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Explicit inclusion of connectivity in geostatistical facies modelling.

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Irrespective of the specific technique (variogram-based, object-based or training image-based) applied, geostatistical facies models usually use facies proportions as the constraining input parameter to be honoured in the output model. The three-dimensional interconnectivity of the facies bodies in these models increases as the facies proportion increases, and the universal percolation thresholds that define the onset of macroscopic connectivity in idealized statistical physics models define also the connectivity of these facies models. Put simply, the bodies are well connected when the model net:gross ratio exceeds about 30%, and because of the similar behaviour of different geostatistical approaches, some researchers have concluded that the same threshold applies to geological systems.

In this contribution we contend that connectivity in geological systems has more degrees of freedom than it does in conventional geostatistical facies models, and hence that geostatistical facies modelling should be constrained at input by a facies connectivity parameter as well as a facies proportion parameter. We have developed a method that decouples facies proportion from facies connectivity in the modelling process, and which allows systems to be generated in which both are defined independently at input. This so-called compression-based modelling approach applies the universal link between the connectivity and volume fraction in geostatistical modelling to first generate a model with the correct connectivity but incorrect volume fraction using a conventional geostatistical approach, and then applies a geometrical transform which scales the model to the correct facies proportions while maintaining the connectivity of the original model. The method is described and illustrated using examples representative of different geological systems. These include situations in which connectivity is both higher (e.g. fluid-driven injectite or karst networks) and lower (e.g. many depositional systems) than can be achieved in conventional geostatistical facies models.