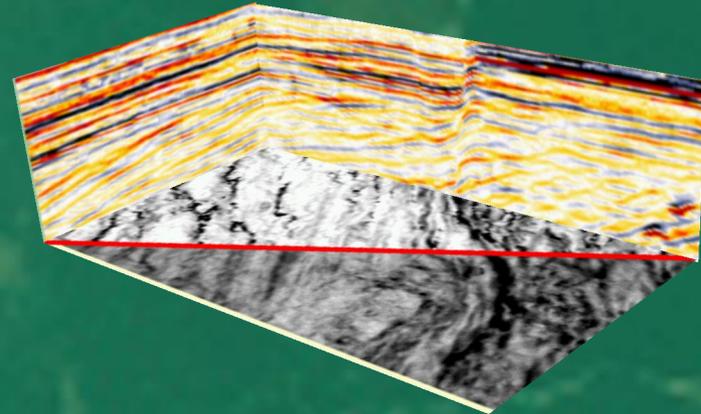
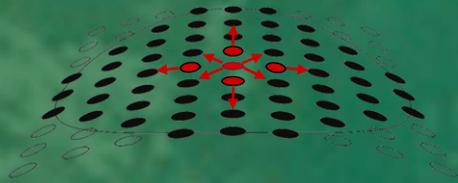




# Creating a good Steering Cube

## Friso Brouwer



*What is a steering cube?*

*Creating a steering cube.*

*Detailed vs. background steering.*

*How to use detailed and background cubes as steering.*

*How to use detailed and background cubes as attributes.*

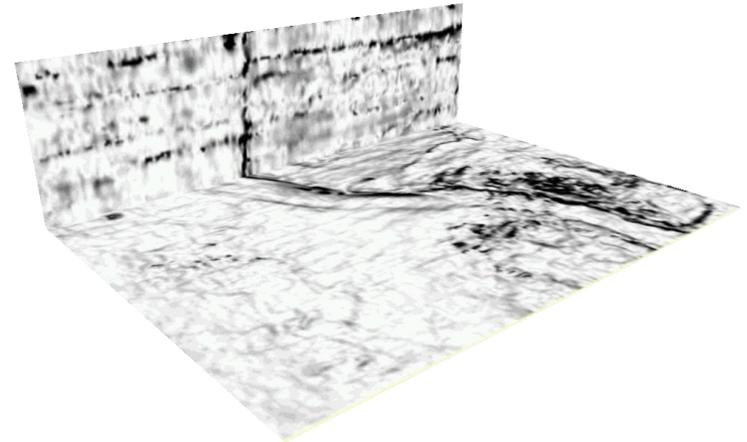
# Steering Cube Definition

## What is a Steering Cube?

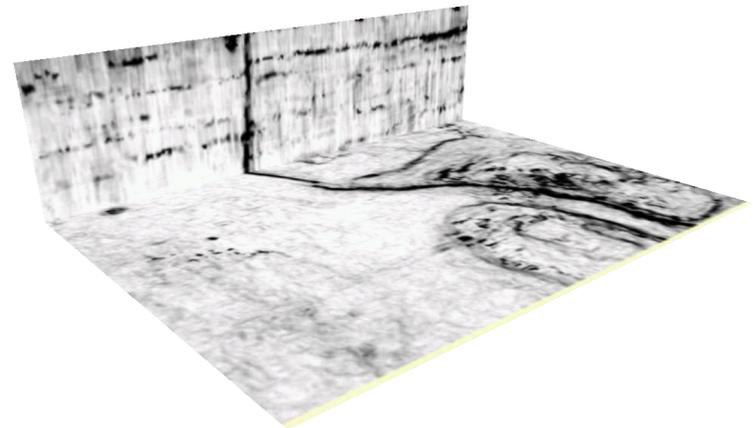
- the Steering Cube contains the dip and azimuth of the seismic events in inline and crossline direction at every sample point.

## Why create one?

- the dip itself is an attribute.
- the dip is used to correct other attributes for structure.
- the dip is used for Structurally Oriented Filtering (SOF).



*Polar Dip: dip is an attribute*



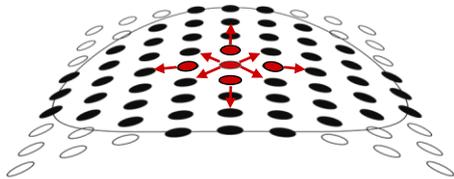
*Steered Similarity: dip is guiding another attribute*





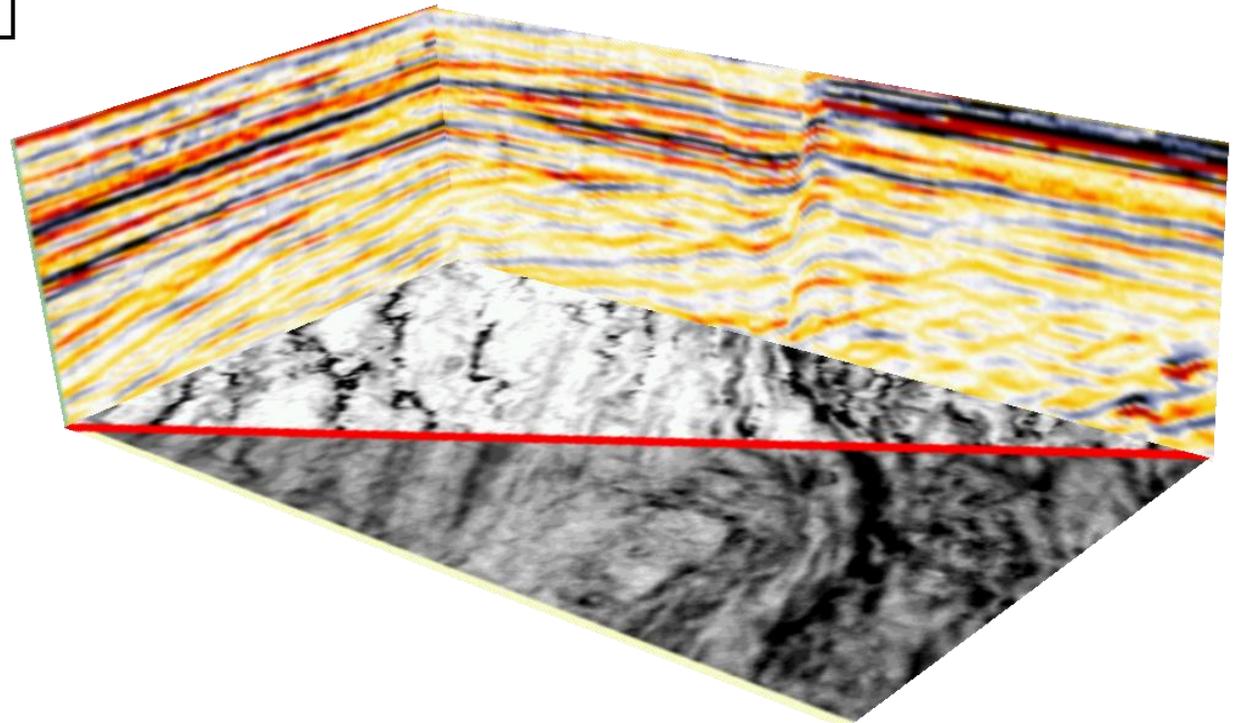
# Steering Cube Definition

## Concept of dip-steering



Attributes are guided along a three dimensional surface on which the seismic phase is approximately constant.

## Effect of dip steering



**Steered similarity** (background of slice) vs. **no steered similarity** (foreground of slice). Note that the steered similarity has higher **contrast**, higher, **resolution** and less **spurious events**.





# Using the BG algorithm

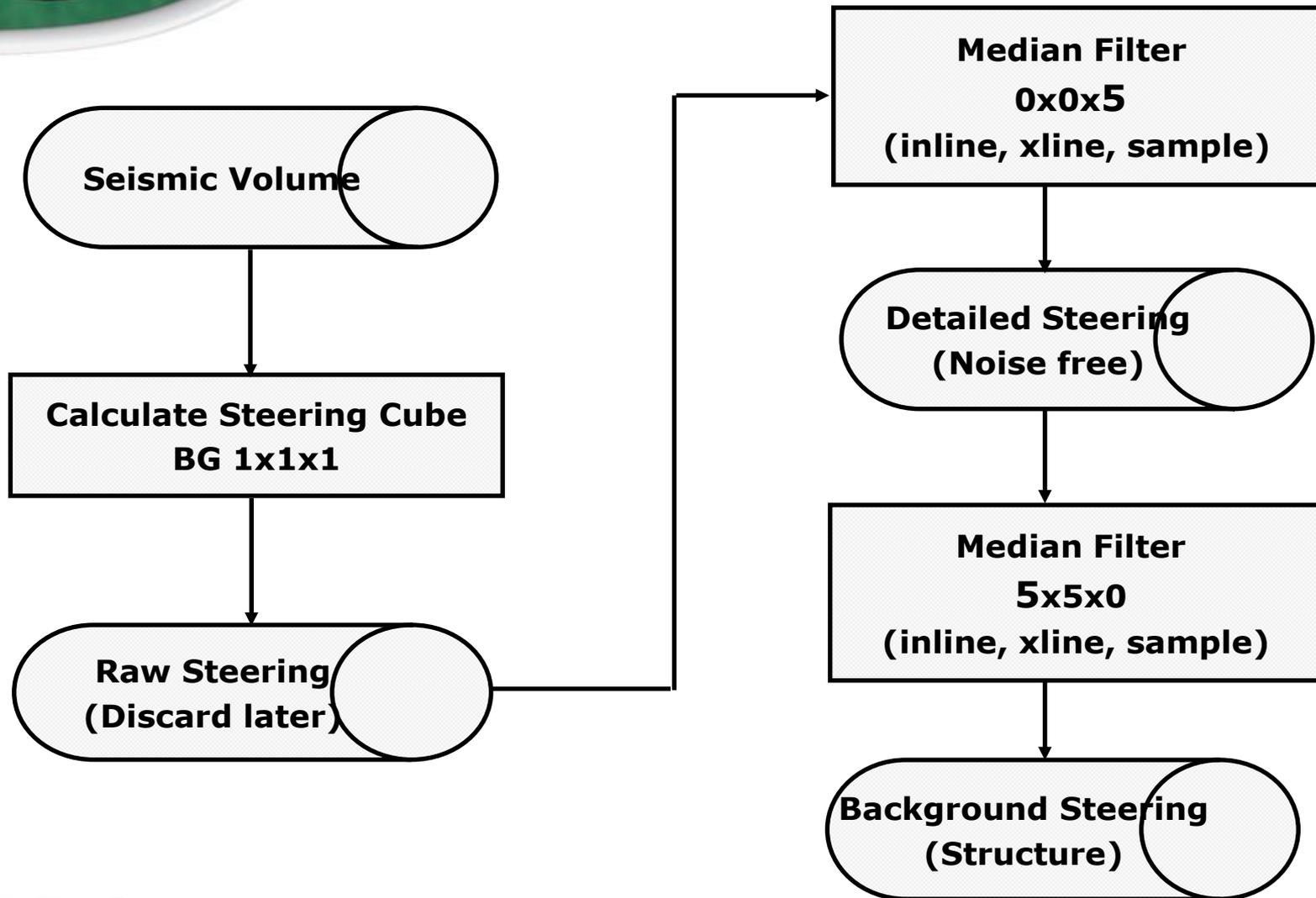
## The BG algorithm

- The **fastest** algorithm available.
- Noise sensitive.
- Noise problem is solved using **MF (median filter)** on the steering cube.
- With MF filtering the speed is still superior to alternative methods.

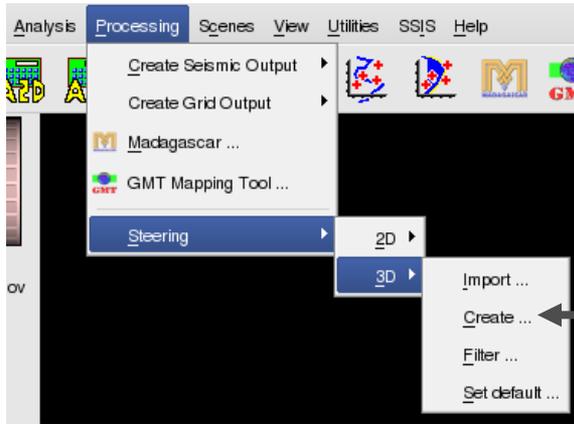
## Detailed and Background Steering Cubes

- **Detailed Steering Cube:** preserved detail in lateral direction (e.g. dip & azimuth variations due to faults or channel cut). Local information preserved.
- **Background Steering Cube:** a laterally smoothed cube that reflect global dip trends. Regional information preserved.

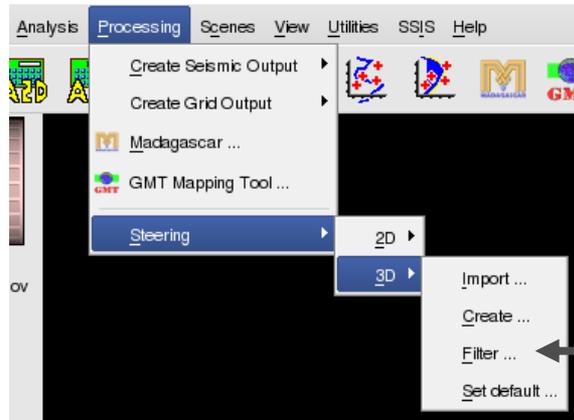




# Creating a Steering Cube



*To calculate a new Steering Cube go to the Processing tab in the menu bar. Select "Steering" (->3D/2D)-> "Create"*

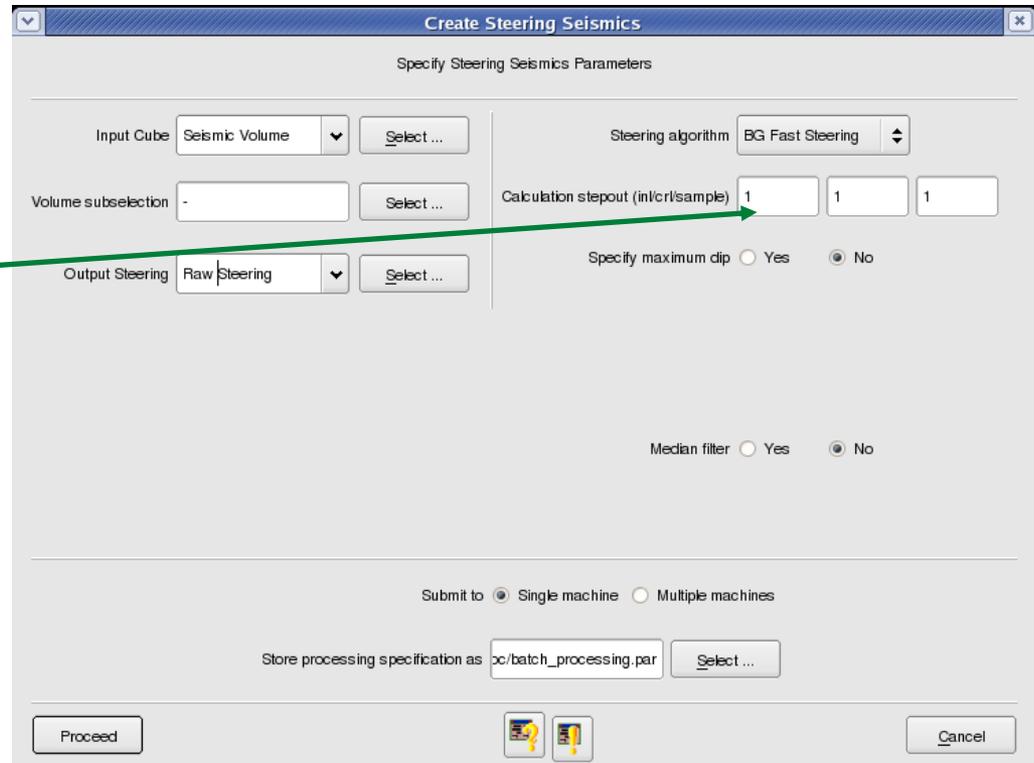
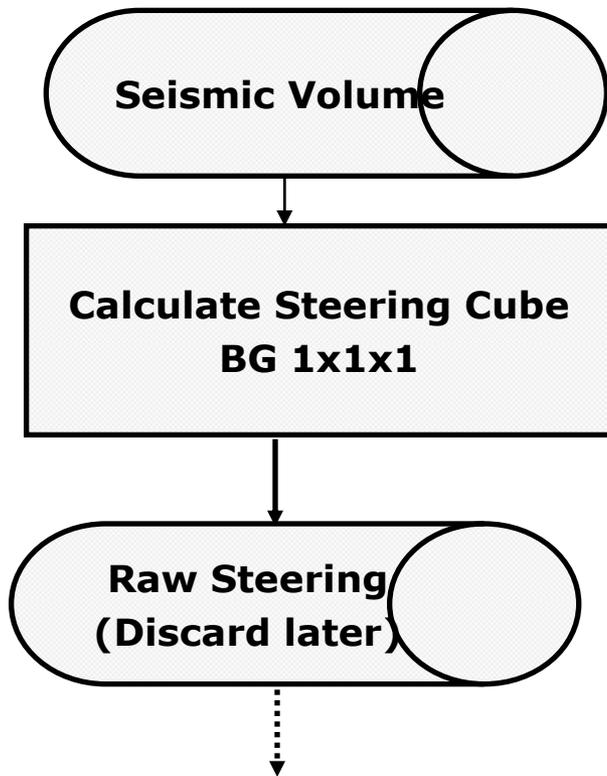


*To filter an existing Steering Cube go to the Processing tab in the menu bar. Select "Steering" (->3D/2D)-> "Filter"*





# Creating a Steering Cube

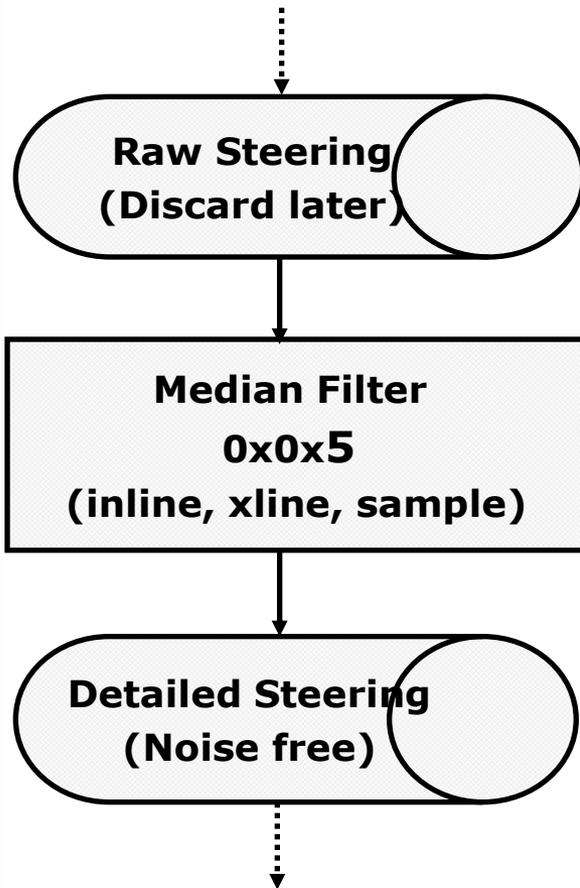


*Input cube is the seismic volume. Default method is BG with calculation stepout of 1x1x1. If "no" is selected for median filter, Raw Steering will be created as output.*





# Filtering a Steering Cube (Detailed)



*The first filter is applied to the **Raw Steering**. Filter step-out size is (0,0,5). The output is the **Detailed Steering**.*





# Filtering a Steering Cube (Background)

Filter Steering Seismics

Specify Median Filter Parameters

Input Steering Data: Detailed Steering [Select ...]

Volume subselection: - [Select ...]

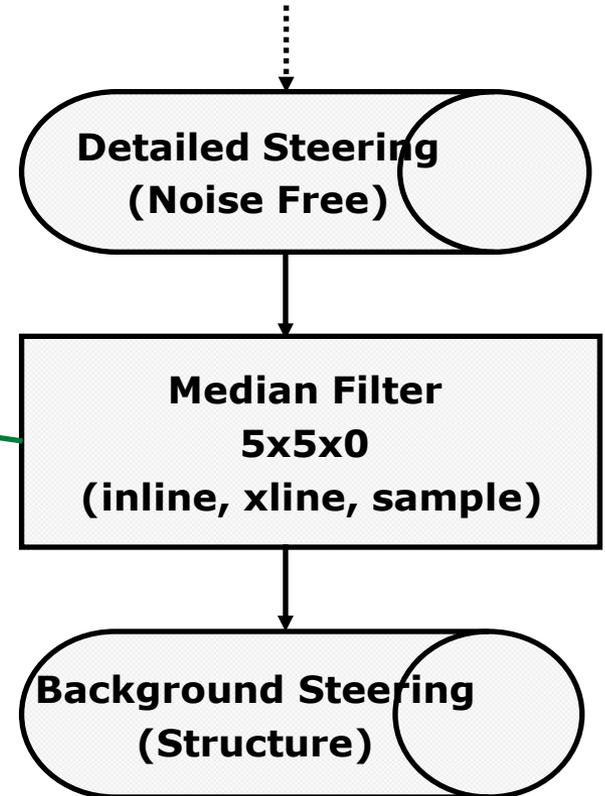
Filter stepout (in/cr/sample): 5 5 0

Output Steering: Background Steering [Select ...]

Submit to:  Single machine  Multiple machines

Store processing specification as: xc/batch\_processing.par [Select ...]

Proceed [?] Cancel



The second filter is applied to the **Detailed Steering**. The filter stepout size is (5,5,0). The output is the **Background Steering Cube**.





# Detailed vs. Background

## Detailed Steering

 Contains information about:

- Faults
- Flexures
- Stratigraphic features

 Use:

- As an attribute (e.g. polar dip, curvature): if detail should be emphasized.
- As steering (e.g. similarity): if detail should be removed.

## Background Steering

 Contains information about:

- Primarily background structure.

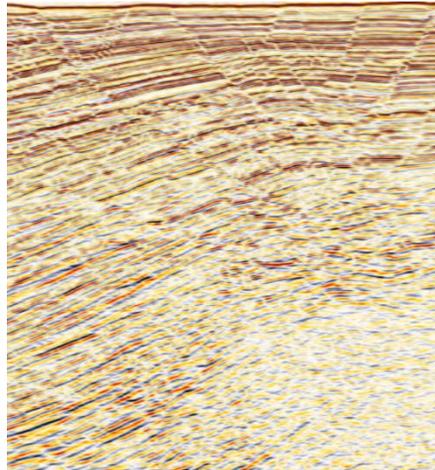
 Use:

- As an attribute (e.g. polar dip, curvature): if overall structure should be emphasized.
- As steering (e.g. similarity): if detail should be emphasized.



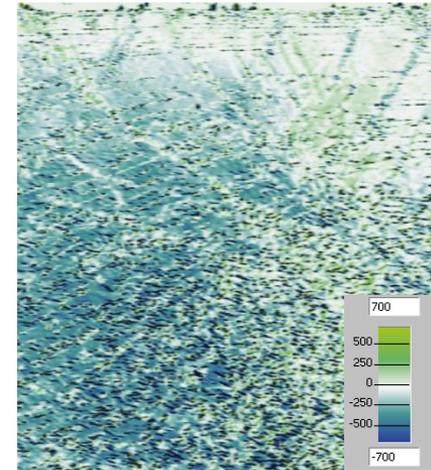
# Example: Steering cubes

## Full Stack



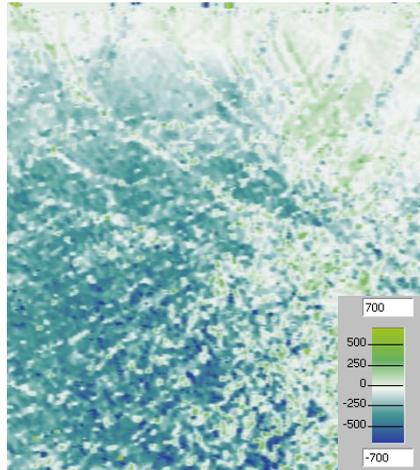
## Raw Steering (BG 1x1x1)

Contains many **noise spikes** and **bands of noise** around low amplitude levels & zero crossings



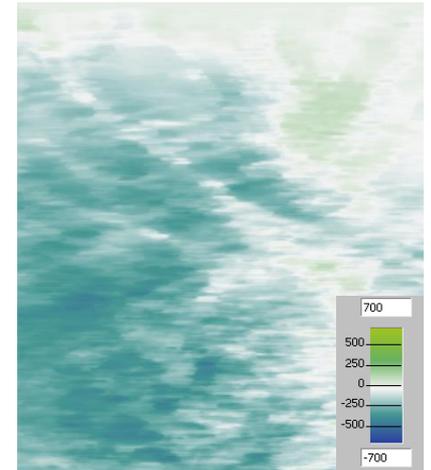
## Detailed Steering (+MF 0x0x5)

Noise removed. Remaining are **details** such as dip associated with fault drag.



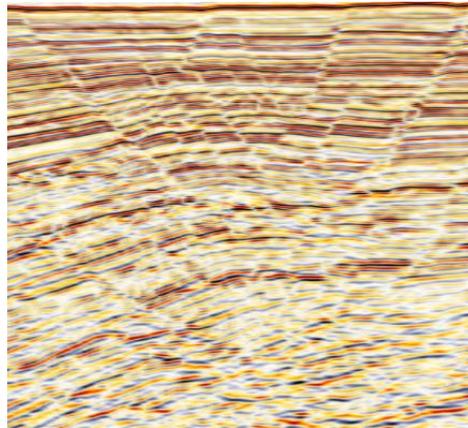
## Background Steering (+MF 5x5x0)

Noise removed. Details removed. Remaining is **structural dip**.



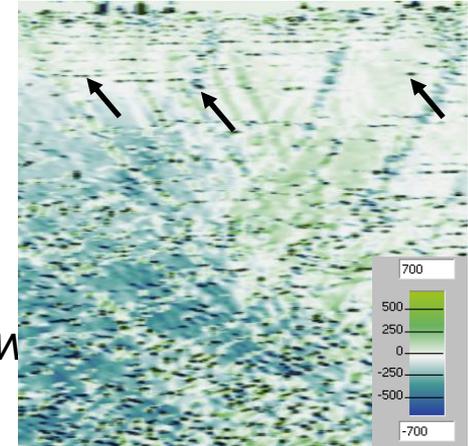
# Example: Steering Cubes

## Full Stack



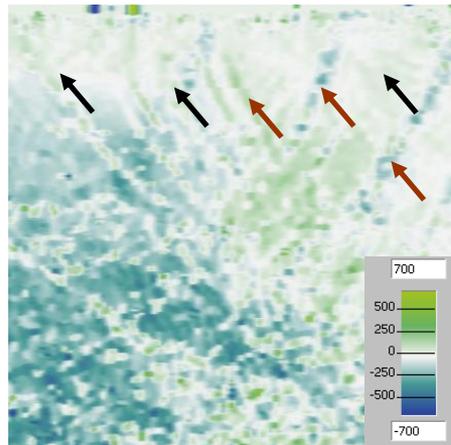
## Raw Steering (BG 1x1x1)

Contains many **noise spikes** and **bands of noise** around low amplitude levels & zero crossings (black arrows).



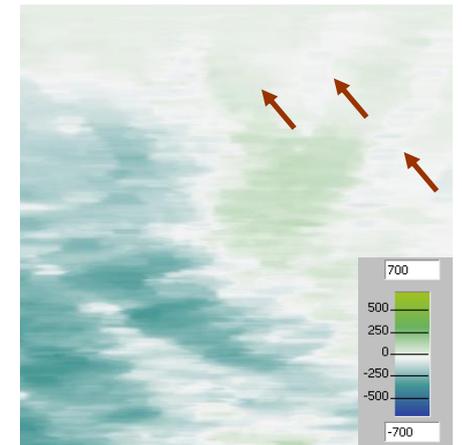
## Detailed Steering (+MF 0x0x5)

Noise removed. Remaining are **details** such as the dip associated with fault drag (red arrows).



## Background Steering (+MF 5x5x0)

Noise removed. Details removed. Remaining is **structural dip**.





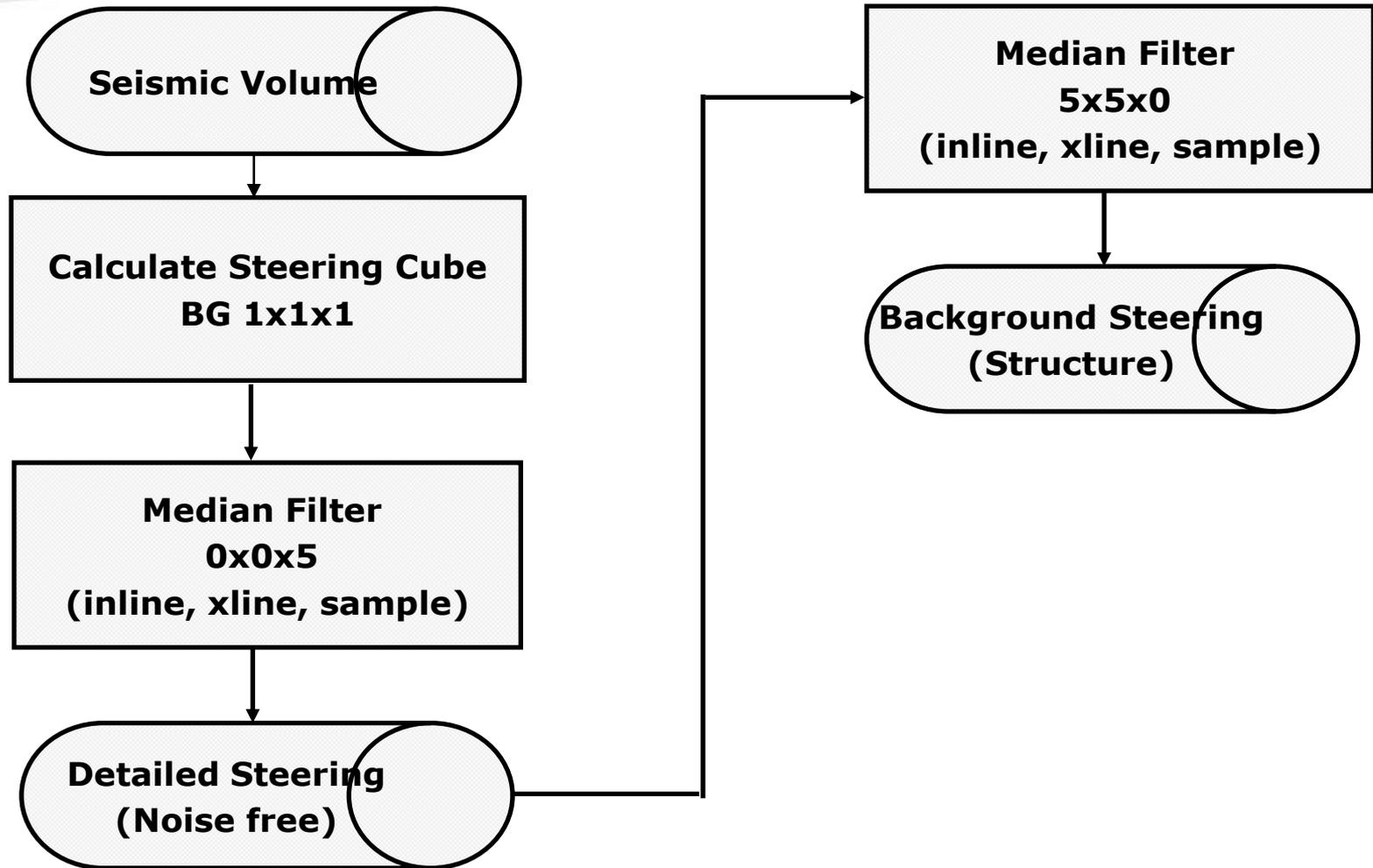
# Workflow: Efficiency

- The previous workflow was an educational step-by-step example.
- In practice, a more efficient workflow is used that streamlines the work.



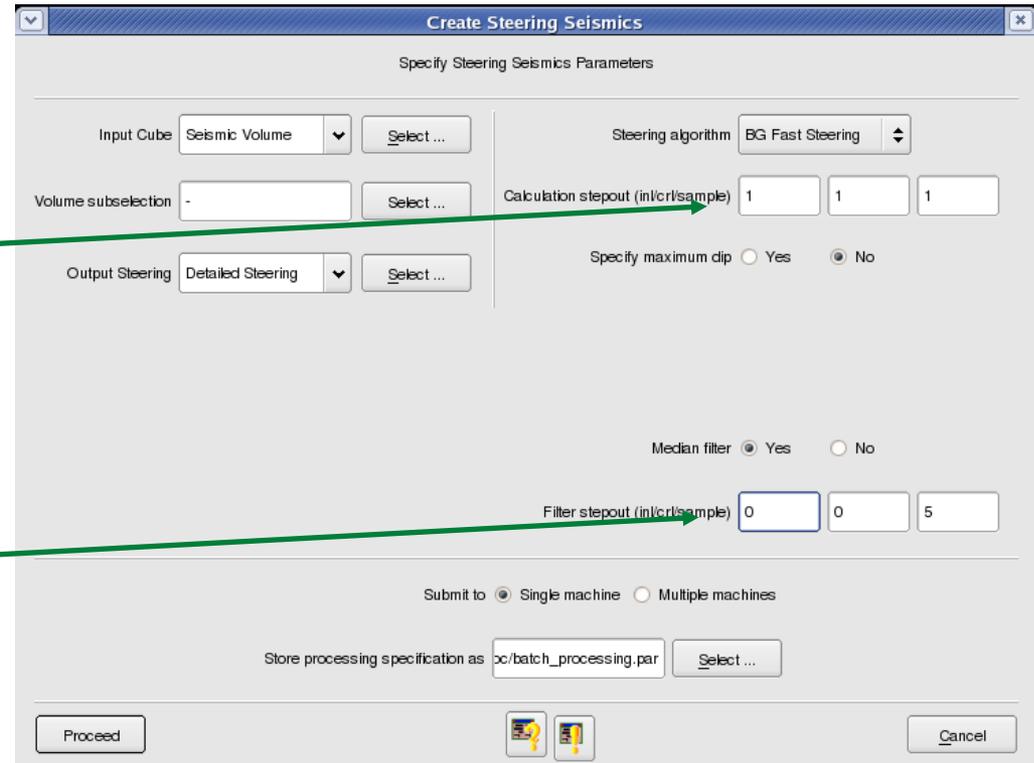
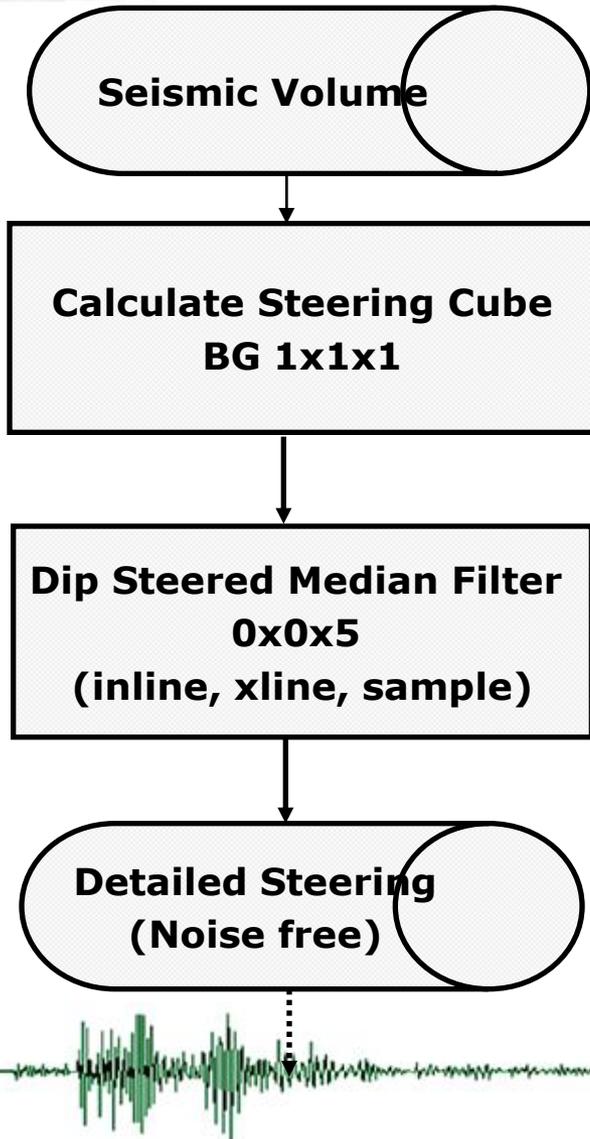


# Workflow: Efficiency





# Creating Steering Cube: Efficiency Detailed



*Filters can be applied to existing steering, as described in previous slides, or in one step in the Create Steering Seismics window shown above. Select "yes" for the median filter, then set parameters for detailed stepout size, and Detailed Steering will be created.*



# Filtering a Steering Cube: Background on Efficiency

Filter Steering Seismics

Specify Median Filter Parameters

Input Steering Data: Detailed Steering [Select ...]

Volume subselection: - [Select ...]

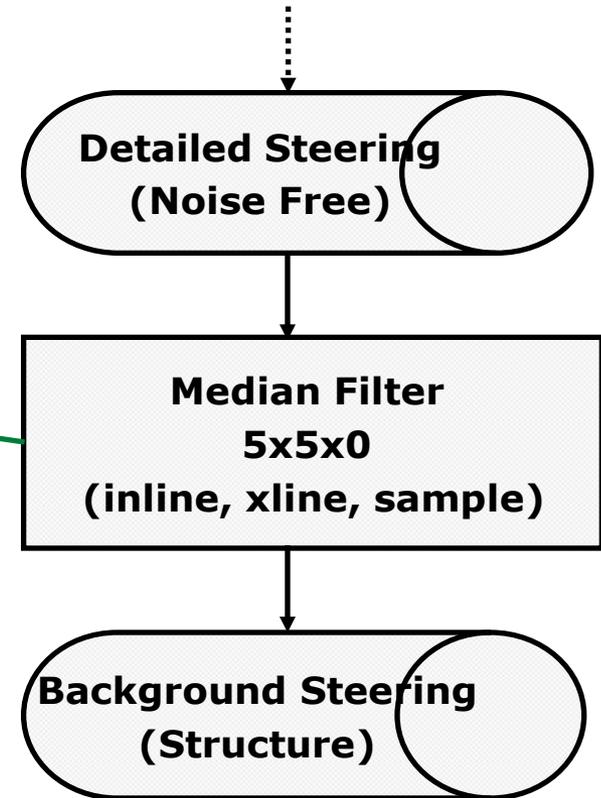
Filter stepout (in/crl/sample): 5 5 0

Output Steering: Background Steering [Select ...]

Submit to:  Single machine  Multiple machines

Store processing specification as: xc/batch\_processing.par [Select ...]

Proceed [?] Cancel



The **background** filter is applied to the **Detailed Steering** (created in the efficiency manner) just as it was done in the example that was created in the educational workflow. The filter stepout size is (5,5,0). The output is the **Background Steering Cube**.





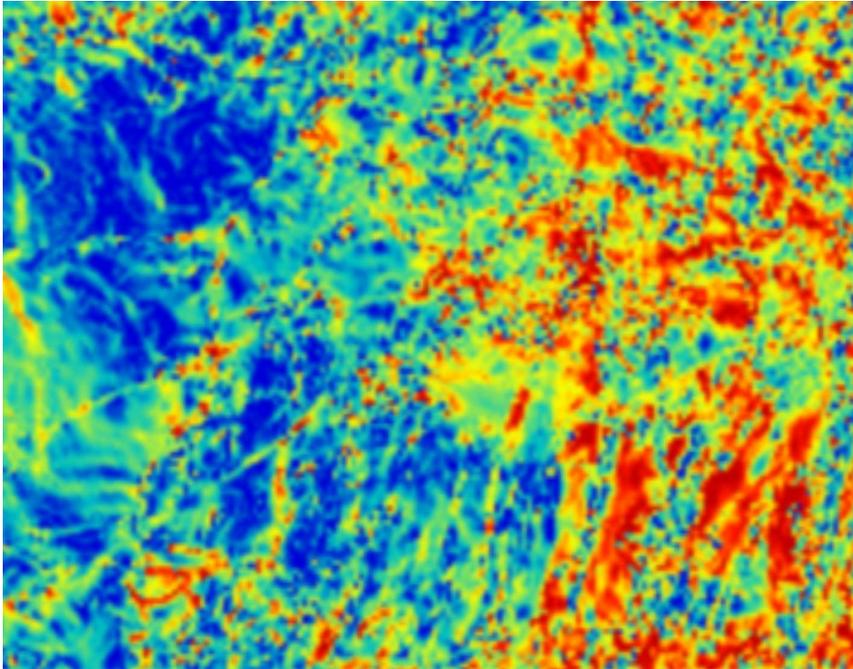
# Additional Ideas

- ✦ Though, in general, the default parameter values will give good results, experimenting with the settings might improve results for some datasets. This can be especially true in situations with anomalous data or data parameters (ex: low frequency content, very steep dips, 1 or 2ms time sample rate, small bin sizes).
- ✦ If the original seismic has low S/N, consider making a second generation steering cube:
  1. Create background steering on original seismic.
  2. Filter the original seismic using a dip-steered median filter.
  3. Create second generation steering cubes on the filtered seismic data.
- ✦ Steering is the input for the curvature attribute. Using different size operators for the background steering (creating multiple background steering options, ex: 3x3x0, 10x10x0, etc.) one can create multi-scale curvature volumes. As a rule of thumb, the median filter used to create the background steering will remove trends with a dominant wavelength smaller than  $\frac{1}{2}$  the filter length.

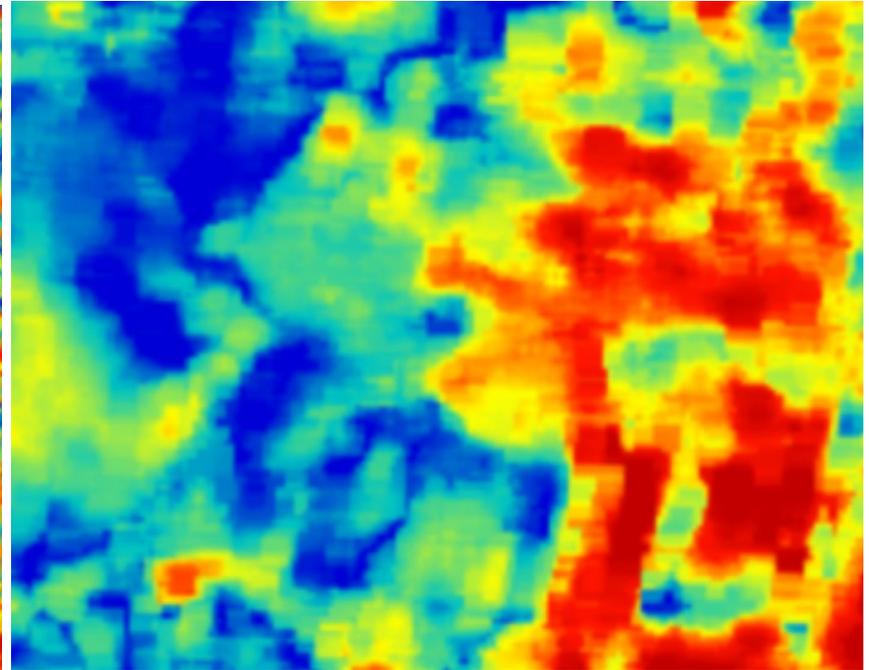




# Example: Attribute - Polar dip on timeslice



***Polar dip*** created with  
***Detailed Steering***. It shows  
***faults*** and other ***details***.

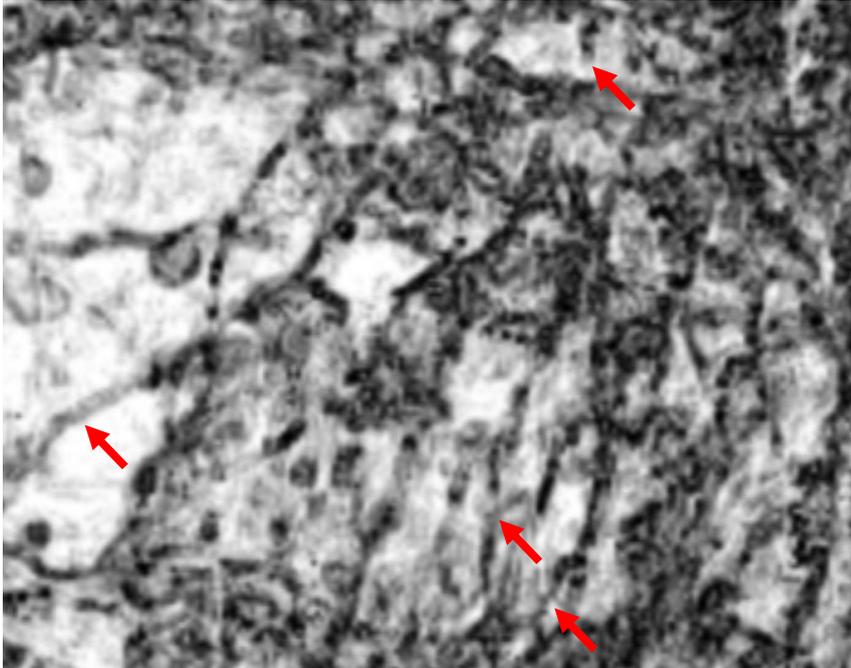


***Polar dip*** created with  
***Background Steering***. It  
shows mainly ***structure***.

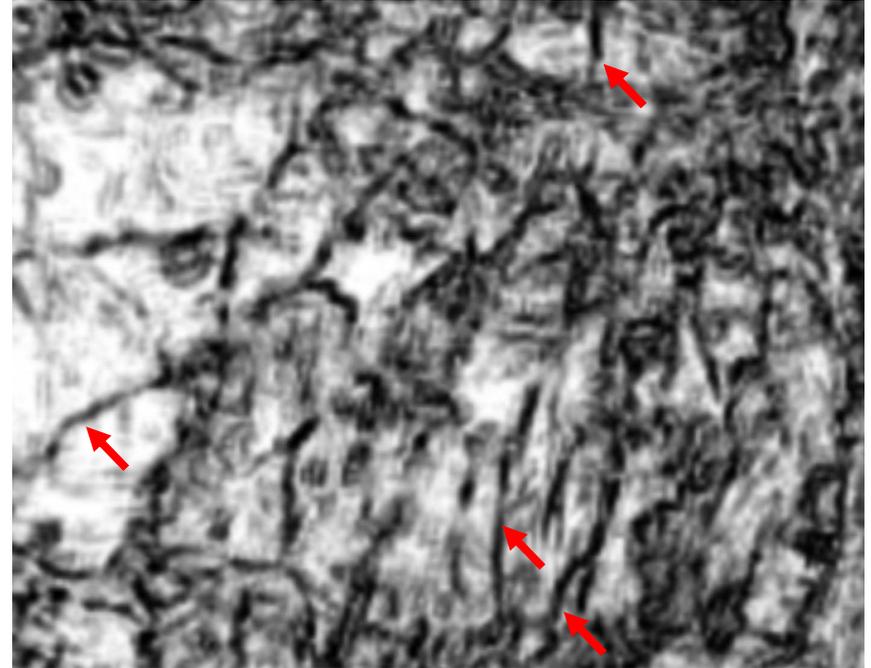




# Example: Attribute - Steered Similarity on timeslice



**Similarity** steered with **Detailed Steering**. It has areas where the faults are faded (red arrows).

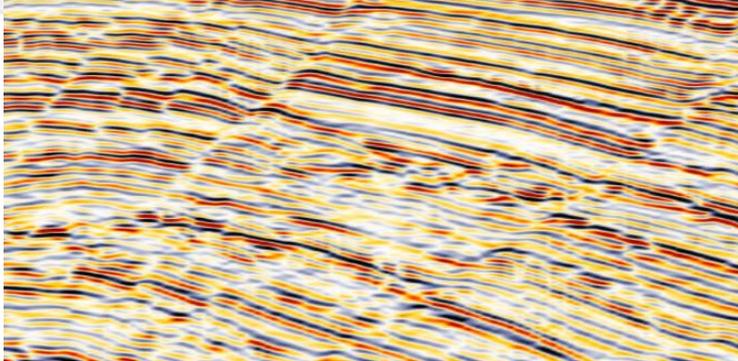


**Similarity** steered with **Background Steering**. **Steering** does **not correct** for **local (fault related) dips**. The imaging is better.

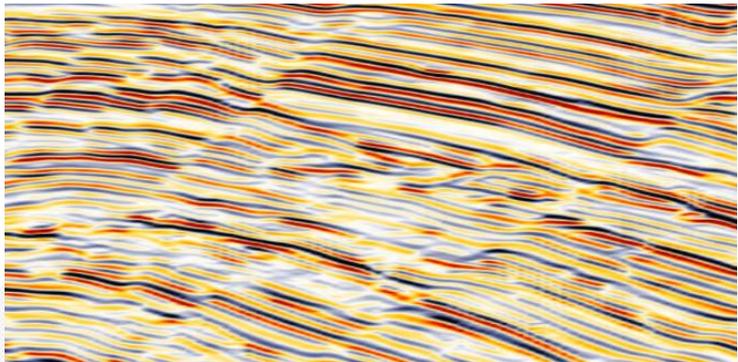




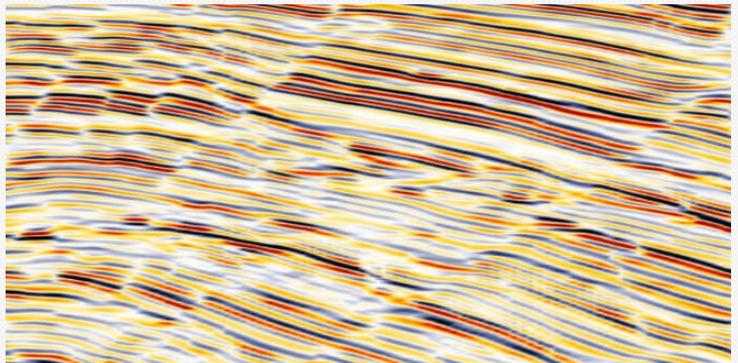
# Example: Steering - DSMF



**Full Stack** for reference.



**Dip Steered Median Filter** steered with **Detailed Steering**. There is smoothing across the faults and a number of artifacts are visible. Using the detailed steering tends to cause data distortion in areas with low S/N ratio. Using the MDF with Detailed Steering would only be advisable if enhancing details of stratigraphy is the main goal.



**Dip Steered Median Filter** steered with **Background Steering**. There is less smoothing across the faults and generally the imaging is better with less artifacts. In general the MDF should be applied using the **Background Steering Cube**.