Optical Fiber VSP using DAS (Distributed Acoustic Sensing) Technology

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Distributed optical fiber sensing technologies have been evolved over more than 30 years started with DTS (Distributed Temperature Sensing). DTS is now commonly used for well monitoring purpose in Oil & Gas business.
The follower, DAS (Distributed Acoustic Sensing) technology has been introduced more than 5 years for the demands of pipeline monitoring and intrusion detection. The latest optical fiber sensing technology now allows DAS to record Borehole Seismic signal including VSP (Vertical Seismic Profiling). The system is called ‘hDVS’ (heterodyne Distributed Vibration Sensing) in order to distinguish from pipeline monitoring system.
Unlike conventional VSP recording tools, which usually use electro-magnetic sensor or Geophone, hDVS/DAS uses optical fiber as vibration sensor. Multi-level borehole seismic tool including VSI (Versatile Seismic Imager) has been commonly used for VSP recording more than 15 years in order to save acquisition time. However, due to the sensing is limited as point basis where Geophone is located, the borehole seismic tool needs to be moved from the bottom section of the well up to surface in order to record VSP data for entire well. Massive number of seismic source shooting may be required, in proportion to number of tool settings. In the case using many numbers of sensor shuttles 20 or more, rig up or rig down time for the multi-level borehole seismic tool increases dramatically when number of the sensors deployed into the well increases. Hence, there is limitation to reduce acquisition time using conventional method.
On the other hand, due to the nature of electronics system, the maximum temperature, which can be deployed conventional borehole seismic tool, is limited up to 200 degC or even lower. In case of optical fiber, the core part of the fiber is made of high-silica glass, so that high temperature version of optical fiber is widely available over 200 degC. Hence, it can be deployed under high temperature environment on a permanent basis, where conventional Geophones cannot be used.
Since optical fiber can be deployed entire well depth as sensor, either permanently (e.g. Control Line) or temporary (Hybrid Logging Cable), the acquisition time required for hDVS VSP would be as small as few minutes, which is essentially the time required for Seismic Source firing, compare several hours to days for conventional VSP including the time required for multiple tool settings. This is absolutely new way of acquiring borehole seismic using fiber optic technology.
During the presentation, overview of hDVS/DAS system will be explained followed by examples of VSP data recorded during Field trials last few years.

Keywords: DAS, hDVS, Optical Fiber, VSP, Seismic

