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Please fill in your abstract title.	Modelling Facies Cyclicity and Diagenesis with Geostatistics

Please fill in your author name(s) and company affiliation.

Given Name	Surname	Company
Thomas	Le Blevec	Imperial College London
Olivier	Dubrule	Total and Imperial College London
Cedric Michael	John	Imperial College London
Gary	Hampson	Imperial College London

Abstract

Geostatistical methods such as object-based models, indicator simulations, pluriGaussian simulations or multi point statistics have proved successful for modelling geological heterogeneity. However, these techniques are usually not capable of accounting for the fact that commonly strata are cyclical and that facies successions in these cycles are asymmetric, in the sense that they differ in upward and downward directions. Another issue is that of modelling diagenesis, particularly in carbonate strata. Diagenesis may conform to depositional stratal patterns or cut across them. Here we present and test an extension of pluriGaussian (PGS) simulations, which addresses the issue of cycle asymmetry and diagenesis modelling.

The standard PGS approach consists of modelling a three-dimensional facies distribution by first simulating two Gaussian variables, then applying thresholds to each of them, according to a truncation diagram, in order to obtain a facies field realization. An extension of this method has also been proposed to model diagenesis. Although PGS has been applied with some success to shallow-marine siliciclastic and carbonate reservoirs, it cannot model asymmetric facies cycles in its standard form. By using transiograms rather than variograms, we have developed a new Shifted PGS (SPGS) approach for modelling asymmetric facies cycles using facies transition probabilities as constraints. By introducing a third Gaussian variable in the SPGS, we also developed an extension of SPGS to model diagenesis.

The method is tested on shallow-marine carbonate and siliciclastic datasets. The first dataset is from the Triassic Latemar carbonate platform of northern Italy, which is characterised by vertical asymmetric facies cycles of somewhat variable lateral extent. Four depositional environments (subtidal; intertidal; supratidal; subaerial exposure) and two overprinting diagenetic facies (dolomitic crust; partial dolomitization) have been modelled. The second dataset is from the Cretaceous Blackhawk Formation, exposed in the Book Cliffs (Utah), which consists of shallow-marine, wave-dominated shoreface sandstones. Three depositional facies are present in upward-shallowing facies successions (distal lower shoreface heteroliths and offshore mudstones; proximal lower shoreface sandstones; foreshore and upper shoreface sandstones). The distribution of depositional facies is non-stationary, and varies systematically from proximal to distal. There are also two diagenetic facies (carbonate cement; leached “whitecap” sandstones), which record early diagenetic redistribution of carbonate material. In both cases SPGS is superior to PGS and most other geostatistical methods and proves capable of successfully representing facies cyclicity and syn-sedimentary diagenesis, respectively in a stationary and non-stationary context.

The new geostatistical facies modelling approach presented here addresses a limitation of standard geostatistical techniques. By properly representing asymmetric facies cyclicity and diagenesis in a stationary (Latemar platform carbonates) and non-stationary (Book Cliffs shallow marine sandstones) context, it proves its potential for generating much more realistic geological earth models.