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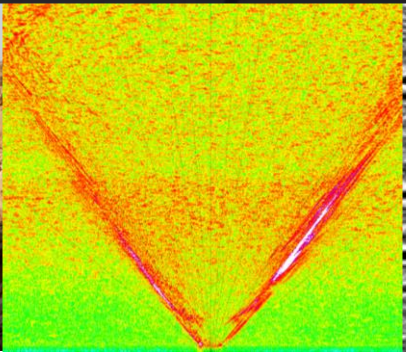

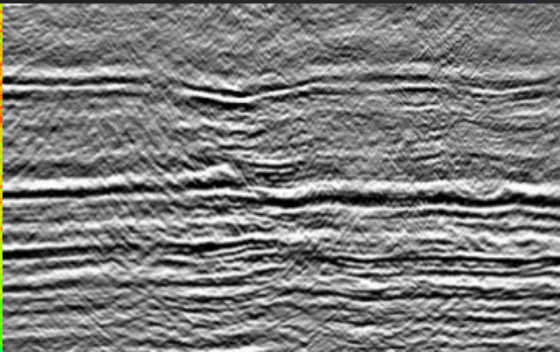

A GSH/SEG Web Symposium

## 3D seismic survey design
## New tools for new challenges

| Start | Title | Speaker | Affiliation |
|---|---|---|---|
| 9:00 | Introduction | Malcolm Lansley | Consulting Geophysicist |
| 9:10 | Recent changes in data acquisition | | |
| 9:40 | Land nodal acquisition and why we need a new nimble node | Ted Manning | BP |
| 10:10 | METIS: Enabling Carpet 3D Land Seismic Surveys with Swarming UAVs | John Archer | SAExploration |
| 10:40 | Break | | |
| 10:50 | Compressive Seismic Imaging: Changing the Mindset in Seismic Acquisition | Chengbo Li | ConocoPhillips |
| 11:20 | New design and acquisition solutions for old challenges | Nick Moldoveanu | Schlumberger |
| 11:50 | De-blending of continuous recording data towards a quantum leap in seismic imaging in the Western Desert of Egypt | Aly Said | CGG |
| 12:20 | The Challenges of Unconstrained, Broadband Land Acquisition: A Case History from the Western Desert of Egypt | Dennis Yanchak | Apache |
| 12:50 | Wrap Up | Dave Monk | Apache |

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Advanced Survey Design

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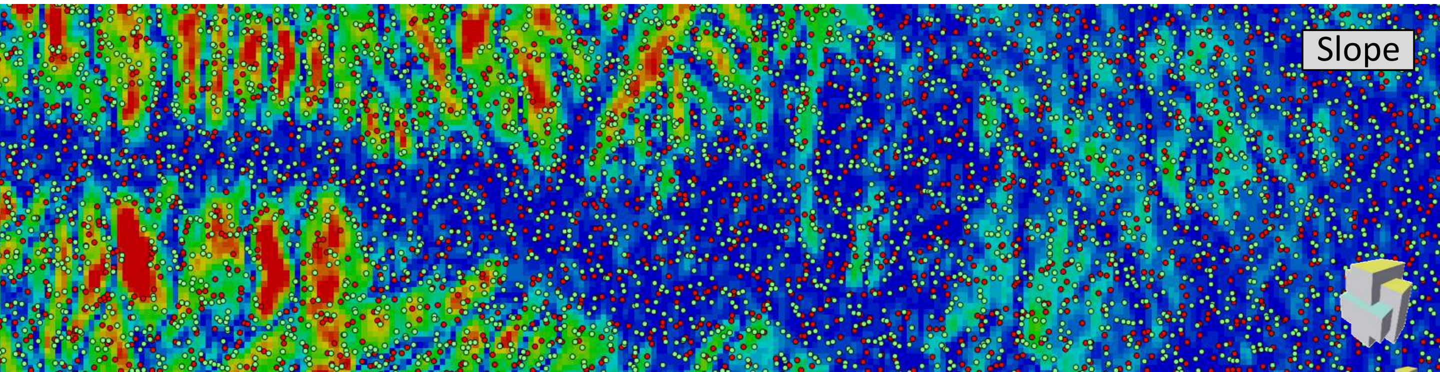
Making complex easy



# Survey Design: Past and Present

By Dave Ridyard

*On Wednesday May 29th, the GSH, in cooperation with SEG, is hosting a web symposium on the subject of 3D Seismic Survey Design, "New Tools for New challenges". The event addresses the latest technologies that are driving modern survey design. In this article Dave Ridyard of ACTeQ uses examples from the past to illustrate why it's so important to continuously reassess the latest practices in survey design.*

## Introduction

I shot my first 3D survey offshore Gabon in 1980. We had a single streamer and a single source, and each vessel pass created one 2D line. Data processing comprised a traditional 2D processing sequence through stack, followed by an in-line migration. Much has changed since then, but the changes fall into three broad categories.

1. *Data acquisition technology.* Changes in hardware and software technology have made things possible that were inconceivable 40 years ago .... And there is no sign that the pace of change is slowing down.

2. *Data processing and imaging technology.* In 1988, while getting ready for our first circle shoot, Bill French told me that everything is noise until you understand it. Once upon a time, we considered variations in source-receiver azimuth to be noise, but today azimuth related variations of signal are used to extract critical information. Years ago, we often threw away signal in the process of reducing noise prior to recording. Today we can generally record the full wavefield (noise + signal) and "processing can fix it".

3. *Objectives.* Perhaps most important of all, our objectives have changed. Back in 1980, our goal was simply the correct 3D placement of the reservoir structure. Today, we are often seeking small targets with marginal economics, and we are required to estimate reservoir properties, even in complex structural settings. Our objectives have also had to be adapted to modern expectations of health, safety and the environment, which plays a growing role in the selection of data acquisition techniques and survey designs.

Let's consider how these factors play into onshore and offshore survey design.

## Land

Broadband wide azimuth recording, with its requirement for dense sampling is driving much of the thinking in this area. Multiple simultaneous sources and high channel count systems are now routinely delivering very high trace densities, approaching 100 million traces per square kilometer. Given sufficient sampling to record and remove noise, the need to use source and receiver arrays is cheaper to record 3 point receivers rather than a single array of 12 geophones ?

Most traditional land survey designs use dense source lines orthogonal to dense receiver lines to obtain dense 3D sampling. These geometries can be efficiently implemented in unobstructed areas using cabled systems, but as recording spreads become larger, operational issues, especially in obstructed or environmentally sensitive areas can cause problems. The appearance of low cost, highly reliable autonomous nodes has enabled a whole range of different geometries. Rather than seeking rigid grids of shots and receivers, many survey designers are now looking at some distribution of randomized receivers, with shots being acquired where they are easy rather than on a regular grid. (See sidebar "What do mediaeval peasants have to do with survey design ?")

## Seabed

For many years, seabed seismic was an expensive complement to towed streamer acquisition, used in marine environments deemed unsafe for towed streamers due to shallow water or large numbers of obstructions. Over the last few years, seabed has emerged as an increasingly adaptable tool. For production and development applications,

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where mobilization is a significant component of overall survey cost, seabed seismic offers a practical alternative, with added benefits such as the availability of multicomponent, wide azimuth and ultra long offset recording.

For exploration surveys, it is the appearance of autonomous nodes that has triggered a mini-boom in the business. Traditional seabed cable systems have always suffered from the risk that a single failure to power or communications can cause downtime, making large scale operations, particularly in deep water risky. Autonomous node systems can be deployed and recovered with minimal risk, either one at a time using a Remotely Operated Vehicle (ROV) or using a Node On A Rope (NOAR) system. Years ago, survey designs were often based on (a) a desire to match the offset and azimuth distribution of a neighboring towed streamer survey and (b) availability of a very limited inventory of seabed cables. The result was an acquisition geometry with small numbers of deployed cables, with shot lines towed "inside" the receiver spread. Increasingly today, wide patches of receivers are deployed, with even larger patches of shots acquired over the spread. The result is a very high trace density, often producing spectacular data quality.

The recent appearance of new systems and service providers has created a whirlwind of innovations and new ideas in survey design. Perhaps the next wave will involve some form of self guided node.

## Towed streamer acquisition

Towed streamer acquisition is ridiculously fast and efficient. In the 1980's, digital cables ushered in streamers up to 12 km in length. In the last few years, multisensor streamers appeared with a promise to address the biggest challenge in marine : "How can we get crossline sampling to match our naturally dense in-line sampling ... at reasonable cost ?"

Marine towed streamer acquisition has always been about efficiency. In general, this has involved ever bigger vessels towing 8, 12, even 20 streamers. This has been a very successful approach, but there are fundamental limits, because as the streamers get further out, the near trace offset can become unacceptably long. But there are answers to this problem too. Some contractors are now towing up to 6 sources. With simultaneous shooting and deblending, these can be used solve the dense crossline sampling problem, or they can be deployed wider to solve the near trace offset problem. Several contractors now have enough faith in their streamer control devices that they are employing a shooting vessel deployed over the towed streamer spread to generate short offset data and minimize infill.

Multivessel acquisition used to be seen as a necessary evil to obtain data under obstructions, but today multivessel fleets are being used to generate wide azimuth data sets. Most surveys are still acquired in straight lines, but there has been a resurgence of deviated, sinusoidal, circular or even cycloidal vessel tracks.

## Mixed mode acquisition

Most projects are acquired using a homogenous acquisition technique, but sometimes that just isn't possible. Data processing companies are now increasingly capable of successfully merging different acquisition types. Ocean bottom nodes deployed around a platform can be used to infill holes in towed streamer coverage. Borehole deployed DAS receiver systems can be combined with surface seismic to provide additional information in unconventional plays.

## Conclusion

Changes in acquisition and processing technology have created great opportunities to deliver more cost-effective imaging. Survey designs must continue to evolve to keep up with the changing requirements of our customers. Designing a 3D survey today requires a knowledge both of the operational limitations of the available acquisition technology and the capabilities available in processing and imaging. The one word answer to all these survey design challenges is "more". Denser (and smarter) sampling. Longer offsets. Broadband. Wider azimuths. But the 3 word answer is "more for less" !

Each of the speakers at the GSH Web Symposium on survey design will cover one important topic on how technology is enabling, and sometimes driving changes in the way we design surveys. I highly recommend this event as a way to make sure that you apply all the best tools to your next survey design.

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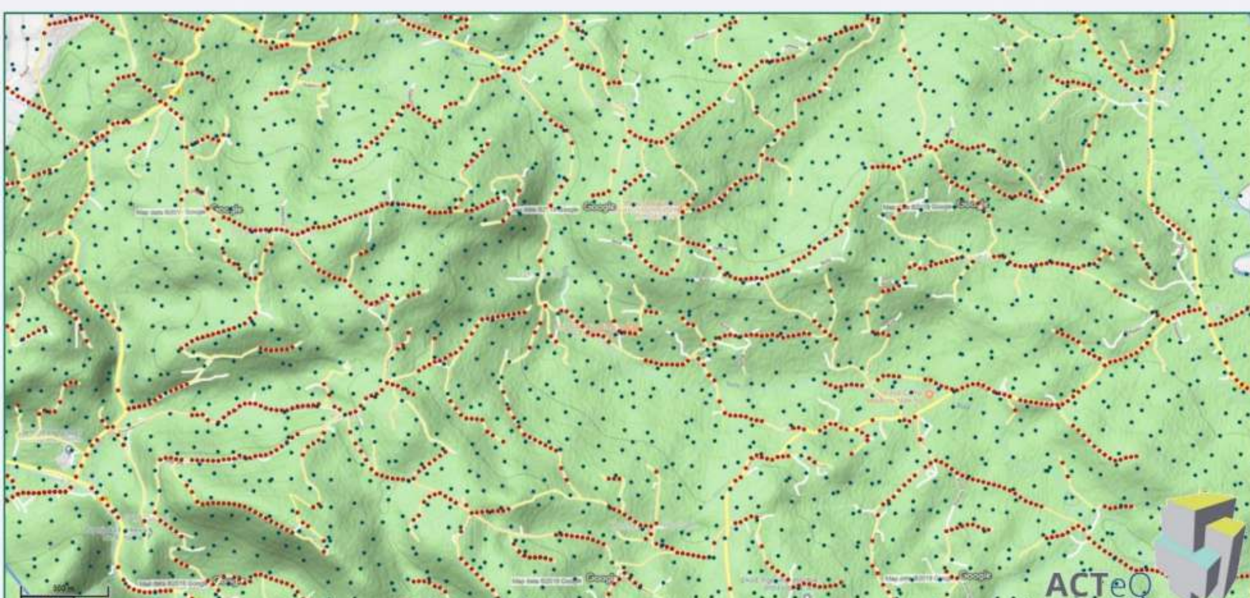
# "What do mediaeval peasants have to do with survey design ?"


I've recently been involved with three survey design projects in Europe. Although each project presented unique challenges, I noticed a striking similarity in that a key goal was to avoid conflict with the local community. For this reason, our approach to the survey design was to start off by looking at the roads as a preferred location for our vibrator points. In each of these surveys, I was pleasantly surprised to find that the pattern of roads and navigable tracks fitted our needs very well. A bit of research revealed that this was not a co-incidence.

In Europe, in the middle ages, peasants farmed lands owned by a local aristocrat. The size of these plots was generally between 20 and 30 acres. Any less than 20 acres was not sufficient to support a peasant and his family, so there would be no surplus to support taxes to the landlord. Any more than 30 acres could not be farmed by a single family, resulting in under utilized land, and lost taxes to the landlord. Consequently, all over rural Europe agricultural dwellings appeared 250-350 meters apart ... and tracks connecting these dwellings appeared at the same spacing.

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