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Experimental Modeling of Dissolution Rule and Porosity Evolution of Carbonate Rocks and Its Significance

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ABSTRACT

Oil exploration shows that dissolution porosity is the significant reservoir space type for carbonate rocks. Some authors propose that significant volumes of porosity are created by deep-burial dissolution. Others argue that this model is unsupported by empirical data and violates important chemical constraints on mass transport. In addition, previous studies focused on finding out the relationship between carbonate dissolution quantity and temperature and pressure, but ignored the evolution of pore structure and change of porosity and permeability, therefore, it is necessary to study dissolution patterns of carbonate rocks by experimental stimulation. In this study, hydrothermal flow experiments of single-pass injection of acetic acid were conducted on 60 carbonate cores to examine fluid-rock reactions in carbonate reservoirs under burial conditions. Pre- and post- experiment porosity-permeability measurement and pore structure construction by CT were conducted and compared. The porous dolostones with network pores were enlarged overall, pore volume and permeability increased accordingly, and the increased pores were mainly matrix pores; for porous limestones, after dissolution, although pore volume and permeability all increased significantly, favorable for the improvement of reservoir quality, but the increased pore spaces were relatively concentrated in fractures and caves; for fractured-porous dolostones and fractured limestones, dissolution led to the permeability increase of 2-3 orders of magnitude, but the increased pore volume was limited, and the main pore spaces increased were fractured pores. Under the condition increased from 30°C, 5MPa to 187°C, 60MPa, the sum of Ca2+ & Mg2+ concentrations of outflow fluids of carbonate rocks decrease from 21.58×10-3 mol/L to 8.90×10-3 mol/L. The dissolution quantity of porous dolomite decreases continuously and steadily to about 20% finally; while the dissolution quantity of porous limestone decreases slowly at first, then fast, then slowly and steadily, by more than 50% finally. Finally, conclusions are summarized: (1) Relatively shallow burial environment is more beneficial to the formation of carbonate scale dissolution pores; (2) Open system is of crucial importance in the development of large-scale dissolution pores; (3) The dissolution patterns of carbonate rocks are controlled by lithologies, pre-existing pore structures.