

# Geophysics topic 3-d vs 4-d seismic surveying research paper example

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## Seismic Surveying: The Cost-Benefits of Carrying out 3D Seismic Reflection Surveys for Reservoir Delineation and 4D Seismic Reflection Surveys for Reservoir Management

### **Introduction**

Many oil and gas companies regardless of their size, whether small or large, have heavily put reliance on 3-D seismic data to effectively and accurately delineate fields and thus discover new reserves. A 3-D survey has turned out to be more effective than a 2-D survey in exploration project. In a 3-D survey, one is able to study the structures and composition of the various layers underneath and therefore, being able to put on the correct gadgets to work. Another crucial development is in the use of sensor rays which allow for the study of the well in order to control the fluid injection. This is further coupled with the introduction of the 4-D seismic survey which provides real images of the reservoir.

Geophysicists are highly putting emphasis on the application of inversion in the exploration work. Inversion is a tool that helps in the interpretation of seismic waves by engineers. In the modern society, there have been a lot of developments in the field of exploration especially due to the rapid development of technology. ory dating back to late 1980s and early 1990s which had its focus on steam injection. The process of monitoring gas injection is rather simpler due to the presence of analogous fluid compressibility effects as the steam being injected with no temperature changes.

## **Description of 3-D Seismic Reflection Surveys for Reservoir Delineation**

A 3-D seismic reflection survey with high resolution is mostly carried out in risky areas with a lot of carbon waste or normal waste materials to study their structure and composition. The origin of 3-D seismic reflection survey lies in the oil industry whereby it was and still used for locating reservoirs containing oil. It utilizes high technology to map all the possible points of presence of oil or gas products.

The 3-D seismic reflection survey work on the principle where a sound wave or acoustic signal which have the power to reflect through the various layers of the earth. An instrument called sledgehammer is the one which produces the impact resulting to formation of waves which goes through the earth layers. The petroleum engineer experts will then apply their knowledge to analyze the data from the waves formed, thus differentiating between stratigraphy and structure.

Through the help of 3-D seismic reflection survey it is possible to interpret all data relating to potential oil reservoirs. The potential reservoirs are mapped in a cross-section view thus viewing all the layers at all angles. The various characteristic of the earth surface are clearly shown and interpreted in a logical manner. The reason why seismic reflection is possible is due to the fact that, different earth layers have different levels of density. The variation in density level will be noticed and reflected all the way back to the surface level for interpretation. The reflections will vary with also the lever of rock density.

## **Description of 4-D Seismic Reflection Survey for Reservoir Management**

The management of reservoir is becoming a norm in the present world of exploration. Seismic survey analysis are done using modern technology of 4-D which is more accurate as compared to others like 2-D. To improve on production in all the strategies, there is need to track the saturation for effective reservoir management. The 4-D seismic reflection technology is acclaimed as successful in all the fields of exploration, both onshore and offshore. For proper reservoir management to be realized, the specific characteristics of the underlying surface layers should be analysed.

The 4-D seismic reflection applies the technology of wave analysis to map the potential layers of the surface. The hydrocarbon reservoir results in changes in reservoir fluid acoustic characteristics which are correlated to the fluid saturation characteristics. The main advantage of 4-D seismic reflection survey in the management of reservoir is its ability to produce independent measures of the level and position of gas and also the saturation position of oil. All the surveys are aimed at reducing the time spent in exploration and also to estimate the resulting net pay of the potential oil or gas reservoir.

## **Seismic Inversion**

The main aim behind the application of seismic inversion is in order to map the structure and composition of the various rocks in the potential oil fields. Through the help of seismic inversion the various surface delineation are displayed and clearly analyzed. The geological composition such as the porosity levels are mapped in a cross-section way. Due to the vulnerability of the seismic lines from the out-of lane reflections all the challenges can be

improved through the help of seismic inversion for proper geological interpretation.

## **The Cost-Benefit Analysis of 3-D and 4-D Seismic Reflection Surveys**

The application of 3-D technology in geological exploration has both its advantages and disadvantages as reviewed by the various scholars worldwide. The major disadvantage of this seismic reflection technology is the associated cost. To install and maintain a 3-D seismic reflection will call for massive capital outlay. Also the expertise to run the whole system is also a major problem especially in developing nations where funds are scarce. The costs of a 3-D seismic reflection amounts to the major setback in the exploration of oil in this industry.

The 4-D seismic reflection technology is also very costly to implement and maintain for the industry. Very few exploration companies have the mastery of the application of this major technology. It calls for the training of the experts and especially the Geologists, Geophysicists and petroleum engineers to be able to handle all the machinery involved and this results to additional costs of exploration. The high costs associated with the exploration process make it difficult for many small firms.

Another problem associate with the two technologies is a thorough knowledge of both onshore and offshore areas of exploration. Some of the experts my lack the knowledge of these areas thus calling for the help of more staff and this leads to additional costs. The introduced staff may come with new cultures which might not be compatible with that of the locals. This may result to a conflict between the two groups of people.

On the other hand, the two technologies have many advantages which cannot be overlooked. The major benefit of 3-D seismic reflection survey is that, it makes it possible to study the structure and composition of the various rocks from all the dimensions. The geologist will be able to interpret the chemical composition of the available carbon layers and thus be able to estimate the useful life of the potential oil field. This is aimed at estimating the benefit of carrying out the exploration process whereby if the benefits are higher than the costs, the potential field qualifies for further development.

Both the 3-D and 4-D seismic reflection technology are accurate when applied properly by an expert. The resulting data is a real reflection of what is on the ground and this result in proper reservoir management. The accuracy levels of these two technologies is far higher than that of 2-D seismic survey since in the 2-D survey, the mapping of the potential fields was done from only two dimensions thus no clear pictures.

The technology is also highly reliable for decision making process. Due to the high level of accuracy in the two technologies, the reliability of the results from the study is high. Seismic reflection survey applies the inversion technology which brings out a clear real map of the surface underground and this is analyzed by the petroleum engineers for future exploration. The reliance level is boosted by the fact that the tests are done from both the field and in the lab where data interpretation is done. The resultant effect is proper positioning and mapping of the potential oil/gas zones. The accuracy is also boosted by the high tech sensors that are used in the reflection method.

Another benefit is that of simultaneous image processing and computation of the various arithmetic and geological calculations in the exploration procedures. Both 3-D and 4-D seismic reflection surveys are able to map and send the picture for further analysis in the laboratory. The earlier challenge in calculation of real time is eliminated by the application of the two technologies in this industry of exploration

A proper application of the two technologies results to a long term benefit to the exploration firm. This will help the investors to scoop back the capital introduced. It is also instrumental in the oil technology development. The clear study of the porosity and rock composition as clearly depicted by the seismic reflection survey allows for proper data interpretation and further decision making.

The application of high lens sensor in the two technologies leads to the accurate data received in the study room. This will facilitate the work of the various experts involved and thus reduce the time taken in the exploration process.

## **Conclusion**

For success in the exploration of oil/gas to be realized, the various technologies necessary should be put in place. The seismic inversion technology should be followed to the latter for better results to be obtained. Potential oil/gas fields should be properly defined so as to reduce the time taken to test all the fields. Also the firm involved should train its expertise in the use and maintenance of the two technologies.

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