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Local Geostatistical Filtering Using Seismic Attributes

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Introduction

Geostatistical filtering is powerful mean to clean post-stack amplitude seismic. The challenge is not to filter too much signal. **Local geostatistics (LGS)** can help to account for non-stationarity that is often encountered within seismic data sets and to filter the right amount of noise at each location. There are several approaches to compute the optimised parameters. Amongst them, **mathematical morphology** techniques provide a set of tools to analyse the image. **Seismic attributes** analysis helps the geostatistical data analysis that is key to the parameters choice. Furthermore, mathematical morphology coupled with seismic attributes can help LGS parameters tuning.

→ **Mathematical morphology coupled with seismic attributes helps LGS characterisation**

Objectives and approach

The aim of this paper is to provide examples of the usage of conventional **seismic attributes** to define local parameters of the geostatistical filters.

What?

- Parameters: variogram model and neighbourhood extension
- Attributes: dip, azimuth, coherency, local statistics

How?

- Use seismic information to decompose seismic amplitudes into signal and noise
- Convert seismic information to kriging parameters

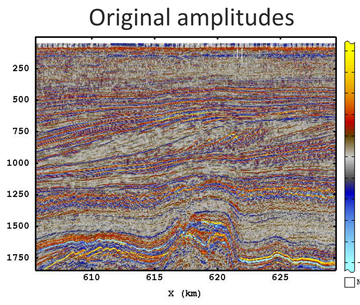
→ **How to find a methodology to derive kriging parameters from seismic information?**

Methodology

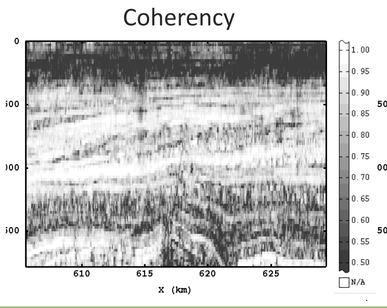
1. Compute initial parameters
- Attributes
- Global variogram
- Trend modeling

→ **Allow to determine coherent noise structures**

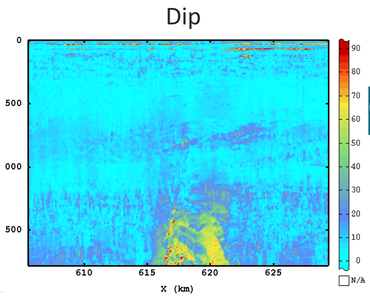
Original amplitudes



Coherency



Dip

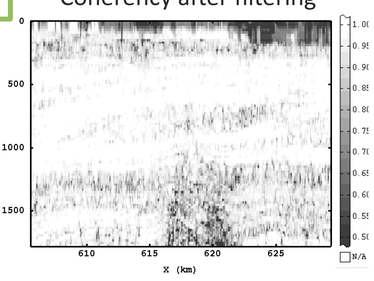


2. Define background parameters
- Attributes
- Local variograms

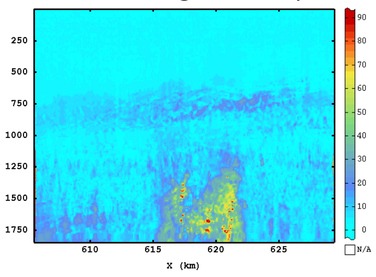
→ **Allow deep analysis of signal vs noise**

2.a. Combine attribute information to create background parameters

Coherency after filtering



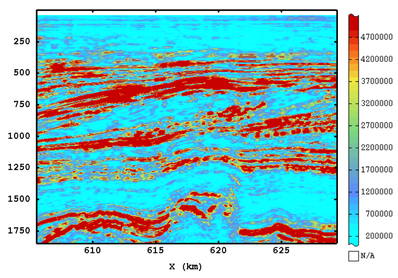
Dip after filtering and edition using coherency



2.b. Compute variogram on flattened seismic

Zone1 Zone2 Zone9

2.c. Compute local statistics (optional)



Local statistical variance

① Global filtering

② Definition of local parameters

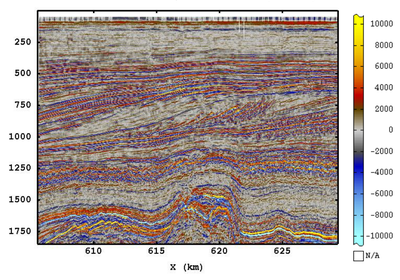
③ Optimisation

3. Optimise
- Local variogram ranges
- Local variogram sills
- Local neighbourhood

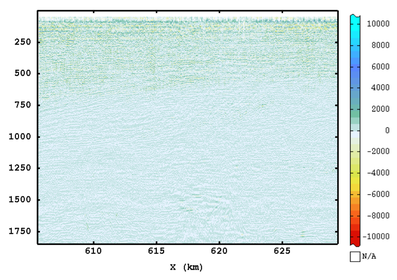
④ LGS filtering

4. Filter with LGS

Filtered amplitudes (LGS)



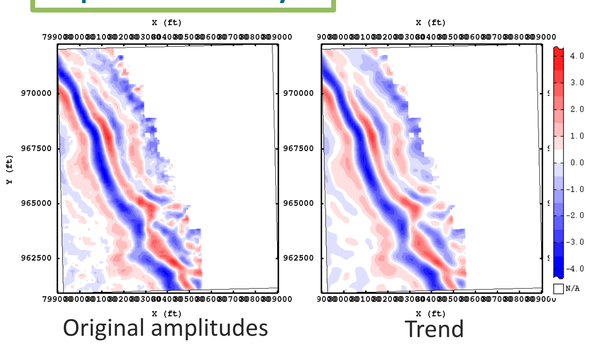
Filtered artifacts (LGS)



Results

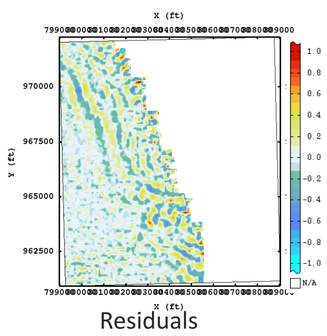
Case 1: Teapot Dome Seismic Data Set (June 13, 2007)

Step 1: Global analysis



Original amplitudes

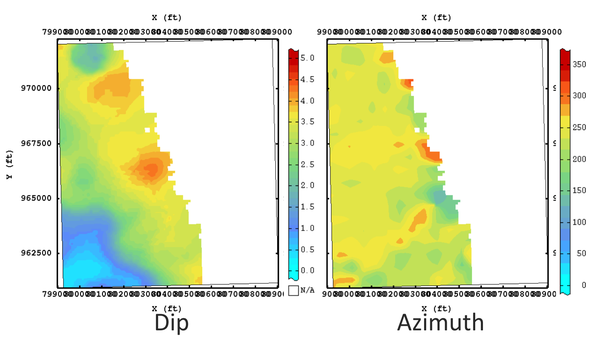
Trend



Residuals

Global variogram

Step 2: Local analysis

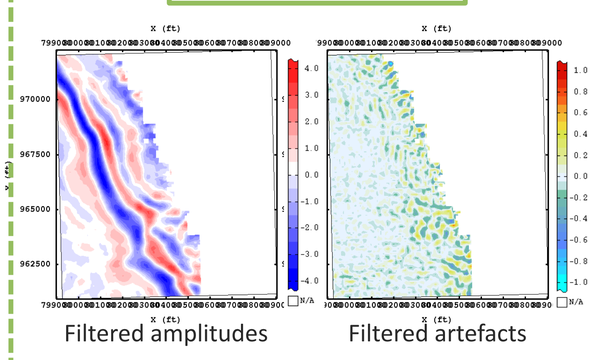


Dip

Azimuth

Need consistency with background geology

Step 3: LGS filtering



Filtered amplitudes

Filtered artefacts

Less geology in the artefacts

Case 2: F3 Block, Offshore, North Sea (1987)

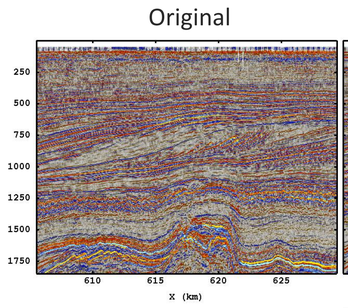
Step 1: Global analysis
- Compute global variogram
- Compute seismic attributes
- Global filtering of seismic

Step 2: Local analysis
- Compute background seismic attributes using filtered seismic
- Compute flat variogram (after flattening per zones)

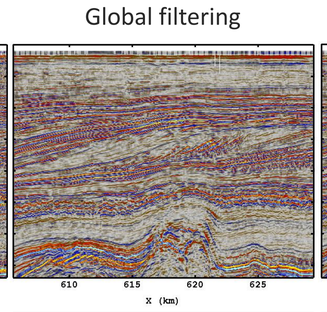
Step 3: Optimise local parameters
- Structures orientation
- Structures sill
  → Use moving variance inside the filtering neighbourhood

Step 4: LGS filtering

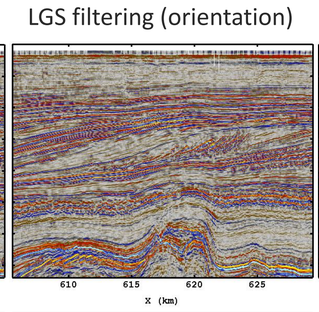
Original



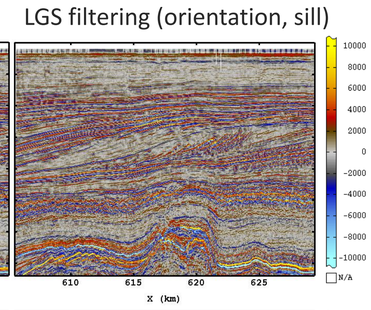
Global filtering



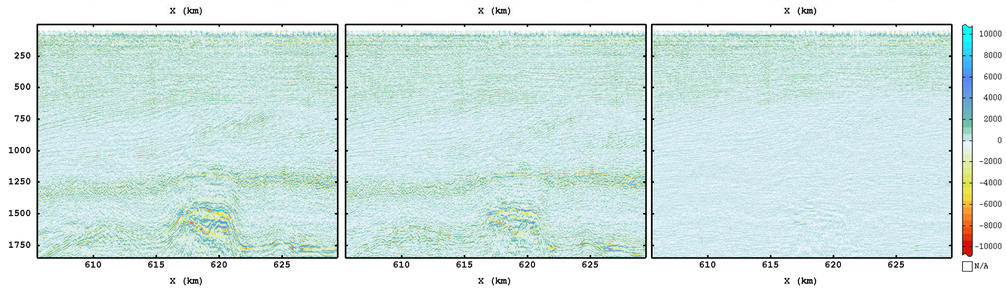
LGS filtering (orientation)



LGS filtering (orientation, sill)



Inline 424 display
First row: amplitudes
Second row: artefacts (i.e. differences with the original)



Conclusions

- **Mathematical morphology** coupled with **seismic attributes** helps **LGS characterisation.**
- **LGS characterisation** helps to **better define signal vs coherent noise structures.**
- Finding local parameters is not trivial since **background parameters** need to represent the true signal and **require an optimisation step.**
- **Local geostatistics** results can be **more precise** but difficult to define and more demanding in term of computation time.

All results obtained using: the iSATIS software, developed by Geovariances (http://www.geovariances.com) & the **EarthQuick** software (http://www.earth-quick.com)