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Constructing 3D Geological model with modified multiple-point statistics algorithm

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As a tool for presenting spatial distribution of geological bodies, three dimensional geological models have become essential fundamental factors of natural resource management and risk estimation. At present, deterministic modelling and stochastic modelling are two main approaches to construct 3d geological models. A unique model with deterministic topology and spatial distribution could be constructed by deterministic approaches. Stochastic modelling can be regarded as the summation of deterministic model and random characteristics. The random characteristics remedy the defect of unique result of deterministic modelling in that the random characteristics reflect diversity of geological phenomena. However, stochastic modelling based on two-point statistics cannot solve the problem of spatial structure thoroughly. Approaches based on multiple-point statistics (MPS) utilize the spatial structural relationships among multiple points and provide multiple simulation results. In the past two decades, multiple point statistics has been improved in algorithm optimization and been applied in many fields such as image process, time series analysis, weather simulation and oil and gas reservoirs simulation [1-3].

Error accumulation during simulation process could seriously impact final results in those multiple point statistics algorithms with local optimization. Therefore, by using geological cross sections as training images, this study proposed a modified algorithm for multiple point statistics in constructing geological models. A global optimized simulation algorithm for MPS termed as GOSIM has advanced in 3D simulation, which can be applied for simulation of continuous data, categorical data and 3D images [4]. Notice that 3D images are used as training images in 3D simulation with the GOSIM. In geological modelling, 2D geological cross-sections are treated as an important kind of input data as this study does. This study focuses on overcoming the shortcoming of the GOSIM. Geological cross-sections in two dimensions are rasterized and coded each cell with property of lithology. Therefore, patterns are extracted from bounding geological cross-sections instead of one training image. In order to keep the consistence of strata, we need to compare stratigraphic position the pattern with the stratigraphic sequence. With concrete example of 2D geological cross-sections in Foshan city, Guangdong Province, China, simulation results show right stratigraphic sequence, similarity of stratigraphic shape and continuity with training image. The results with different parameters testing show that the shape and continuity of strata are positively related with geological cross-sections. The stratigraphic sequence in results will be disorder if the pattern size is too small. When pattern size is too large, results are difficult to keep consistent with constraint data. Simulation results become smooth when weight value of constraint data decrease.

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