Qualitative modeling of etch-pit formation (dissolution) on the K-feldspar surface through phase-field approach

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Feldspar dissolution is a widespread occurrence in clastic bedrock reservoirs in petroleum-bearing zones, and it has a serious influence on reservoir quality [1]. This present study demonstrates a diffused modeling strategy, namely the phase-field method, for addressing the phenomenon of dissolution of the (001) K-feldspar (Orthoclase) surface, which happens with the development of diamond shape etch pits in two and three dimensions. The [100] and [010] axes are parallel to the etch pit diagonals, and similarly the pit boundaries are present laterally to the (6 5 6), (6 5' 6), (6' 5 11), and (6' 5' 11) planes [2]. On the (001) surface, the size of the etch pits and the global surface retreat have been observed to rise linearly with the passage of time. A thermodynamically consistent phase-field model was devised to account for anisotropies in surface energy and kinetic mobility associated with diamond-shaped etch pits that occur during dissolution. The proportional growth parameters of a pit morphology were calibrated using the values found in literatures. There are two novel elements to this work: (I) 3D-Modeling of diamond etch-pit development on orthoclase (K-feldspar) surfaces in a bi-crystalline and multigrain system, and (II) identifying growth patterns of these pits to better understand and remark on their impact on sandstone's porosity and permeability. Additionally, the findings of the porosity study enabled us to evaluate the development of porosity in a sandstone pack through time as a consequence of partial and total orthoclase crystal dissolution. Simultaneously, the permeability study was performed using a fluid-flow simulation via a polycrystalline grain pack, which validates the fundamental notion of the implications based on K-feldspar dissolution. The offered prescription may qualitatively forecast dissolution processes in diverse crystal-liquid geological systems [3].

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