VVAz analysis for trimmed "dynamic" alignment of azimuthally migrated volume (Work plan, 2015)

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1. Introduction:

Fracture is a key factor in the optimization of reservoir production. High natural fracture usually means high production in unconventional reservoir production, but it also caused 'time lag' on azimuthal variation of seismic amplitude in different azimuth seismic data. VVAz and AVAz are particularly useful in estimating the direction of maximum horizontal stressing. VVAz appears as variations in travel-time with shot-receiver azimuth. These variations increase in intensity with increasing shot-receiver offsets and are caused by azimuthal variations in the velocity layer above.

2. Methodology:

We propose correlation and least square fitting to velocity variation n anisotropic layers. We first calculate crosscorrelation and autocorrelate of azimuthal seismic volume; fitting interval velocity in anisotropic layers by least-square method, and find the max ε_{aniso} to fit azimuthal seismic data; finally reduce VVAz effect to get better resolution seismic volume.

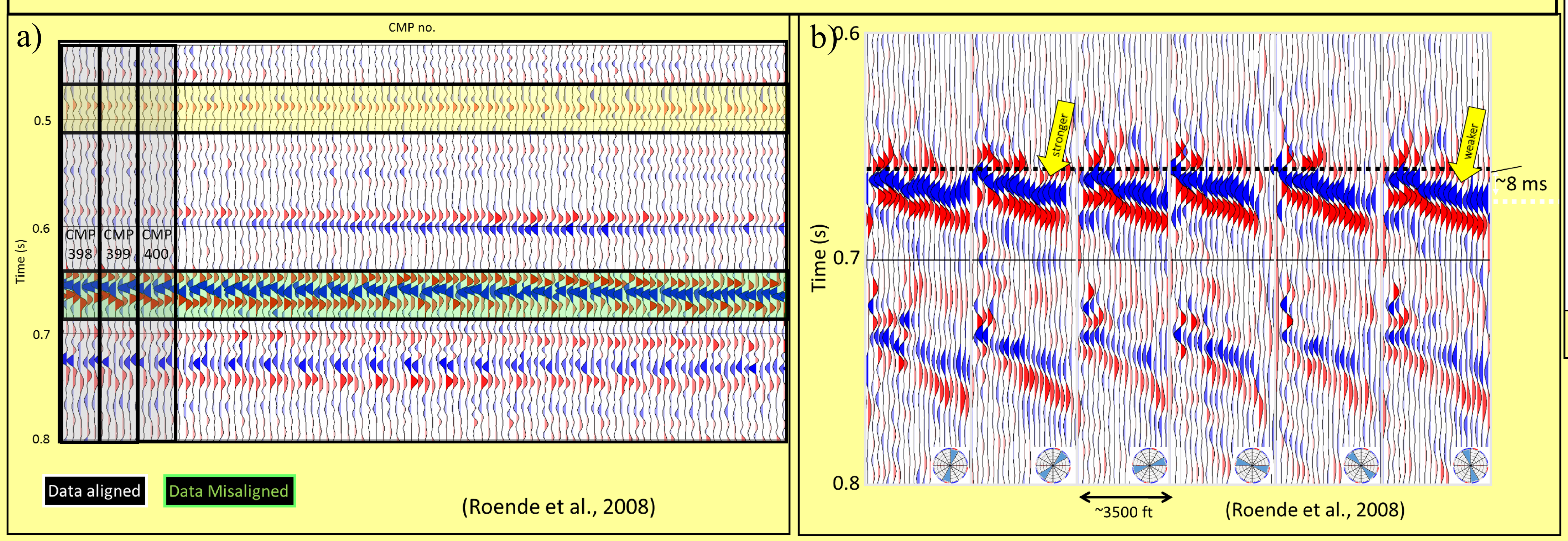


Figure 1. Workflow (a) to precondition the seismic data prior to attribute computation and (b) illustrating the steps for SOF based on principal component analysis (modified after Marfurt, 2006).

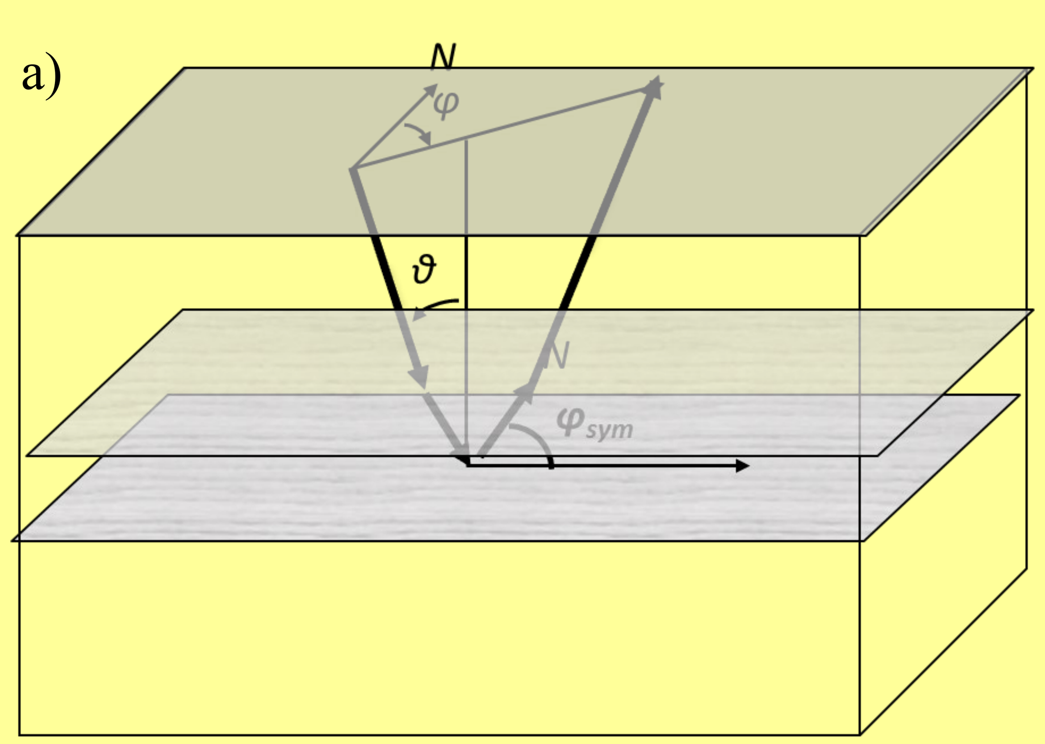
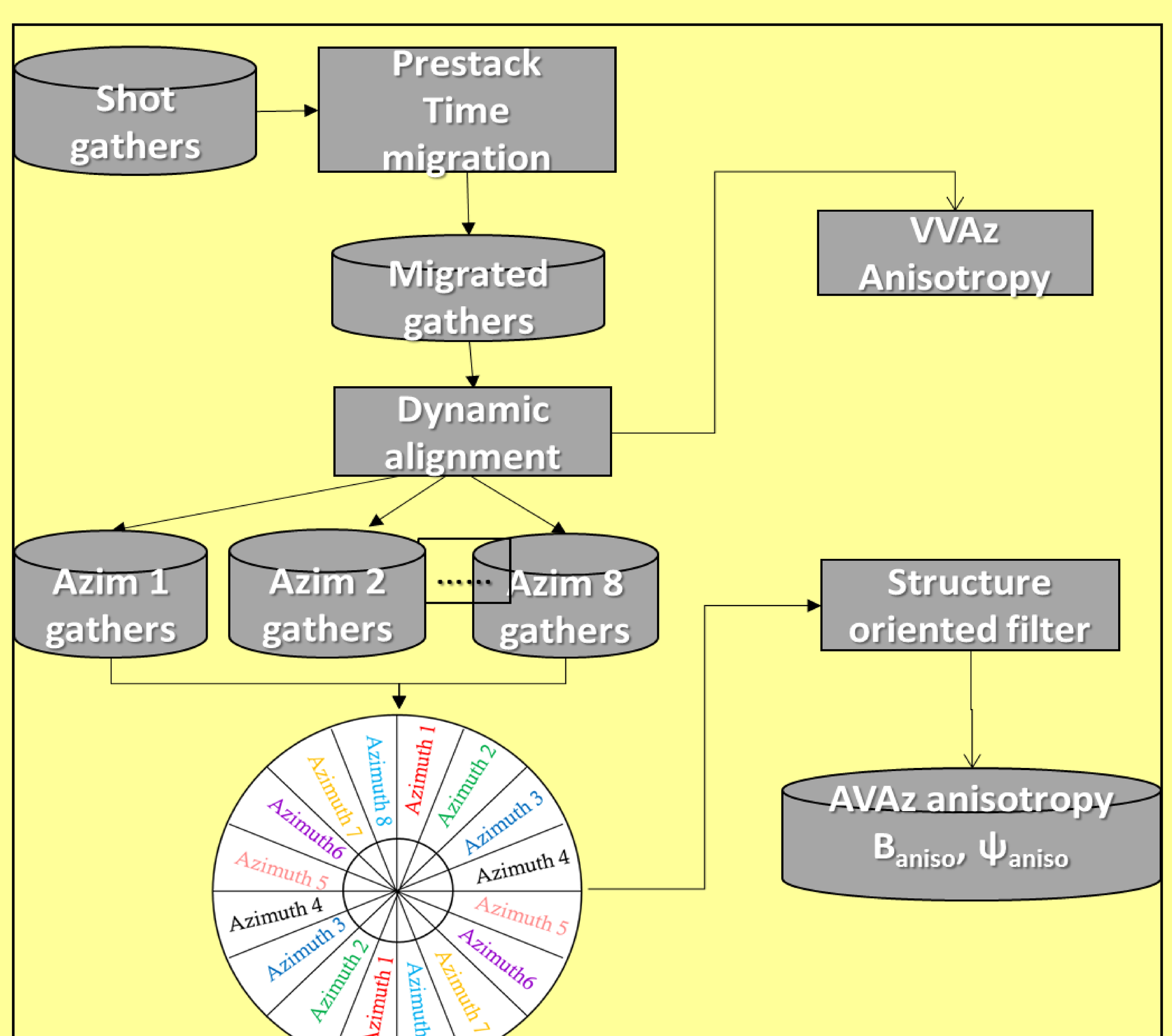


Figure 2. (a) velocity variation in anisotropic layer; (b) workflow of VVAz dynamic alignment and correlate to structural curvature.



3. Workflow and future work:

VVAz workflow includes

- Generate long-offset 'tiles' at different azimuths φ (Barnett Shale)
- At discrete picked horizon, compute V_{RMS} as a function of azimuth φ
- Compute interval velocity $V_{int}(\varphi)$ using Dix's equation
- Fit a sinusoidal curve to $V_{int}(\varphi)$ to obtain the magnitude and azimuth of anisotropy

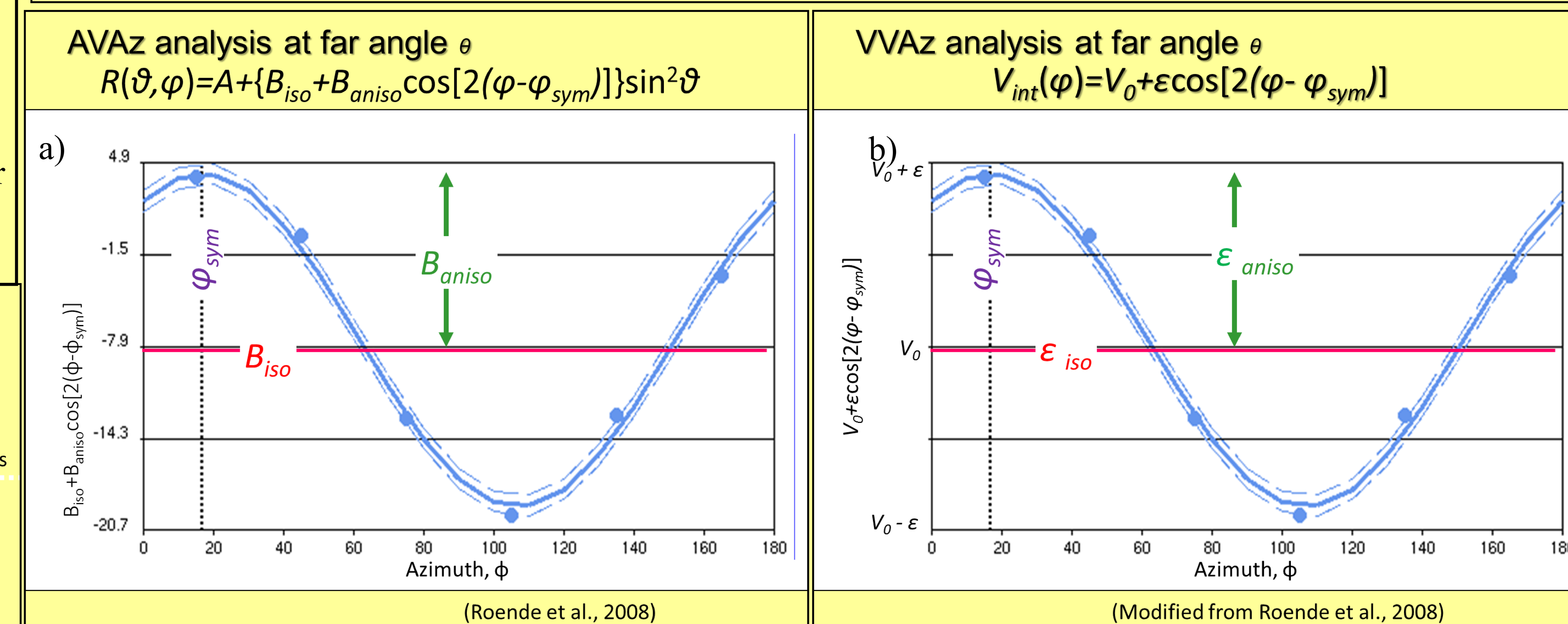


Figure 3. (a) Example of ellipse fitting (AVAz) on a single bin and time sample. Vertical axis is intensity and horizontal azimuth; (b) Expected ellipse fitting of VVAz: using azimuthal correlation to calculate time lag on azimuthal seismic volume; find "best fit-ted" φ_{sym} by non-linear least square fitting.

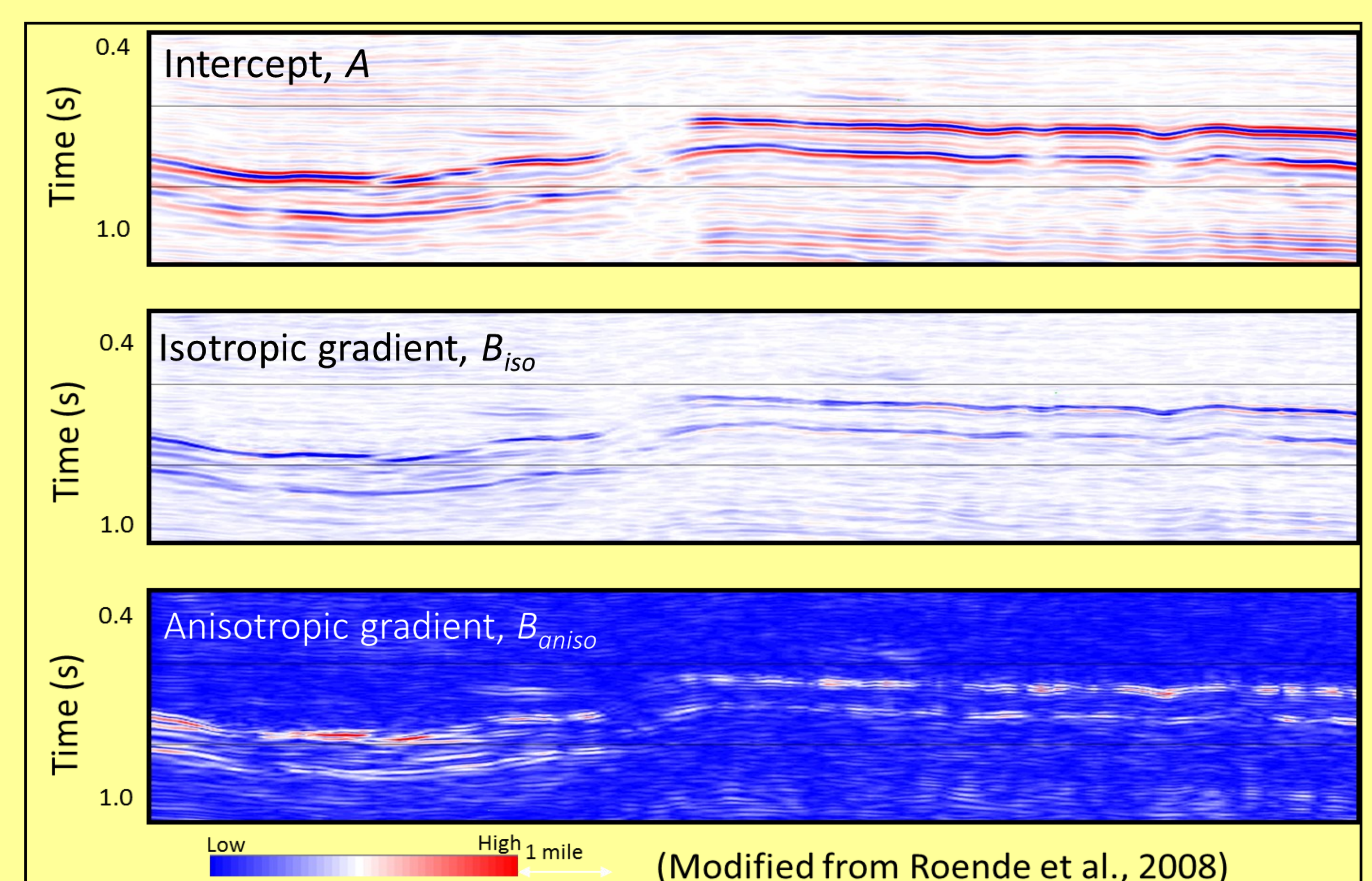


Figure 4. shows anisotropic attributes which applied to Barnett Shale. The high anomalies in those attributes indicate high fractural Bar-nett Shale.

5. Conclusion:

- By fitting the velocity variation to an ellipse, we can derive estimates of fracture intensity and orientation independent from those obtained through AVAz.
- High ε_{aniso} will cause high "events moving" on seismic section.
- Correlation of azimuthal seismic traces can find φ_{sym}, and reduce the effect of VVAz.

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