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Application of a Training-Image Library to Reservoir Modeling Using Multi-Point Statistics Based on Quantitative Fluvial Facies Characterization

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ABSTRACT

Facies modelling seeks to reproduce the geometry and distribution of the reservoir-forming sedimentary bodies in three dimensions to provide a framework for the construction of property and flow models. However, variogram-based facies modelling techniques are not well suited to the reproduction of complex geological shapes (e.g., sinuous fluvial channels), whereas object-based simulations may fail to honour conditioning data (e.g., well data). New workflows have been developed for the generation of fluvial reservoir models with improved geological realism compared to outputs of conventional methods. These workflows are suitable for modelling reservoirs that comprise fluvial meander-belt deposits, and can therefore provide the models of spatial heterogeneity (training images) required to apply simulation techniques based on multi-point statistics (MPS), which are then useful to integrate complex geological patterns. A library of training images from which MPS modelling algorithms replicate geological patterns has been developed using quantitative information derived from a relational database of geological analogues (Fluvial Architecture Knowledge Transfer System, FAKTS), and a forward stratigraphic modelling tool that simulates fluvial meander-bend evolution and resulting point-bar facies organization (PB-SAND). The devised training images incorporate fundamental features of the facies architecture of fluvial point-bar elements and larger meander belts composed of these and related elements. The application of training images has been optimized to three widely used MPS algorithms: SNESIM, DEESSE and FILTERSIM. A quantitative and qualitative quality check of MPS realizations has been performed whereby facies proportions, facies relationships, element geometries, dimensions, control of non-stationarity and runtime are optimized for particular fluvial successions being modelled. The sensitivity of multiple simulation results to input parameters has been analysed to define preferred modelling recipes, paired to each training image and to each MPS modelling algorithm. Research outcomes are the development of an extensive library of training images for MPS simulations of the architecture of subsurface successions deposited by a variety of types of meandering fluvial systems. Devised workflows are applicable to multiple MPS algorithms, and enable off-the-shelf training-image selection for the effective establishment of a hierarchical approach to facies modelling.