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Current Challenges in Seismic Drilling Operations: A New Perspective for Petroleum Industries

Omar Dheyauldeen Salahdin, Salih Mahmood Salih[1], Abduladheem Turki Jalil[2,3]*, Surendar Aravindhan[4], Mohammed Mustafa Abdulkadhm[5] and Hui Huang[6]

Al-maarif University College, Medical Laboratory Techniques Department, Anbar, Ramadi, Iraq
[1]College of Agriculture - University of Anbar, Ramadi, Iraq
[2]Faculty of Biology and Ecology, Yanka Kupala State University of Grodno, 230023 Grodno, Belarus
[3]College of Technical Engineering, The Islamic University, Najaf, Iraq
[4]Department of Pharmacology, Saveetha Dental College and Hospital, Saveetha Institute of Medical and Technical Sciences, Chennai, India
[5]Al-Manara College for Medical Sciences, Iraq
[6]Department of Quality and Information Technology, Hunan Labor and Human Resources Vocational College, Changsha – 410100, Hunan, China
✉ abedalazeem799@gmail.com

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Abstract: The location of the well is usually selected with the help of surface seismic images. It can be helpful to know the position of the drill relative to the seismic section when starting underground drilling. However, obtaining this information is based on the fact that the vertical axis of the seismic section is in terms of distance. Seismicity during drilling operations provides valuable solutions to overcome many limitations in conventional well seismography. Nevertheless, so far, it has not succeeded in gaining a significant share of the market. Recent advances have provided new opportunities for this technique. As we know, revising the prediction of the results or data of a well is only possible when the drilling work of the well has been completed. Indeed, the new information and conclusions obtained from the revision of the information will be considered too late, and there is no possibility of changing the drilling performance. In this study, techniques are discussed in which the information obtained during drilling can affect the performance and drilling path. The project also presents the principles of seismic drilling and its application potential and examines the progress made so far and how new research initiatives are reviving enthusiasm for the technique.

Key words: Drilling operations, seismic data, conventional wells, well performance.

Introduction

During drilling, seismic services correct the previous seismic sections drilling and show us the new position of the subsurface horizons, which increases the drilling efficiency (Tang et al., 2017). Adequately covered, it will withstand a lot of adverse conditions, including $ 0.5 million to $ 3 million in-wall and lining pipe costs per well (Ali et al., 2020; Krishna et al., 2020; Nesic et al., 2020; Noshi & Schubert, 2018; Zarei et al., 2021). Obtaining high-pressure layers in front of the drill and preventing the well from erupting is another feature of this method (Davarpanah and Mirshekari, 2018; Liu et al., 2012; Zhang et al., 2015). For example, between

*Corresponding Author

1960 and 1996, there were 30 eruptions per year in Louisiana state wells. Given that the cost of erupting offshore wells is between $ 50 million and $ 1 billion, this method has resulted in significant savings in drilling (Afshin Davarpanah et al., 2018; Jin & Davarpanah, 2020; Nunes et al., 2018; Sabukevich et al., 2020). Therefore, with a slight reduction in drilling risk and hazards, it will save huge operating costs. Seismic services are the best way to identify high-pressure and high-pressure areas because high-pressure layers significantly affect seismic velocity (Azma et al., 2021; Ehyaei et al., 2020; Roychaudhuri et al., 2019; Yu et al., 2019). When seismic information during drilling is compared with other information such as surface seismic information or well seismic profiles or drilling parameters, the hazards of the drill can be easily predicted and prevented from occurring (Cudjoe et al., 2016; Davarpanah & Mirshekari, 2019; Rabbani et al., 2018; Zhu et al., 2020). Based on the agreements, layer pressure detection services underground must meet the following conditions:

- Do not cause any delay in the well process.
- Provide at least 1000 feet in front of the drill for use.
- It must have an accuracy of more than 50 feet.
- The velocity obtained from different formations should be 5% different from different logs (cable tools - vertical seismic profile).
- Prediction should be made in the least waste of time to be done in less than 10 hours.

Service companies have developed a wide range of services and techniques for this purpose. Available services include pre-drilling interpretations, vertical cable seismography, a vertical seismic profile of the drill string, and seismic drilling during drilling and obtaining a seismic profile using an impulse impactor (Davarpanah et al., 2019; Ghosh et al., 2017). Pre-drilling seismographs help us obtain a pre-drilling velocity model. This method is limited when there is doubt at great depths, especially if our well is in the exploration environment. If the amount of energy entering and passing through the formation is limited (in the current position of the drill), it will weaken the high-frequency waves, which will naturally increase the resolution of the work above 300 feet (above 50 ms). Here, we will interpret the prototype of a hydraulic pulse generator. This machine is able to generate a seismic signal at all the required seismic frequencies during drilling. This device is designed to overcome the problems in providing seismic services during drilling (Alexander et al., 2020). Existing problems include limited use with diamond drills and drilling in soft structures as well as drilling angled wells, problems in the processing stage and also problems in using this method at shallow depths. This machine has been tested at a depth of 2000 to 2500 feet with a diamond drill when drilling a diversion and angled well. These experiments were the first demonstration of the use of this device in wells drilled with a diamond drill or in diversion wells. The hydraulic pulse generator generates a strong compressed signal with wide bandwidth that can be used for a high-resolution seismograph. The accuracy of the obtained velocities is comparable to the vertical seismic profile, time and depth information or acoustic graph, and these results are available without interfering with the drilling (Saruev et al., 2019; Xue et al., 2020).

Performing vertical seismic profiles are used to obtain time-depth information using the IRGAN energy source. Typically, the range of these tools is 70 Hz and with a maximum resolution of 150 feet or more. Higher-resolution power is available on offshore platforms using the number of receiving arrays and more irons. On the other hand, in offshore platforms, where the water depth is high, the time cost of the platform is very high, and any error and failure of the cable tool has caused the failure of the safety device that prevents the eruption, and there is a risk of losing the well. Vertical Seam Drilling Profile is a newly introduced service similar to vertical cable seismic profiles, except that the receivers are mounted on well-bottom tools. A series of arrays of irons are arranged around the platform to fire several times while communicating. The received information is stored in a temporary memory at the bottom of the well and in the tool, and this information is available at the first drill rise. Seismography is performed during drilling using drill blows using the energy produced by the drilling string and drill and receiving the signal by receivers located on the ground. This method is used to obtain time-depth information maps and the internal pressure status of the floors. In this method, an impulse shock absorber source is used at the bottom of the well, and a series of ground array receivers perform wave detection.

Methodology

Seismography during drilling using drilling bits as follows:

Principles

The location of the well is usually selected with the help of surface seismic images. Knowing the position of the drill relative to the seismic section can be helpful by starting underground drilling, Also, obtaining this information is important because the vertical axis of the seismic section is in terms of distance. It is not straightforward when it takes time for a seismic wave to pass through the ground, it hits a reflector underground and returns to the surface. To attribute the drill position to the seismic section, the vertical axis dimension must be converted from time to time. This conversion requires information about the speed of movement of seismic waves within the formation. The velocity of the wave's motion depends significantly on the rock material, and often, instead of modeling, it is better to calculate with the help of a combination of sonic and log data and data obtained from well seismography. The theory of intra-well seismography has been known for many decades. In its simplest form, a geophone sent by cable into a well records the time it takes for seismic waves to reach from the surface to the receiver, located at a certain depth in the well. In order to be consistent with the round trip time, the time obtained is doubled. This simple service is known as seismography for capturing in-depth and temporal information. There are now auxiliary cases that significantly improve the usefulness of in-well seismography. Good quality data is sampled at the appropriate depth and enables vertical radiative imaging or vertical seismic profiles. In a vertical seismic profile mapping, the seismic sources are fixed, and the geophones move at different levels inside the well. Images may be displayed in the time dimension to adapt to the surface seismic section and the depth dimension to adapt to the cable images. Alternatively, the location of the geophones may be fixed, and the seismic source may be located along a line that passes through the "analysis line" of the rig (see Figure 1).

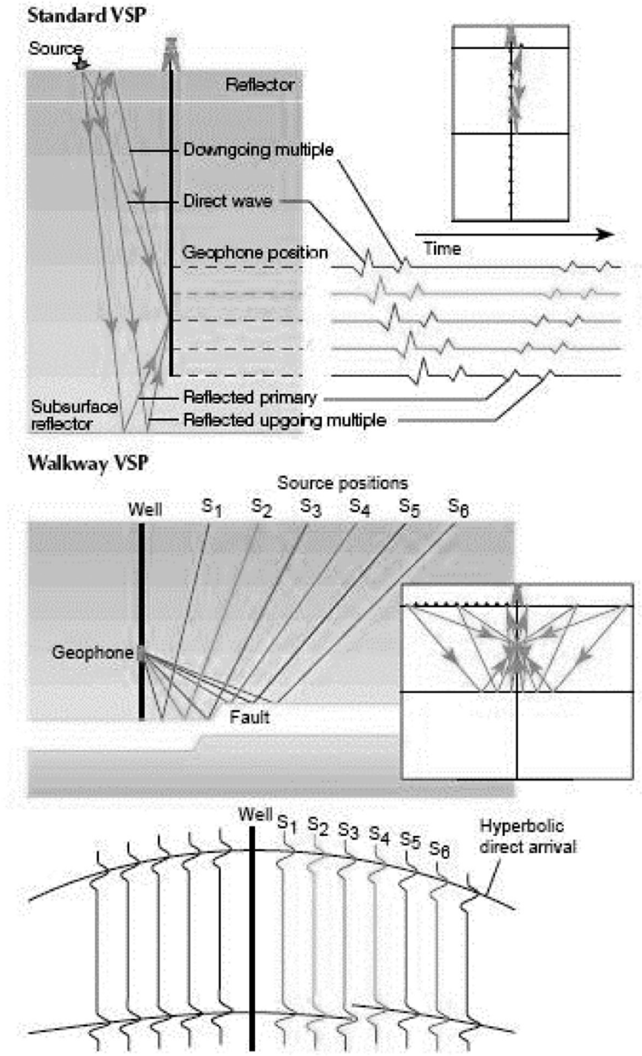

Figure 1: Normal wellbore seismography: A basic vertical seismic profile mapping uses a fixed seismic source while the receivers move at different levels of the well (up) to create side images of the formation from a vertical seismic profile observation-location a fixed-line and source from a receiver.

Results and Discussion

Vertical Seismic Profile

The vertical seismic profile produces an analytical image of the ground with a cover that is usually between half and a quarter of the depth of the well. An analytical method is used. Today, in-well seismography provides a range of quality images; however, like all cable services, drilling operations must be stopped, and the drill string pulled out before starting the mapping operation. As a result, "in-well seismography is usually performed during well drilling in wells without wall pipes and just before wall pipes are laid. The results certainly give us useful information, but it may be too late. The well may be in an unfavourable position, for example, on the wrong side of a fault, which can be determined by analytical vertical seismic profile." In addition, it may be very expensive or impossible to install sufficient surface springs to create an image of a vertical seismic profile by satisfactory analytical analysis. In seismic drilling, compact waves of the active drill propagate both perpendicular to the surface and down the drill and are reflected by the boundaries of the formation (see Figure 2). Using surface geophones to detect these waves, the mapped image is extracted by reverse and temporal information retrieval method, vertical seismic profile, and vertical seismic profile by analytical method.

Advantages

This technology has several advantages over in-well seismography with conventional methods:

- There is no need to stop drilling operations.
- Because the measurement is done continuously, the information obtained allows us to change the well before it is too late.
- Seismography also poses a tremendous technical challenge during drilling. Conventional seismic sources control the emitted signal.
- Either a single spike-like shock or a sweeping state of a signal from the seismic generator.

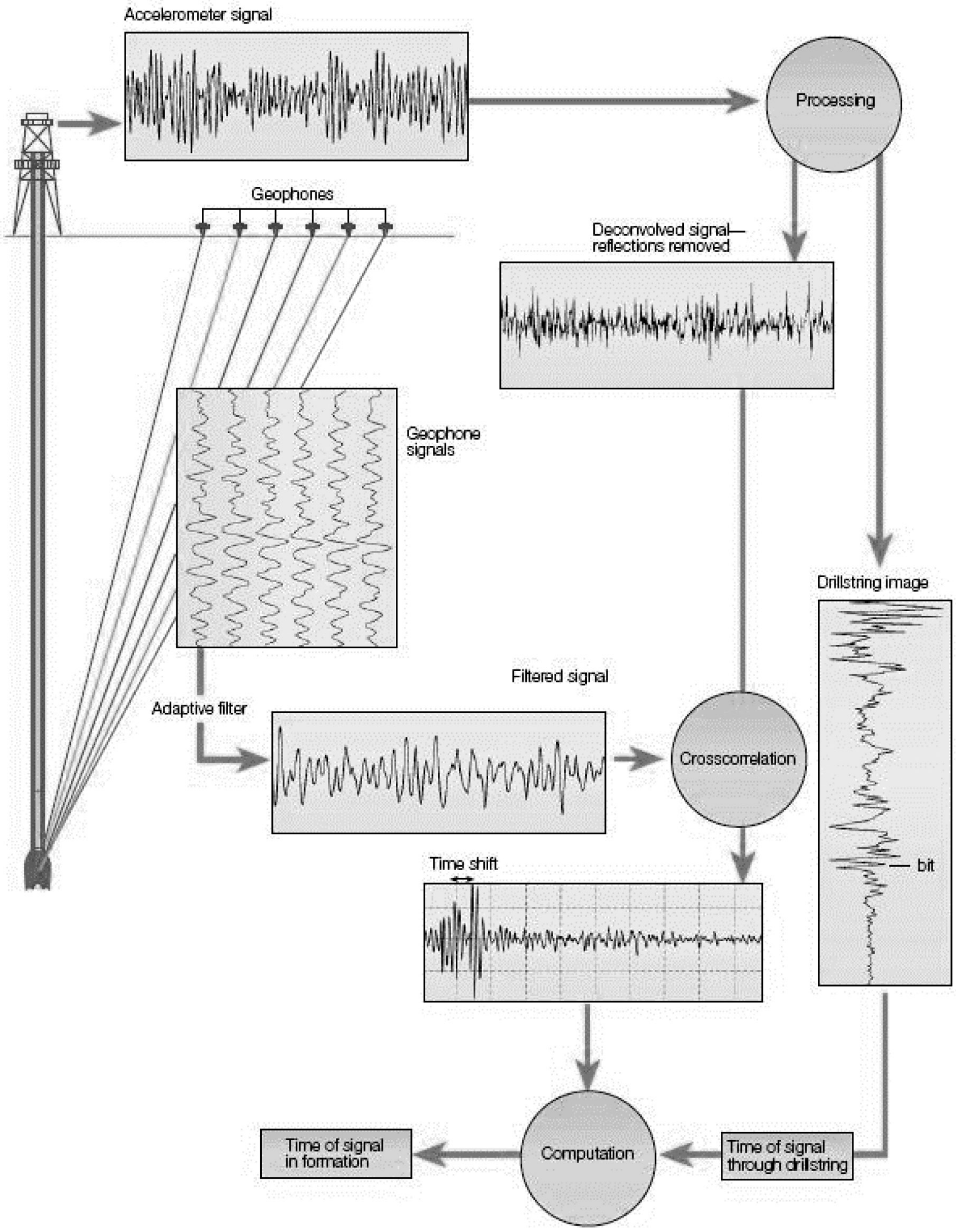

Figure 2: Drilling string image: The measured drilling string vibrations are used to calculate the change in apparent resistance when the vibrations are encountered from the bottom of the drilling string to its tip. By understanding which part of the image is related to the drill, it is possible to calculate the time spent in the drilling field.

The signal emitted by the drill is no longer necessarily "continuous" and controlled. A geophone on the surface continuously records continuous earthquakes propagating in the ground. In addition, the environment around a drilling rig is boisterous.

Disadvantages

So far, the possibility of imaging during drilling and harvesting of in-depth and continuous information has been identified, but only in limited environments have these two methods been tested. So far, the systems have been limited to onshore operations and low-deviation wells drilled into rigid structures with tapered drills without using overhead drilling techniques without a pump motor. Many problems are not expected in other environments and applications. The use of offshore platforms requires further reflection on hardware requirements and various processes but does not seem impossible. On the other hand, since the upper propulsion is not yet widely used, there is no problem. However, in some cases, more problems appear. Drill bits do not produce the same signal that taper drills produce. Horizontal wells also require different arrangements of receivers as well as new processing techniques. Working with the pump motor also has its problems. By gathering the field experiences of researchers, the limitations of this technology can be better understood. This method can modify the use of systems so that the possible cost of unsuccessful drilling and thus the cost of drilling additional windows is minimized, and it can also predetermine the possible risks to the drill. This system gives explorers a chance to correct the final target during drilling before it is too late.

Conclusion

In land rigs, the information received by the geophone includes various noise components. Some of this noise is due to seismic signals moving up the drill string by drill vibrations, and also due to the annular space of the well, which is filled with liquid and eventually "twists and disturbances at the joint surface of air and the surface of the earth and the geophones." Earth-related disturbances are caused by vibrations of surface equipment such as motors and mud pumps, and accidental noise is caused by events such as the passing of trains or trucks. In comparison, the seismic signal of the drill, which has a low energy level, is completely lost between these noises. The challenge here is to identify the unknown and variable drill marks to find the signal-to-noise ratio and convert a continuous propagation into a single signal so that independent seismic phenomena can be distinguished.

Technologies such as well surveillance during drilling and seismic drilling during drilling, accompanied by appropriate interpretation, software, and processing, are valuable exploration and drilling planning factors. These methods are significant in several ways, as follows:

- They are cheap.
- They do not interfere with drilling.
- They promise us risk-free drilling. If these methods are appropriately selected and used, they provide a superior solution for advancing the estimation of the underground geological model during drilling. These methods provide a superior solution for guiding the drill more accurately toward the reservoir and predicting abnormal pressures as the drill progresses. All this leads to a reduction in cost during operation.

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