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Implication of Carbonate Dissolution Dynamics based on Multifractality of microstrures on Rock Surfaces

Shuyun Xie (1), Zhiliang He (2), Yang Fang (1), Yin Liu (1), Dianwei Zhang (2), and Zhengyu Bao (1)

(1) Faculty of Earth Sciences, China University of Geosciences, Wuhan 430074,China (tinaxie@cug.edu.cn), (2) Exploration & Production Research Institute, SINOPEC, Beijing 100083

It is of great significance to study the dissolution kinetics of carbonate rocks for evaluating the microstructures of the rocks and the potential of the reservoir. Dissolution potential and the effects of carbonate dissolution rates can be evaluated from quantitative descriptions of geomographical rock surface roughness. And the carbonate dissolution difference can be quantitaively characterized by the multifractality of element distribution patterns on thin-section surfaces. The present study therefore aimed to apply the method of moments to obtain multifractal parameters to measure dissolute carbonate rock surface roughness and the element distribution patterns on thin-sections, and then to assess the dissolution degree of different rock samples. Based on the interpretation of grey scales of ESEM micro-topographic shadows, this new procedure is primarily designed for use in the analysis of rock surface geometry after acid dissolution. The principle is based on the direct relationship between rock surface roughness and the shadows cast by rock micro-structures under fixed color conditions. The parameters obtained with multifractal analysis were compared to the dissolution rates of the carbonate rocks based on dynamic dissolution experiments. The tests were conducted on carbonate rocks collected from Sichuan and Xinjian Basins from China and their ESEM photographs before and after the chemical dissolution. The highly significant correlation between the rough surface multifractality and the dissolution rate shows well that rock surface geometry may affect the dissolution processes to a certain degree. The fractal and multifractal analysis indicates that the dissolution process is controlled by differences between the element distribution heterogeneity of Ca,Mg and Si. The reaction surface heterogeneity of oolitic limestone with high Ca content and low Mg content is weak, while the heterogeneity of oolitic dolomite with low Ca content and high Mg content is strong. Additionally, large difference of composition, strong heterogeneity of elements distribution can promote the dissolution reaction. Such kind of study may provide new insights into the study of carbonate dissolution dynamics and will be helpful for carbonate reservoir assessment.