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NANOSEIS

Narrow Beam Scan Microseismic Monitoring

Figure 1. The NBS method is conceptually similar to parabolic listening devices.

NanoSeis's Narrow Beam Scan (NBS) surface microseismic monitoring method is a patent-pending technique that is conceptually similar to the parabolic listening devices that are used at sporting events to record conversations in the presence of high levels of noise (Figure 1). The Narrow Beam Scan method was born out of frustration with existing surface monitoring techniques, which cannot detect most of the events that occur during a hydraulic fracture well stimulation.

The Narrow Beam Scan method uses powerful filtering techniques that can detect events that are far below the threshold of visibility to the human eye. Realistic wave

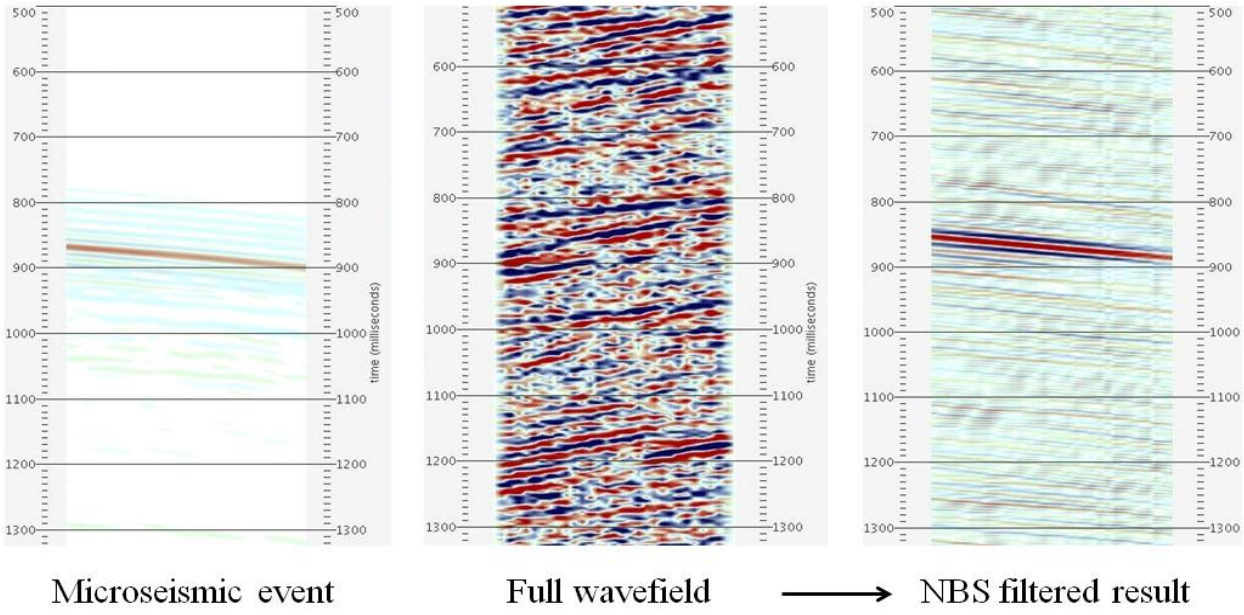

Figure 2. A modeled microseismic event (left); the full simulated wavefield with random noise, reflected noise, and surface noise (center); and the result after Narrow Beam Scan filtering (right).

equation 3D finite difference modeling (Figure 2) shows that the Narrow Beam Scan method can provide approximately a 20x improvement in signal/noise ratio. Similar results are observed on real data. The filters are fast enough to allow the method to be used in real-time microseismic monitoring.

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The Narrow Beam Scan method is integrated with a common method for locating the source position of microseismic events, which is the Source-Scanning Algorithm published by Kao and Shan in 2004. Figure 3 depicts the application of the Source-Scanning Algorithm to surface microseismic data. Possible source locations are treated as subsurface voxels, and a grid of subsurface voxels are taken into consideration, and for each voxel the travel times to the receivers are computed and subtracted. Where the voxels coincide with the location of actual microseismic events the microseismic event energy is flattened by the subtraction of the travel times, and the energy can then be summed or evaluated using semblance, thereby representing an event location.

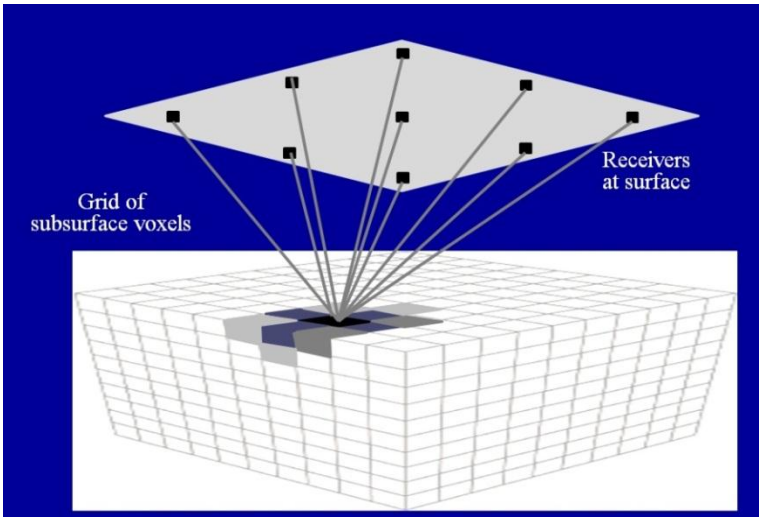

Figure 3. The application of the Source-Scanning Algorithm to microseismic data, after Kao and Shan, 2004.

Ultimately the power of the Narrow Beam Scan method comes from the integration of the filtering methods with the Source-Scanning Algorithm. The combination is conceptual similarity to rotating parabolic listening devices so that they are directed at the voxel of interest during the application of the Source-Scanning algorithm (Figure 4).

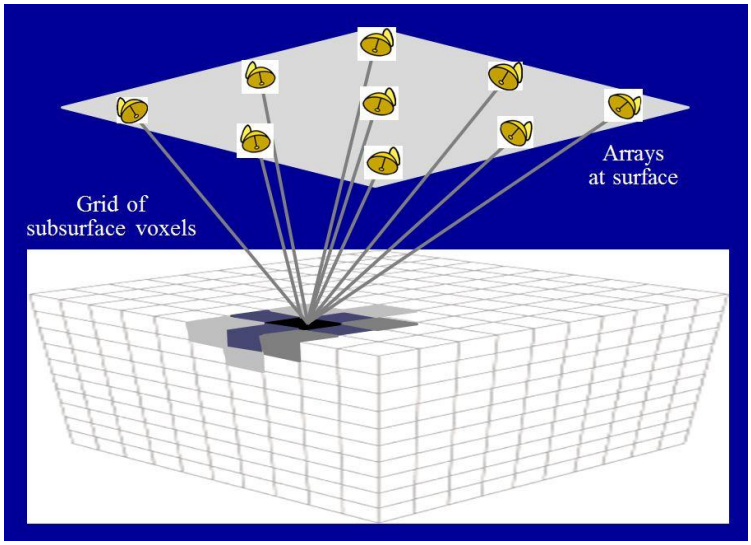

Figure 4. The Narrow Beam Scan method integrates powerful directional filtering methods into the Source-Scanning Algorithm.

The 2D Narrow Beam Scan method can be applied to traditional surface microseismic datasets such as star arrays, with improved results over traditional methods. The costs of the Narrow Beam Scan method are generally lower than traditional methods. For more information please email Dave.Diller@NanoSeis.com or call +1 720-320-3525.