OTC 19421

Seabed Logging Survey Design Optimization Using Grid Modeling

E.U. Aasland, J.E. Danielsen, and P.T. Gabrielsen, EMGS ASA

This paper was prepared for presentation at the 2008 Offshore Technology Conference held in Houston, Texas, U.S.A., 5–8 May 2008.

Abstract

We present how Grid Modeling is used to take out several survey geometries from one single modeling pass, and how it is used to make conclusions on survey geometry issues. For Scanning surveys this is interesting, not so much to assess absolute anomaly responses, but to investigate how the relative sensitivity changes as a function of a change in survey parameters.

We show how that the sensitivity of an adequately dense-sampled receiver grid is robust towards orientation, even for narrow targets like a meandering channel. This ensures that a robust data set can be acquired even when the target orientations are unknown. We also show how data acquired in grids give a better feeling for regional context than long single lines.

Introduction

Seabed Logging has in recent years been adopted in the workflows of the oil companies (e.g. [1]). Initially, the method was mainly used to rank prospects. One or several lines were placed over a prospect defined from seismic, and the aim was to map the presence or absence of a resistive layer at the prospect and, preferably, map it at a similar depth. The last two years seabed logging has found another application, namely Scanning. In Scanning the scene is less defined. It is used at the same earlier exploration stage as 2D seismic, and the aim is to identify areas of interest, which can be underlain further investigations with dense grid seabed logging and 3D seismic ([2] and [3]).

In Scanning a receiver grid is spread over an area. The grid is comparably coarsely sampled, with typical receiver spacing between 2 and 6 km. The advantage is that large areas can be covered fast with seabed logging and provide high-resistivity leads for further evaluation later in the exploration process.

Three prerequisites had to be in place before Scanning could be realized as an exploration tool. Firstly, electromagnetic measurements had to be fully adopted by the oil companies’ exploration teams, since confidence in data is needed for them to have an impact – as for any other data set. Secondly, the number of receivers on the vessels had to be large enough to perform the operation in a cost-effective manner. Data have to be gathered with on several receiver lines simultaneously (several lines live) to ensure an offline data coverage, but this requires more hardware than single lines. This is illustrated in Figure 1. Thirdly, processing routines had to be developed so that the larger data volumes and grid data could be handled. [4] describes how azimuth receivers (see Figure 2) are decomposed in to inline and broadside field components to enable qualitative analysis of azimuth receiver data.

When Scanning surveys are designed, the workflow is different from when surveys for prospect ranking are designed. First and foremost, the survey area is less known and less data are available for construction of a resistivity geomodel. Often certain play types are expected and a generic model can be constructed based on this, using conservative model parameters if nothing else is available. Now the survey geometry has to be decided and this can be quite complicated. The geomodel can be used to simulate the various options for survey geometry. This may, however, lead to a very large number of modeling runs.

Although azimuth receivers provide off receiver-line coverage, the lateral resolution drops when the receiver spacing increases. On the other hand, the receiver spacing will also be the factor controlling the cost of the survey. These two aspects have to be balanced: The receiver spacing must be dense enough to detect the given high-resistive targets, but this has to be achieved for the lowest cost possible. Similarly, the source will typically only be towed over the receiver grid in one direction, along parallel lines. A second set of tow lines over a large receiver grid indeed gives better data coverage, but it come at a cost. The direction of the source tow will decide the propagation direction of the active electromagnetic field in the subsurface. The ability to detect the high-resistive targets depends on their structural orientation in the electromagnetic field [5], i.e. the response from a high-resistive structure is larger when the source is towed along the longest axis of the target. If these two fundamental survey parameters have to be modeled, it easily amounts to 10 to 15 rounds of 3D modeling. This is a time consuming affair and it can make the decision process around the grid survey somewhat discontinuous.