

# Superimposed Geologic Features in Seismic Interpretation\*

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## Abstract

In seismic interpretation, accurate identification of geological features builds a better understanding of subsurface geology, which turns a prospect into a success. Most often geological features are superimposed on a seismic map because of geophysical and analysis parameters, or geologic complexities. Additionally, the seismic data is always band-limited and it is often hampered by noise. If the geologic features (e.g. channels, faults, and other structural and/or stratigraphic features) are superimposed together with noise, interpretation and finding scientific explanations can become difficult. The issue is primarily in 3D analysis, which has its own merits but it adds misleading elements and pitfalls in interpretation. These problems can include limited observation, loss of evidences, and reservoir distribution. The first challenge in interpretation is to resolve the problem by distinguishing the features from one another (improving resolution and definition). In this paper, few examples are presented to demonstrate the issue. Solutions to the problem of superimposed features are sought by applying advanced seismic interpretation techniques. Several of the workflows are proposed here. To remove noise and improve the visibility of geologic features, a structurally oriented filter is applied. The resolution problem is improved by applying spectral enhancement and spectral decomposition, which have improved the efficiency of algorithms and seismic attributes. Apparent seismic attributes and spectrally enhanced seismic data are also considered as the optimal choices to improve the results. This paper attempts to present various workflows as solutions to the issues that would indirectly help the industry to manifest such problems in prospect identification.

## References

Chopra, S. and K.J. Marfurt, 2007, Volumetric curvature attributes add value to 3D seismic data interpretation: *Leading Edge*, v. 26/7, p. 856-867.

Chopra, S. and K. Marfurt, 2007, Curvature attribute applications to 3D surface seismic data: *Leading Edge*, v. 26/4, p. 404-414.

Smith, M., G. Perry, J. Stein, A. Bertrand, and G. Yu, 2008, Extending seismic bandwidth using the continuous wavelet transform: *First Break*, v. 26, p. 97-102.

# *Superimposed Geologic Features in Seismic Interpretation*

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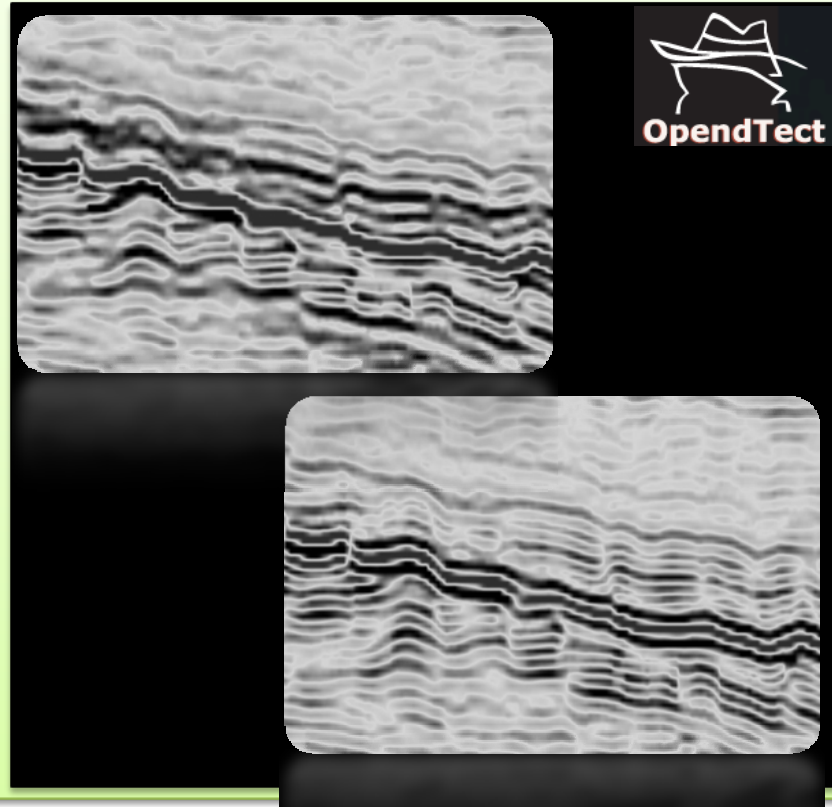
Sohail Yousaf<sup>2</sup>, Danish Malik<sup>3</sup>, Raheela

Zaheer<sup>4</sup>, M. Hammad Manzoor<sup>5</sup>

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Bahria University, Pakistan; <sup>5</sup>Geophysicist, Oil and Gas  
Investment Limited (OGIL), Pakistan.



# OUTLINE

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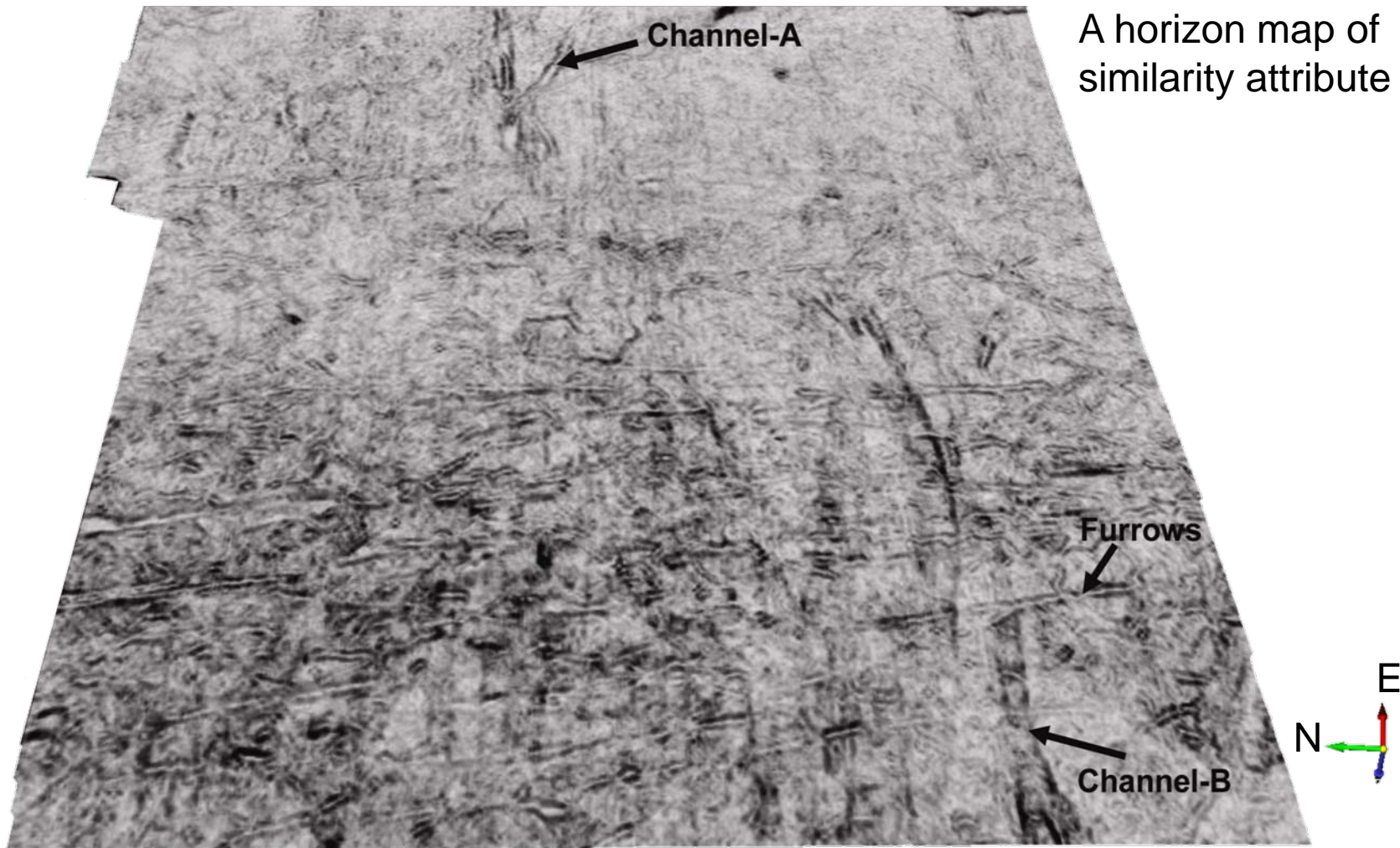
Slide 2

- Introduction
- Potential Triggers
- Workflows
- Conclusions
- Acknowledgement

# INTRODUCTION

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# POTENTIAL TRIGGERS

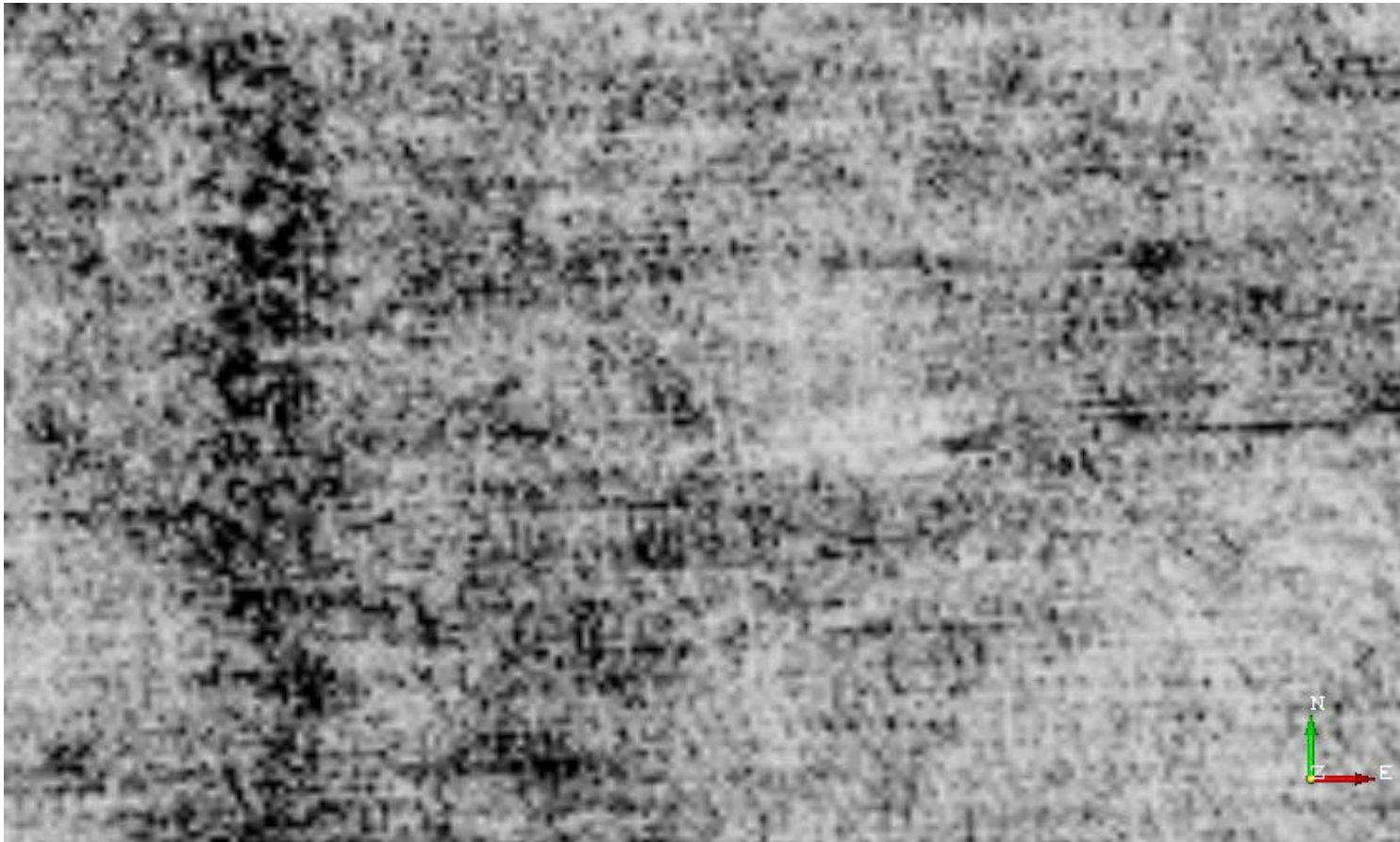
- Noise or Signal
- Seismic Resolution and Beyond
- Multiple Algorithms
- Choice of Seismic Attributes
- Algorithm Parameters
- Geologic Complexities

# POTENTIAL TRIGGERS

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## Noise or Signal

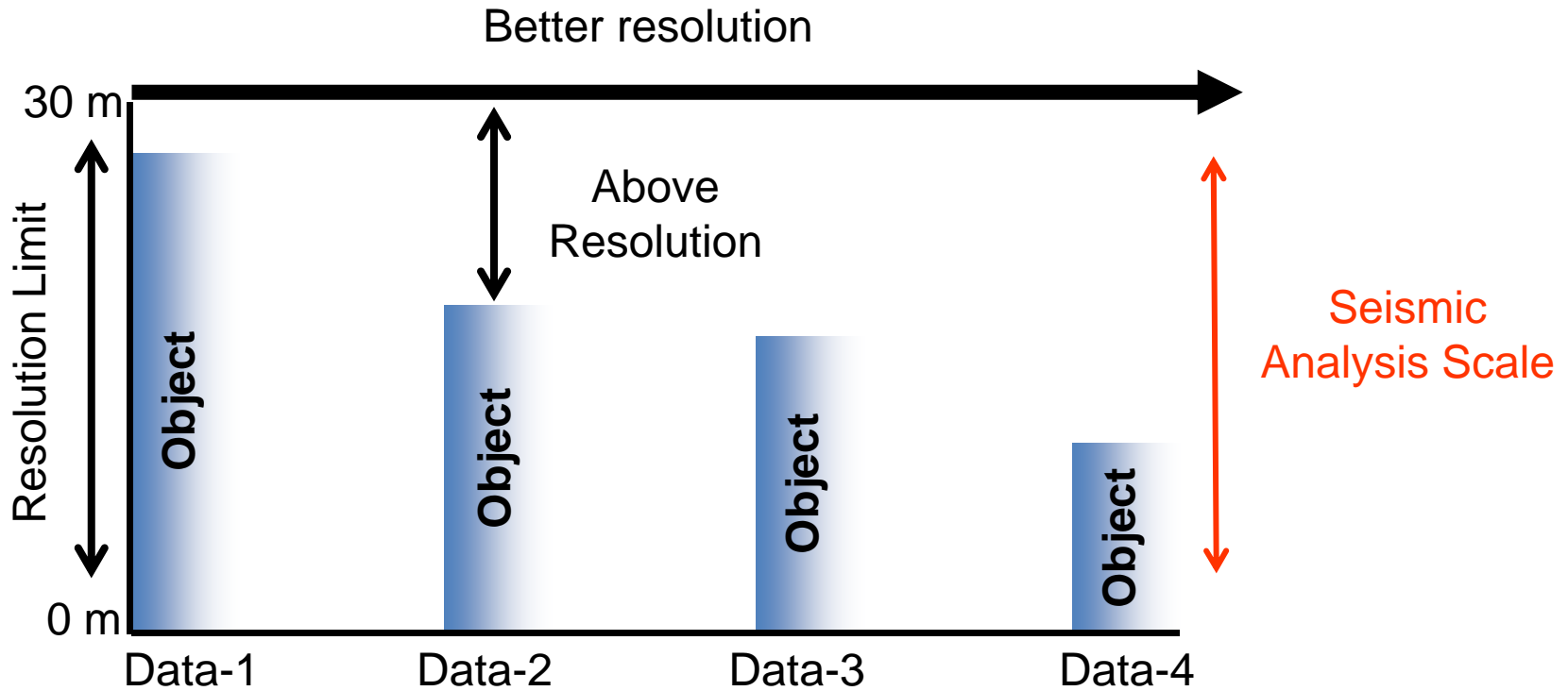


# POTENTIAL TRIGGERS

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## Seismic Resolution and Beyond



*Each data has it's own resolution limit*

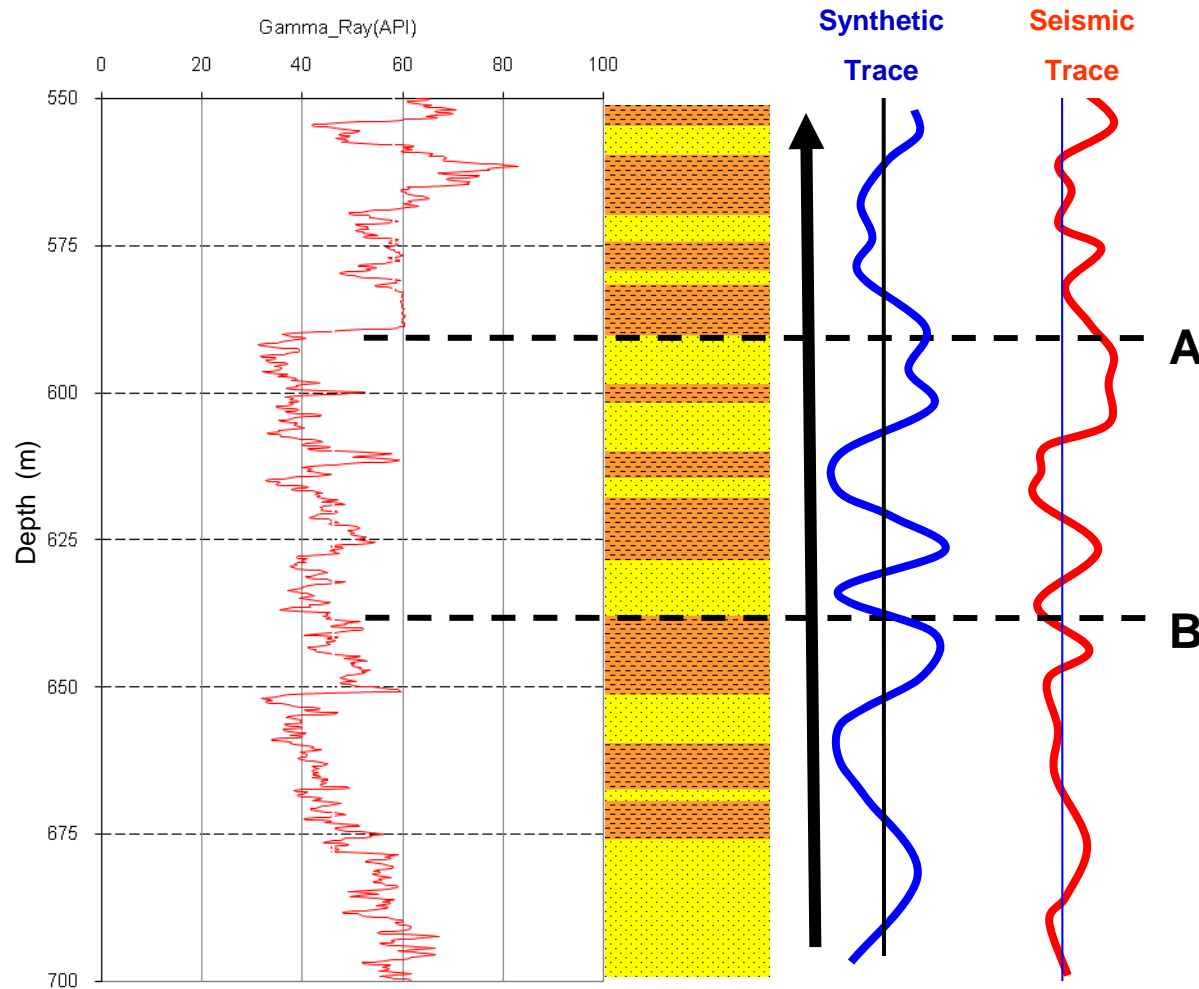


# POTENTIAL TRIGGERS

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## Seismic Resolution and Beyond



# POTENTIAL TRIGGERS

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## Multiple Algorithms/Attributes

***Attribute 1***

***(phase dependent)***

***Attribute 2***

***(amplitude dependent)***

***Attribute 3***

***(time gate limit)***

....

***Purpose-A***

# POTENTIAL TRIGGERS

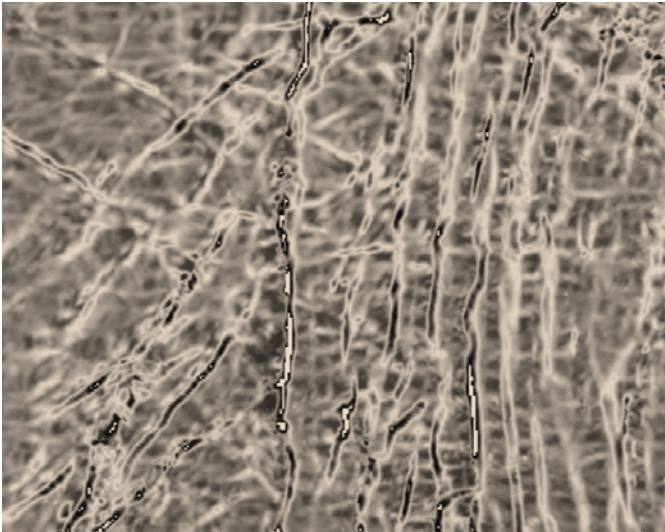
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## Choice of Seismic Attributes

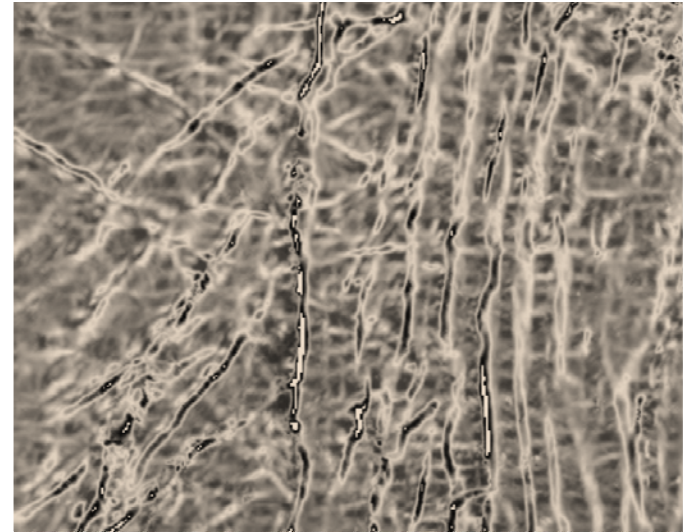
**Purpose:** *Structural interpretation*

**Good choice**

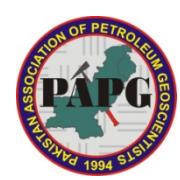


**Purpose:** *Stratigraphic interpretation*

**Bad choice**



*Same attribute but different purposes.*



# POTENTIAL TRIGGERS

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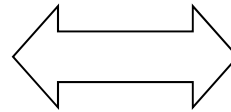
## Algorithm Parameters

*Vertical Samples (ms) – Time gate*

*Lateral Samples – Trace steps*

*Algorithm Constants,*

*other limitations*



Objective dependent choice

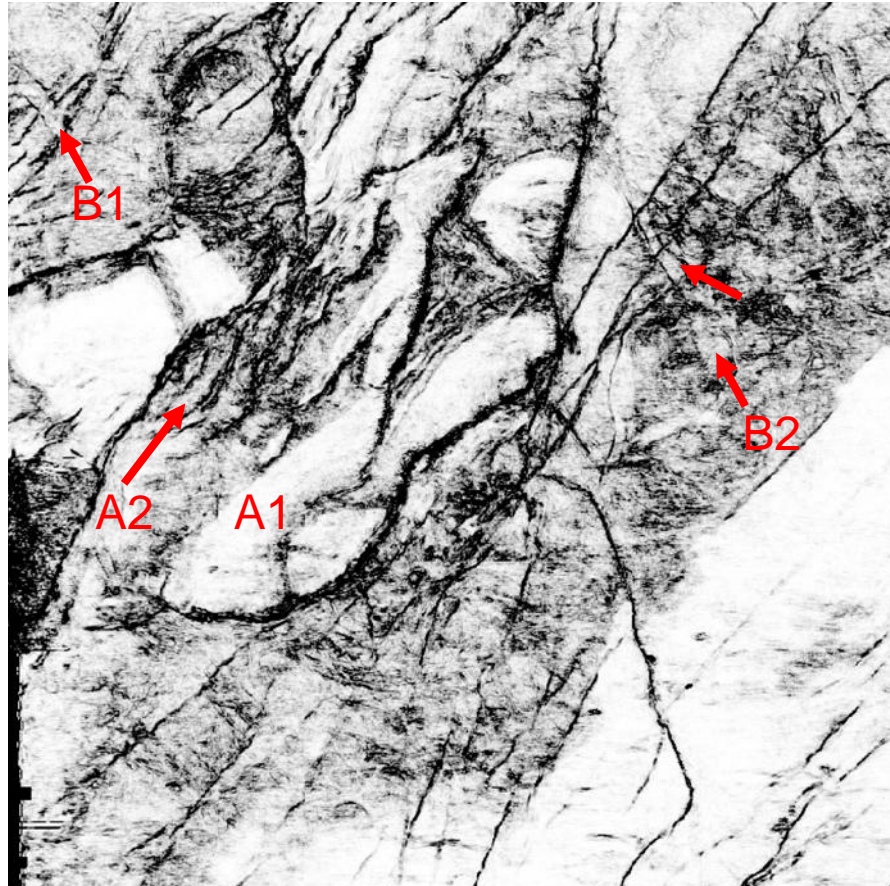
*Mostly these parameters remain CONSTANT in a seismic analysis (e.g. attribute evaluation), but Geology changes in time and in space.*

# POTENTIAL TRIGGERS

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## Geologic Complexities



# WORKFLOWS

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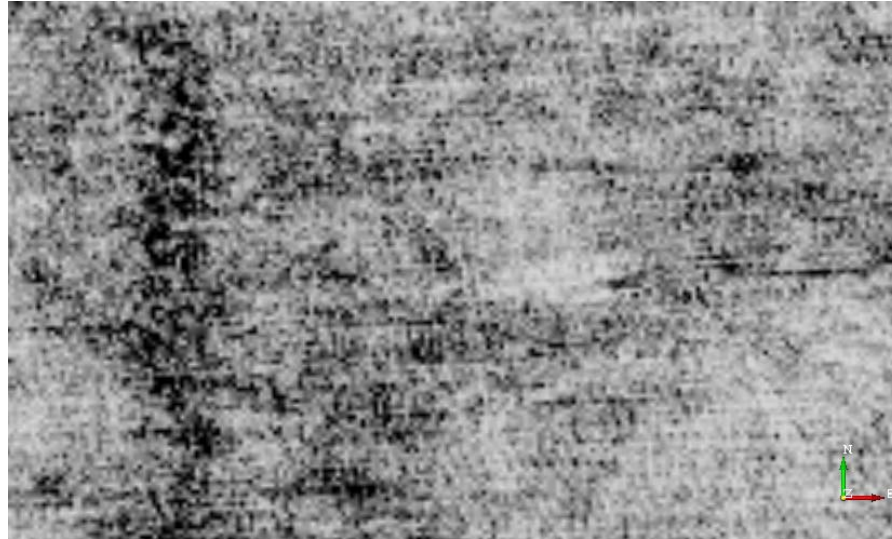
- *Dip Steered Median Filter*
- *Choice of Attribute and Algorithm*
- *Spectral Enhancement*
- *Apparent Seismic Attributes*

# WORKFLOWS

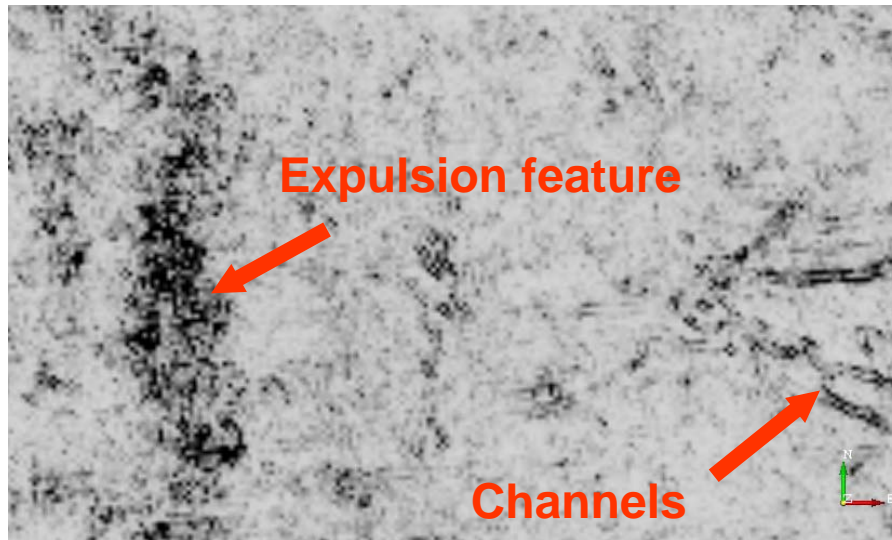
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**Before**



**After**  
Dip steered median filter



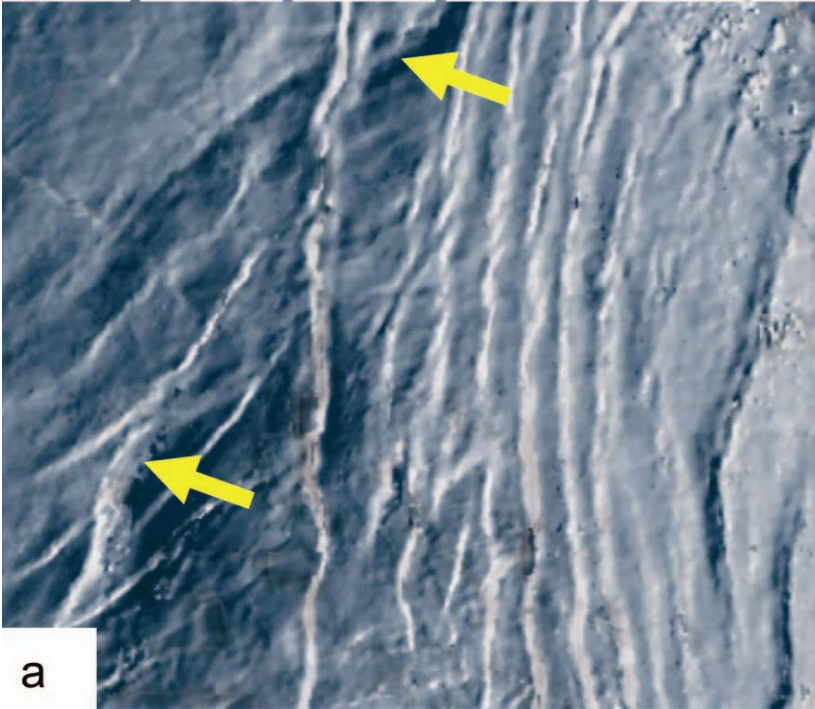
Less noisy and better to identify geologic features

# WORKFLOWS

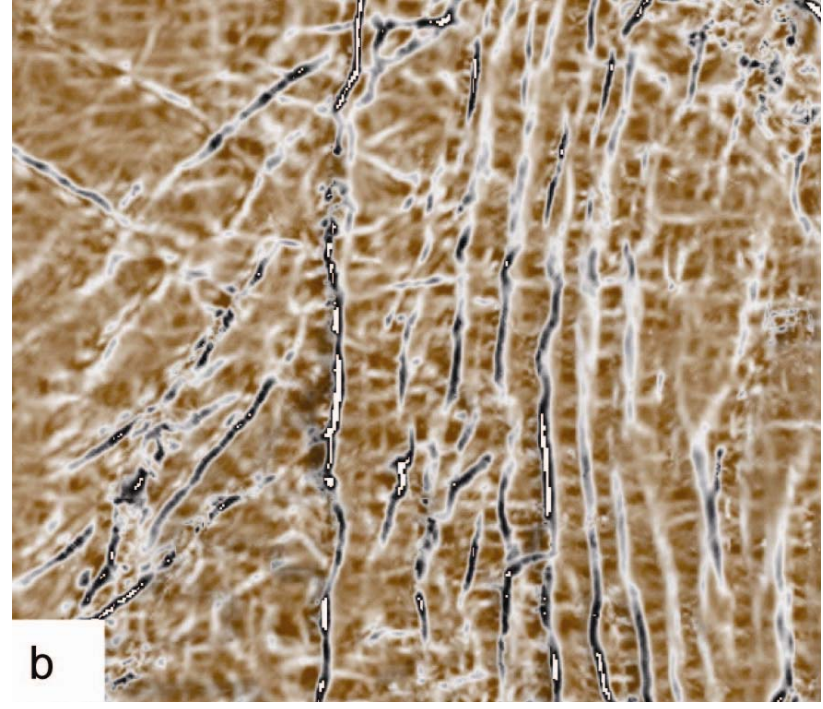
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## Choice of Attributes



A horizon map of seismic dip attribute



A horizon map of curvature attribute

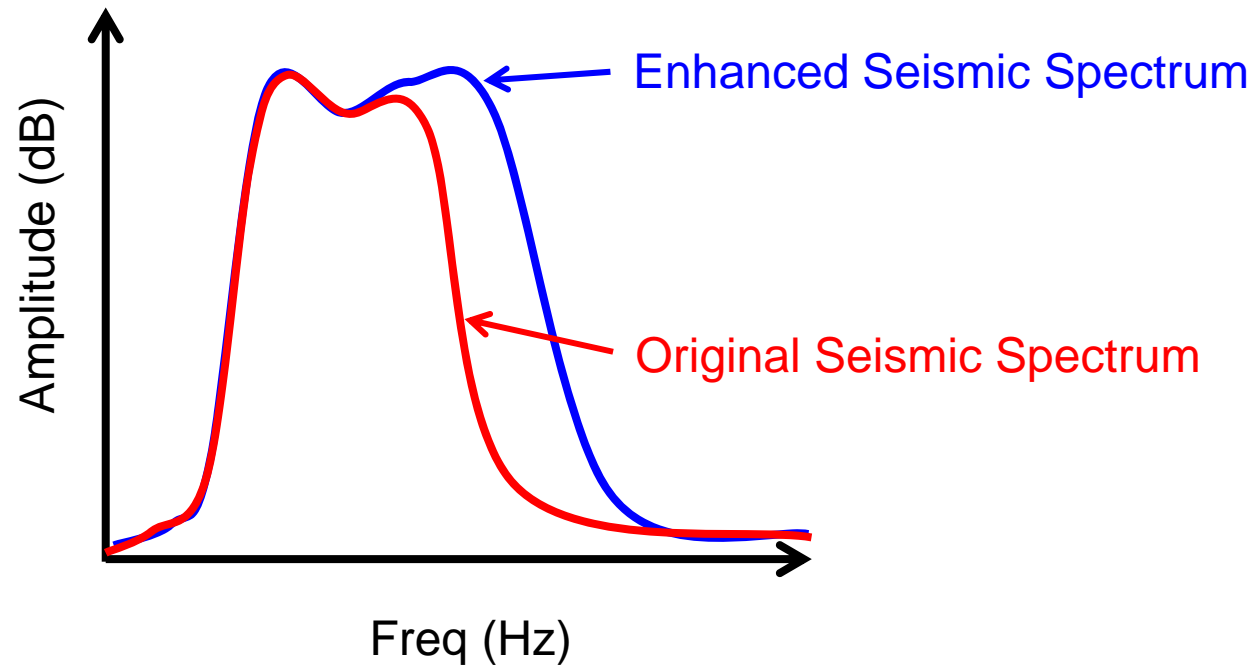


# WORKFLOWS

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## Spectral Enhancement



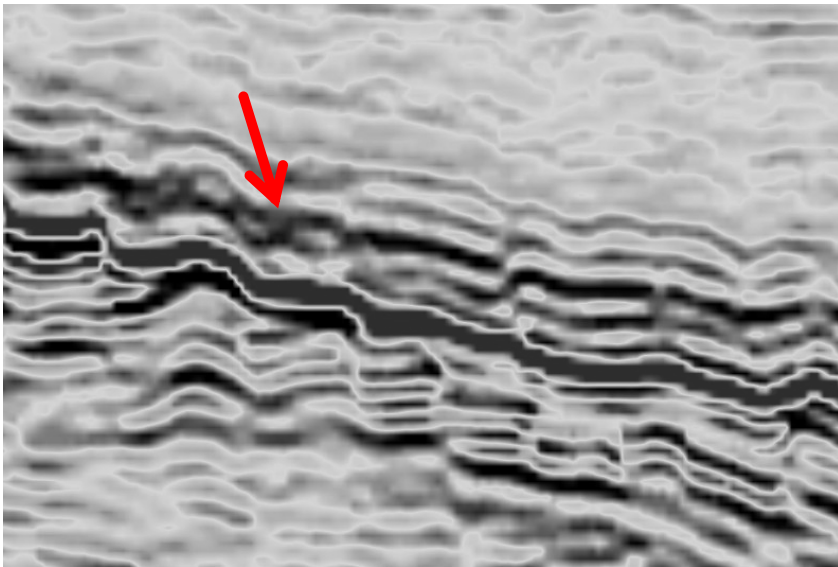
# WORKFLOWS

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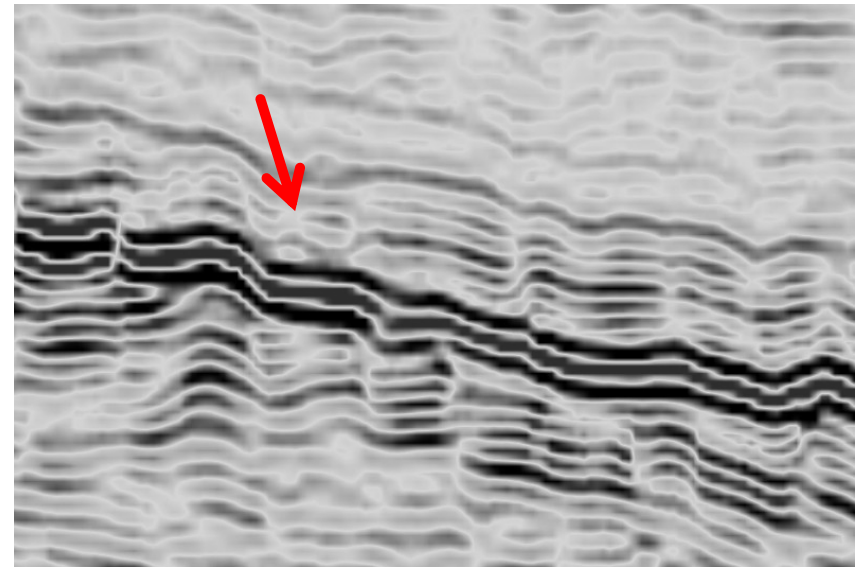
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## Spectral Enhancement Seismic Spectral Blueing (SSB)

Before SSB



After SSB

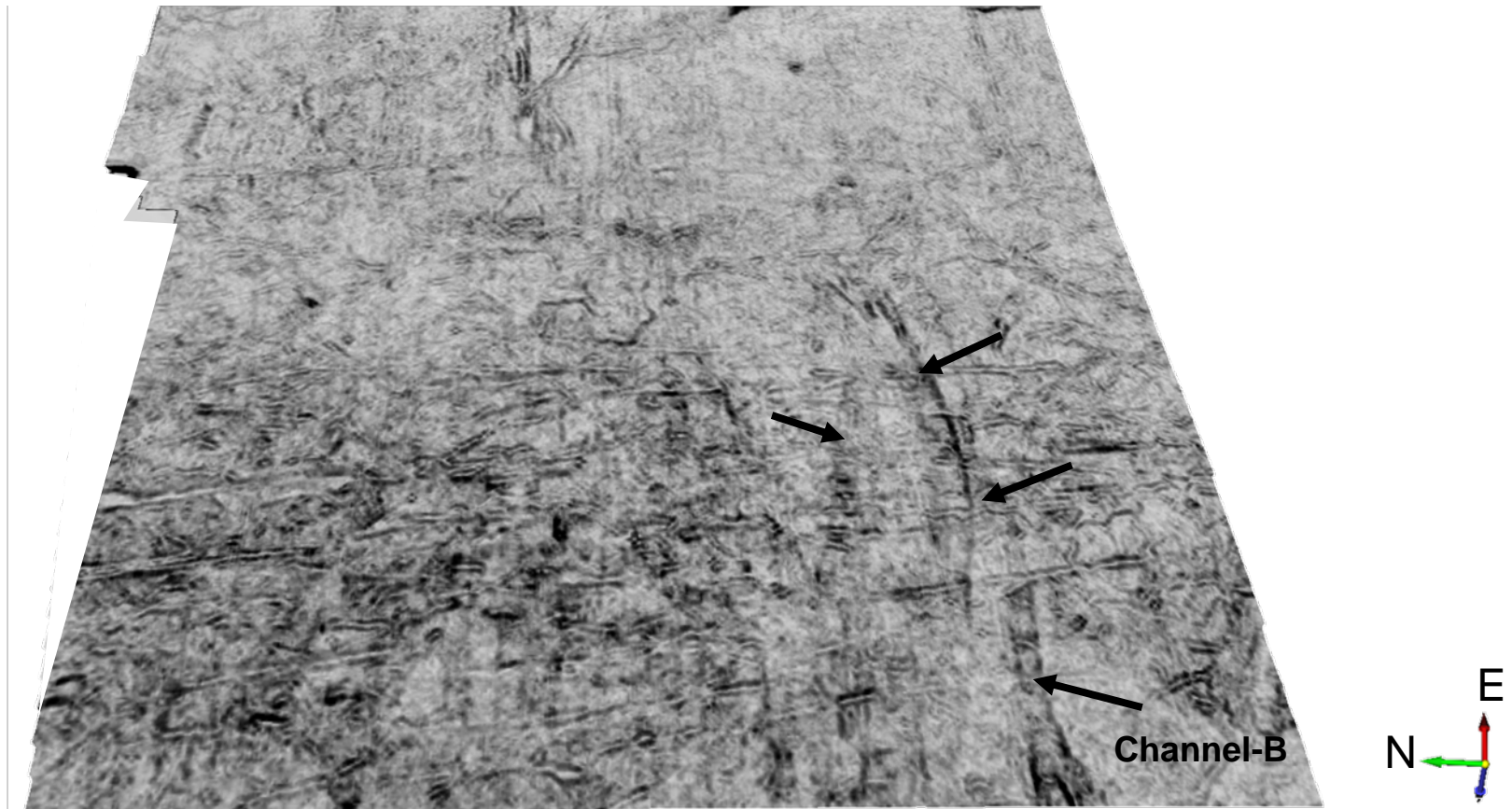


Bandwidth Extension is another alternative workflow (Smith et al., 2008)

# WORKFLOWS

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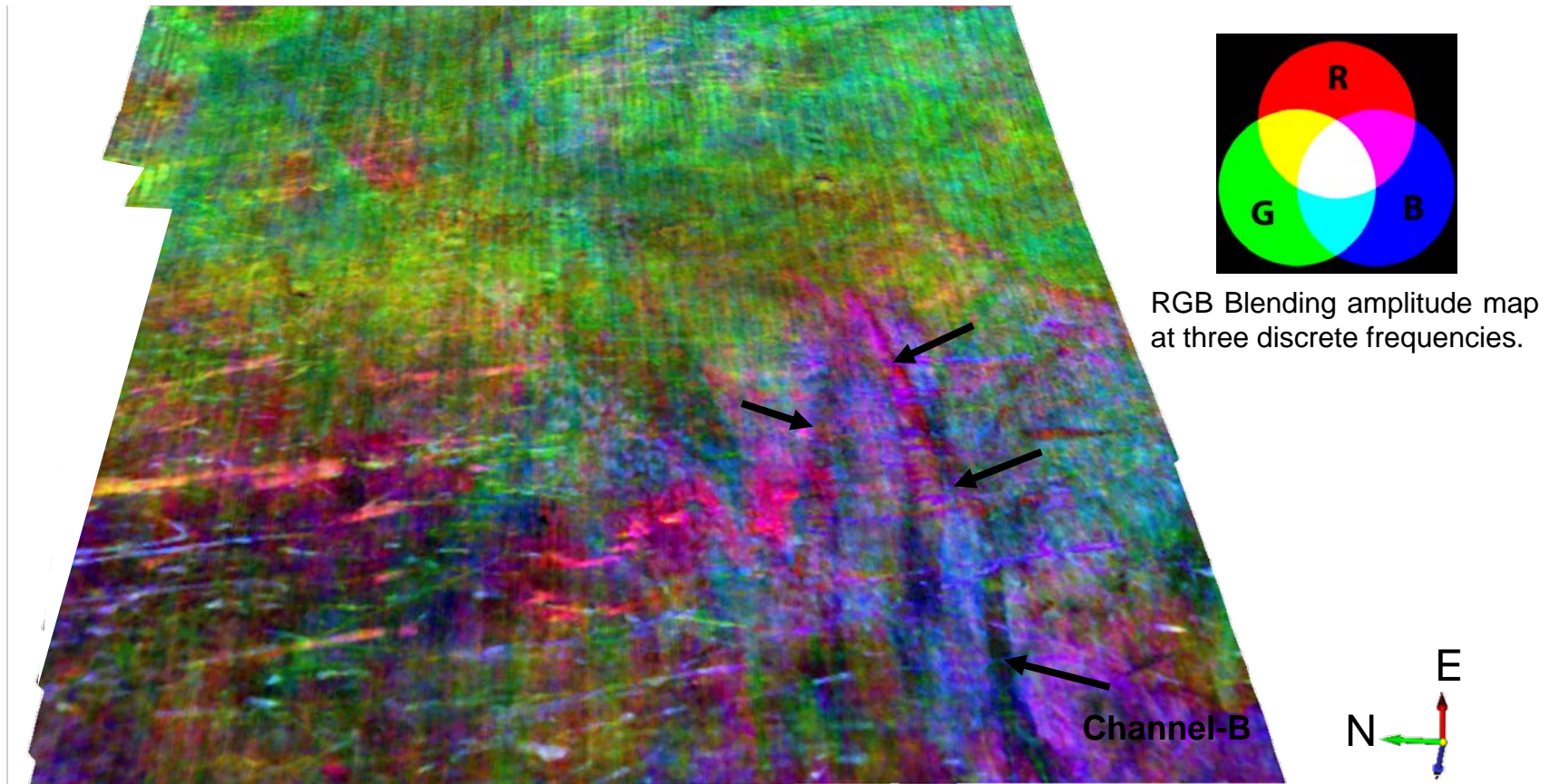


# WORKFLOWS

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## Spectral Enhancement Spectral Decomposition

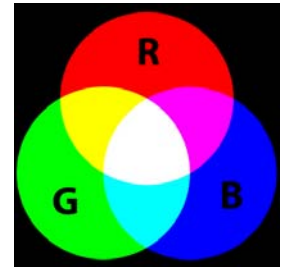
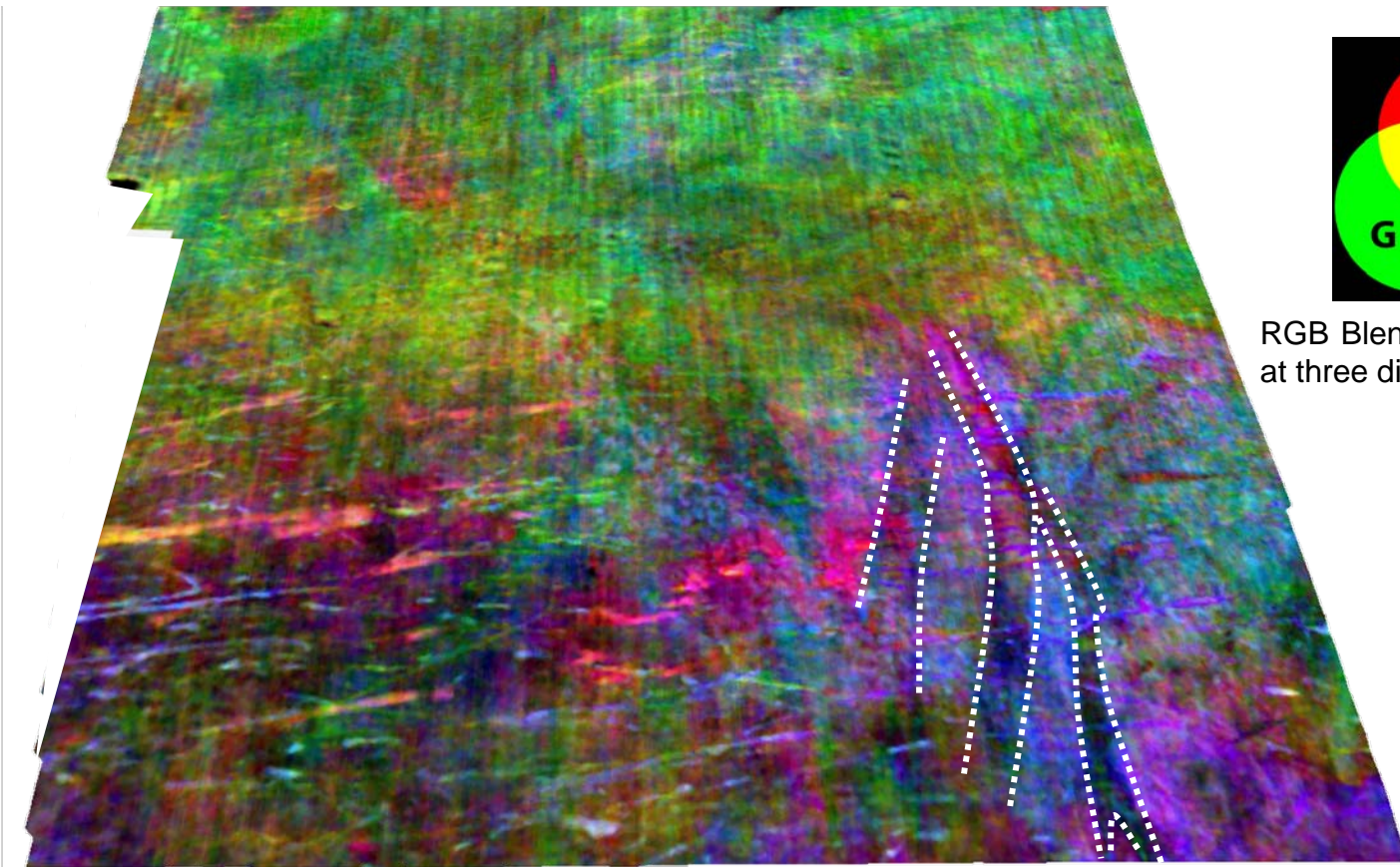


# WORKFLOWS

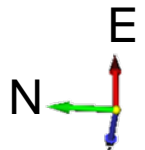
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## Spectral Enhancement Spectral Decomposition



RGB Blending amplitude map  
at three discrete frequencies.



# WORKFLOWS

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## Apparent Seismic Attributes

$$\text{Output apparent attribute} = A \times \cos (\text{Azimuth}) + B \times \sin (\text{Azimuth})$$

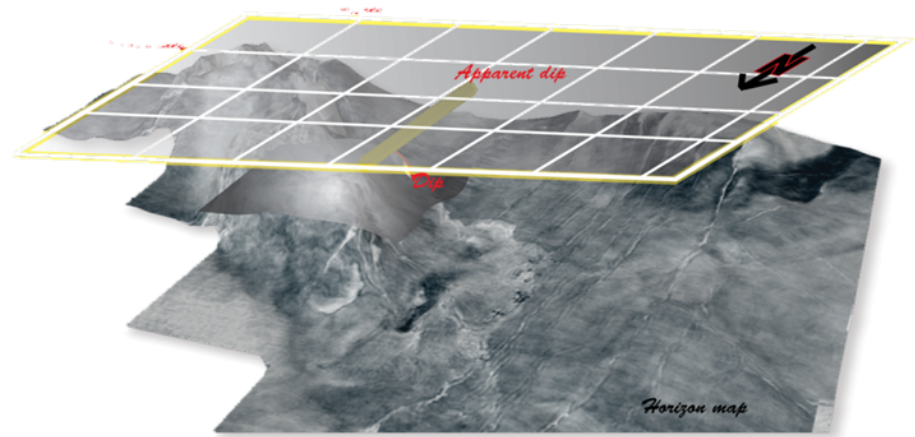
where,

A = Input attribute in inline directions

B = Input attribute in crossline directions

Note:

Azimuth is measured from geographic north



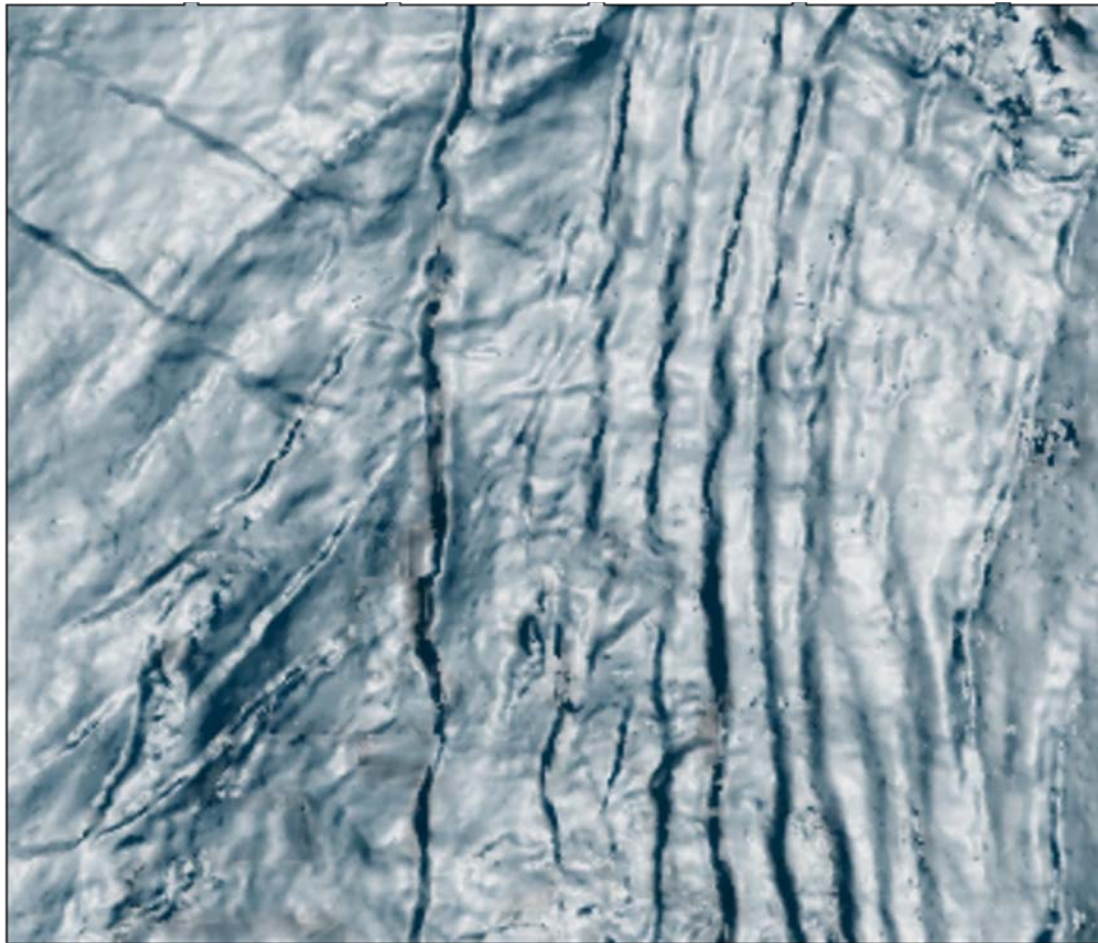
*For more details, please refer to Chopra and Marfurt, 2007.*

# WORKFLOWS

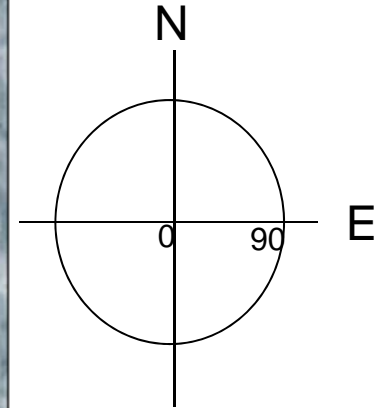
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## Seismic Polar Dip Attribute



0 90  
us/m

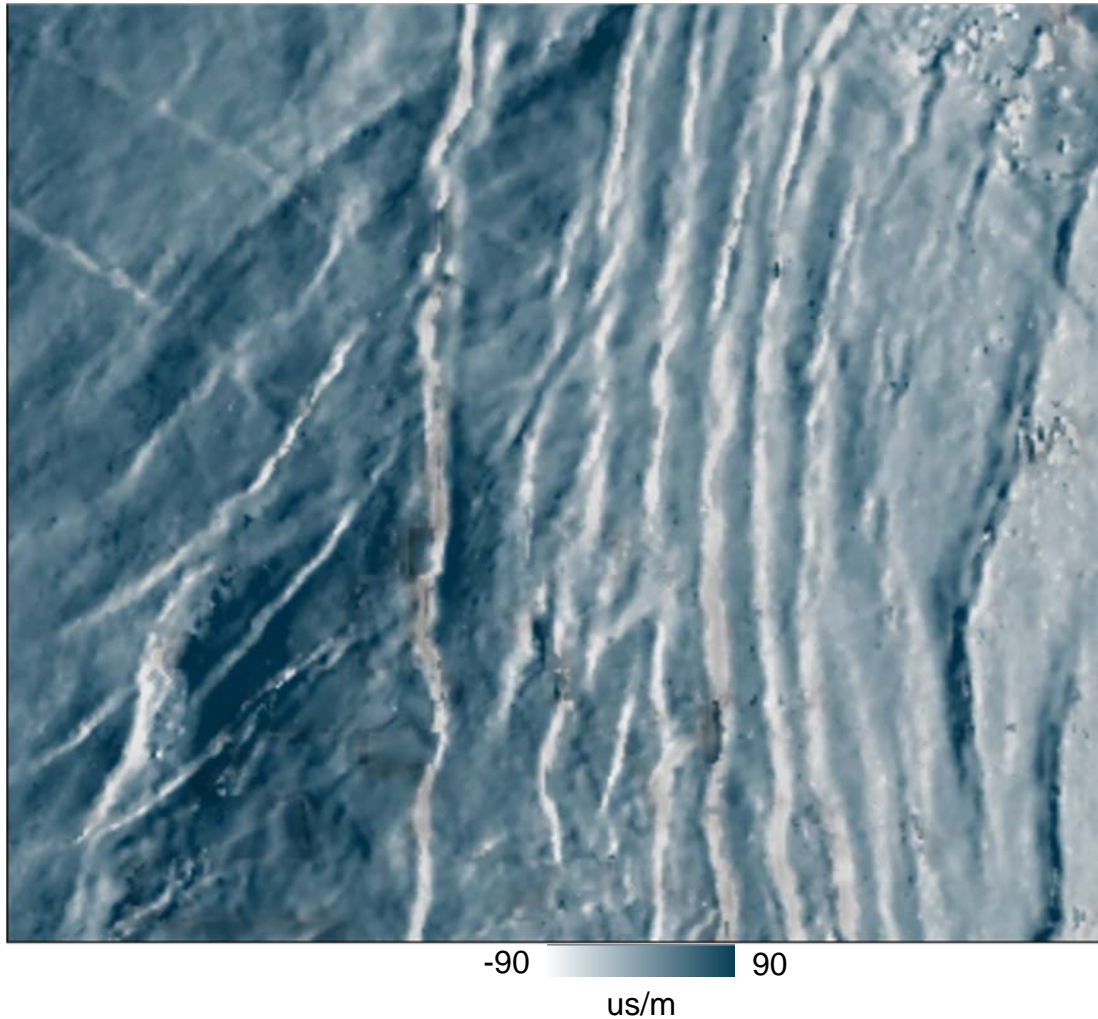


# WORKFLOWS

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## Seismic Apparent Dip Attribute



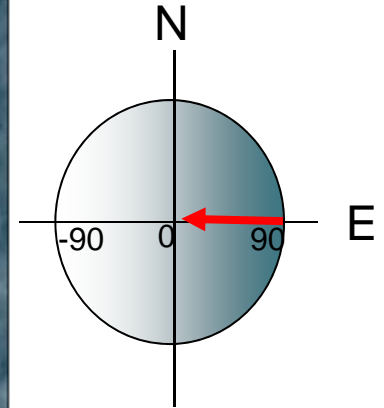
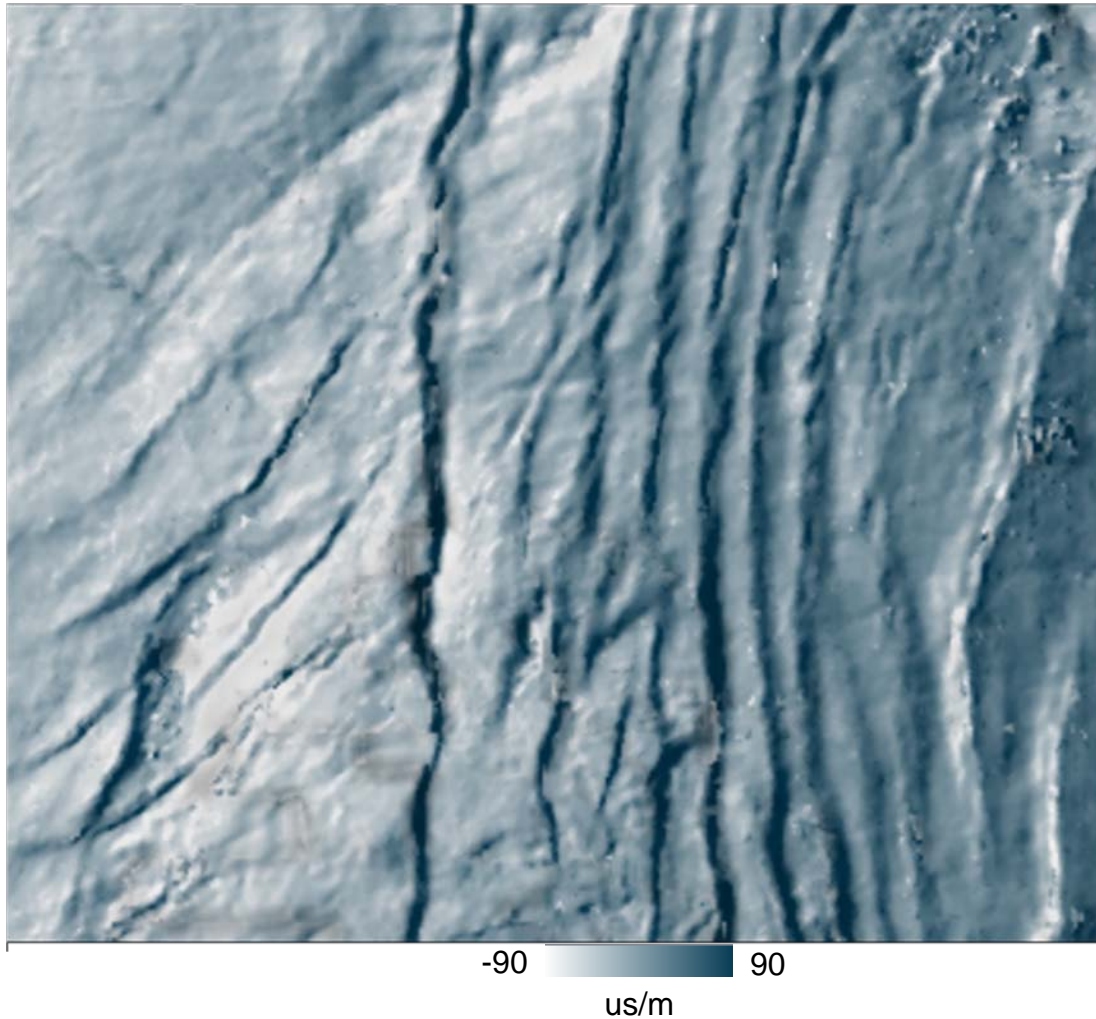


# WORKFLOWS

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## Seismic Apparent Dip Attribute

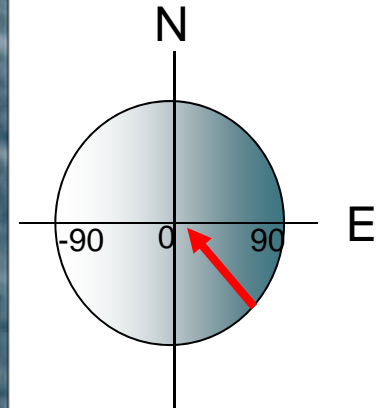
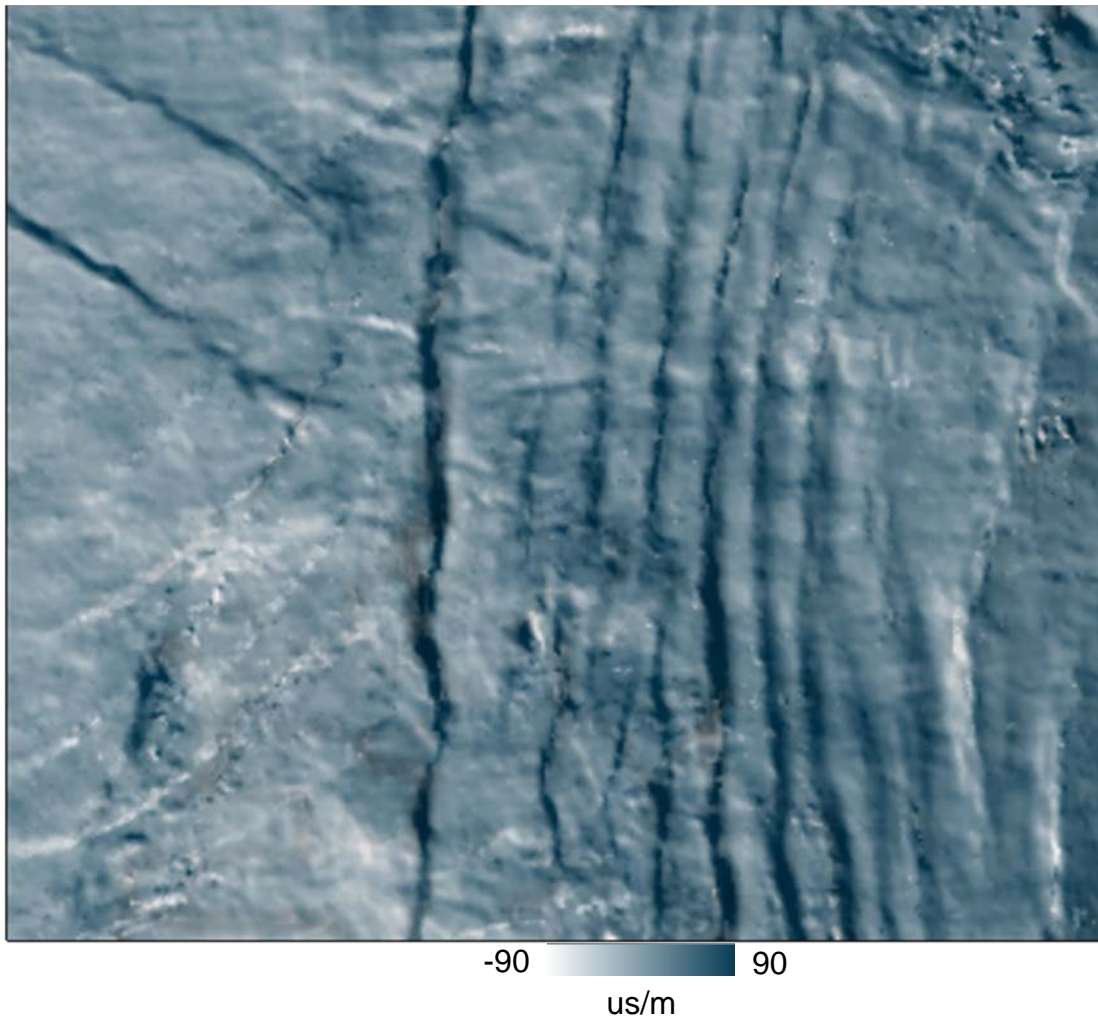


# WORKFLOWS

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## Seismic Apparent Dip Attribute



## CONCLUSIONS

- There is no single or unique reason that may result into the superimposed geologic features.
- The workflows are applicable if the situation demands improvement.
- Direct application of geologic principles should be avoided for the seismic data because this leads to a hypothetical conclusion.

# ACKNOWLEDGEMENT

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The dataset used for this study can be downloaded (**FREE**) from dGB's web-site:

***Open Seismic Repository (OSR)***

<http://www.opendtect.org/osr/>



# THANK YOU