



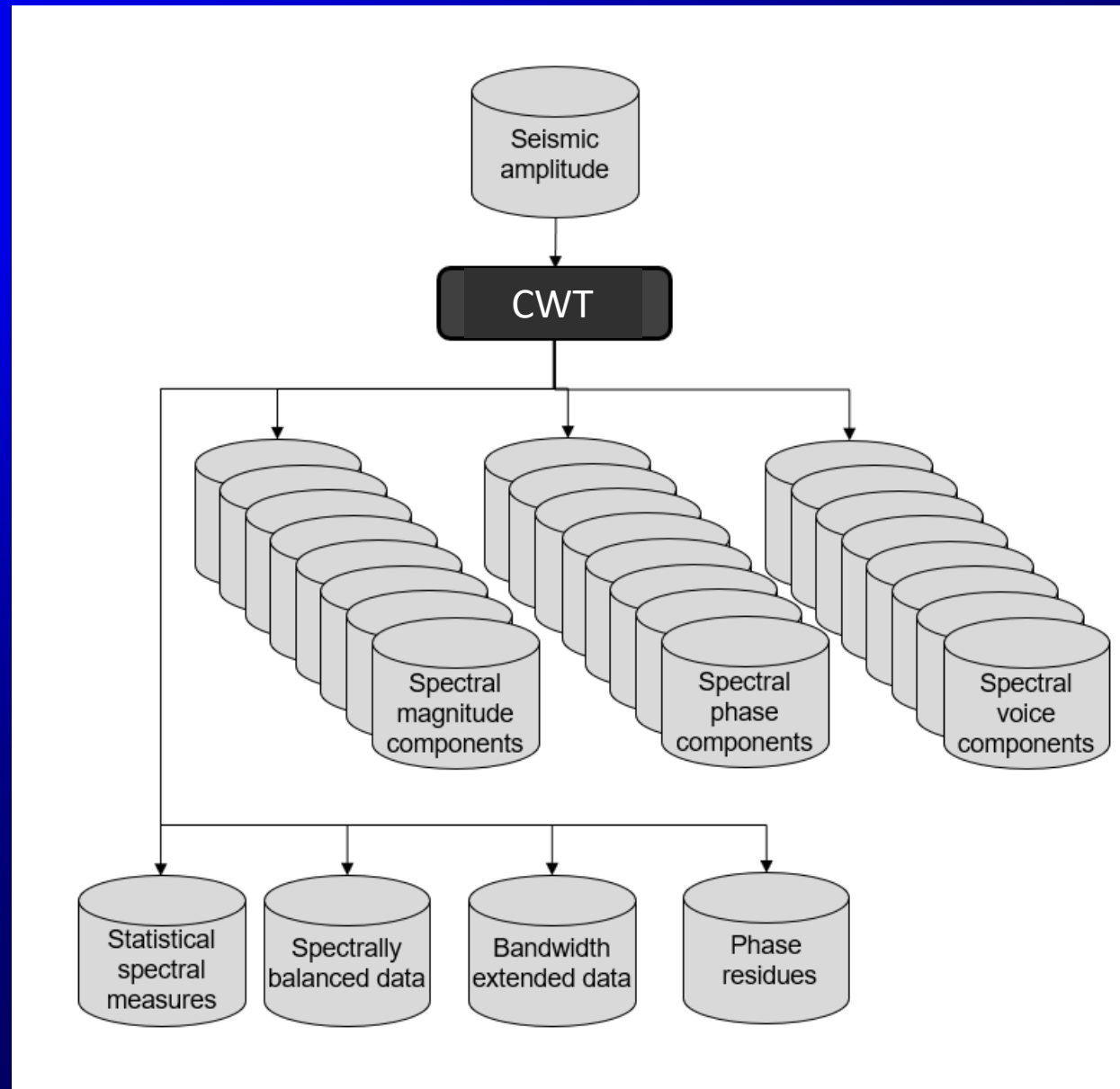
MEWBOURNE COLLEGE OF EARTH AND ENERGY  
**SCHOOL OF GEOSCIENCES**  
*The UNIVERSITY of OKLAHOMA*

# Seismic Attributes - from Interactive Interpretation to Machine Learning

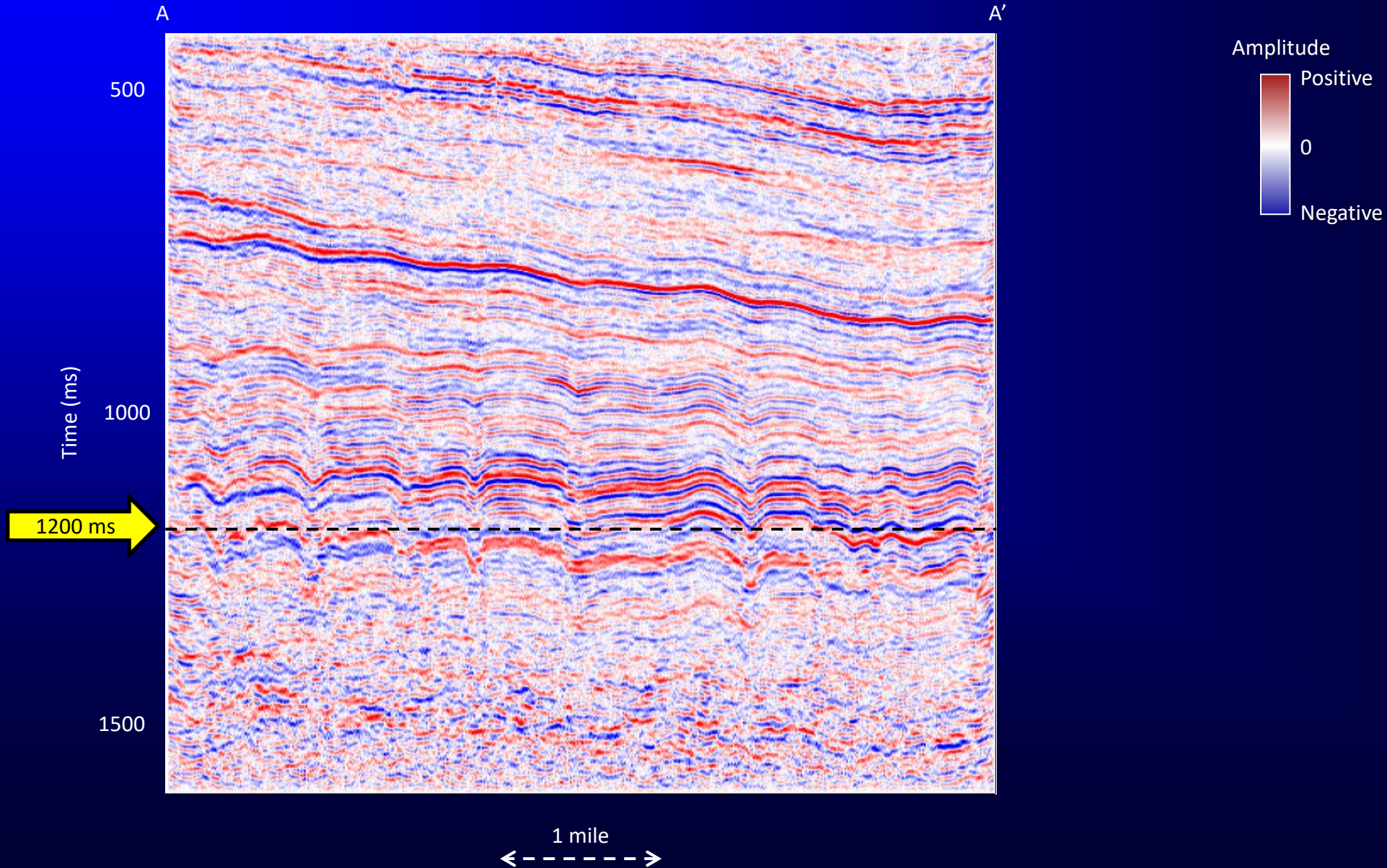
*Kurt J. Marfurt (The University of Oklahoma)*

Mathematically Independent Geometric Attributes Correlated through Geology

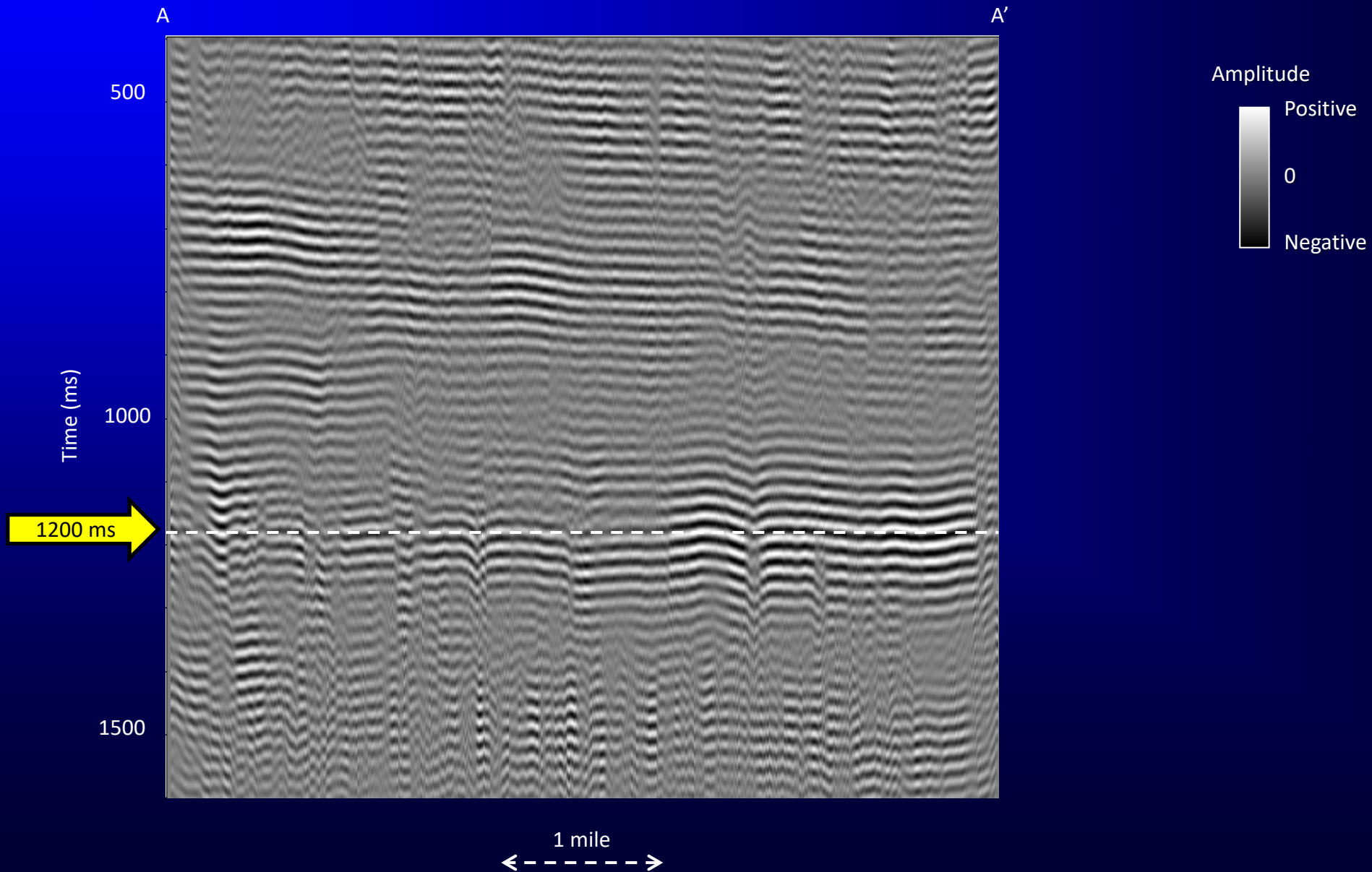
# Spectral decomposition



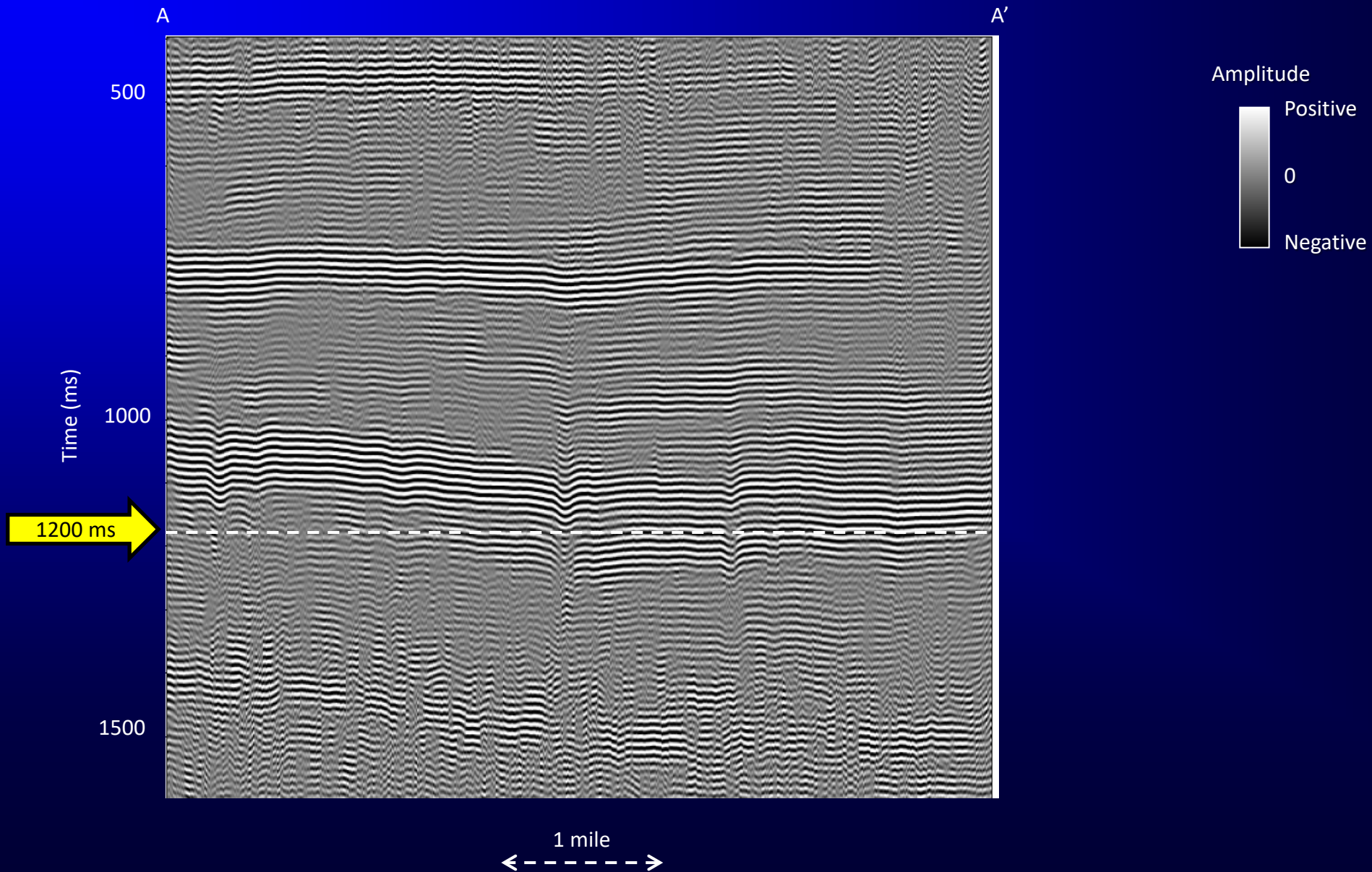
# Broadband seismic amplitude



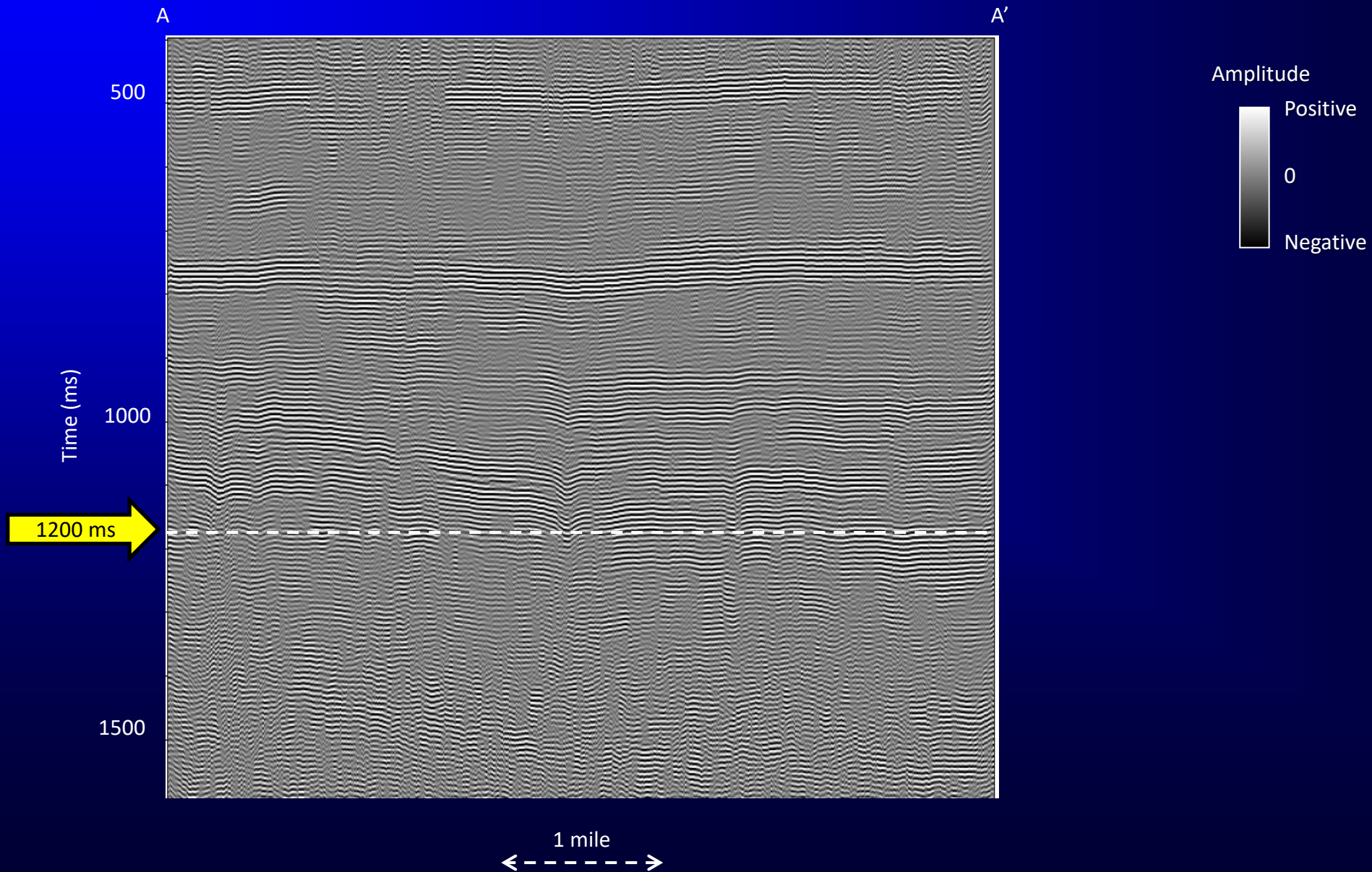
# Spectral voice at 20 Hz



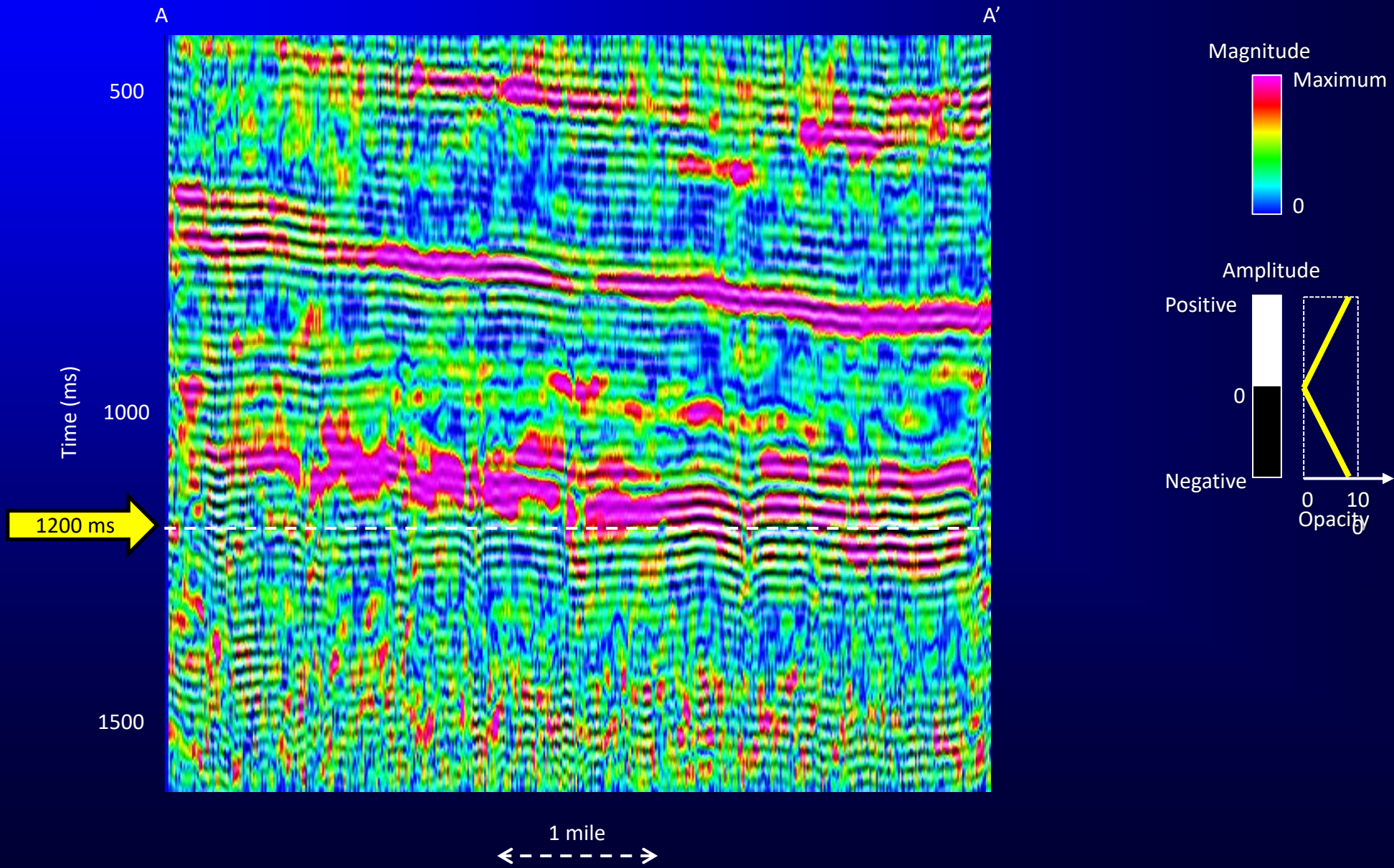
# Spectral voice at 40 Hz



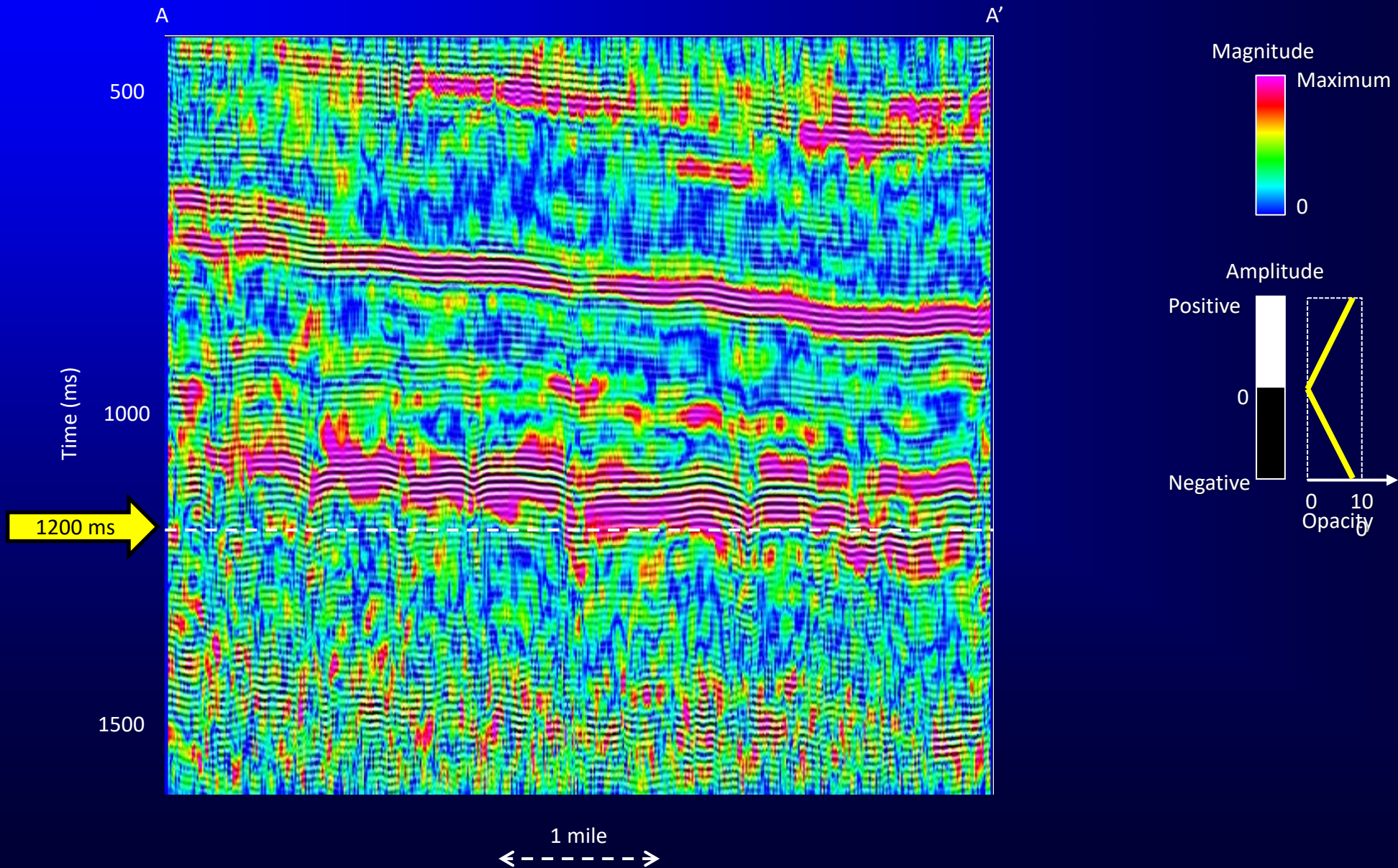
# Spectral voice at 60 Hz



# Corendered spectral magnitude and spectral voice at 20 Hz

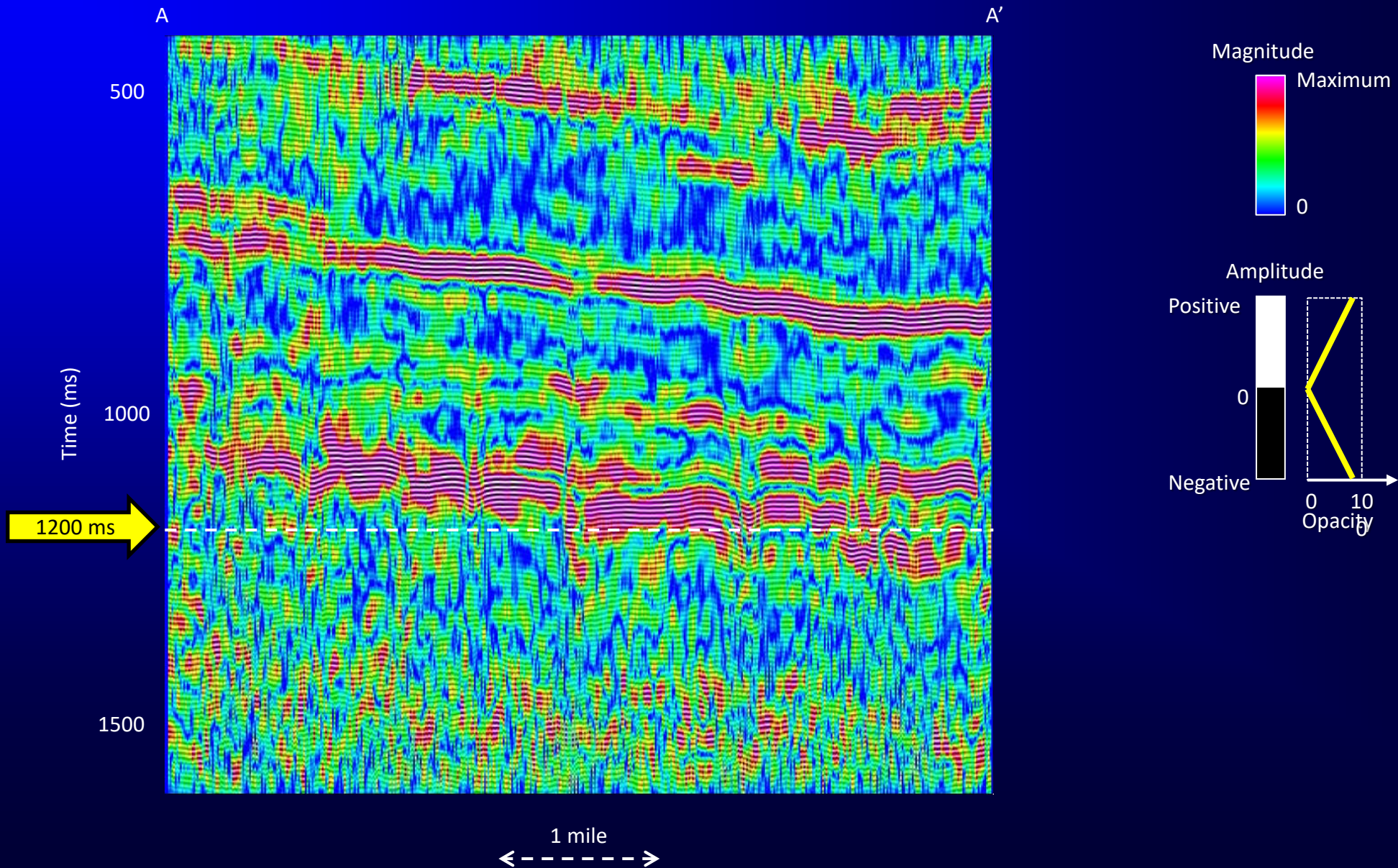


# Corendered spectral magnitude and spectral voice at 40 Hz

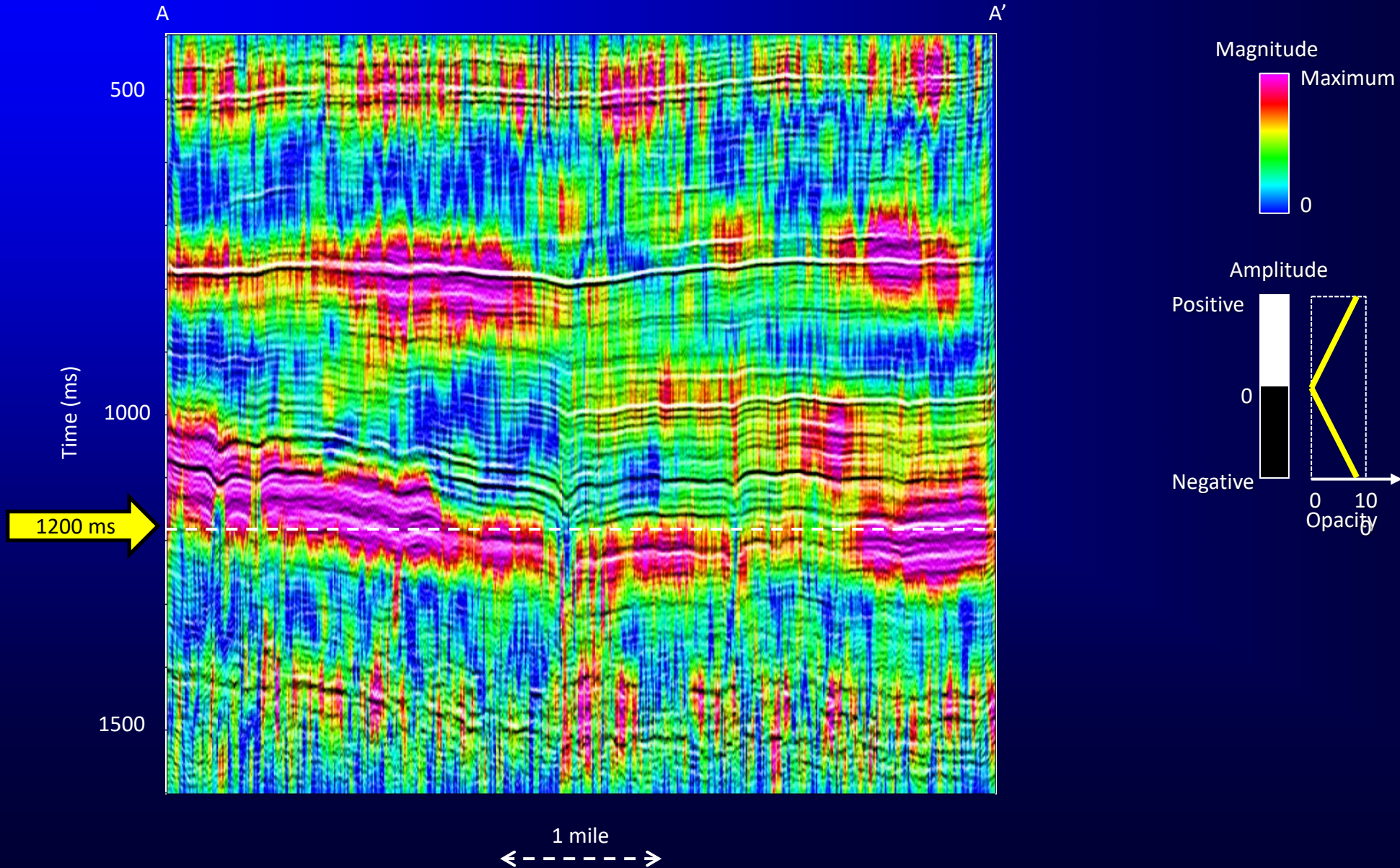




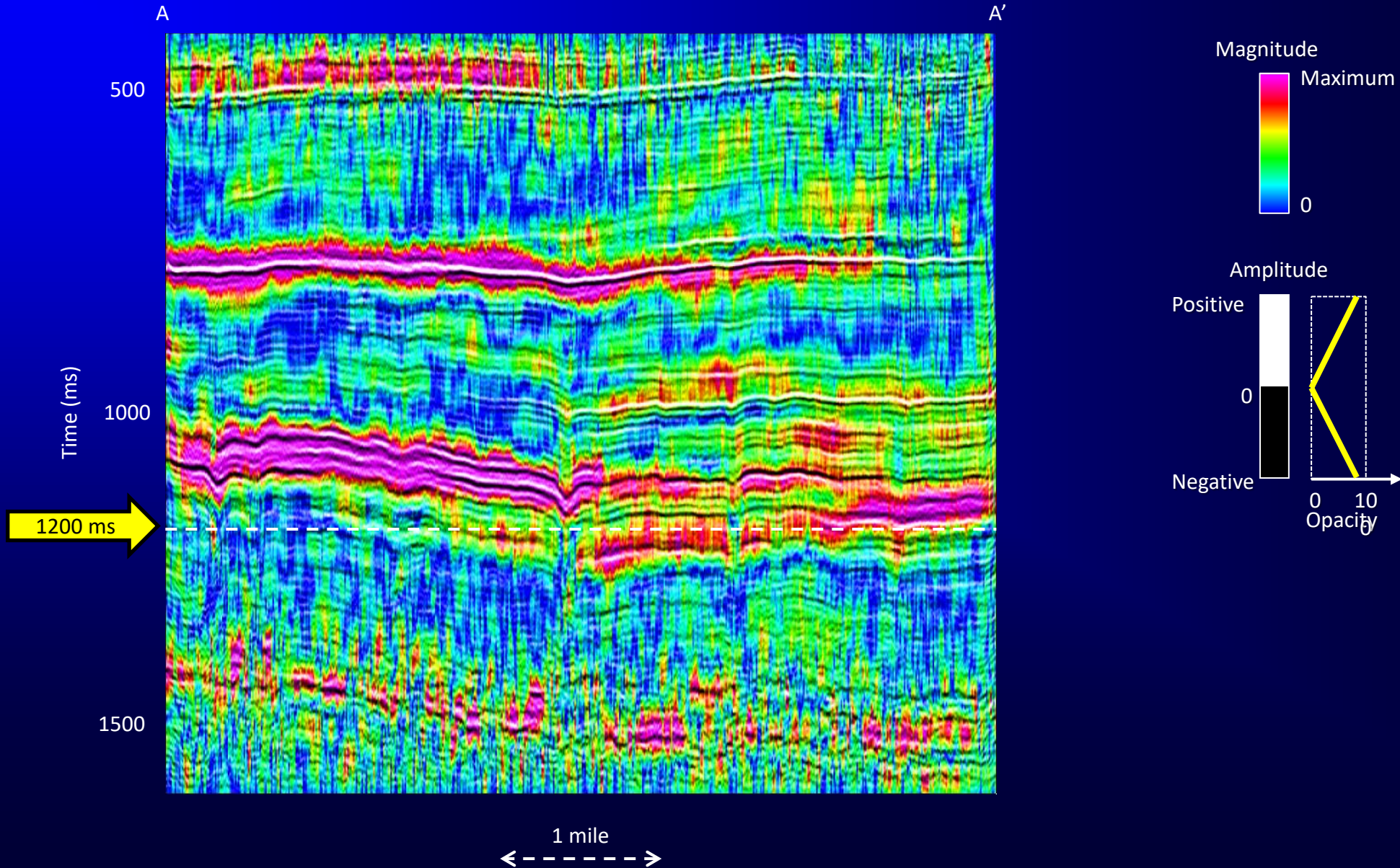
# Corendered spectral magnitude and spectral voice at 60 Hz



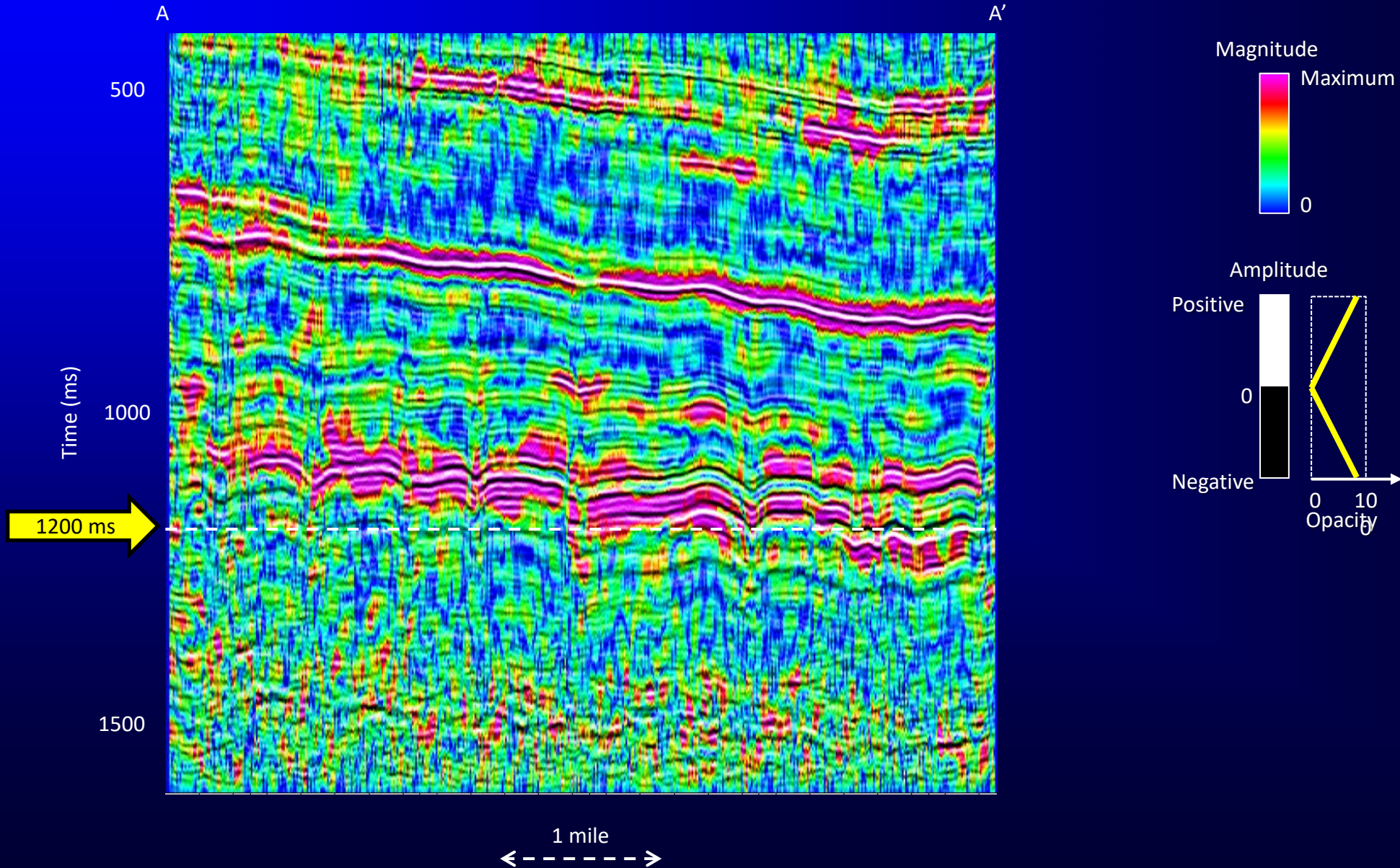
# Corendered spectral magnitude at 20 Hz and broadband amplitude



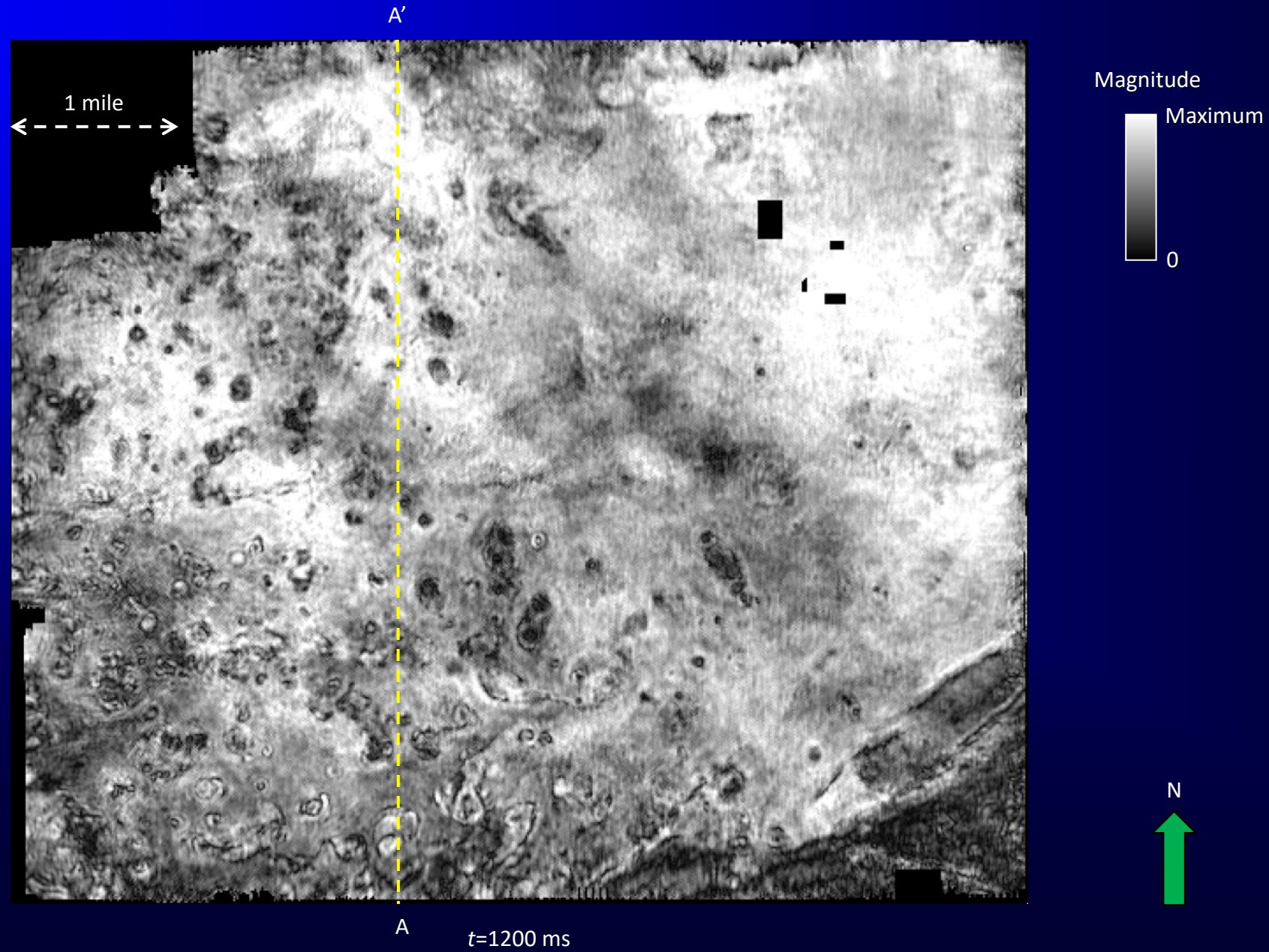
# Corendered spectral magnitude at 40 Hz and broadband amplitude



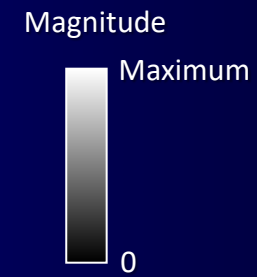
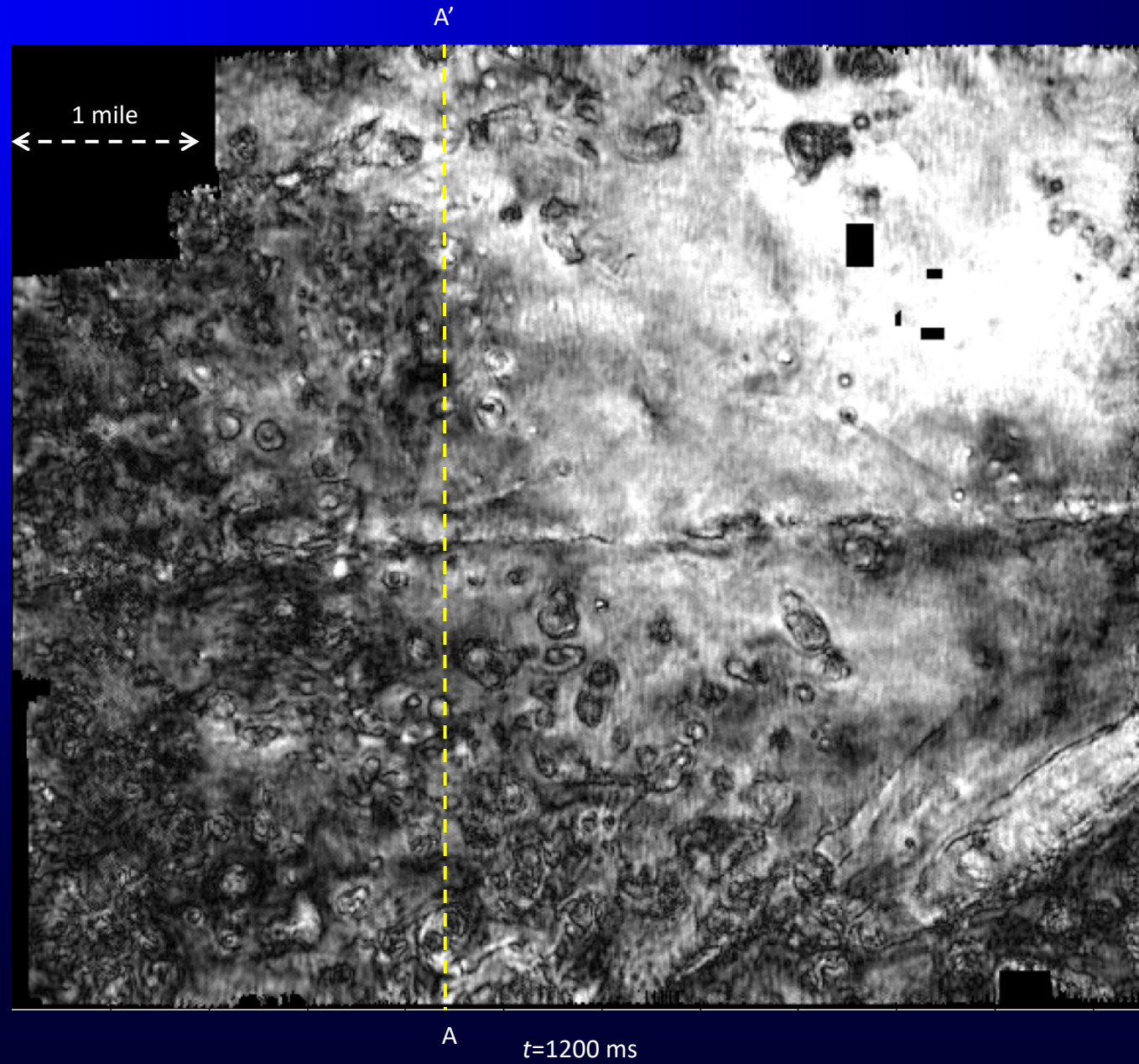
# Corendered spectral magnitude at 60 Hz and broadband amplitude



# Spectral magnitude at 20 Hz

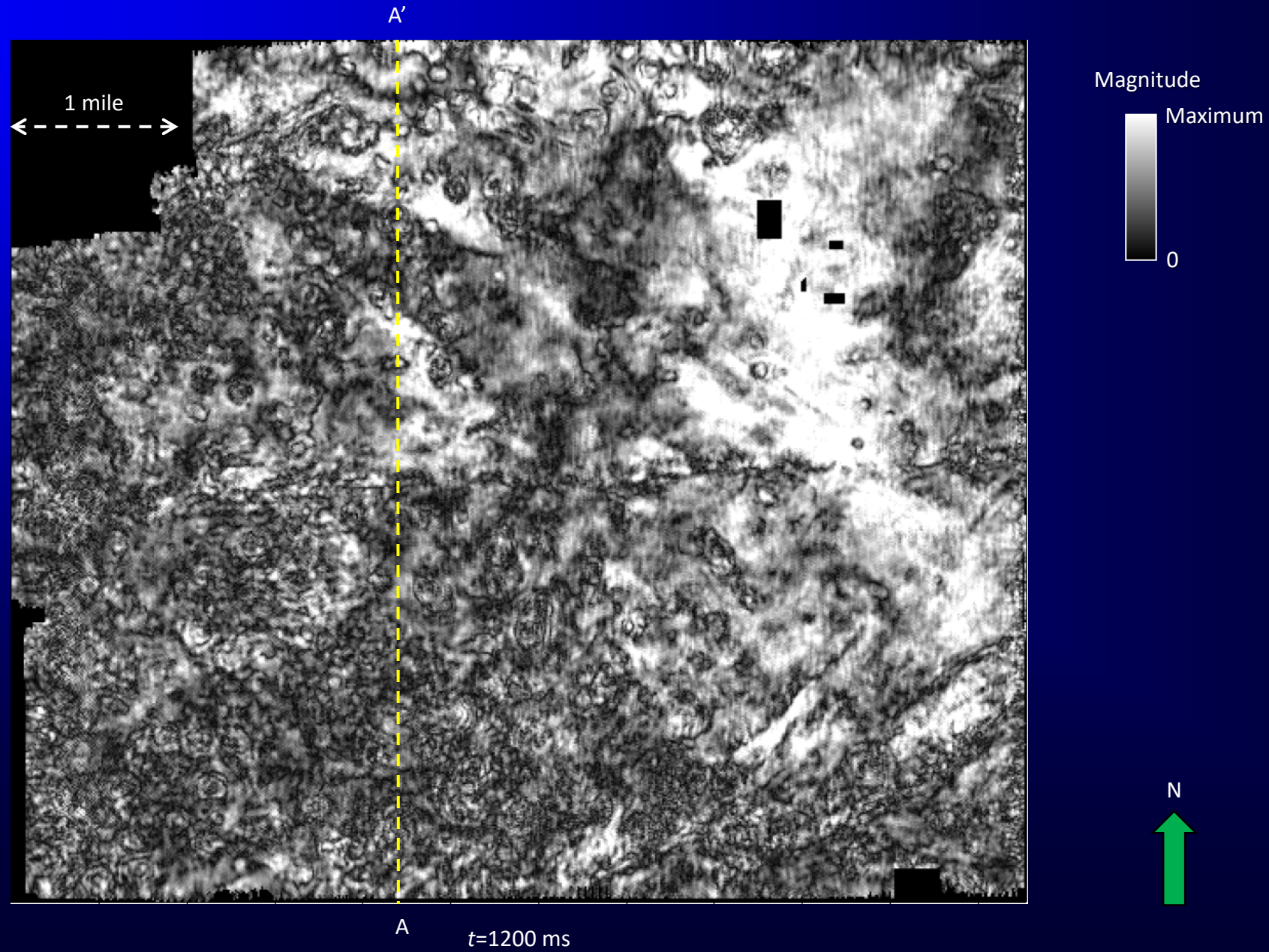


# Spectral magnitude at 40 Hz

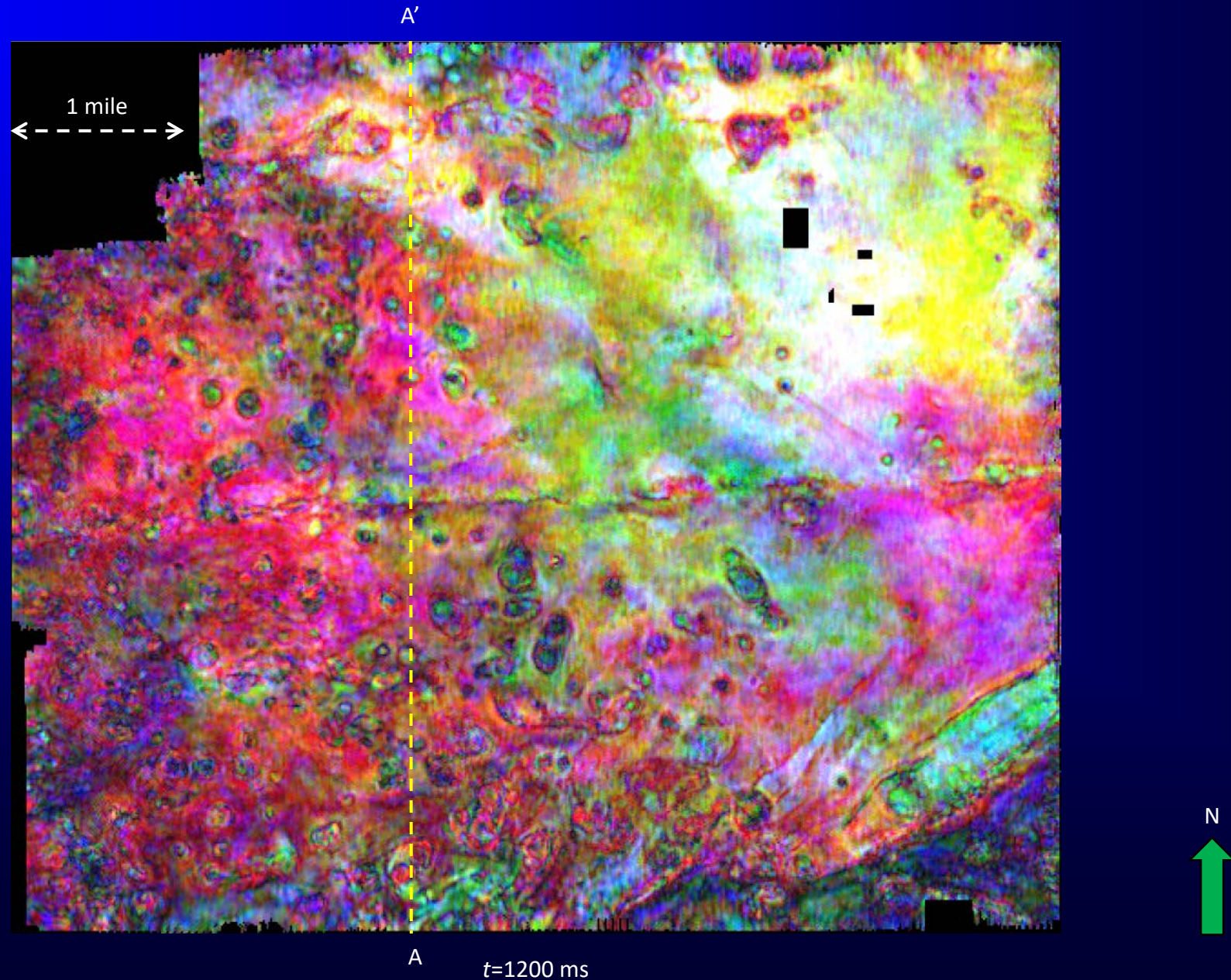


A t=1200 ms

# Spectral magnitude at 60 Hz

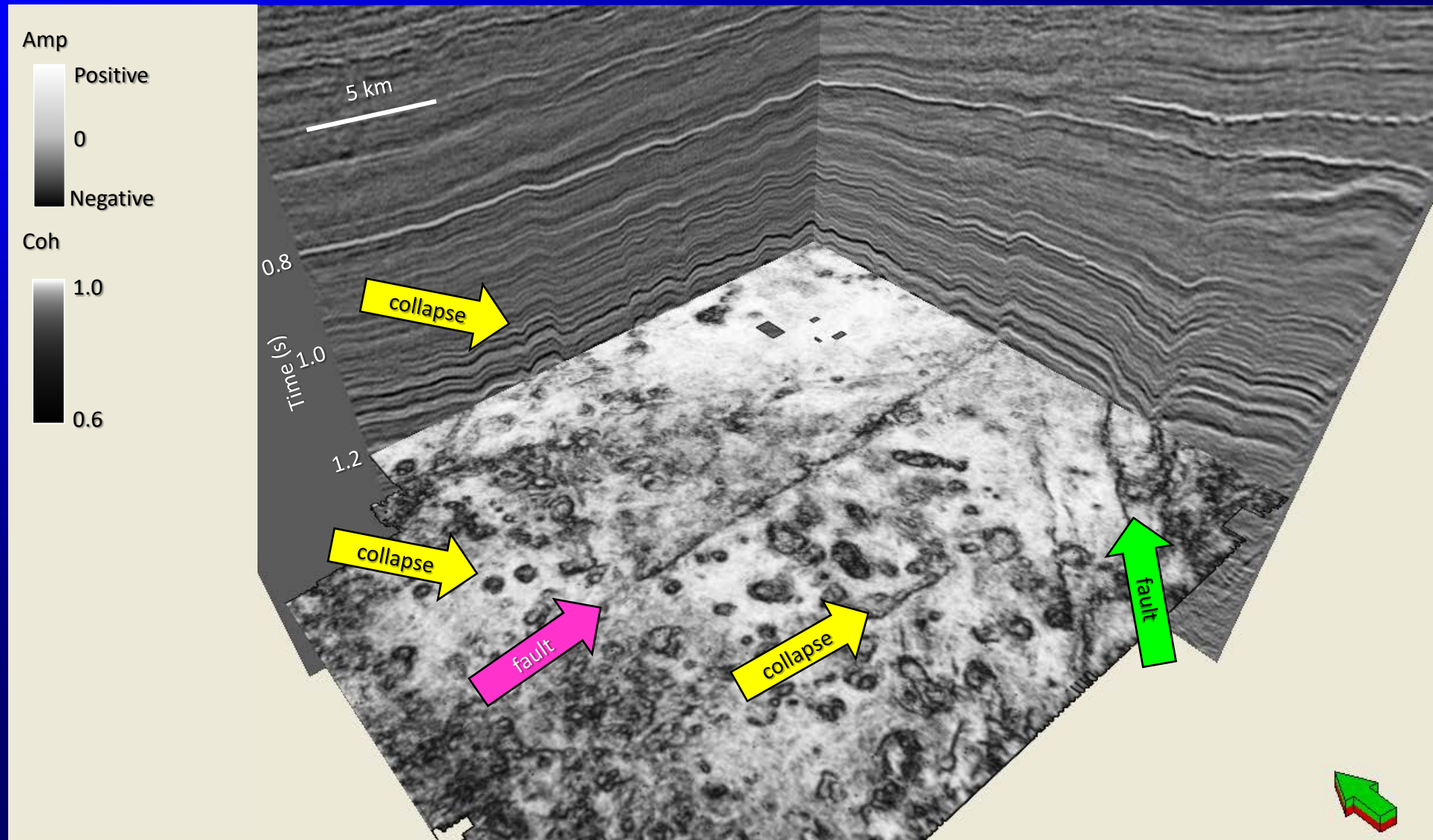


Corendered spectral magnitude at 20 Hz, 40 Hz, and 60 Hz

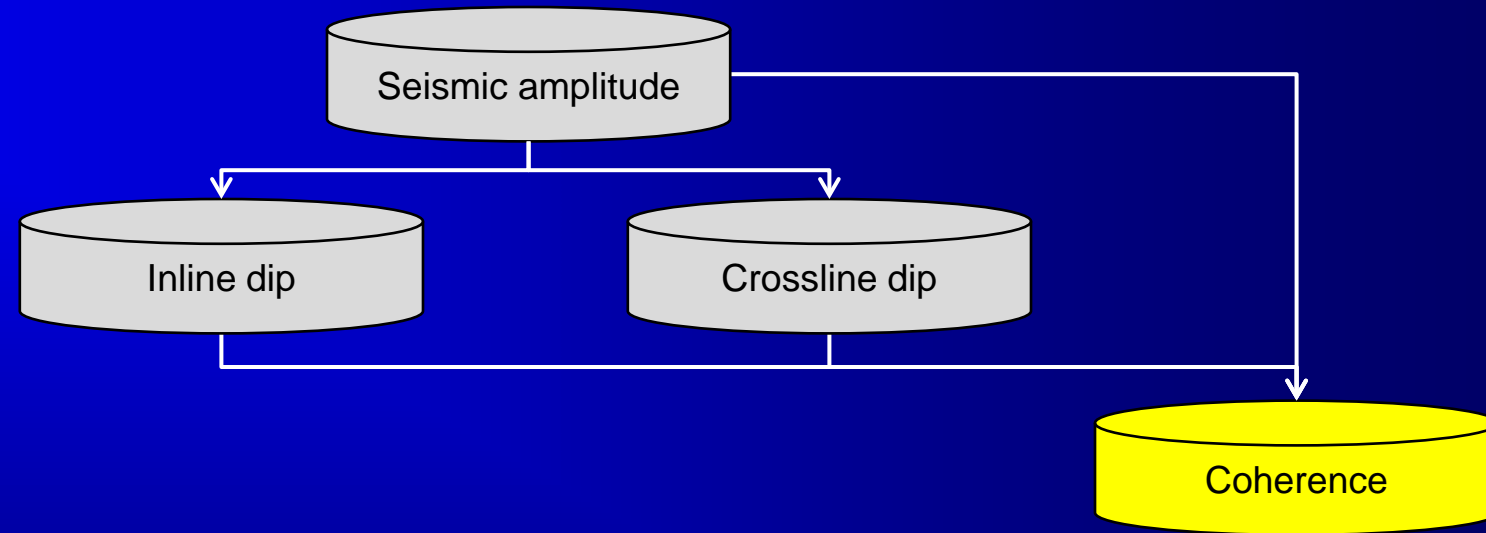




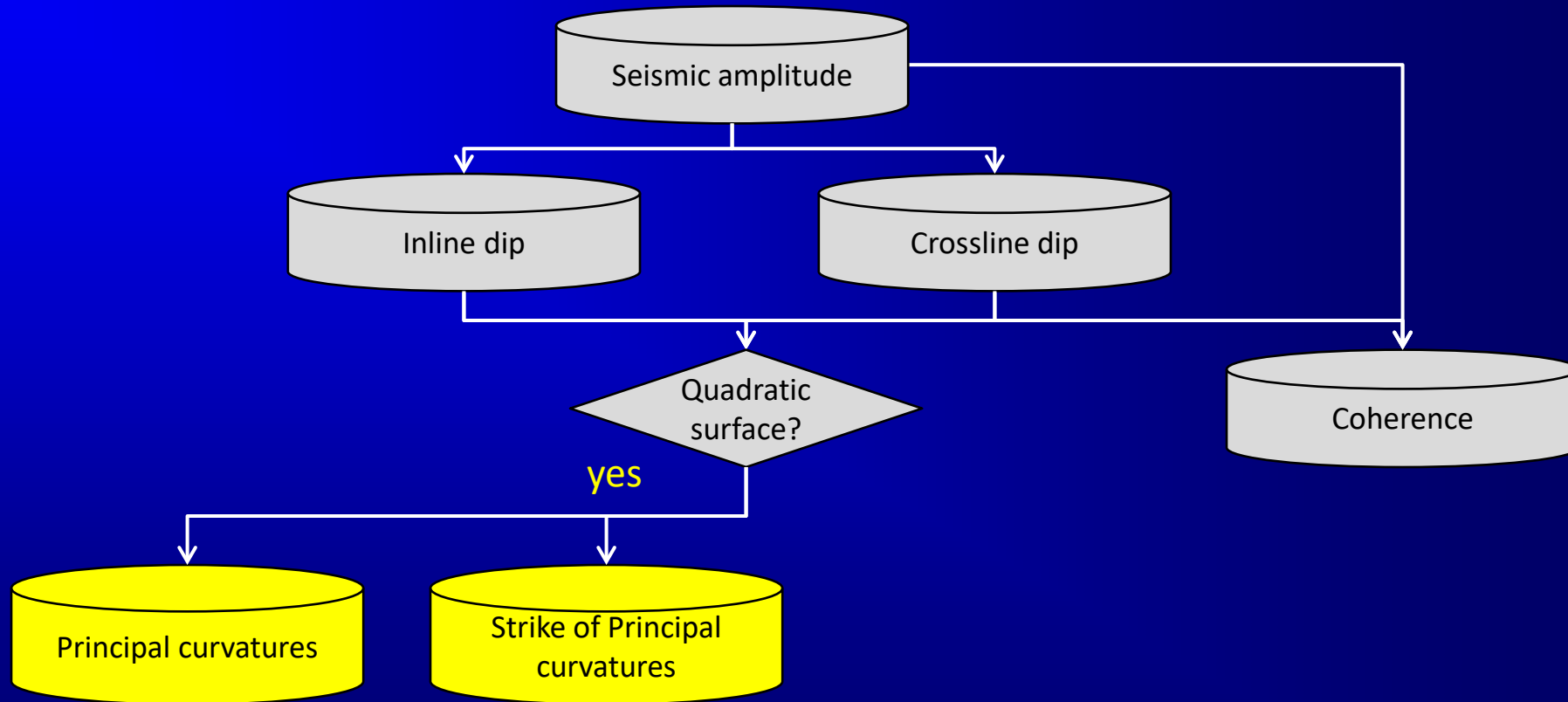
# Coherence



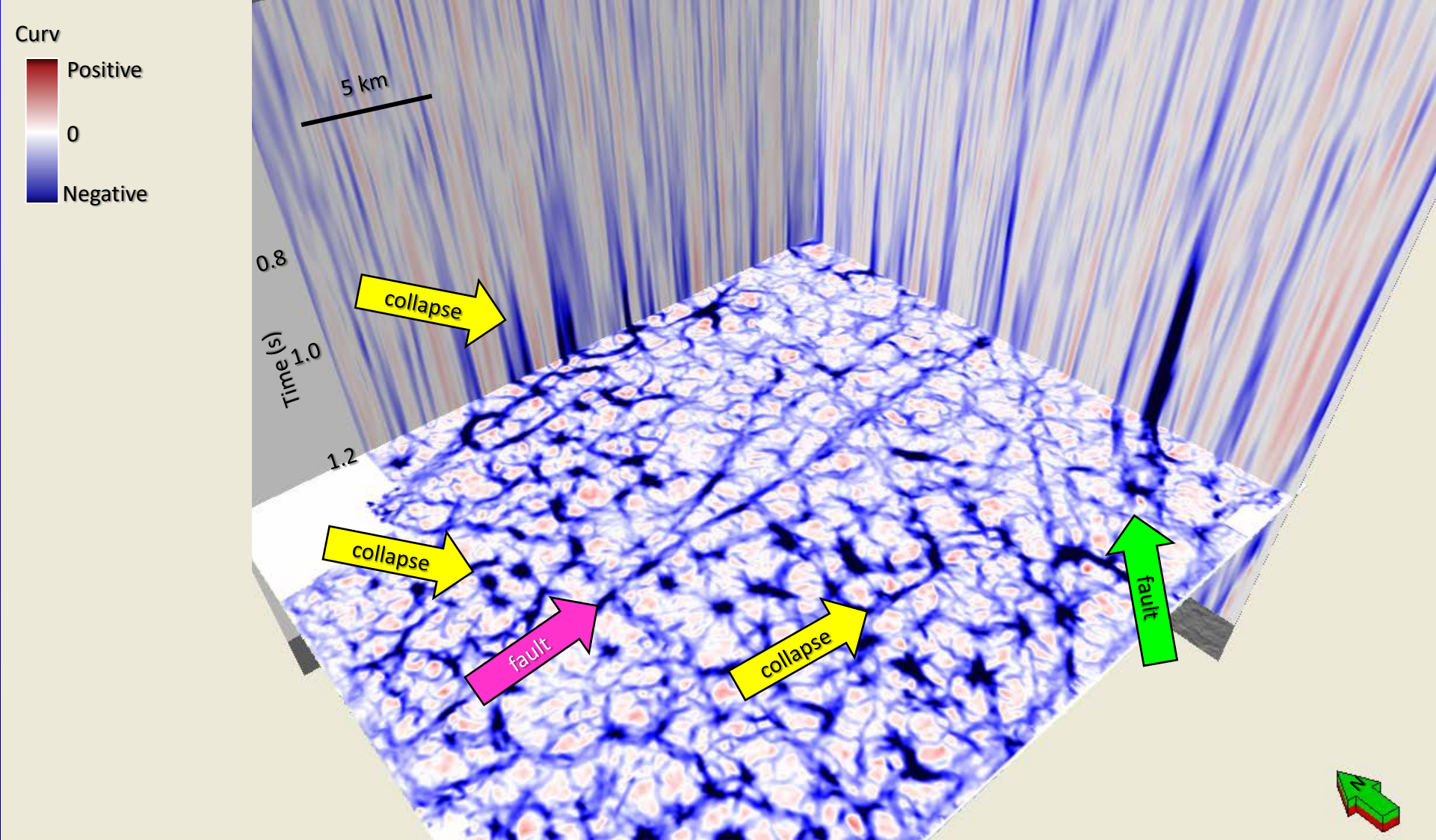
# Attributes based on volumetric dip and azimuth



# Attributes based on volumetric dip and azimuth



# Most negative principal curvature, $k_2$





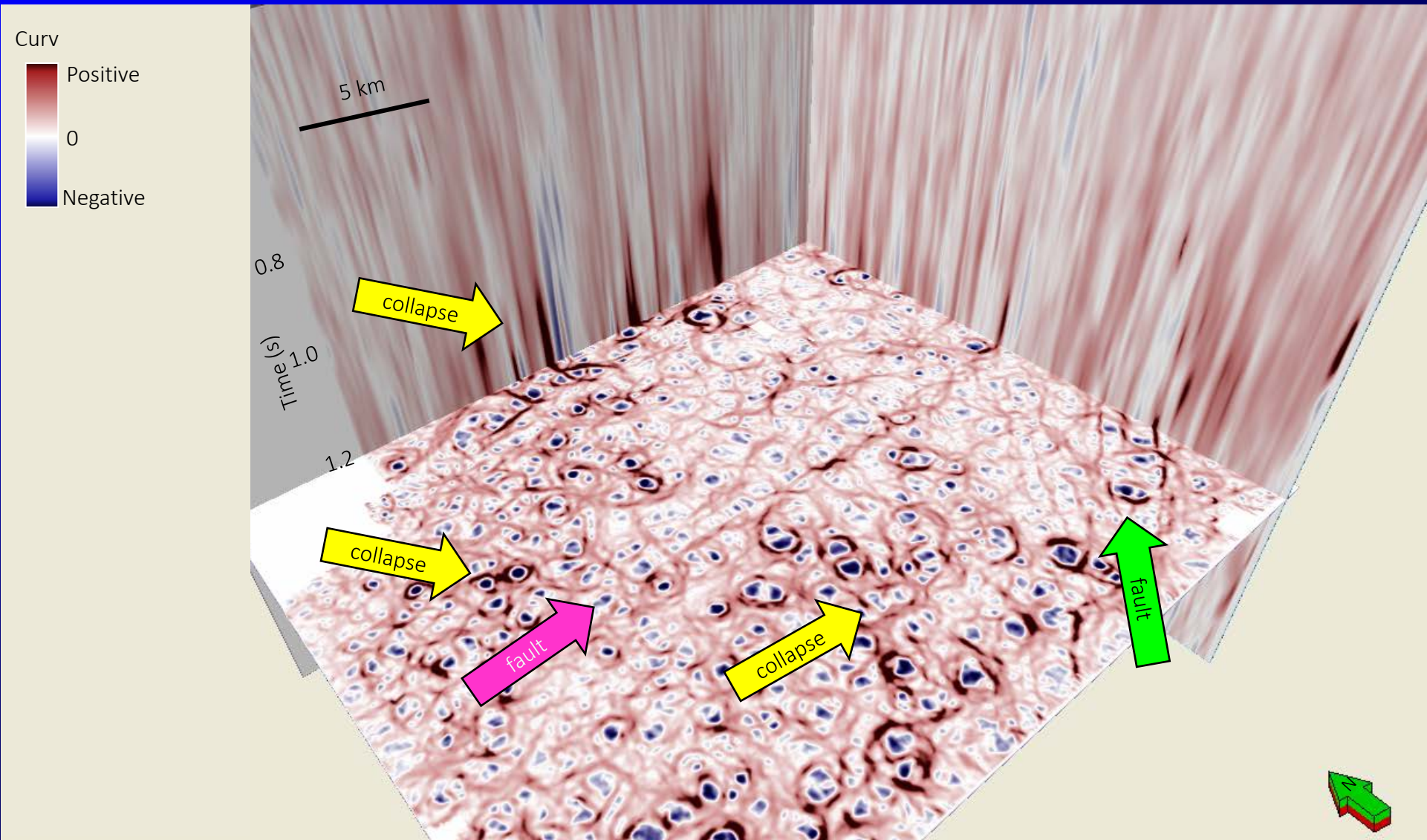


# Diagenetically altered joint (cave collapse) Devil's Den State Park, AR



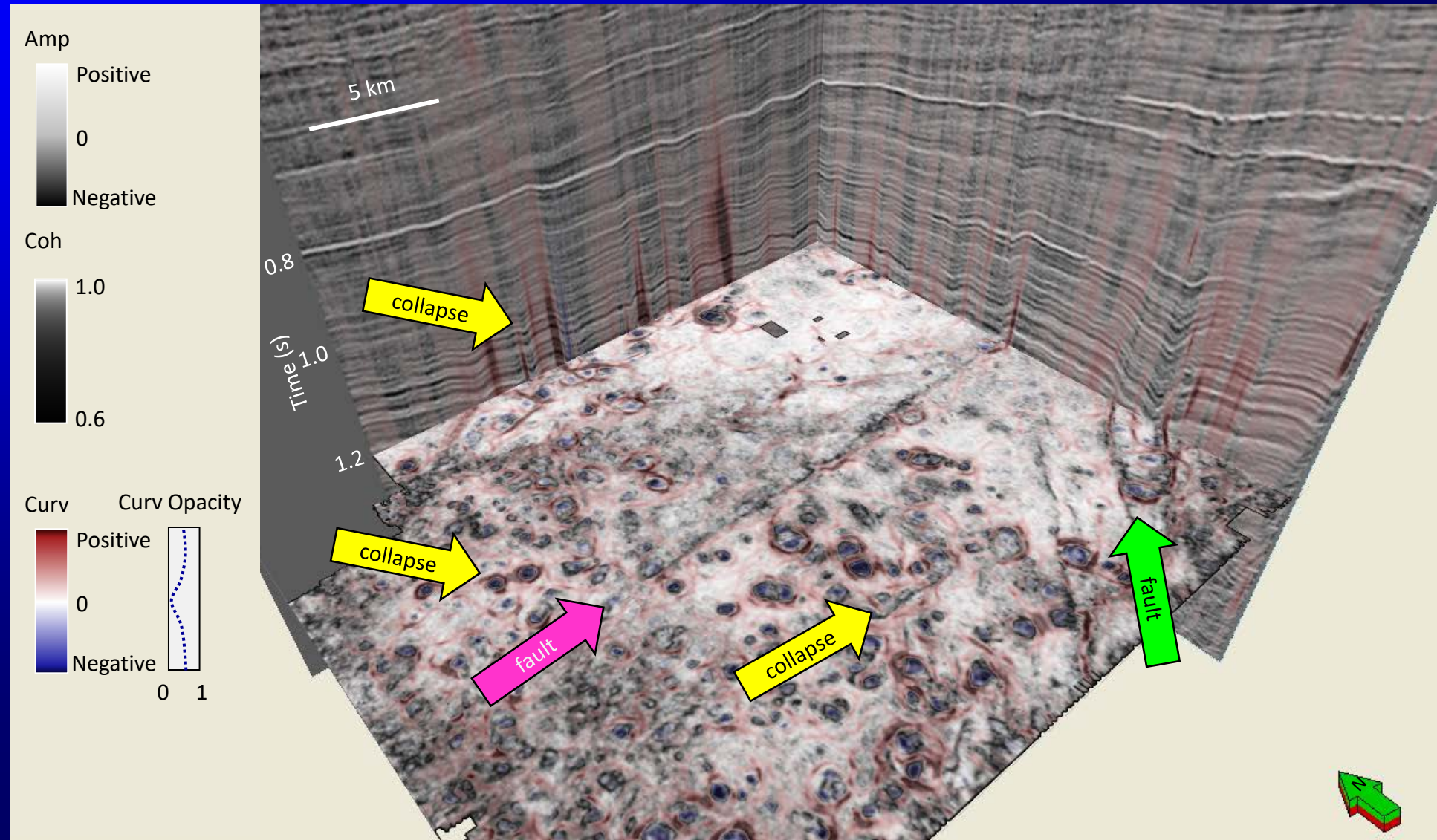


# Most positive principal curvature, $k_1$



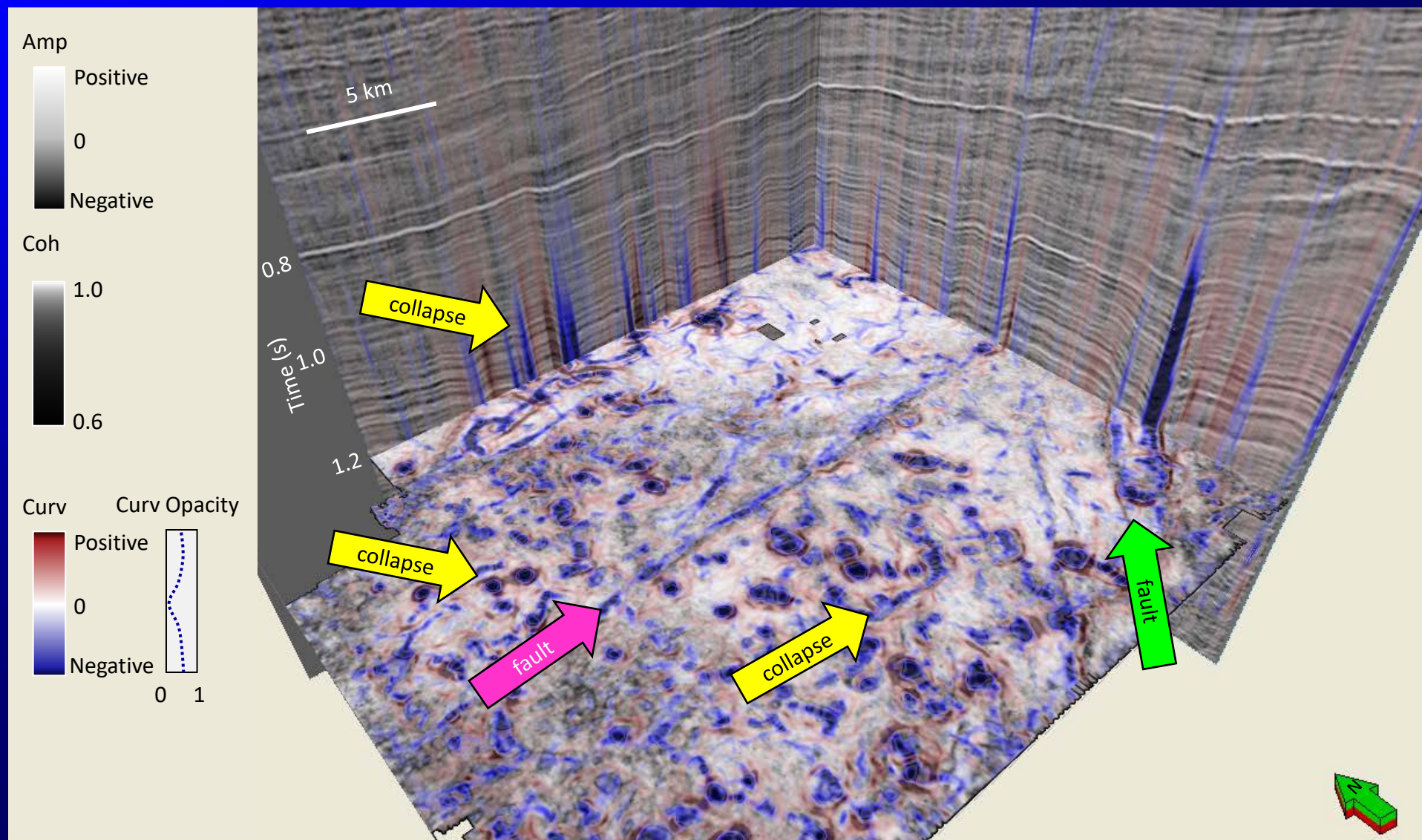


# Most positive principal curvature, $k_1$ , co-rendered with coherence

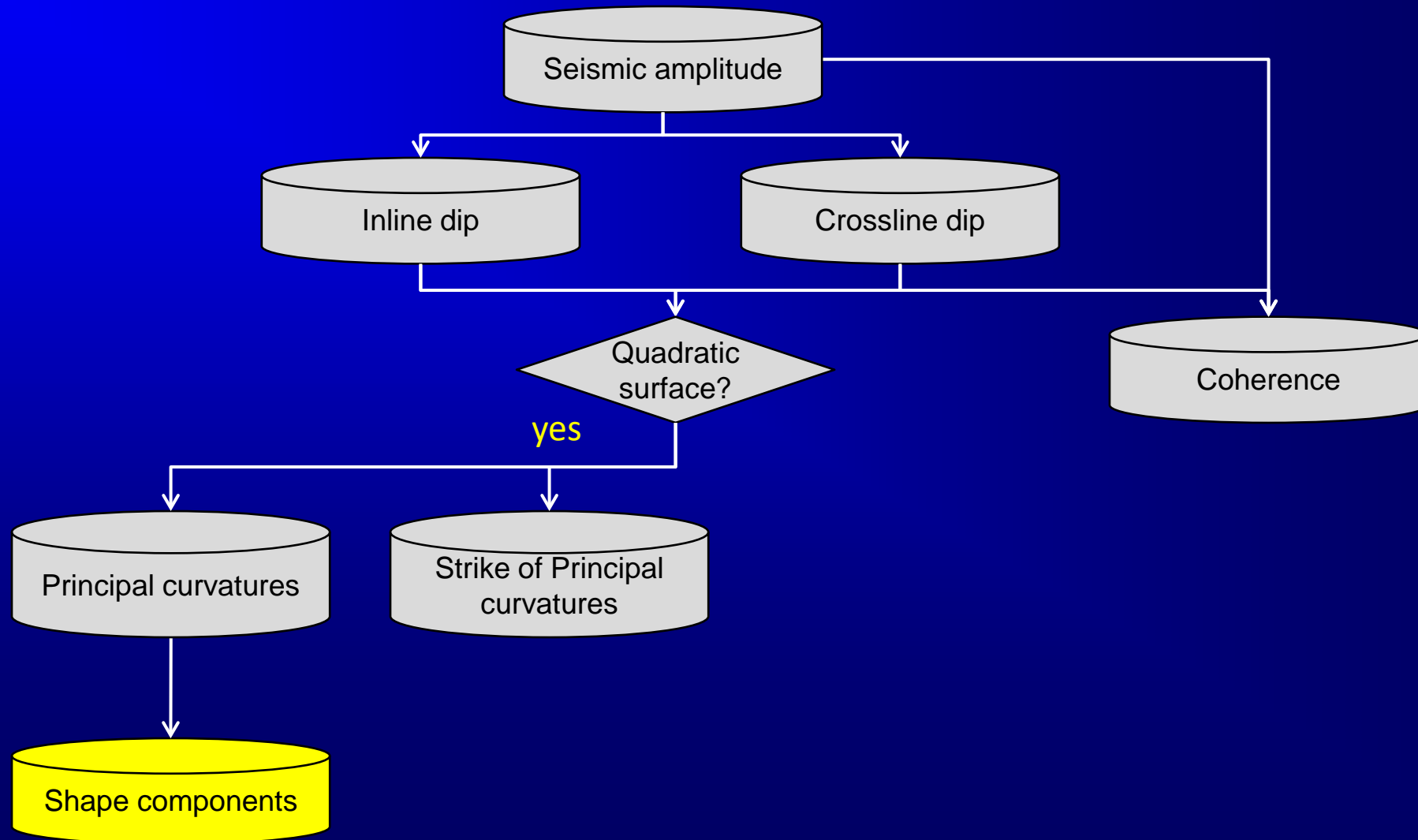




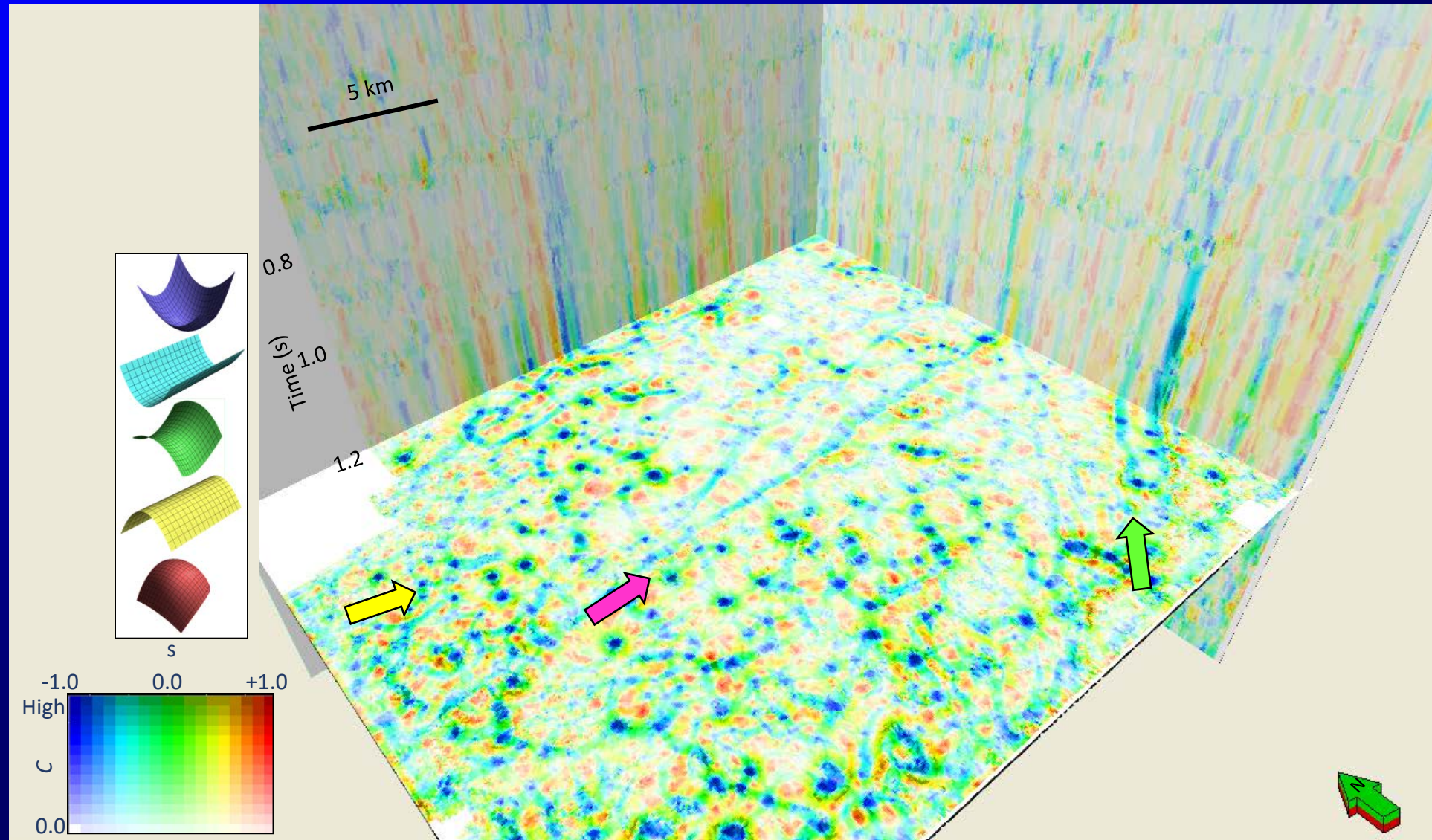
# Both principal curvatures, $k_1$ and $k_2$ , co-rendered with coherence



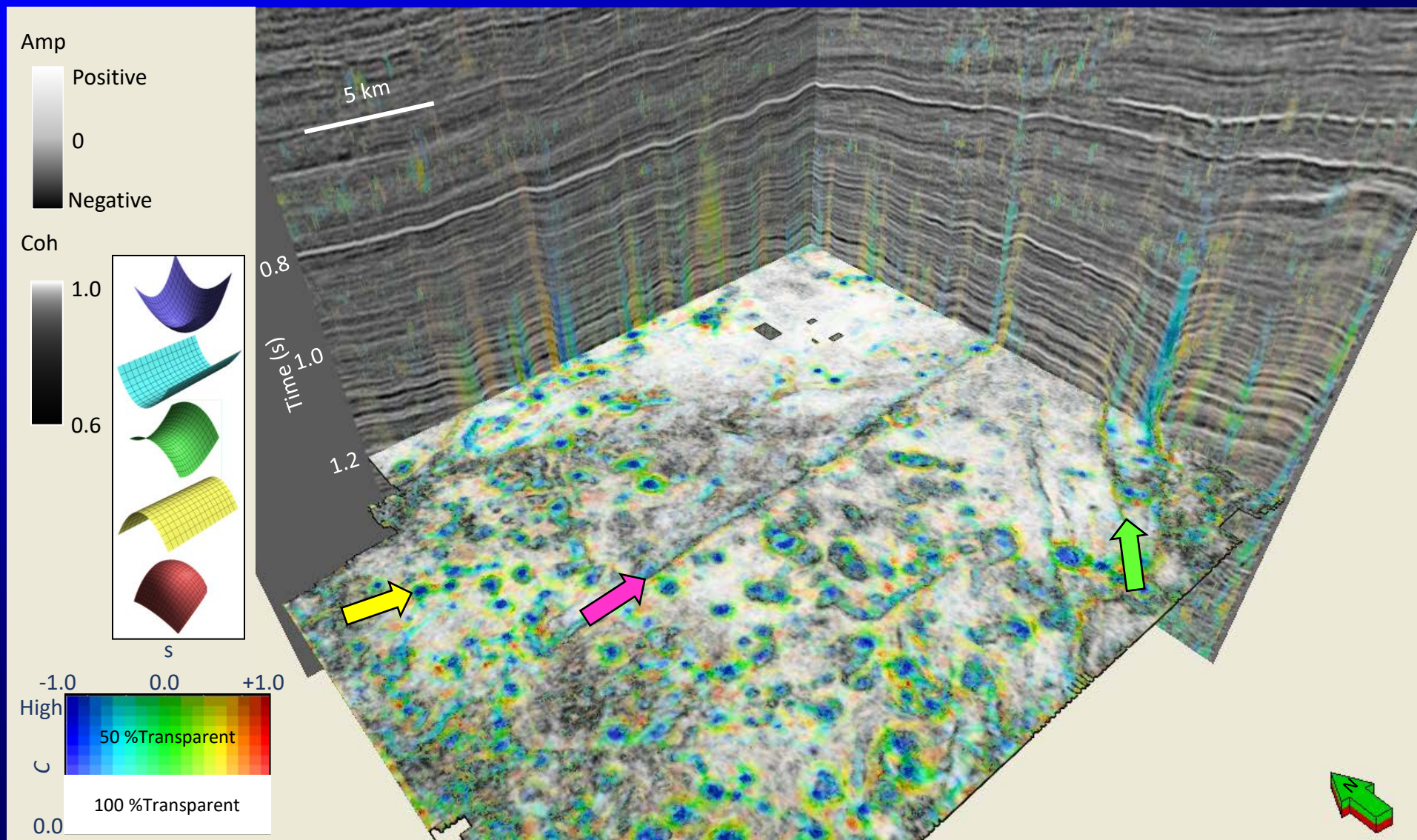
# Attributes based on volumetric dip and azimuth



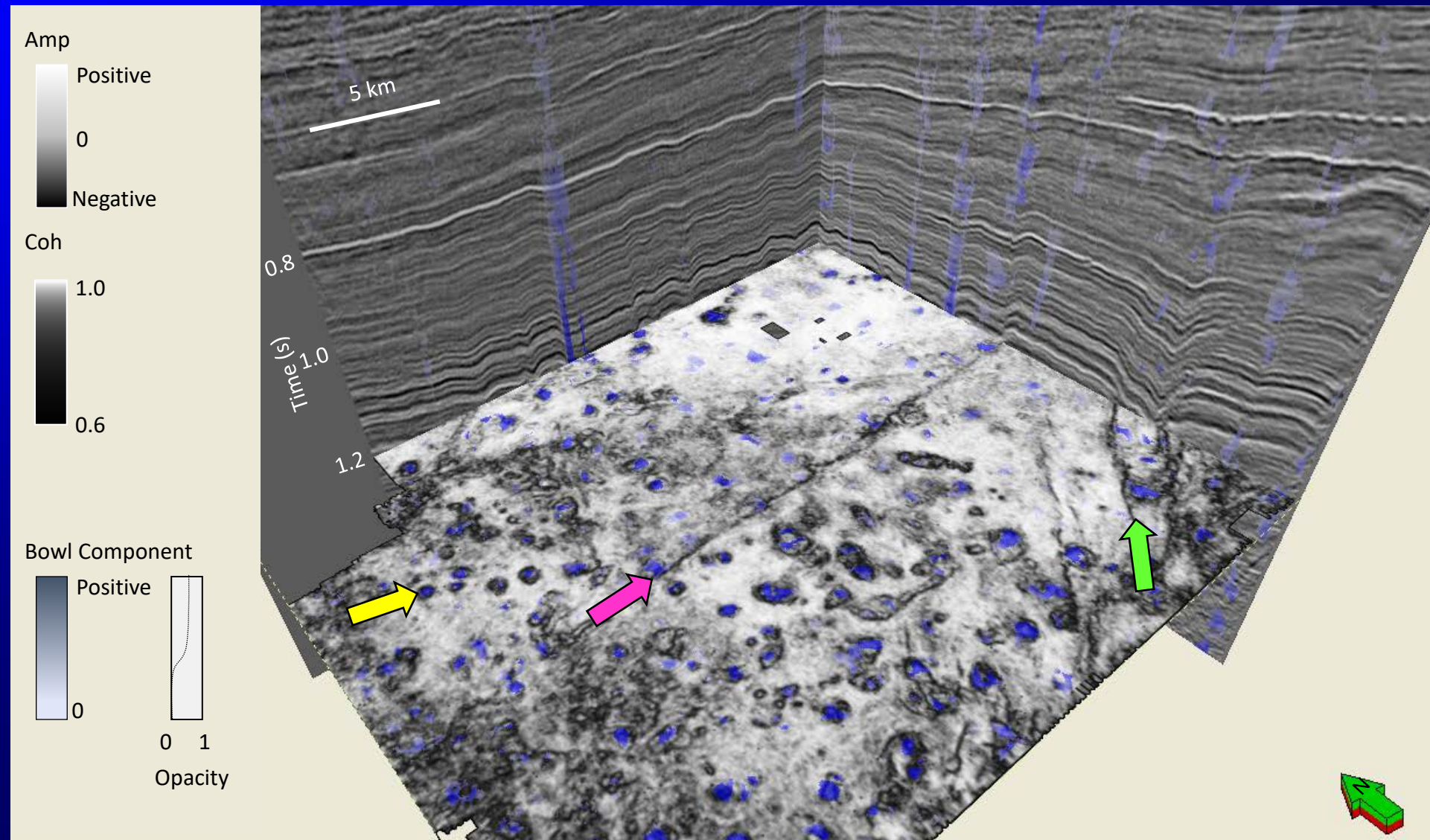
# Shape index modulated by curvedness



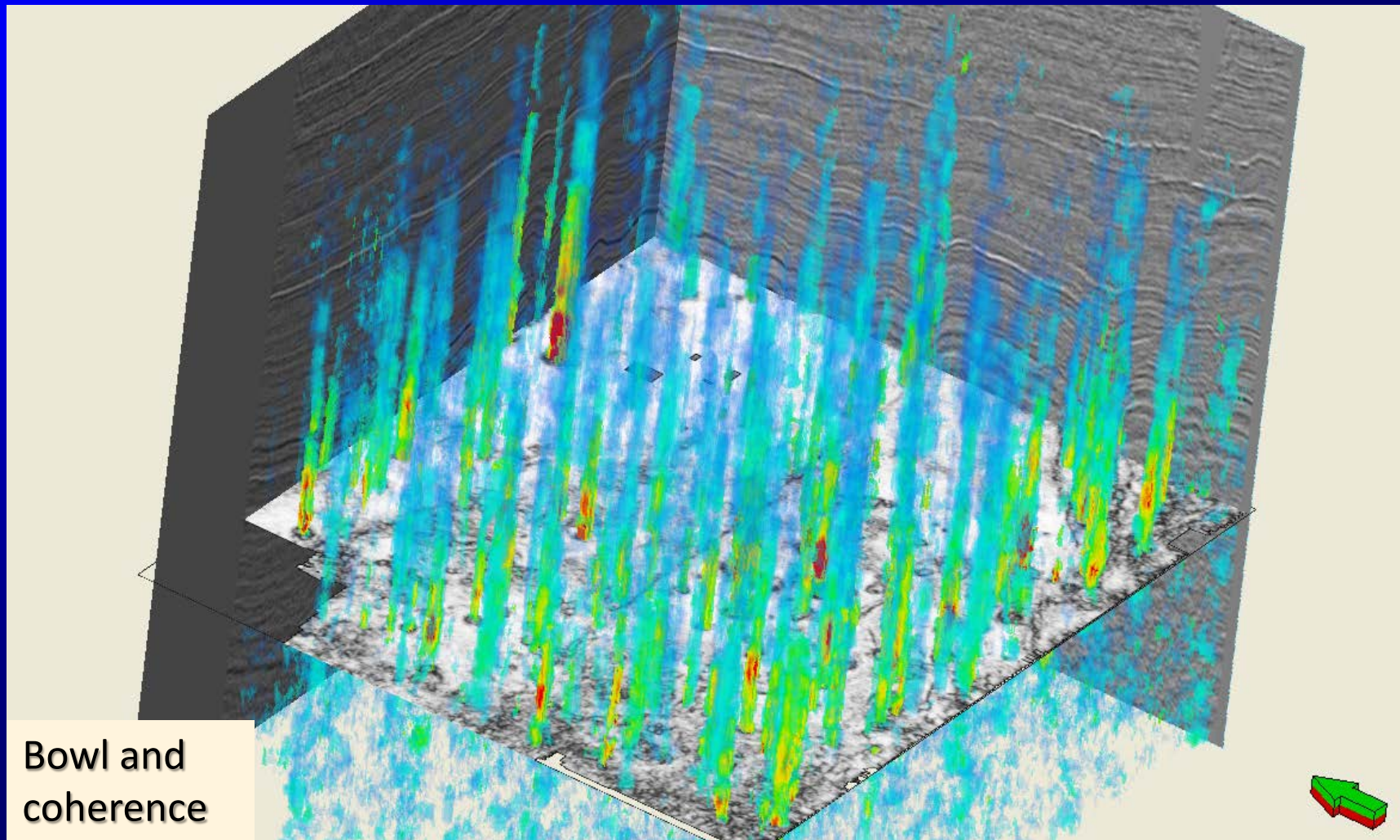
# Shape index modulated by curvedness, co-rendered with coherence



# Bowl component co-rendered with coherence



# Correlation of bowl shape component with collapse features

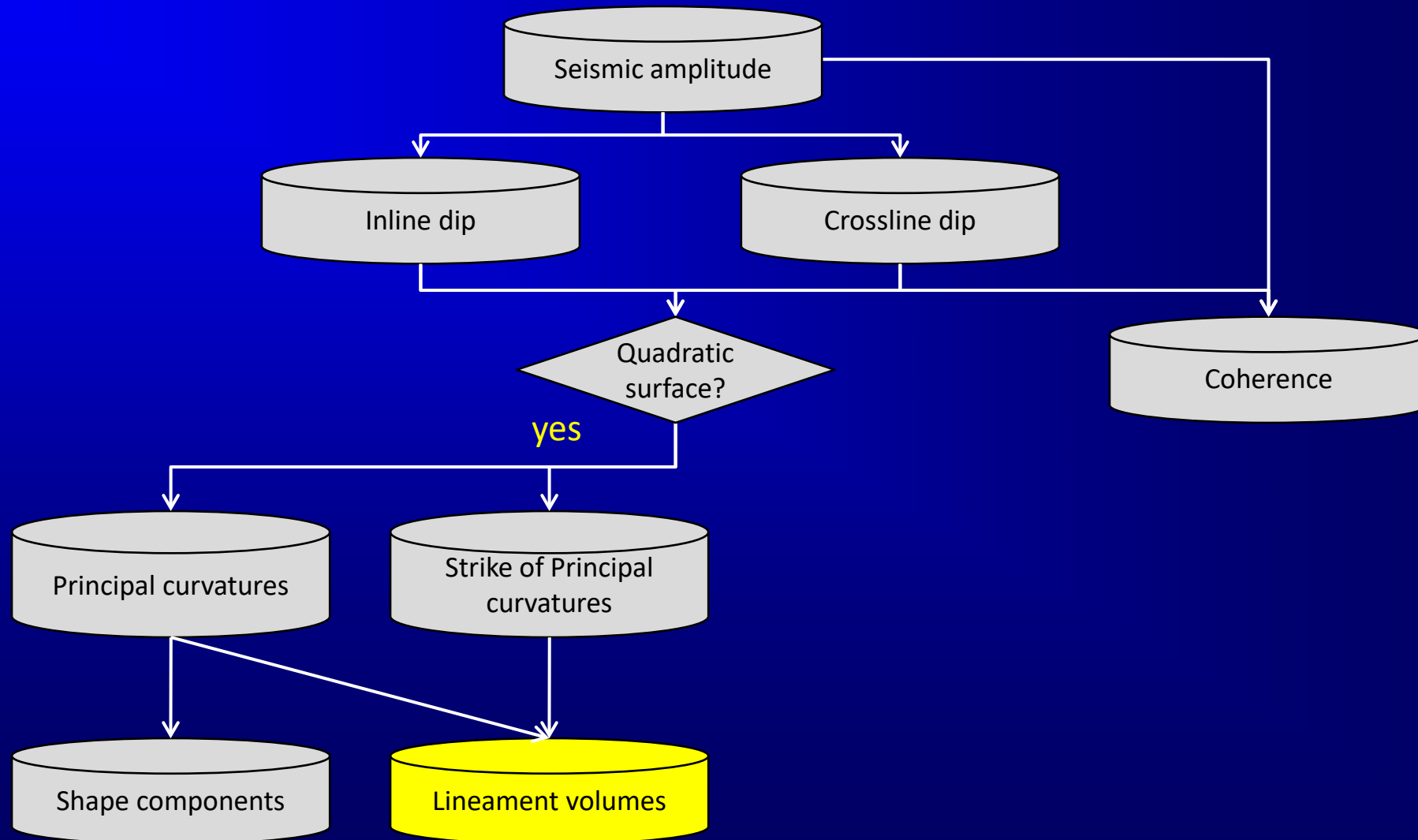


# Correlation of bowl shape component with collapse features

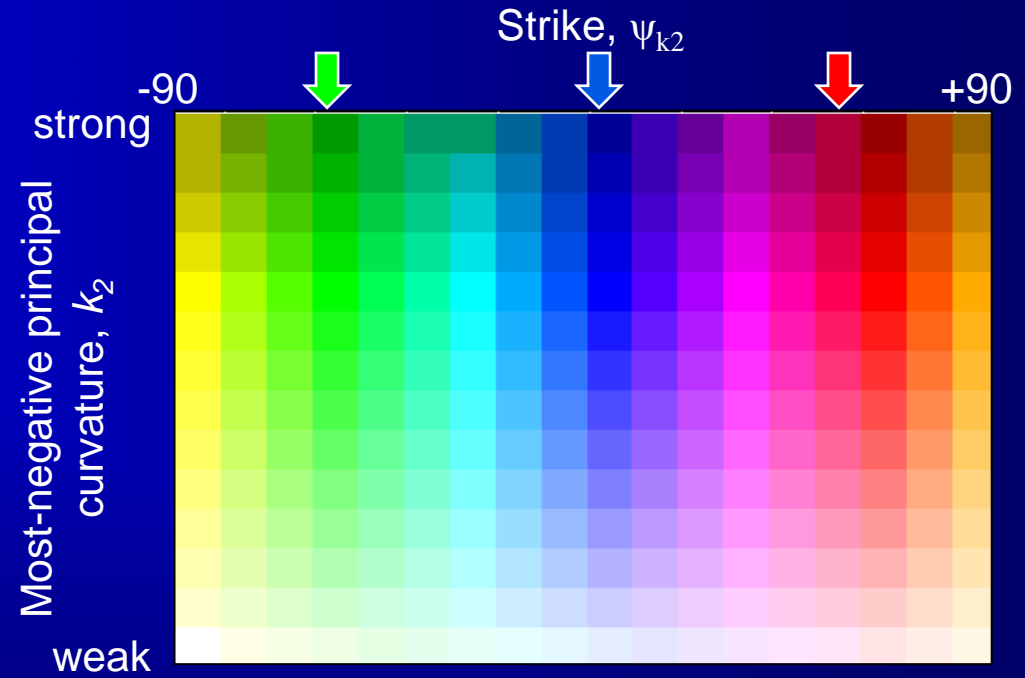
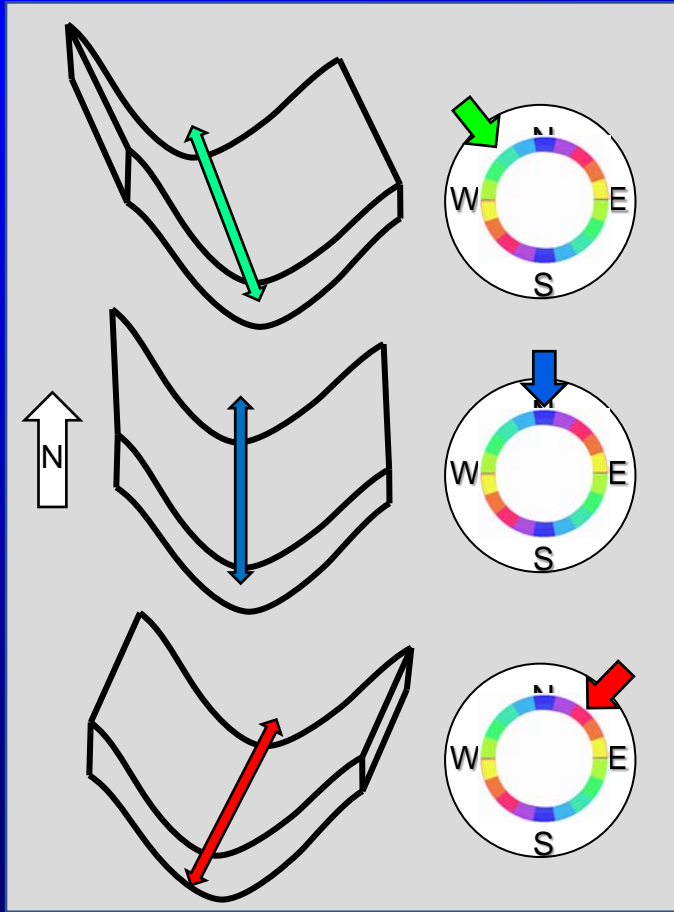


Bowl and coherence

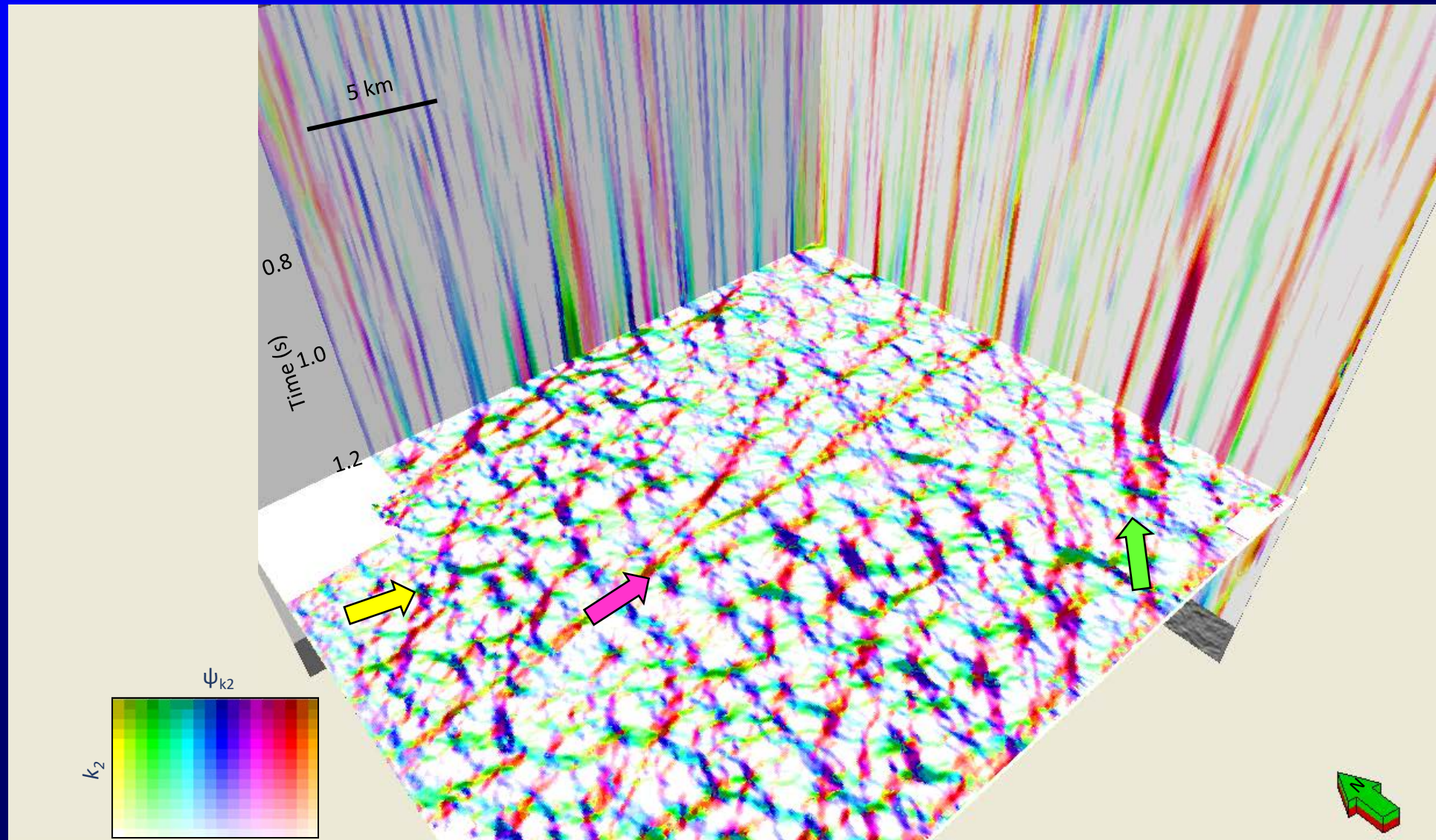
# Attributes based on volumetric dip and azimuth



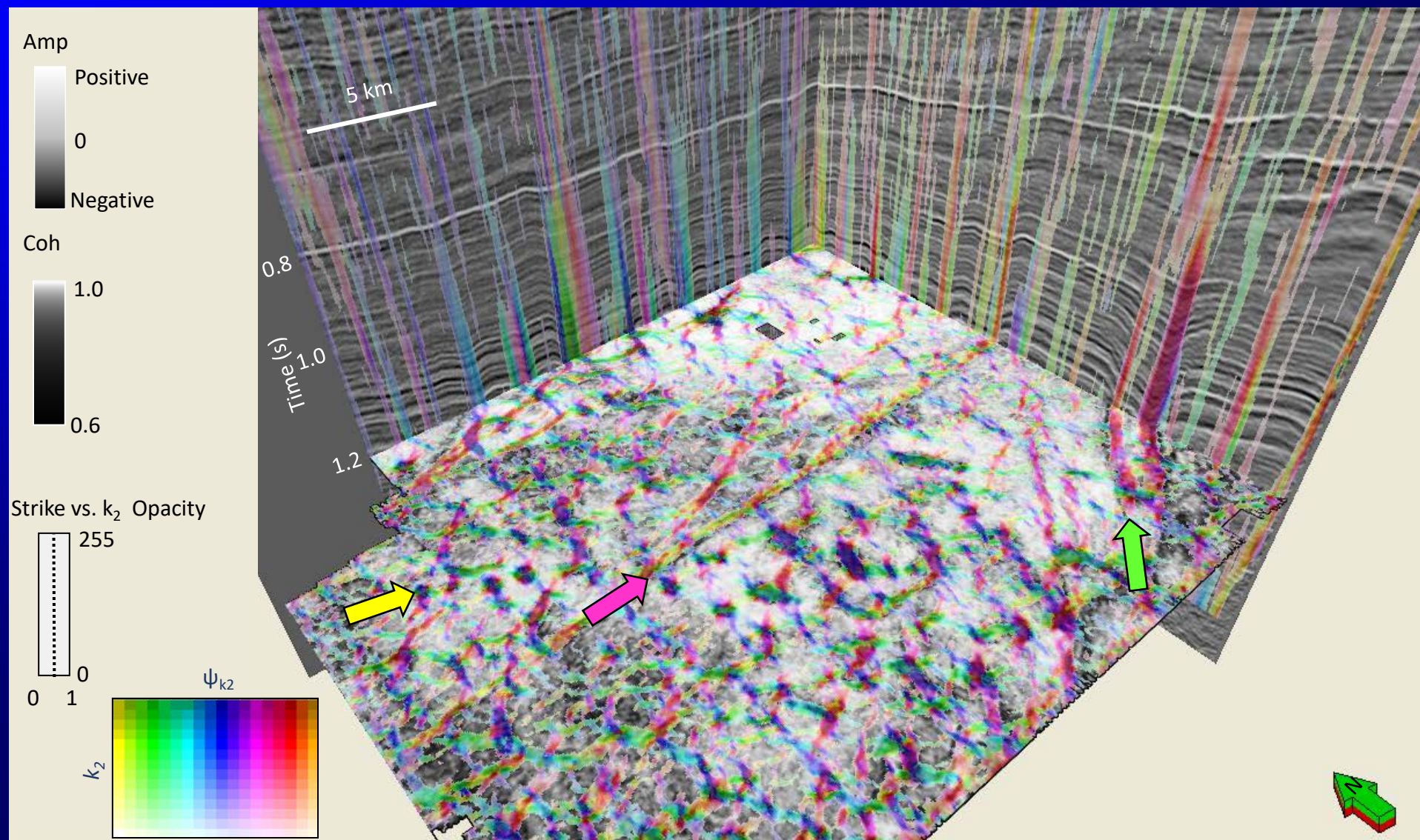




# Strike modulated by most-negative principal curvature



# Strike modulated by most-negative principal curvature, co-rendered with coherence



# Strike of most negative curvature modulated by its strength

Diagenetically altered joints appear as structural lows



# Mathematically Independent Attributes Correlated through Geology

## In Summary:

- In general, always use mathematically independent attributes in your interpretation
- In interactive interpretation, mathematically independent attributes that delineate the same feature provide insight into its generation and confidence in its interpretation
- In machine learning interpretation, mathematically independent attributes that delineate the same feature provide a means of discriminating a target class of features from the background