Cable coupling of DAS in VSP surveys

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In the past few years a new technology of seismic acquisition has emerged, where fibre optic technology is used to detect seismic events, also called distributed acoustic sensing (DAS). In contrast to point sensors, DAS is a distributed acoustic measurement system and therefore records sampling points along the entire cable length. The system is based on optical time-domain reflectometry (OTDR) exploiting the principle of Rayleigh backscattering (Hartog, 2017). DAS is largely used for borehole seismic acquisition, i.e. VSP. However, results obtained by different strategies of fibre optical cable deployment vary significantly. While the cable cemented behind the casing recorded a high signal fidelity, clamping it at regular intervals to the tubing generated coherent noise but also increased the ambient noise level. The lowest SNR has been recorded using wireline deployment, where the cable was simply lowered down the borehole. However, this deployment technique is by far the most cost-effective method. Since the biggest advantage of DAS compared to conventional seismic acquisition is the lower cost in acquisition, the motivation of this work is to investigate the latter deployment technique. It is desired to understand under which circumstances improved data quality can be acquired. Hartog et al. (2014) have presented results of a field trial where they acquired DAS data using wireline deployment in a 600m vertical fluid-filled well. While any signal of interest was superimposed by high amplitude and sinusoidal noise, the first break was detectable throughout the entire well, when tension of the cable was released by lowering more cable into the borehole (left panel of Figure 1). At the start of the PhD it was unclear why and when data quality as seen in Figure 1 can be acquired. A numerical study showed that a direct contact of the cable with the borehole is necessary to record a high SNR (right panel of Figure 1). Furthermore, additional conclusions have been drawn and further analysed to increase the signal sensitivity of the measurement (Schilke et al., 2016).

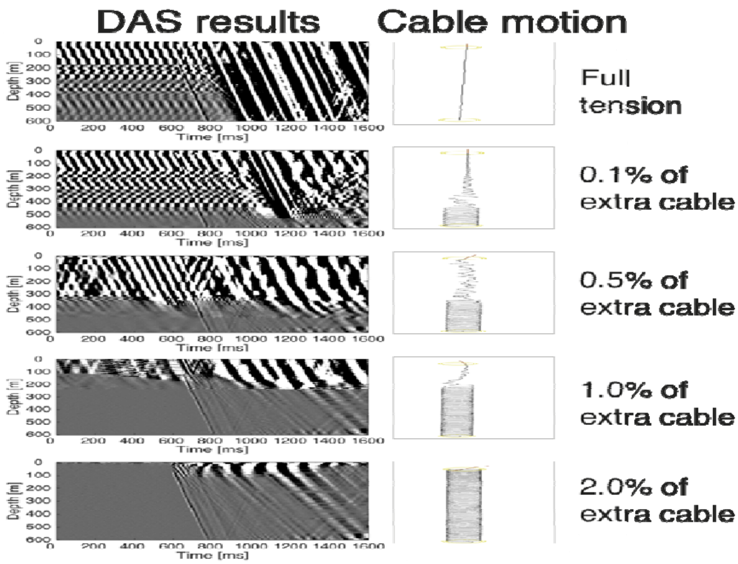

Figure 5 DAS results and cable movement with increasing cable slack. Left panel: DAS results under full tension (upper column) to 2% of cable slack (lower column). Right panel: Corresponding numerical evaluation of cable movement when additional cable has been lowered down the borehole (adapted from Schilke et al., 2016).

References:

Hartog A.H., Frignet, B. Mackie D. and Clark M. 2014. Vertical seismic optical profiling on wireline logging cable. Geophysical Prospecting, 62(4), 693-701.

Hartog, A.H. 2017. An Introduction to Distributed Optical Fibre Sensors. CRC Press.

Schilke, S., Donno, D., Hartog, A., Farahani, A., Pico Y. and Chauris, H. 2016. Numerical evaluation of sensor coupling of distributed acoustic sensing systems in vertical seismic profiling. SEG International Exposition and 86th Annual Meeting, 16-21 October, Dallas, 2016.