MODELLING TURBIDITE RESERVOIRS USING OBJECT MODELS

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INTRODUCTION

Turbidites are deposits from tubidity currents, which are down slope movements of dense, sediment-laden water. The local geometry and orientation of the turbidites are therefore strongly controlled by local topographic variations. The local characteristics of the turbidite bodies make the facies modeling difficult. We use an object model for the facies model as described in Lia et al. (1996), but with new and very complex object geometry. The new objects are called backbone objects, and they are able to orient locally according to a vector field.

Another key feature of turbidity flows is the segregation of grain sizes within flows, which results in systematic spatial trends in petrophysical parameters. The trends are in three directions – proximal to distal and from axis to margin in lateral and vertical direction. The use of object model allows the trends to be preserved in the reservoir model. Petrophysical properties can be simulated separately for each turbidite body using Gaussian random fields in a coordinate system defined along the backbone.

DIRECTIONAL CONTROL IN OBJECT MODELS

In conventional object models, the orientation of the object is defined by a single direction. The direction is defined at the object's reference point, which can be located anywhere on the object. The object can not change direction according to local topographic variations. Therefore we introduce a new type of objects called backbone objects. Backbone objects have a flexible shape that can follow a vector field. They have a piecewise linear centre line, and the direction of each piece is conditioned to a local value of the vector field. The flexibility of the object, that is, how well the object follows the vector field, is determined by a stiffness parameter. The width and thickness of the object can vary along the axis.

GULF OF MEXICO EXAMPLE

We have used the object model with backbone objects to model turbidites in the Gulf of Mexico field shown in Figure….. The field contains six wells with facies log used for conditioning. The geometry of a typical turbidite is a long and elongated body. The width increases and then decreases distally, and the thickness decreases distally. The cross-sectional shape is lensoid. See Figure ….

The turbidite bodies should start in the same area and then spread out in the traditional fan shape. In order to focus the entry point of the objects, a point source intensity field is used. The intensity field has a high value in the starting area for the turbidites, and a very small value elsewhere. The reference point of the objects is placed at the starting end. When simulating from the object model, the object's reference point is placed according to the intensity field. The intensity field used in the Gulf of Mexico example is shown in Figure 1.

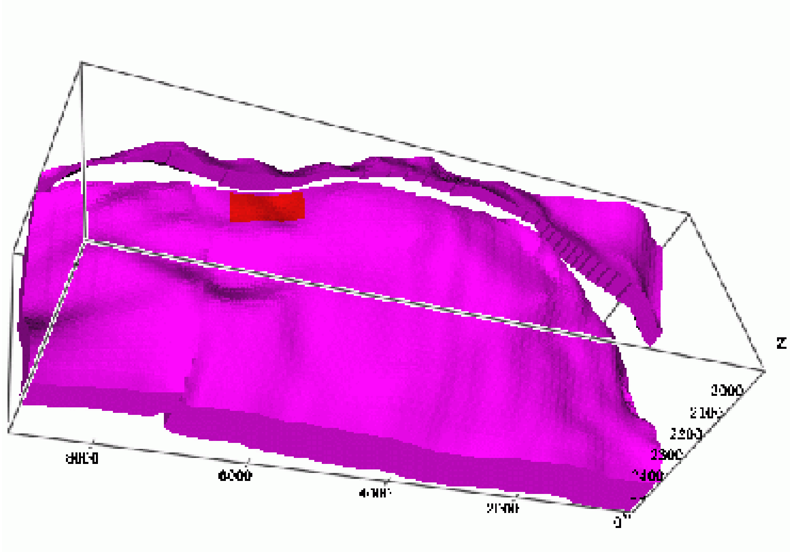

Figure 1 Intensity field. The high intensity region is shown in red.

The turbidite fan shape is taken care of by a vector field. Based on flow lines, which are constructed based on the isochore and geological knowledge, the vector field is created. See Figure 2.

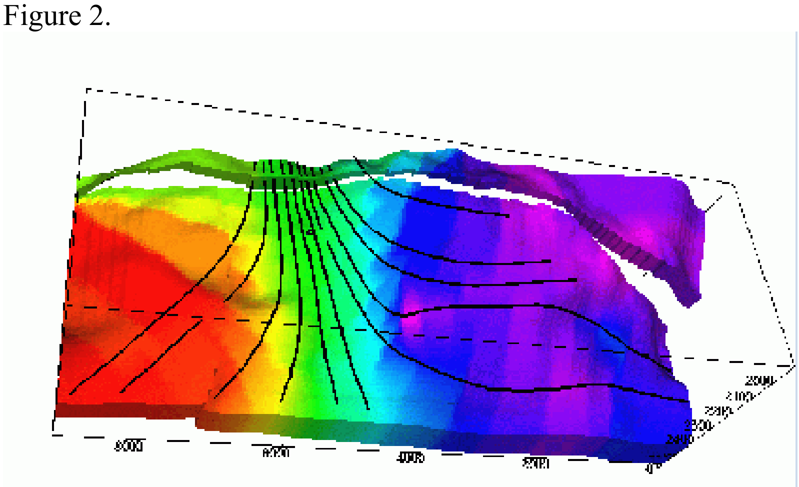

Figure 2 Vector field and flow lines.

In Figure 3 we see an example of a single simulated turbidite body. We recognize the characteristic shape of the body shown in Figure …, but we see that the body is deformed to follow the vector field. In Figure 4 we se a realisation of the whole reservoir, with about 30 turbidite objects. We see that most of the objects start in the same area, and are spread out in the characteristic fan shape. The realization is conditioned on the wells shown in the figure.

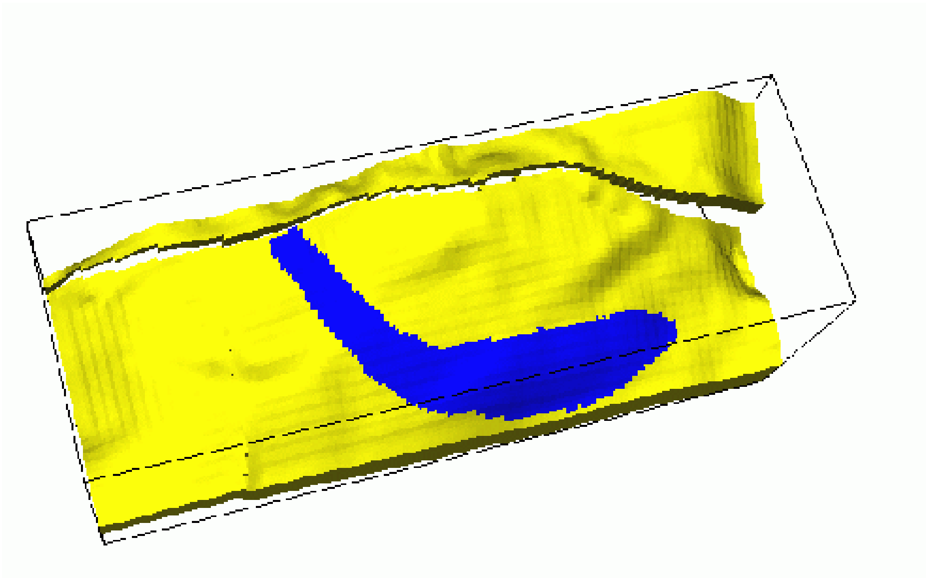

Figure 3 Example of turbidite body.

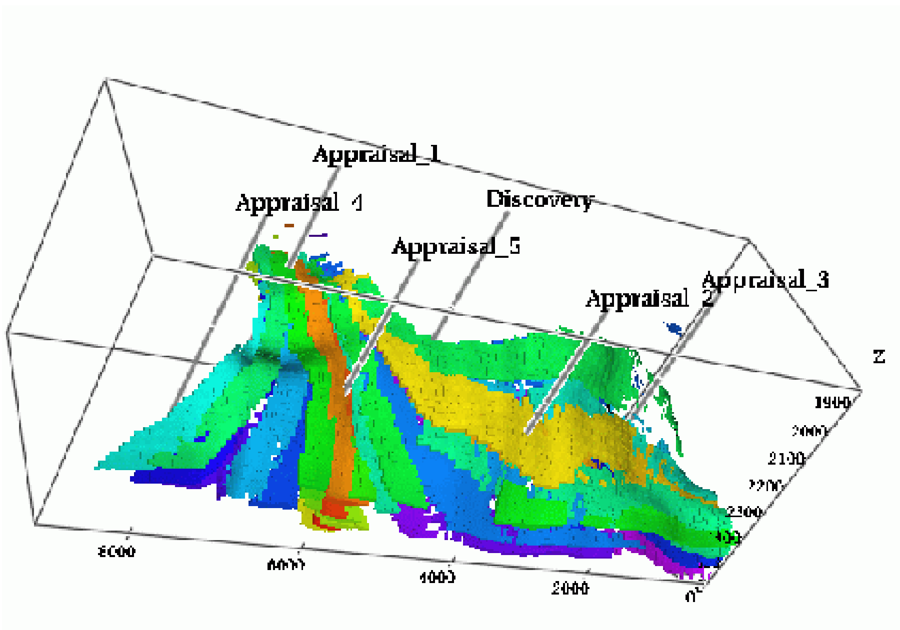

Figure 4 Simulated facies bodies.

Figure 5 shows a porosity realisation. Two of the intrabody trends are visible in the figure. We see the proximal to distal trend, and the axis to lateral trend. In addition we have a vertical trend, which is not visible in the figure.

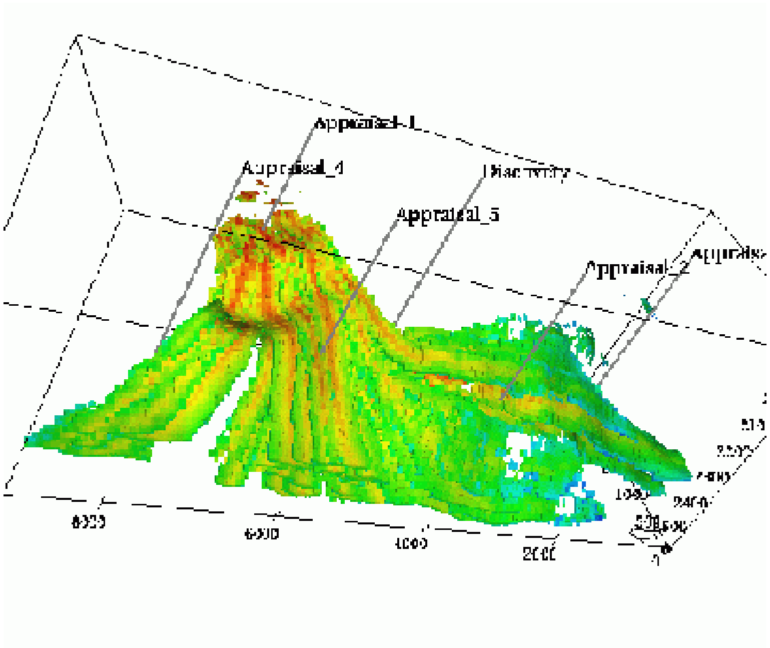

Figure 5 Porosity realisation. Red indicates high values, yellow, green and blue lower values.

REFERENCES

Lia, O, Tjelmeland, H, and Kjellesvik, L.E. (1996) Modelling of Facies Architecture by Marked Point Models. Geostatistics Wollongong'96. Kluver Academic Publisher.