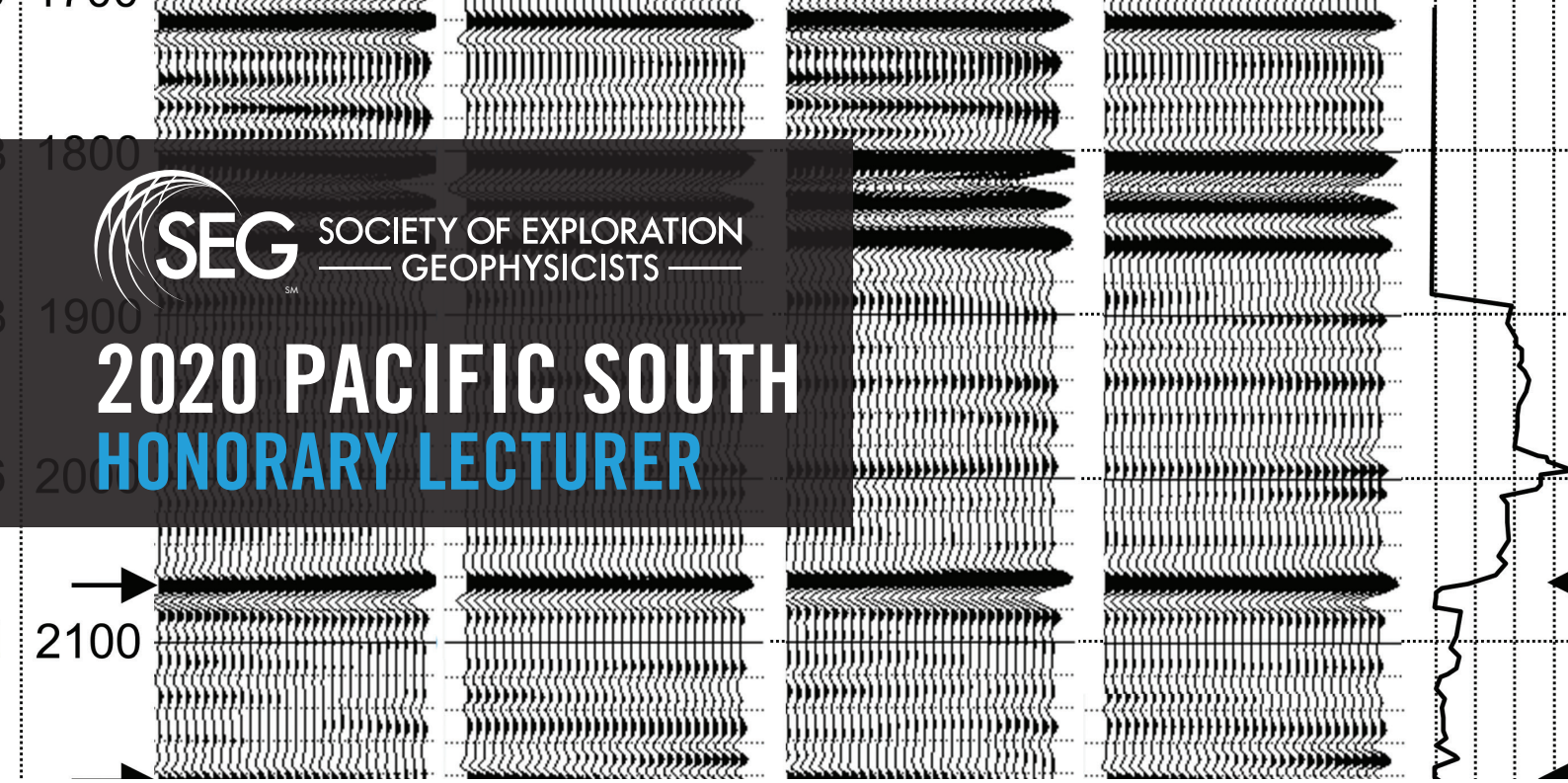

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2020 PACIFIC SOUTH HONORARY LECTURER

Regional to reservoir stress-induced seismic azimuthal anisotropy

by Lisa Gavin, Woodside Energy, Perth, Australia

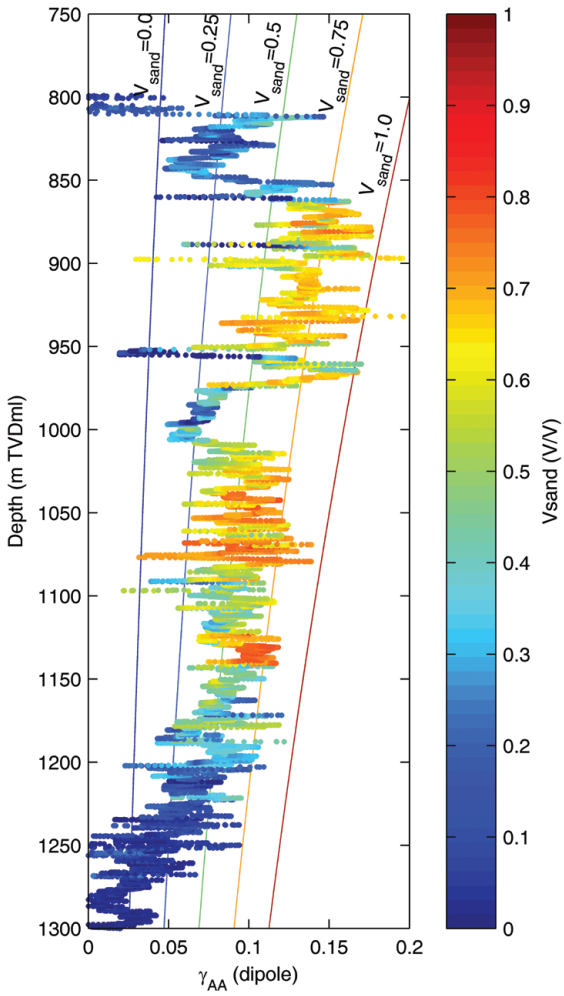
ABSTRACT

Seismic azimuthal anisotropy is observed in many areas of the earth, and knowing where it is present is important because it affects the propagation velocity of seismic waves. Not accounting for velocity anisotropy in processing or inversion of seismic data can lead to incorrect images and physical property estimates, and, therefore, incorrect geologic interpretations. While anisotropy has historically been considered a complication, the effect it has on data can be utilized as a source of information, giving an indication of geologic features much smaller than the seismic wavelength.

In this lecture, I will focus on the North West Shelf (NWS) of Australia, an area with significant stress-induced azimuthal anisotropy. I will explain observations of azimuthal anisotropy across the NWS from the regional-to reservoir-scale.

I first give a regional overview of seismic azimuthal anisotropy across the NWS using seismic exploration data. The results show that fast polarization azimuths and maximum horizontal stress direction trends correlate across a geographical area spanning almost 2,000 km, which compares well with published results from earthquake seismology studies. I also discuss why azimuthal anisotropy is detectable in some areas of the NWS and not in others.

I present a rock physics model that reproduces log azimuthal anisotropy observations in unconsolidated sand-shale sequences based on Vshale and depth. This method naturally introduces two new concepts; "critical anisotropy" the maximum amount of azimuthal anisotropy expected to be observed at the shallowest sediment burial depth, where the confining pressure and sediment compaction are minimal and "anisotropic depth limit" the maximum depth where stress-induced azimuthal anisotropy is expected to be observable, where the increasing effects of confining pressure and compaction make the sediments insensitive to differential horizontal stress.



Finally, I demonstrate the importance of accounting for azimuthal anisotropy and acquisition azimuth in 3D and 4D seismic modeling, feasibility, inversion, and interpretation studies. Azimuthal anisotropy does not affect the small angle reflection angles of 3D and 4D AVO, but it can have a significant effect on larger reflection angles. I show that this effect can influence 4D seismic interpretation where there can be an "apparent 4D effect" when reservoir properties do not change, and a "contaminated 4D effect" when reservoir properties do change.

The methods, techniques, and conclusions discussed in this lecture are likely to be useful in other regions where stress-induced azimuthal anisotropy is present.

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BIOGRAPHY

Lisa Gavin is a geophysicist with academic and industry experience in the oil and gas industry. She has worked as a geophysicist at Fugro Seismic Imaging, Chevron, and is currently at Woodside Energy in Perth, Australia. She has interests in seismic anisotropy, quantitative interpretation, 4D seismic, and rock physics. Lisa completed a BSc with first class honors in geophysics from Curtin University. She then joined the Centre for Energy Geoscience - CEG (formerly Centre for Petroleum Geoscience and CO_2 Sequestration – CPGCO_2) at the University of Western Australia (UWA) to complete a PhD in geophysics. Her PhD was on stress-induced seismic azimuthal anisotropy with a focus on the North West Shelf of Western Australia. The project was supported by an Australian Society of Exploration Geophysicists (ASEG) Research Foundation grant. Lisa was awarded a Robert and Maude Gledden Postgraduate Award Scholarship to support her postgraduate studies. For her thesis, she received the Nick Rock Memorial Prize for completing the most outstanding piece of research in the fields of numerical geology or computer modeling in geoscience. Lisa is currently broadening her subsurface knowledge by studying petroleum engineering by distance at Heriot-Watt University while completing an adjacent cross posting as a reservoir engineer at Woodside Energy.

Lisa is a member of SEG and EAGE. While at UWA she was the President of the UWA SEG Student Chapter and participated in the Chevron/SEG Student Leadership Symposium (SLS) in Houston, U.S.A. and the ExxonMobil/SEG Student Education Program (SEP) in Prague, Czech Republic. As part of the UWA SEG Student Chapter activities, Lisa coordinated volunteer field work to locate historical Aboriginal gravesites using near-surface geophysics. Lisa is currently on the EAGE Young Professionals committee and previously served on the Petroleum Exploration Society of Australia (PESA) WA committee. Lisa has published three papers focused on seismic anisotropy and eight conference abstracts. She was on the technical organizing committee for the EAGE workshop on Seismic Inversion for Reservoir Characterization held in Perth, Australia and has reviewed papers for the journal Geophysics.

To see Lisa Gavin's full itinerary or to view previous Honorary and Distinguished Lecturer presentations, visit: **seg.org/education/lectures**

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