4D monitoring enhancement with LostCor filtering

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Geostatistics for Geophysics

Thomas Demongin[1], Cédric Magneron[1], Matthieu Botz[1]
[1]Estimages S.A.

Introduction

Seismic data sets are impacted by acquisition or processing artefacts that challenge seismic interpretation. **Factorial Kriging** is a variogram-based filtering technique, an additive model where the spatial variable is modeled by a random function. This function is defined by independent terms: signal and noise. Estimating the signal part of a variable with factorial kriging enables noise filtering. In the case of **seismic reservoir monitoring (4D)** the base and monitor surveys can be filtered independently (single-variable approach) or simultaneously (multi-variable approach). This poster presents a **multi-variable filtering** approach called **LostCor Filtering[1]** which uses **co-factorial kriging**. Results correspond to seismic reservoir monitoring data of a field in production located in the West of Shetlands area (offshore UK).

LostCor Factorial Kriging

With a single-variable approach, experimental variograms of the base and monitor surveys are interpreted independently. A model is then chosen to represent both the signal and noise terms. With a **multi-variable approach** such as LostCor, the following assumption is made: base and monitor variables are correlated in terms of signal and sometimes of noise (repeatable noise); however, their signals are not **100% correlated in areas where production effects are expected.**

This assumption enables a robust filtering model, where a co-variogram model is used to filter out the noise components of the base and monitor simultaneously.

The key parameter is the **correlation coefficient between signals of the base and monitor surveys:**
it fluctuates in areas with 4D effects and is otherwise 100% correlated

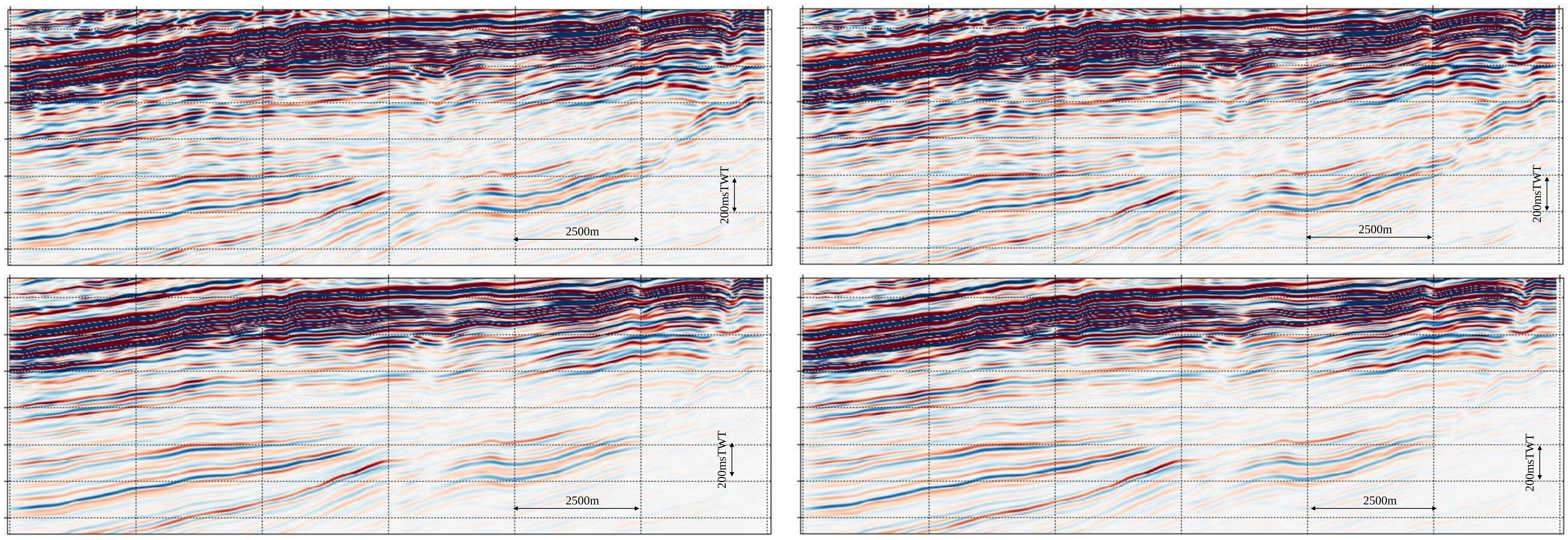

Figure 1. Results of co-factorial kriging applied on seismic reservoir monitoring data. Vertical section displays of base (left) and monitor (right) seismic amplitudes. Raw base and monitor seismic volumes (top) and co-filtered base and monitor seismic volume (bottom).

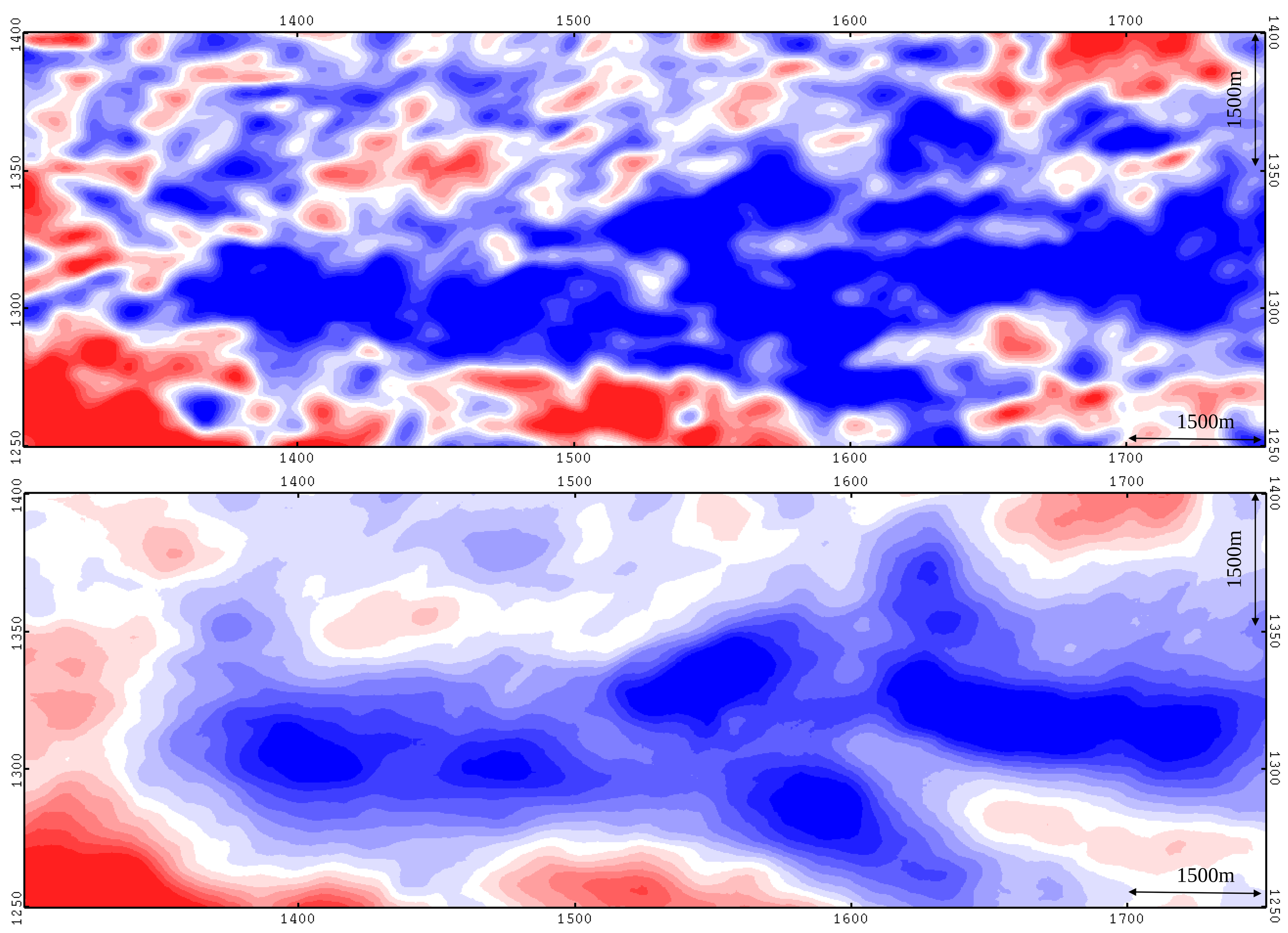

Figure 2. Time-slice displays (zoom). 4D difference of raw 400ms-window RMS attribute (top). Co-filtered (bottom).

Results

The base and monitor surveys illustrated here were acquired over an area of ~600km² with an interval of 8 years. A **short-scale isotropic artefact** was identified on both the base and monitor full stack volumes. This noise accounted for ~20% of the total spatial variability of the data sets and was filtered out. The use of **local parameters (M-GS®)** for all the components of the LostCor model was strongly recommended. Varying parameters such as dips, azimuths, ranges and sills improved the quality of the final results. In this example, 4 regional interpretations fed the model with additional information about the geology. Combined with the M-GS® technology**[2]**, they served as a structural guide for the full 3D filtering process. Knowing that very low amplitude regions corresponding to cemented zones were present in the local geology, the filter intensity had to vary locally.

Results show an efficient attenuation of noise while regions of consistent seismic response are strengthened. All 4D QC properties are improved and the amplitude difference shows a more laterally consistent response around producing wells. Filtered volume and extracted artefacts were scanned to make sure that no geology was removed during the co-filtering process.

Conclusion

Co-filtering the base and monitor with the LostCor model
enabled easier interpretation of 4D difference attributes

Combination of multi-variable geostatistics and local parameters gave impressive results in a 4D noise attenuation context. The LostCor model is flexible enough to integrate local constraints (cemented zones, coherency attribute) while ensuring the **optimal removal of all types of noise, structured or not, stationary or not**. The same co-filtering process could be applied on sub-stack volumes for AVO studies.

Contact

ESTIMAGES France
email: contact@estimages.com
website: estimages.com

References

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