HEADING in a new direction

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All of the easy oil has been found. This is an oft repeated statement, and a misleading one. To the contrary, finding and extracting oil, as well as natural gas, historically has been a challenging, complex and expensive task in most instances. The effort has become even more difficult and costly over time as the operators increasingly search for new reservoirs in supposedly drilled up areas and target new deposits in hostile environs. This makes it tempting to think of past efforts as being 'easy'. It is all relative.

Numerous mature fields still harbour promising bypassed/misunderstood hydrocarbon bearing zones and compartments, and promising areas in sensitive environmental locales beckon to one and all. Given the advances in oil industry technology, particularly seismic, it is only natural that the oil finders would choose to zero in on such opportunities as well as other, more intimidating hydrocarbon targets that would have been impossible to deal with in past times.

Seismic data ordinarily play a key role in such efforts. On land, however, there are specific challenges to acquiring the seismic data needed for identifying, evaluating and

Figure 1. *Deploying an autonomous recording unit.*

managing hydrocarbon bearing zones. These include congested urban locales, jungles, mountainous terrain, and more. Toss increasingly stringent environmental rules and regulations into the mix, and it becomes more than a tad intimidating for the contractors.

A new day dawns for seismic data acquisition

The ability of operators to most effectively pinpoint and evaluate potential drilling targets depends in large part on acquiring superior subsurface images. This high quality imaging must be accompanied by data acquisition efficiency and cost effectiveness. Autonomous nodal seismic systems bereft of cables have proven their merit for superior quality imaging on land, as well as in shallow and deep marine environments, and are increasingly becoming the method of choice to best accomplish this goal. In fact, some industry experts anticipate that nodal systems sans cables will dominate the land market in 10 years or less resulting in a non-cable land world.

A number of so designated cableless and cable-free nodal land systems are currently available. There also is a no-cable system dubbed ZLand®, which was developed specifically for dry land operations and is completely devoid of cables. This is the land system member of the ZNodal® Technology trio of autonomous nodal systems developed by FairfieldNodal. The no-cable land system is designed for brisk, easy production and accelerated field deployment; it is particularly suited for use in congested urban areas and over rugged terrain as well as simple topography. The complete absence of cables means the easy to deploy self contained nodes, or autonomous recording units, require minimal or no troubleshooting. Reduced cost and increased productivity are the result.

This battery powered single component nodal system can continuously and seamlessly record as much as 288 hrs or 12 days of seismic data, unattended. These data are stored onto internal FLASH memory. Individual units can be cycled into and out of a sleep state at predetermined times to extend the time they can remain in place.

Once the recording cycle is complete, the nodes are retrieved to download the data for quality control (QC) prior to recharging the batteries of the units for re-deployment. The QC monitoring during the survey programme ensures a superior end product. The system has successfully acquired data using conventional Vibroseis®, simultaneous sourcing Vibroseis and dynamite sources.

Being unencumbered by any cables, each small 4.7 lbs nodal unit can be buried in the ground, completely hidden from view. The unit is hand placed in an 8 in. hole and covered with only a couple inches of soil.

Spurring the need for change

Nodal land seismic data acquisition is a stark contrast to what the land seismic crews have long been accustomed to dealing with to acquire data. To appreciate being at the forefront of such significant technological accomplishment, it helps to take a quick look at past and still dominant data acquisition technology on land.

The majority of the data being acquired today requires a central terminal, or ‘doghouse’, to synchronise crew activity and to provide accurate timing to the remote acquisition units deployed over the survey area. A central recording system (CRS) controls all timing and synchronisation operations of the data acquisition system. The CRS uses a cable and/or radio frequency (RF) link to telemetrically relay information to the various remote units and seismic sources and to retrieve the acquired seismic data.

Most of the land data acquisition systems currently in use employ some type of cable to connect the sensing units, e.g. geophones, to a remote acquisition unit. Once the data are acquired, amplified, digitised and filtered, they must be placed on some sort of storage medium. Most systems transmit the data via cable, or RF in some instances, to the CRS. The downside to telemetry is that the CRS can become a bottleneck because of dwindling availability of bandwidth, meaning one is nearing the limit to retrieve data using either real time telemetry or reasonable time telemetry.

Besides limited bandwidth, the data gatherers must constantly contend with problems associated with the myriad cables and connectors used in seismic acquisition programmes to attach sensors and external batteries to the remote acquisition units. Cables also are routinely used to connect all of the remote units together for the purpose of telemetry and/or power supply. The sensors typically are composed of a string of anywhere from six up to 72 geophones wired together by cable.

The conventional 3D land seismic crew is further burdened with a bevy of other equipment. This includes such indispensable items as batteries and power packs, crossing line cables or an RF antenna for each remote unit and much more. In other words, the majority of today’s systems are ‘joined at the hip’ via some method of telemetry, creating an extreme network of interdependent remote acquisition units that are in constant communication with the CRS. To deploy, maintain and retrieve the massive array of equipment can be a daunting task.

For example, a typical 10 000 channel cable system using a 25 m station interval and a string of six geophones per receiver station with external batteries deployed in 20 lines of 500 channels per line requires a huge equipment inventory of spread cables, power plants, crossing line units, geophones and more. The weight of this sample system is calculated to top out at 134 540 lbs. Scale this system up to 50 000 or more channels, and it becomes far more demanding to deploy and manage.

Maintenance could well be called the curse of cable system technology. Batteries must be monitored constantly, and communications must be maintained to ensure the equipment is capturing and recording the seismic reflections. Because the many exposed cables and connectors are highly susceptible to environmental and cultural damage, they must be monitored/repaired on an ongoing basis, thereby hindering productivity and increasing cost.

Versatile nodes are a game changer

The principal advantages of a no-cable land acquisition system versus cable can be summarised succinctly:

- Requires no bandwidth for operation.
- Requires no cables, connectors, repeaters, or RF licence.
- Unlimited expansion opportunity.
- Less weight.
- Less environmental impact.
- Increased production due to essentially no troubleshooting.

Substitute the aforementioned 10 000 channel cable system with a nodal system and the weight drops to 50 000 lbs, which is a reduction of almost 270%. The reduced weight and the lack of cumbersome, sometimes damaging cables make no-cable nodal systems the logical choice for seismic data acquisition in jungles crowded with overgrown vegetation and numerous varmints who tend to gnaw on the exposed cables.

Nodal seismic data have also been collected successfully in mountainous terrain, such as Wyoming's Wamsutter gas field in the Rocky Mountain region.

During November to December 2009, the no-cable ZLand nodal system was utilised in a whole different kind of seismic programme. The system successfully completed its first 4D and surface microseismic survey where two wells were being perfed and fraced in the now famous Barnett Shale play in Texas.

California based NodalSeismic operated the land system for the client to acquire the high resolution, closely spaced seismic data near the wellsites. The three phase programme entailed 1225 receiver points, 1592 vibrator points and 12 days of 24/7 surface microseismic recording during the perf and fracing phase of the project.

The autonomous nodal units recorded 3.1 terabytes of raw continuous data, which were downloaded onto the field data recorder; 1.8 terabytes of field recorded formatted data ultimately were delivered to the client. The deliverables included Vibroseis formatted data and continuously recorded microseismic data.

27 days elapsed from the time the equipment arrived on the site until everything was removed, even though the field personnel deploying and retrieving the individual nodes had little or no seismic experience. Upon being briefed via a 1 hr training session, they were able to utilise the ZLand Hand Held Terminal (HHT) to deploy the nodes, averaging 1 min./unit or ground station. This accomplishment is attributed to the simplicity of HHT operation and utilisation of the same equipment (a single node) at each receiver location.

Prior to the 4D/microseismic survey, this same land system was used to perform a series of 2D seismic surveys in the environmentally sensitive and congested urban municipalities of Long Beach and Signal Hill in California. The successful survey programme, which received kudos from officials and the citizenry in general, covered a part of the giant old Long Beach/Signal Hill oilfield, which is operated principally by Signal Hill Petroleum, Inc. Earlier attempts at seismic surveying using cable systems encountered myriad problems.

Figure 2. *A planted autonomous recording unit.*

The plethora of shale gas plays that have sprung up, particularly in the USA, offer a whole new opportunity for seismic acquisition systems without cables. These plays can include highly urban areas, such as the core area of the Barnett Shale, and forested areas having numerous landowners such as much of the newer Marcellus Shale play in the northeastern part of the country. In fact, a cableless system seismic survey was completed recently in the Marcellus.

Going global

Look for nodal land seismic systems, whether designated as cableless, cable-free or no-cable, to become increasingly in demand as onshore opportunities regain much of their former cachet. In the USA, for instance, a number of companies including some of the majors were observed to be snapping up smaller companies and cutting deals onshore to enhance their portfolios, even before the infamous oil spill in the Gulf of Mexico in April 2010. International firms are participating in this action as well, especially in the prolific shale plays, which are also in the early stages of gaining prominence in other countries.

There are innumerable areas worldwide that stand to benefit from nodal land seismic systems application. For example, high production nodal seismic acquisition systems without cables have the potential to play a major role in the so named BRIC countries, which are predicted to be the primary engines powering the 21st century economy. New proven seismic technologies such as nodal systems will be essential to help bump up hydrocarbon output there to ensure continued economic growth.

Depending on the locale, these countries harbour their fair share of deterrents to seismic programmes, including highly populated urban areas, deserts and jungles. Where seismic data acquisition is needed, the potential demand for nodal seismic systems could be intense.

On the international front, nodal land systems have already been used successfully to acquire seismic data in certain regions, including Argentina and North Africa. OT