



Maximizing the seismic survey investment

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Introduction

Any acquisition of seismic data has some deficiencies in the geophysical measurements and hence inherent uncertainties in the seismic image. This impacts the confidence of the interpreter to arrive at the most appropriate interpretation. The industry has yet to acquire a full-fold, fully imaged survey with line spacings that equal station spacings; the desire for ever increasing resolution requirements makes this even more difficult to achieve. Compromises in acquisition parameters need to be made as most companies simply cannot afford such high-effort surveys. The recent dramatic reduction in oil prices makes achieving this target even more difficult. Therefore it is more important today than ever that we understand the geophysical risks and how well we can mitigate them with higher effort designs. In this abstract we outline a workflow that can be applied to help rank 3D seismic survey designs by addressing 5 key elements of the decision process: the geophysical risks, acquisition parameters, methods of risk reduction, geological targets and financial impact.

Workflow

The survey risk analysis methodology presented below allows oil and gas companies to compare the value of information (VOI) of different 3D seismic designs through an assessment of the ability to mitigate a given set of geophysical risks within the prospect area. While several of the criteria have similar characteristics, many concepts are dependent upon the location and therefore require attention to detailed analyses. This is achieved within a software platform that facilitates easy communication between all parties. Best results are obtained through close collaboration between the oil company and the designers of the 3D seismic survey.

Geophysical Risks

The following geophysical risks are contemplated (not necessarily an exhaustive list): linear noise, multiples, velocity, attenuation, short and long wavelength statics, signal/noise ratio, lateral resolution, deconvolution, migration, acquisition footprint, and HSE. In addition to the acquisition risks, one may also want to consider processing risks; this could be due to using existing processing or experimenting with processing algorithms that are (or not yet) proven.

Acquisition Parameters

The choice of acquisition parameters will greatly influence how well the above risks may (or may not) be mitigated. The reduction of the geophysical risks can be quantified through experience with seismic operation in a prospect area, with the chosen acquisition and processing contractors, and through consultation between the designer and the oil company. Parameters under consideration are: the type of acquisition, maximum desired frequency, minimum and maximum offsets, bin size, fold (and also unique fold), offset and azimuth distributions, and source and receiver station intervals.

Risk Reduction

Each different acquisition scenario with its set of parameters needs to have the likelihood of mitigating these risks properly assessed to compare e.g. high-effort, medium-effort and low-effort scenarios. The case of not acquiring any new data, or potentially simply reprocessing existing seismic data, may be considered a good base case scenario. Each of these will have the chances of success (and thereby also the chances of risk) calculated.

Geological Targets

Oil companies often want to evaluate shallow and deep exploration targets. This survey risk analysis contemplates the different seismic parameters, their associated potential geophysical risk reductions and therefore results that can be obtained by either considering the shallow target only, the deep target only, or a combination of the two.

Financial Impact

Seismic data will be acquired in areas where it is believed that such acquisition provides an economical benefit. The financial impact can be measured when there is a clear understanding of how well geophysical risks are addressed by a seismic survey. The expense side of the equation is defined by taking into account the cost of the seismic data acquisition, processing, drilling of wells (both discovery as well as field development) and the associated infrastructure costs including tie-ins to existing pipelines. The revenue side includes assumptions about the expected reserve estimates (P10, P50, and P90), porosity, hydrocarbon saturation, recovery factor, oil (or gas) price, percentage interest in the acreage, etc. Only once all of those are weighed against each other can one make a true analysis of the financial impact of the seismic survey.

The focus is on calculating the VOIs for each design under consideration. The comparison of the VOIs shows them all relative to each other given the same economic circumstances and assumptions (Figure 1). The results may show that the most expensive survey does not provide the highest VOI; it may indeed be a less expensive survey that offers the best return. Ranking the seismic survey design options by VOI presents a clear picture to the stakeholders as to how to proceed, understanding the risk/reward ratio and what results can potentially be obtained.

The analyses that are being contemplated do not include any net present value (NPV) considerations as those are very subjective and different from company to company; of course they may also change quickly over time. These can be added by the oil companies, meeting their particular assumptions at the time of evaluation.

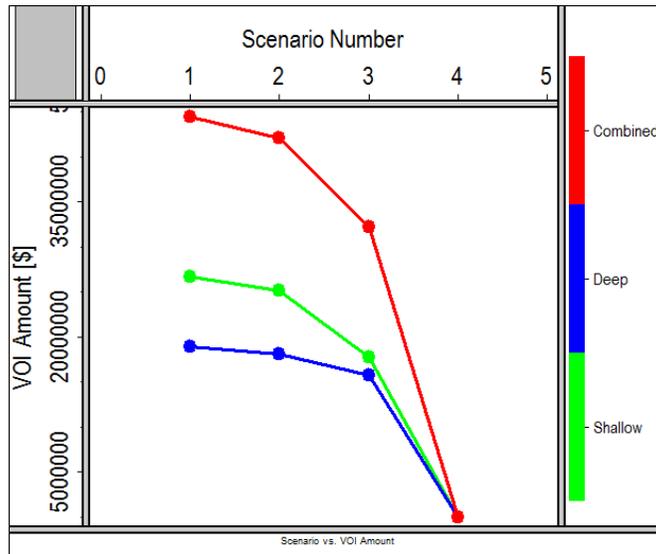


Figure 1: Relative comparison the value of information (VOI) of several different acquisition scenarios related to the geometries under consideration. The horizontal axis lists the numbering for the scenarios, while the vertical left axis shows the VOI for each consideration. Color indicates various depths of geologic targets including a combination of them.

Conclusions

A method of ranking different seismic data acquisition design options will be demonstrated. Oil companies can make informed decisions on the basis of an economic analysis taking into account how well the 3D seismic survey designs address the geophysical risks that are present in the prospect area. Ranking the 3D designs on the basis of factual VOI information is a significant advance over the traditional practice of using anecdotal wisdom and hence it maximizes the seismic survey investment. Ultimately the stakeholders benefit from the acquired seismic data meeting the geophysical requirements.