V023 DEALING WITH THE GEOSCIENTIFIC SCALING PROBLEM — AN OBJECT-ORIENTED APPROACH

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Introduction

Up- and downscaling of geoscientific information represents one of the major challenges in characterising reservoirs. The scaling problem originates from the fact that various types of data and knowledge becomes available during the life cycle of a field. Information with widely varying scales and accuracies is gathered from 0 to 4 dimensions (e.g. core-plug, well log, 2D seismic line, 3D seismic volume, time-lapse seismic). All available information needs to be integrated in order to arrive at consistent results on which economic decisions can be made with confidence.

To relate information from one scale level to another it is imperative that a hierarchical ordering in the geological setting is identified. The ordering facilitates correlations and enables qualitative and quantitative descriptions of rock units at the desired degree of detail. However, in sedimentary geology the hierarchical organisation of rock units is not unique. An overview of some forms of hierarchical systems is given in Table 1.

Table 1.
Hierarchy of rock units in sedimentary geology. After Reijers et.al., 1993.

Observational / Descriptive Units				Interpretation	
Lithostratigraphic Unit ⁴	Stratal Units		Lithofacies Unit ⁵	Sedimentary depositional feature	Examples
<div><div>bed</div><div>member</div><div>formation</div><div>group</div></div>	lamina horizontal and foreset ¹	lamina ³	lithofacies	depositional event	avalanche
	bed ¹	lamina set ³		depositional process	migrating sand wave
	simple bedset ¹	bed ³			
	composite bedset ¹	bedset		lithofacies association	sub-environment
	Parasequence		family of lithofacies associations	major-environment	alluvial plain
	Parasequence set		suite of lithofacies families	supra-environment	continental
	Sequence				

- ¹ Reineck & Singh, 1973
² Van Wagoner et.al., 1990
³ Campbell, 1967
⁴ Hedberg, 1976
⁵ Reijers et.al., 1993

In this paper an object model for integrating data and knowledge at different scale levels is described. The model has been implemented in a software portfolio in which any hierarchical ordering system as well as all properties and quantities of interest can be captured. Data described in the system can be manipulated at the natural scale levels identified by the geoscientist. Non-linear relationships between quantities of interest and geological objects can be established within the software portfolio a.o. with the help of artificial neural networks. The relationships are then

used to upscale the information to other natural levels in the hierarchy. Application examples will be presented in this paper.

Integration framework concept

The object model is implemented in a so-called integration framework. This is a generic description of the zone of interest in terms of framework units, Fig. 1. These are geological objects with attached physical properties (non-numeric) and quantities (numeric). The objects are defined at natural scale levels corresponding to a tree with nodes and leaves. Depending on the type of application objects can be defined from the basin-scale down to the pores and grains level. Each object is related to its parent and its children, hence to the hierarchical system.

Fig 1. Core objects and data items in the integration framework object model (OMT notation)

In the integration framework each object is given a user-defined reference name as well as a user-defined unit code (a mnemonic). In realisations of the integration framework geological objects are uniquely identified through unitIDs (unit identifiers). These consist of a concatenation of unit codes with unique occurrence numbers.

Applications

Examples will be shown of upscaling information via the integration framework concept. So far, the integration framework has been used in seismic interpretation studies for relating low(er) resolution seismic signals to high-resolution stratigraphic and well log information. Examples are conventional lateral prediction studies, seismic pattern analysis, feasibility studies, sensitivity analysis and testing seismic inversion algorithms (e.g. de Groot & Bril, 1996). It is also feasible to use the concept in rock physics and petro-physics applications, however. For example to establish empirical relationships between rock-sample porosities and well-log porosities, or between porosities and permeabilities.

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