Multi-physics geophysical acquisition system for land, borehole and marine applications

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ABSTRACT

Over the past years we have completed our integrated geophysical acquisition system beyond electromagnetics application. The system uses 24/32-bit architecture and can be expanded to unlimited number of channels. It is wireless with the optional wired 32-bit sub-acquisition controllers. The broadband electromagnetic and seismic sensors and system go from DC to 40 kHz where it excels 27 noise free bits at 16 kHz. Typical broadband MT configuration uses $<$ 5W including powering of the sensors.

When first deployed in 2010, the system was only used for magnetotellurics. It can now be expanded to an 11 channel MT system going from DC to 40 KHz (LMT-MT-AMT) in a true simultaneous acquisition. More recently, we added a 100 KVA and 150 KVA CSEM transmitter, which is controlled by the same GPS synchronized acquisition unit. With that it can be used as CSEM system and we are presently operating a 200 channel version that includes microseismic sensors. It is used for monitoring of hydrocarbon reservoirs for Enhanced Oil Recovery. Using electric and magnetic field sensors allows you to monitor resistive as well as conductive reservoir changes. Examples from the US and Asia confirm this.

The sensors include fluxgate sensors for low frequencies, induction coils for higher frequencies, geophones and accelerometers. The design of the sensor packages is in all cases carried out with 3D modeling of real field conditions. They are specifically adopted for land, marine and borehole environments. Recently we added an integrated borehole sensor because the vertical electric field includes advantageous information as 3D modeling confirm. Also both the 3C geophones and 3C magnetometer have less noise in shallow boreholes. The shallow borehole version is in operation and we are presently designing the deep borehole version with 3D modeling which includes full oil field steel casing.

Apart from the sensor package itself, we have also tested novel EM focusing methodology that allows us to focus the EM information directly under the receiver. After 3D modeling, we tested and confirmed this over a salt dome case history in Texas. The advantage of using this technology is not only the now known information focus (versus the unknown focus for CSEM) but it allows you to do a more direct integration of other geophysics method using the same integration volume. It will make joint inversion easier and allow better calibration with borehole information.

By adding high precision clocks to the system, we can integrate GPS synchronized land system with marine system that are clock synchronized. We have already built and tested the deep water node for seismic and electromagnetics, with different exploration version being in preparation. This will allow to acquire seamless data from land to deep water.

While we illustrate here the uniqueness of the system with geophysical case history, it has also been used in other fields. During the past years our system and sensors have been used for various other unique applications including border security monitoring, oil field reservoir to surface wireless

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communication, tunnel detection and gravity wave observations.

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