

## F-32 DETECTION OF SEISMIC OBJECTS, THE FASTEST WAY TO DO PROSPECT AND GEOHAZARD EVALUATIONS

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### Abstract

A method for automated detection of seismic objects has been developed recently by Meldahl et al. (1998 and 1999). Initial applications included the detection of seismic chimneys and faults (Heggland et al., 1999 and 2000). However, the method, which uses a neural network to transform multiple 'directive' attributes into 'object probability' classes, has general applicability to detect a range of seismic objects. Application of the method to detect objects, such as reflectors, faults, chimneys, flat spots, traps, etc., which are normally mapped during a standard prospect evaluation, has revealed details not seen before and has led to new insights. Moreover, interpretation cycle time can be reduced drastically by applying the method. Examples of prospect evaluations and geohazard evaluations will demonstrate the potential of the method.

### Introduction

Prospect evaluations today involve interpretation of increasingly larger 3D seismic volumes, as well as use of multiple versions of the same volumes. The interpretation of such volumes is very time demanding and will normally take several months, even with more than one interpreter co-operating to perform the task. The new method developed for automated detection of seismic objects helps to reduce the cycle time drastically. The use of 3D data in geohazard evaluations has become an industry standard during the past ten years. The time span between approval of a well location and the planned spud date is often too small to allow for a proper geohazard evaluation. Automated detection of relevant seismic objects helps to release the time pressure and enables us to perform proper evaluations.

### Method

A neural network is trained to make classification of the seismic data into two groups, object and non-object. The detection is focussed on one type of object at the time. Multi-trace and multi-attribute calculations are performed on the input seismic data, in order to increase the contrast between the object and the background. The different attributes that are input to the neural network are weighted according to their contribution to the contrasting of the object. The attributes that give the highest contributions depend on the type of object that is selected for detection. As an example, the best attributes for the detection of seismic chimneys seem to be trace to trace similarity, energy (or absolute amplitude), which both generally are lower within chimneys than in the areas surrounding them, and the variance of the dip. The neural network is

trained on attributes extracted at object and non-object example locations identified by the interpreter. After training, the network is applied to the entire data set. In the chimney detection process, multiple vertical attribute extraction windows are used. This enables the network to distinguish between objects with a certain vertical extent and objects with similar attribute characteristics but ‘without’ a vertical dimension. In a similar manner the detection can be steered along the main directions of extent of any seismic object (Tingdahl, K. M., 1999).

The neural network finally makes a classification of the seismic data into object and non-object. The output samples are given high values for object (high probability) and low values for non-object (low probability).

## **Results**

Examples from prospect and geohazard evaluations illustrate how seismic object detection can increase the efficiency of the mapping of 3D seismic data.

For example, a set of reflectors can be detected in a single run by tuning the method to the detection of reflectors. Combining the detected reflectors with the detected faults provides a framework from which standard maps can be generated. Filling, or highlighting, the framework with detected objects like chimneys, flat spots, amplitude anomalies, structural and stratigraphic traps, will give sufficient information to perform an early prospect evaluation.

Examples of seismic object detection, like chimneys and faults, also show that a much better definition of the objects is achieved as compared with results from the use of other known techniques.

Figure 1 shows a 3D illustration with objects that can easily be detected by using the seismic object detection method. In this example the different objects have been visualized in a 3D-visualization environment. High amplitude clouds represent two prospects. The upper surface represents the seabed. Detected seismic chimneys tie in with faults visible on the lower surface. The chimneys may represent hydrocarbon migration through faults, between the two prospects and the seabed.

## **Conclusions**

The method of seismic object detection has proved to have potential to reduce the time needed to do prospect and geohazard evaluations drastically.

The use of the method has showed that the definition of seismic objects also has been improved as compared with the use of other known techniques.

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## References

- Meldahl, P., Heggland, R., de Groot, P.F.M. and Bril, A.H., 1998. Method of Seismic Body Recognition. Patent application GB 9819910.02.
- Meldahl, P., Heggland, R., Bril, B. and de Groot, P., 1999. The chimney cube, an example of semi-automated detection of seismic objects by directive attributes and neural networks: Part I; methodology, Expanded Abstracts of the SEG 69<sup>th</sup> Annual Meeting, Houston, Oct. 31 – Nov. 5, 1999.
- Heggland, R., Meldahl, P., Bril, B. and de Groot, P., 1999. The chimney cube, an example of semi-automated detection of seismic objects by directive attributes and neural networks: Part II; interpretation, Expanded Abstracts of the SEG 69<sup>th</sup> Annual Meeting, Houston, Oct. 31 – Nov. 5, 1999.
- Heggland, R., Meldahl, P., de Groot, P. and Aminzadeh, F., 2000. Chimneys in the Gulf of Mexico, *The American Oil and Gas Reporter*, Feb. 2000.
- Tingdahl, K. M., 1999. Improving seismic detectability using intrinsic directionality. M.Sc. Thesis. Göteborg University, Earth Sciences Centre, B194. ISSN 1400-3821.

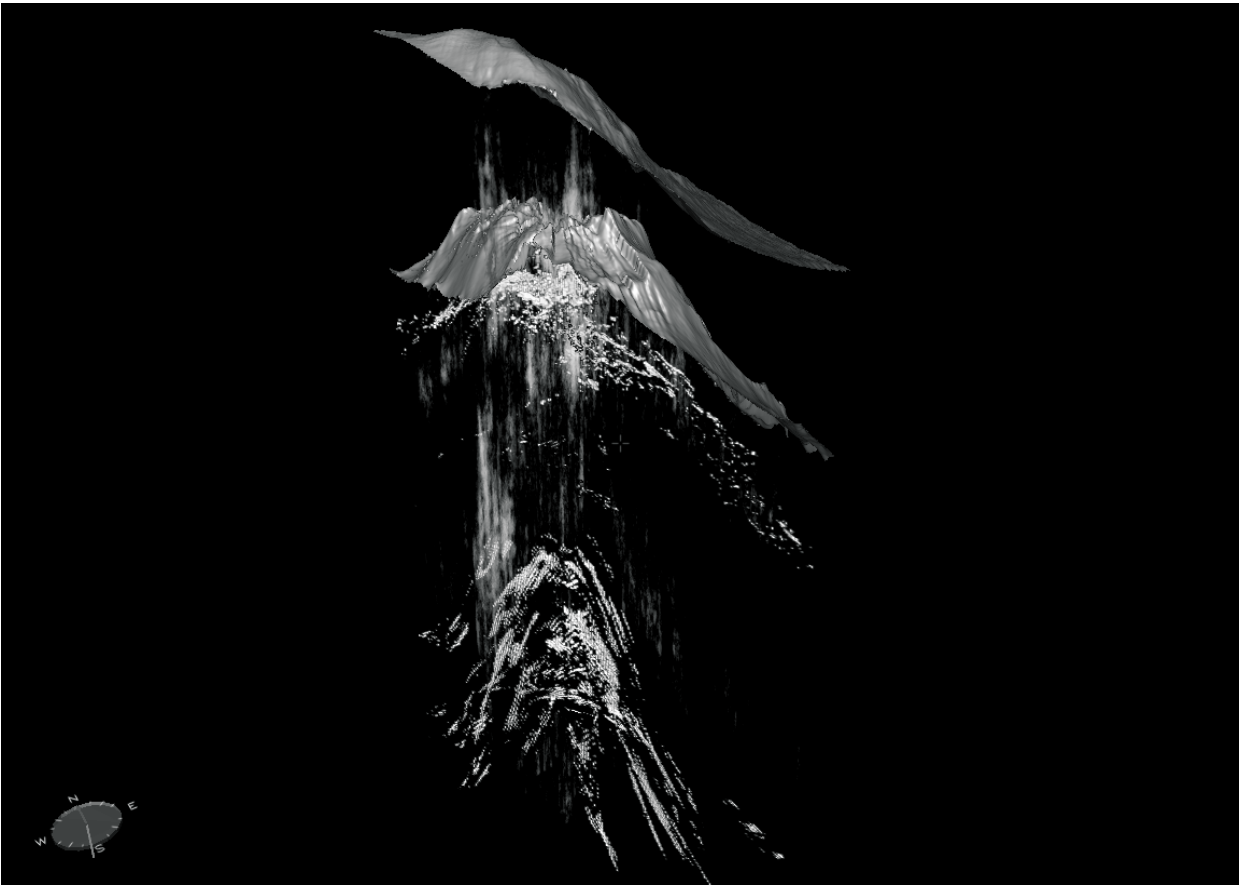


Figure 1. 3D illustration of detectable seismic objects. Two high amplitude clouds (lower part of the figure) indicate hydrocarbon prospects. The upper surface represents the seabed. The vertical objects are detected seismic chimneys. The chimneys tie in with faults visible on the lower surface. The chimneys may represent hydrocarbon migration through faults, between the two prospects and the seabed.