Geophysical Society of Pittsburgh

Proudly Presents Tuesday, May 2nd, 2017
At
Cefalo's Restaurant, Carnegie, PA

Cracking The Code: Fracture Detection Without Anisotropy

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Abstract: Fracturing in shales. In some resource plays, these fractures are the key to making a good well. In other shales, fracture avoidance is paramount for proper fracking. Is specialized & expensive acquisition & processing required, generating a host of volumes to bury the already busy interpreter? Can these sub-seismic cracks be reliably detected, & in such a way that someone other than a specialist could readily employ the results? Could it even work on 2D, the ultimate in no azimuthal coverage?

Anisotropy has typically been used to infer fracturing. Velocity Variation with Azimuth (VVAz) or shear wave splitting have lower frequency characteristics for fracture detection, the latter data being relatively expensive to acquire & process. Azimuthal AVO (AzAVO) has potentially better resolution in fracture finding, but it also has a degree of interpretive ambiguity. Both lower (VVAz, shear waves) & higher frequency (AzAVO) methods generally require more costly wide azimuth 3Ds, putting them off limits for older surveys & where acquisition budgets are limited. In all of these techniques, multiple volumes might be generated, providing a daunting ball of yarn for the usually time-strapped interpreter to untangle. More recently, some have advanced diffraction imaging routines, whereby the fractures themselves are actually imaged from their diffractions – but what if the shale is too thin or the cracks too small for accurate seismic detection?

In addition, the model of (somewhat) aligned fractures may be a bit too simplistic. One could imagine a case where conjugate or orthogonal fractures, or even fracture swarms, would produce low anisotropy in the most prospective locations. Being the opposite of the interpreter's typical method, one might need to explore for the anisotropic lows in such cases to gain the best production, & this decidedly cuts against the prospector's anomaly hunting grain. Clearly we desire a method that highlights rather than lowlights our fractured shale targets.

Reducing the number of volumes, widening the potential applicability, trimming costs, easing the interpretive burden, & finding fracture sets or swarms with weak to no anisotropy are the goals of Fracture Scattering Analysis (FSA) & high resolution velocity analysis (HiResV). In sum, either these two products work in an area or they do not, thereby diminishing the interpretive ambiguity. FSA & HiResV can also be run on 3D of any stripe, or even on 2D, as demonstrated herein, thus potentially decreasing the seismic budget while expanding the scope of the fracture hunt.

Are these just fractured fairy tales? No. We are simply advocating an alternate path that may compliment the anisotropic or diffraction ones previously taken. Seismic waves that encounter heavily localized fracturing should be scattered, and that scattering should result in measurable perturbations in the wavefield. FSA works on unmigrated gathers, searching for places where the scattering has increased. In this mode, its validity is only for relatively flat-lying events. With sufficient 3D azimuthal coverage, FSA may also be used with PSTM & azimuthal sectoring or offset vector tiling (OVT) on more structurally complicated targets.

In addition, significant localized fracturing should reduce the interval velocity. If the prestack data are of sufficient quality, a high resolution velocity (HiResV) approach may bolster the case made by Fracture Scattering Analysis. Together, these two volumes could supply the interpreter with some significant fracture detection horsepower without costly new acquisition or processing.

Finally, the target horizons themselves may be below the seismic threshold of detectability, in which case a superwhitening technique may help the interpreter see what is already present in the data (just like any other seismic attribute – no "new" frequencies here!).

A shallow horizontal resource well on a 2D line demonstrates the application of these methods. The target is a high TOC 30' shale at less than 2000'. The first horizontal section of the well had the best production, while the latter segment is substantially poorer. Can these be seen from the seismic? Yes, by reduced PSTM interval velocities (HiResV) in the early horizontal segment, plus some intriguing lateral variations in the fracture scattering analysis (FSA). The best fracturing seems to be located by FSA in a high/low pattern, wherein high fracturing is indicated in the upper portion of the shale, while reduced fracturing appears at the base.

2D (or any 3D) seismic fracture detection on flat lying shales therefore appears to be within our grasp, at least in this instance, but further investigation is needed for additional verification.

Biography: Bill Wepfer earned his B.S. in Physics (1983) from Miami University (Ohio), then his M.S. in Physics (1984) & his Ph.D. in laboratory rock physics (Geophysics) from Purdue University in 1989. Afterwards, he worked for Amoco (now part of BP) in Houston doing onshore AVO, ultimately leading a nine member technical group. Upon exiting Amoco in 1997, he joined Brigham Exploration (now part of Statoil) in Austin, continuing his onshore AVO efforts. Throughout this period, Bill was heavily involved in the seismic efforts, realizing that the core of the amplitude problems lay in the proper processing of problematic, low S/N land data. He left Brigham in 2000 to join AXIS Geophysics (afterwards part of GX Technology / IO, later Ion, & now part of NEOS) as the fledgling company's processing manager. Bill moved to Echo Geophysical (purchased in 2013 by SEI) in 2004 as a senior seismic analyst. In 2006, he moved outside of Raleigh to marry a North Carolina native, & he processed seismic from home for Echo until 2012. In early 2012, Bill formed Eskaton Seismic to help support a local charity. He has 3 stepchildren ages 24, 23, & 15, plus 1 adopted child, age 4.

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Cost: $35 Members, $40 Non-members ($20 for Students). Meeting Location: 428 Washington Ave, Carnegie, PA 15106
(412) 276-6600. Note the significant detour warning on page 2 of the newsletter.

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5:00 pm Social Hour (Beer and Wine) sponsored by:

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7:00 pm Lecture sponsored by:

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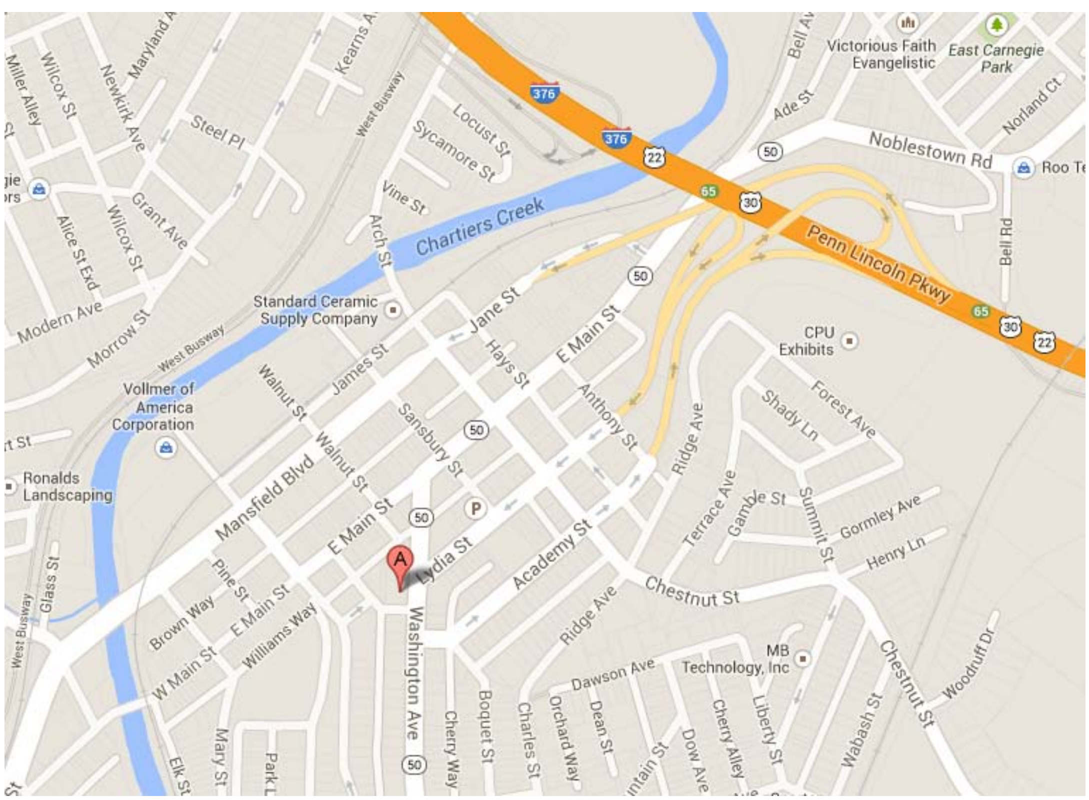

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