAGD) is used in Alberta to stimulate immobile bitumen to produce it from oil sands. The caprock is ultimate seal of bitumen that can effectively withstand stresses and strains induced from SAGD processes throughout life of reservoir. The caprock here is soft and heterogeneous. It is comprised of mudstone, shale and silt facies from clear water formation. Assessing caprock integrity is a challenging operational problem in any SAGD project. With increased heating and as steam chamber grows, caprock heaves. In past, there have been multiple documented steam and bitumen leaks. The objectives of this research include demonstrating importance of capturing shale caprock anisotropy via considering effect of natural discontinuities in the accurate determination of an equivalent continuum. The research aims to highlight fundamental role of discontinuities on hydro-mechanical properties of fractured caprock. It focuses on illustrating how discontinuities affect caprock deformability and its seal/flow characteristics. Research methodology includes fundamental characterization of clear water shale geological framework using in situ data captured by Light Detection and Ranging (LiDaR) technique. Numerical simulations have been carried out using 3D Distinct Element Code (3DEC). The index parameters needed were determined from laboratory testing. Preliminary results of an analysis comparing continuum versus discontinuum modeling illustrated the crucial role the discontinuities play in precisely determining the magnitude of uplift of caprock above SAGD. Neglecting discontinuities can result in an underestimation of heave value and overestimation of flow-resistance characteristics of caprock. New practical addition of this research is inherent in generating a fundamental integrated workflow that can be conveniently followed to build a geomechanical model from geological *in situ* data. The novel contribution of this research to the oil and gas industry includes studying a 3D DEM of a deterministic DFN of caprock.

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Current status and future technical orientation of tight gas development in China

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Tight gas plays an important role in natural gas of China. After about 15 years exploration and development, the original reserves and explored reserves of tight gas have been proven to be in large scale. It has fulfilled the beneficially development in Ordos basin, Sichuan basin and Songliao basin and the total production has exceeded 30 billion cubic meters, accounting for about 1/4th of total natural gas production of China. In this paper, geological characteristics of China's tight gas reservoirs are systematically analyzed, which are divided into three kinds: Multi-layered stacked lenticular reservoir, layered reservoir and massive reservoir. Meanwhile, it is more complicated for tight gas development in China than that in the United States or in Canada through the comparison of reservoir geological characteristics. As the first large-scale used unconventional natural gas in China, tight gas development is benefit from engineering and technology based on its own geological characteristics, including high-quality reservoir prediction and well placement optimization, low-cost and fast drilling technology, large well group-multiply well group-factory operating pattern drilling technology, stimulation technology, underground restriction and low pressure transmission, water drainage technique and digital management. Even though shale gas develops fast and is scaled used, it faces with the general problem of low recovery at the same time, just around 35%. Therefore, enhance gas recovery rate has become the key issue now and in the future. Taking Sulige gas field, the largest natural gas field in China for example, four kinds of technical methods, reasonable allocation of well production, water drainage technique, old well lateral drilling and well pattern infilling are introduced to increase gas recovery efficiency. The series of techniques can also provide reference for the same kinds of reservoirs to guarantee stable and beneficial development in long term.

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