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# Advances in Land Seismic Data Acquisition Technology

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**Summary**

During the past decade, the seismic industry has undergone a paradigm shift in the way it acquires seismic data, moving away from cabled telemetry systems to completely cable-free, fully autonomous nodes. Developed in response to the inherent problems associated with cables and connectors, which lead to frequent downtime due to repair & maintenance, these light weight, self-contained units – thus called autonomous nodes - come fully integrated with sensor, electronics, battery and memory, all within a single water-proof container. They do not use any external cables and no connectors are used during acquisition. The Nodes just sit and acquire data from the time they are laid out until their pick-up, which can be up to several weeks later, drawing power from their internal battery and recording data to internal flash memory. Being completely autonomous, they operate independently from one another and independently from a central station. In fact, there is no traditional central station as such. Then again, as no cables are involved, there are no constraints on the spread layout or on the number of stations that can be deployed.

Starting with marine (Ocean Bottom Nodes) wherein they have been in vogue for quite some time, nodes are increasingly being used now for land surveys, revolutionizing the way data is collected in the field leading to much higher productivity, lower costs (less equipment, manpower) and reduced HSE exposure**.** To top it all you could now use them in places hostile to cable deployment thereby opening up new areas for exploration. They can also be used for high-density exploration surveys as well as for wide-azimuth, broad bandwidth, point-source/point-receiver reservoir surveys. With thousands of successful installations to date, these extremely reliable nodal systems have laid to rest the industry's initial concerns about requiring QC. With cables gone, no connectors used during acquisition and reliability of electronics no more an issue these days, there is, after all, nothing much really left to troubleshoot and supervise. Furthermore, they can be completely buried to avoid theft, to ensure good coupling and to reduce seismic noise.

Low deployment and maintenance costs leading to increased productivity and reduced HSE is making both E&P companies and contractors make the switch to cable-free nodal systems. Cables are fast becoming obsolete just as improvements in the cable-free domain are pushing for longer battery life and memory so that units can stay longer on ground. In fact, all new seismic data acquisition systems purchased for use in North America is nodal only; cabled systems are no longer competitive.

Three specific projects wherein E&P companies specified their use to ensure higher productivity and reduced HSE exposure are discussed herein. Being a continuous recording system, which requires extremely accurate internal timing, therefore land nodes needs a GPS time chip in each node. The GPS chip used in one-piece land nodes are used specifically for precise timing purposes and are not used for positioning, because of their less than accurate performance in that mode. Therefore, this also highlights the importance of staked surveys.

Inset – a complete seismic station consisting of a one piece autonomous node with self-contained geophones,

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acquisition electronics and battery. No wires or cables involved. Absolute reliability and longevity are the keys to high productivity.

## Long Beach – California

In 2006, California-based Signal Hill Petroleum Inc. (SHPI) wanted to shoot a 3-D survey in the old Long Beach oil field, which sits smack-dab in the midst of a dense urban jungle. Often referred to as Long Beach/Signal Hill, the giant field has produced more than one billion barrels of oil sourced by the Miocene-age Monterey, the source for most of the oil in California. SHPI tried the conventional cable and some cable-less technologies. They always had issues with cables, noise, vibrations, even theft and had to stop after a couple of days. Finally they opted for the single-piece fully cable-free autonomous nodes especially ones that could be buried under the ground to avoid theft. And they went as far as to build a crew from the ground up using it. In the process they ended up forming a new seismic acquisition company aptly naming it NodalSeismic. The nodes: the small, single-piece. self-contained, battery-operated recording units, could be temporarily secured to the ground – even covered with several inches of soil, if necessary. Troubleshooting was history because the nodal system lacked the cumbersome, break-prone cables that create myriad problems during the course of data acquisition. Plus they provided superior quality data and economy of scale. Moving on, Nodal Seismic has conducted several surveys in the Long Beach area, a 4-D survey over the Barnett Shale, 3-D in the Eagle Ford for Sigma Energy Ventures and a dense 2-D for Underground Energy. Since the nodes record 24/7 they help monitor micro earthquakes and in fact, NodalSeismic conducted a seismic hazard analysis using them for the Diablo Canyon nuclear power plant in Northern California. Likewise, Underground Energy is preserving the passive data to improve its velocity models.

## Australia

Empire Oil operating a block bordering the Bonnanaring nature reserve in Western Australia had to satisfy stringent environmental regulations to be able to conduct a 3D survey. Conditions included no vehicle movement through the paddocks and, in particular, the environment sensitive reserve and no clearing of bushes to run the cables. Quite keen to do the survey given the block's prospectivity, Empire Oil thus had to conduct a heliseismic 3D survey, the first ever to occur on mainland Western Australia. The light weight, single-piece, cable-free autonomous nodes were the ideal choice and about 6400 of them were used for this survey. Heli-lifted in bags of 12 or more, the nodes were walked to each location from the bag drop points. The entire deployment took about 5days. A total of 1642 shot holes were drilled, about 10sq km of data recorded every day and all shots completed within 5 days. Then another 4-5 days took to recover the nodes. Overall it just took two weeks to deploy and recover them. When all this was done only foot prints remained – no wheel ruts in paddocks and no bulldozed tracks through vegetation.

## Uganda

Uganda's Murchison Falls National Park is bisected by the majestic Nile River and boasts some of Africa's wildlife treasures - elephants, lions and a rare giraffe sub-species. Beneath it, within the Albertine Graben, lays another natural prize: oil. Total, operator of the block therein, wanted to ensure that every mitigation measures were taken while acquiring seismic to minimize the environmental and social impacts of oil activities. The fully cable-free, single-piece, autonomous nodes with minimal foot print were its natural choice. The high performance, low impact surveying method was ideally suited to work in sensitive environments, providing optimum coverage and quality without having to deploy kilometers of cables. Nodes are helping Total produce quick results with less manpower and fewer supporting vehicles thereby limiting the impact on wildlife and vegetation compared to any other technique.