Quantitative Simulation of Sandstone Porosity Evolution Accounting for Compaction and Unloading

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Abstract

Knowledge of porosity evolution is essential for burial history analysis and paleopressure prediction in sedimentary basins. Nowadays porosity evolution is mainly focused on the qualitative study in terms of the relation between porosity and depth, pressure, temperature, neglecting the impact of burial time and the quantitative simulation of porosity evolution during the process of compaction and unloading. Based on the integration of Bingham model, we propose a new model for porosity - burial depth and burial time, simulating the dynamic sandstone porosity evolution accounting for compaction (i.e.,φ=φ0e(aZ+bt+cZt), where φ0 is porosity in the mudline, φ is porosity in the compaction/loading case, Z is burial depth, t is burial time, a, b, c are constants). In addition, field data in several representative petroleum basins and are analyzed and verify the theoretical relationship between sandstone porosity and burial depth, burial time, also the lab experimental data from simulative compaction of sandstone prove that porosity and burial time have an exponential relationship like burial depth. This model leads to a new understanding of the impacts of burial depth and burial time on porosity evolution accounting for compaction, and a new method for restoring the paleoporosity geological history. In the unloading case, filed data and lab experimental data verify that the formation unloading from maximum burial depth causes a different path compared to compaction/loading curve of porosity and burial depth, burial time, resulting in the different compaction constants with the loading case. The model for porosity - burial depth and burial time accounting for unloading is also proposed (i.e.,φ'=φ0'e(a'(Z'-Z) +b'(t-t')+c'(Z'-Z)), where φ0' and t' are porosity and burial time of maximum burial depth, φ' is porosity in unloading case, Z' is maximum burial depth, a', b', c' are constants).