

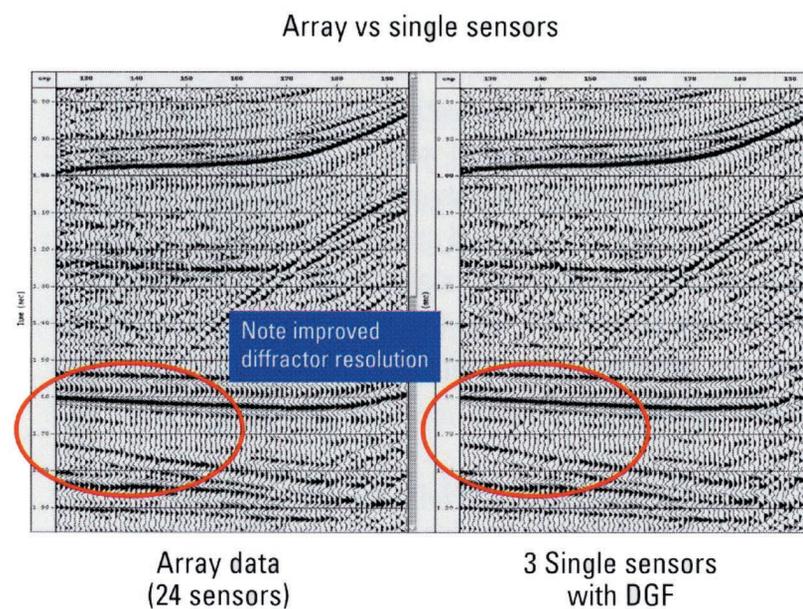
Will Schlumberger's Q system provide the cue to a revolution in seismic acquisition?

Can it justify the hype? That's the question that the exploration industry will be asking now that Schlumberger Oilfield Services has unveiled Q-Land, the first component of what is claimed to be a revolutionary seismic acquisition and processing system.

CEO Euan Baird was on hand for the official launch of the system in March at the Bahrain Geo 2000 exhibition which suggests that the company itself believes it is onto something significant with its new Q-Land technology. Visitors to Glasgow EAGE 2000 will be able to judge for themselves later this month.

In the meantime we know that Q-Land in Schlumberger's mind represents quality and a quantum leap in seismic imaging technology, which represents a platform for continuous improvements spanning not just land but marine and borehole applications. The company says that the Q-Land revolution, as opposed to evolution, arose as a result of scientists and engineers returning to first principles to overcome limitations in current practice. They came up with the Q-Land system which records single sensors rather than grouped arrays of sensors as found in conventional systems and offers a real time 30 000 channel acquisition capability (at 2 ms sample rate), a stunning increase on the maximum number of channels currently being used.

In summary, Q-Land is designed to provide enhanced imaging quality and resolution to improve selection of targets and well locations, reduce acquisition time, offer proof to verify booking of reserves and ultimately assist production and reserve management. Mario

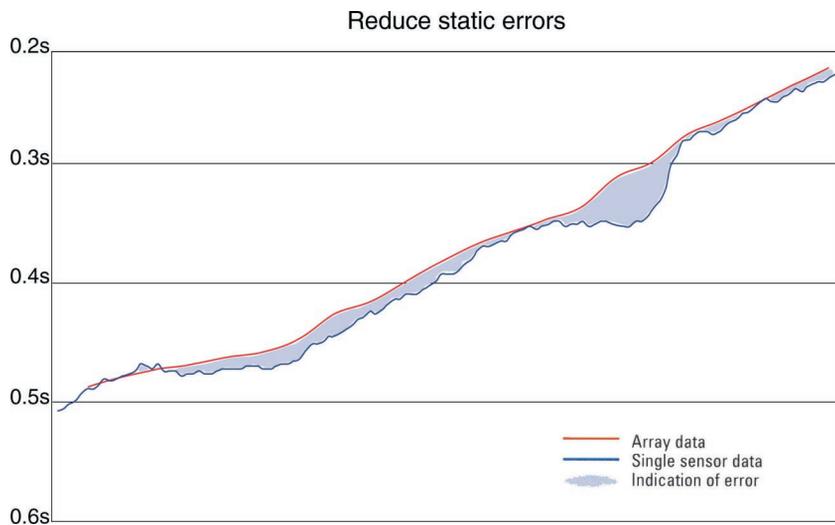


Ruscev, president Schlumberger Reservoir Evaluation Seismic, said the Q system would 'prove particularly beneficial to any client whose prospect has complex logistics, a poor signal-to-noise ratio, groundroll contamination, statics problems or elevation variations,' adding that specific applications included 3D multicomponent seismic, high resolution imaging and avoiding potential drilling hazards. The system was qualified in 1999 and is now operational in the Middle East.

In designing the new technology, Schlumberger addressed what it regarded as the drawbacks in conventional seismic data acquisition, namely the deployment of geophone arrays containing a large number of geophones positioned in a linear or areal pattern. This means that the geophone array output is the hard-

wired summation of all geophone responses which encounters a number of problems, some documented by Leo Onkiehong, ex Shell and Delft University as guest speaker at the Q-Land launch dinner in Bahrain reminded his audience that in the 1980s he had advised the seismic industry that single sensors were the only way to record an 'uncompromised wavefield.'

Schlumberger discuss three particular problems with conventional seismic. First, the wave number response: because the summation of geophones corresponds to a sinc-type wavenumber response, it suffers from sidelobes and does not have a desirable passband shape. In addition, Schlumberger says that the wavenumber response is frequency and time independent when ideally higher frequencies should have a larger wavenumber passband, as reflec-



tion moveout increases with decreasing arrival times, the wavenumber passband should be broader in the shallow section of the shot gather. Second, perturbations: conventional geophones within the array do not measure identical reflection signals due to different elevations within the array, geophone coupling differences, differential normal moveout and intra group statics. The geophone simply averages the individual geophone outputs, which is an imperfect method to correct for the effect of these perturbations. Third, output sampling: since the length of the geophone arrays is normally fixed, the output sampling of the wavefield is also fixed, thereby limiting the options in the subsequent data processing stage.

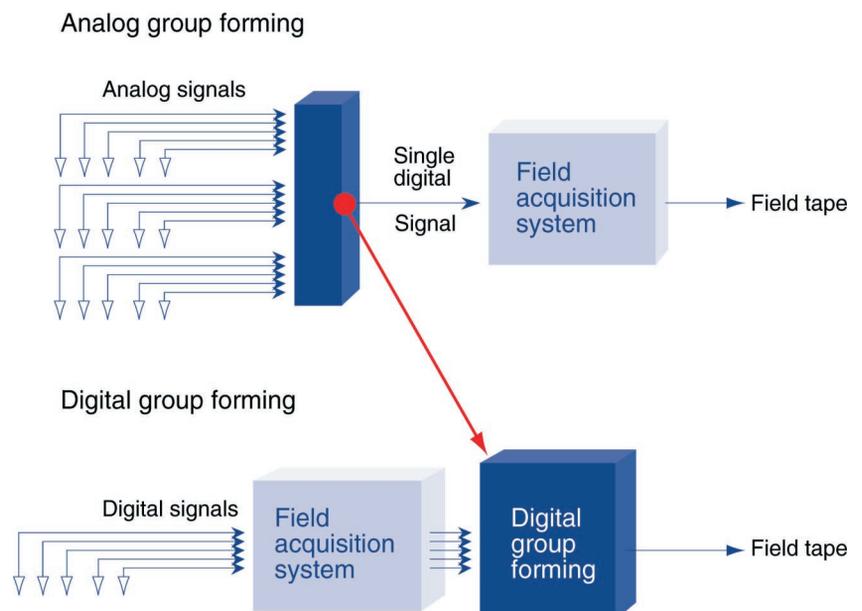
Two of Schlumberger's key innovations to overcome the problems in current seismic acquisition are single sensor recording and group forming. Single sensor recording goes beyond the sampling and use of anti-alias filtering that have become standard techniques in time domain digital recording. The company says that the use of point re-

ceiver recording allows extension of the implementation of basic sampling rules to the spatial domain. Proper pre-processing of the single sensor data facilitates the computation of a group formed output data set which is essentially free of aliased noise. The company admits that in contrast to temporal

sampling, the initial sampling interval in space is limited by cost considerations and operational efficiency so the number of single sensors employed during field operations will have to be chosen carefully to facilitate the attenuation of coherent noise events.

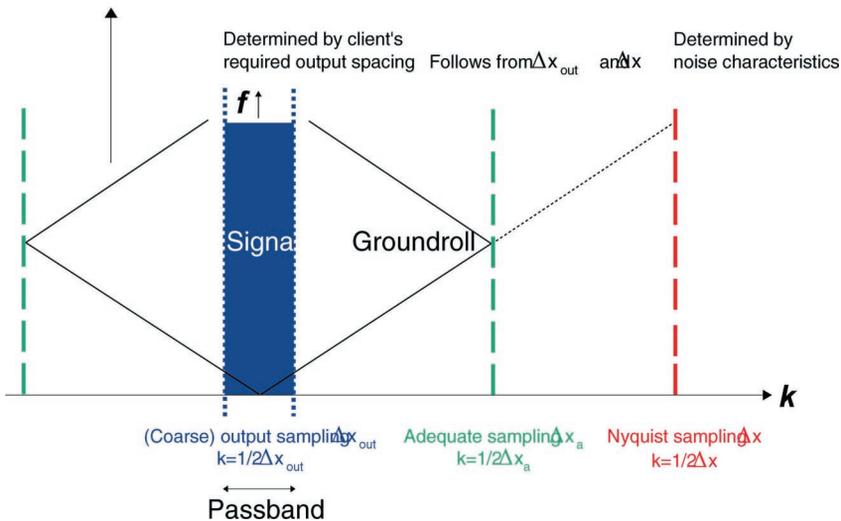
At some stage in the acquisition and processing chain, the single sensor data volume will normally be reduced via group forming. In general the group forming is described as being much more sophisticated than straight summation of the single sensor. A toolbox of data processing algorithms is available for application to the single sensor measurements, all of which are aimed at improving the group formed result over the conventional array result.

Group forming itself is the result of applying several algorithms from a processing toolbox to the single sensor data. The algorithms include correction for time shifts within the group, attenuation of coherent noise, spatial anti-alias protection and reduction of



Adequate sampling

Groundroll aliased (less than 2 points per wavelength) but does not contaminate filter passband



random noise. Different options are available for group forming of the single sensor measurements. Group forming at the geophone has the advantage of reduced data rates over the acquisition network but lacks flexibility and requires pre-determined group forming parameters. This option is not favoured by Schlumberger. With Q-land, all the measured single sensor signals are transmitted to the recording truck. Since all single sensors are available in digital form to facilitate group forming, Schlumberger refers to this process as Digital Group Forming (DGF). DGF can be applied in the recording truck to

deliver one or more datasets with group interval optimized for specific targets. A further option is to do the group forming at the processing centre which requires the measured single sensor data to be recorded on tape. The company says that this provides the largest degree of flexibility as several grouping options can be tested during processing, but the amount of data to be handled during data processing will increase dramatically.

One early independent industry reaction to the Q-Land launch in Bahrain came from Gijs Vermeer who, after a career in Shell research, started his own

geophysical consultancy 3DsymSam-Geophysical Advice. He is also author of *Seismic Wavefield Sampling*, published by the SEG in its Geophysical Reference Series. Vermeer said that the 30 000 channel system was an important step towards alias-free recording of the seismic wavefield, but he cautioned that 'this development does not mean that from now on it will be possible to record the total wavefield alias-free. Recording the full-fold wavefield (shots and receivers in a dense areal coverage across the whole survey area) will remain impossible due to practical and cost limitations.'

Vermeer suggests that it was necessary to look for 'compromise geometries' which in his opinion means aiming for alias-free recording of cross-spreads when using orthogonal geometry. 'With Q it is possible to record all shot records alias-free including coherent noise. And that is an enormous improvement, because the response of field arrays is lousy and we can do much better in the computer. On the other hand, Q does not allow full alias-free recording of receiver records. This requires the recording of single sources at very small station spaces.' Schlumberger claims that they will announce their solution to this challenge later this year.

So, Q for quality and quantity leap? The seismic jury is out.