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A Case of SI Attenuation in 4D Seismic Data Recorded With a Permanently Installed Array

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Abstract

For seismic reservoir monitoring, interference noise from other seismic operations can cause either delays in data acquisition due to timesharing, or additional efforts to attenuate the seismic interference (SI) during processing.

Here we present a method which takes advantage of the different shot interval and flexible recording length of the monitoring system, allowing efficient attenuation of the SI by adaptive subtraction. The method is successfully applied to multi-component 4D data.

Introduction

In 2003 a multi component geophone array was installed at the Valhall Field in the Norwegian sector of the North Sea, to allow acquisition of time lapse seismic for reservoir monitoring. Since then seven surveys have been acquired over the array as part of the Valhall Life of Field Seismic (LoFS) project.

To get optimum data quality it is important to minimize the effect of non-repeatable noise, such as rig activity or noise from other vessels working in the field, or from SI. To reduce the amount of SI in the data will in many cases mean delaying the acquisiton by having to set up a time sharing agreement with a competing seismic operation. And if the data has to be collected within a given time window, time sharing may not be an option.

Experience from Valhall LoFS has shown that SI often presents a particular challenge due to the strength and duration of the interfering signal, and the method that we present here was triggered by an instance where we had a seismic streamer vessel operating only 20-40km west of Valhall while we were acquiring LoFS data. This situation was of course equally problematic for the streamer operation, and for the streamer operator, the SI from the LoFS shooting had to be handled during data processing. Manning et al. (2006) present an account of this and a list of different approaches that can be applied.

Here we will explain the method that was used for LoFS to mitigate the problem of excessive SI.

Survey	1	2	3	4	5	6	7
SI	44%	10%	23%	0%	12%	25%	29%

Table 1. Amount of shot lines with SI for each LoFS survey.

Each full LoFS survey has about 50 000 shot points and covers an area of about 125 sq. km. The array itself covers 45 sq.km, for more details see Kommedal et al.(2004). As can be seen from table 1, which shows the amount of SI for each survey, only survey 4 was acquired without SI, but this could only be done at the cost of 10% added survey days due to time sharing. The strengt of the SI varies, but it is typically about 30-40 microbar, the same range as vessel noise and noise from the rig. However, while the rig and vessel noise are most noticable within a couple of hundred meters from their source, the SI is recorded on all receiver stations as it propagates across the survey area. In this part of the North Sea the water depth is relatively constant at about 70-80m, and so the water layer acts as a wave-guide, and the SI signal is a dispersive, ringing signal with strength depending on the distance to the source.

Method for SI removal and Data Examples

The method we have used to remove the SI is based on the observation that the shot interval for the LoFS acquisition and the interfering streamer operation are different, 22s and 9s respectively. In addition to this we are able to vary the recording length for the LoFS array and in this case we have chosen 20s records. In each 20s record there will be two instances of interfering shots. For the processing of the LoFS data, only the first 9s of the seismic traces are used, and so if there is a SI signal in this part of the trace, there will be a second SI signal in the latter part of the trace. This second signal can be extraced and used to eliminate the SI signal in the useful first 9s of the record. This is done by estimating the travel time difference between the two SI signals from the maximum of the autocorrelation of the 20s records in a window between 8 and 11s. Then a window containing the second SI signal is found simply by using a suitable amplitude treshold, and finally the extracted signal is shifted to match with the SI signal in the first 9s of the trace, and a least square