**Title:** **Integrating P-Wave and S-Wave Seismic Data to Improve Characterization of Oil Reservoirs**

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**Author:** **Innocent J. Aluka**

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**Institution:** **Prairie View A&M University**

**Address:** **P.O. Box 2516, Prairie View, TX 77446**

**Telephone:** **936-857-4510**

**Fax Number:** **936-857-4148**

**E-Mail Address:** **innocent_aluka@pvamu.edu**

**Subcontractor:** **Bureau of Economic Geology, Austin, Texas 78713**

**Industrial Collaborator: Seismic Micro-Technology, Inc; Houston**

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## ABSTRACT

**During this period, the principal investigator wrote an abstract and research accomplishments which was published in the journal of the historically black colleges and universities and other minority institutions contract review meeting of June 2003.**

**Interpretations and analysis of data from the study area shows that incident full-elastic seismic wavefield reflected four different wave modes, P, fast-S (SH) , slow-S (SV) and C. These four wave modes image unique geologic stratigraphy and facies and at the same time reflect independent stratal surfaces. It was also observed that P-wave and S-wave do not always reflect from the same stratal boundaries. At inline coordinate 2100 and crossline coordinates of 10,380, 10430, 10480 and 10,520 the P-wave stratigraphy shows coherency at time slice 796 m/s and C-wave stratigraphy shows coherency at time slice 1964 m/s at the same inline coordinate and crossline coordinates of 10,400 to 10470. At inline cordinate 2800 and crossline coordinate 10,650, P-wave stratigraphy shows coherency at time slice 792 m/s and C-wave stratigraphy shows coherency at time slice 1968 m/s.**

## TABLE OF CONTENTS

**EXECUTIVE SUMMARY**

**During this segment of the project period attempts were made to convert P and S images to depth domain because a unified interpretation of P and S images can be achieved easily in the depth domain than in the image-time domain. This is so because S-wave image time differs remarkably ( typically a factor of 2) from P-wave image time.**

**The P and S wavelets were equalized in order to correctly compare P and S seismic images of geologic informations from the subsurface. Generally, two seismic images that are to be compared with regards to their geologic informations need to be generated with equivalent image wavelets to avoid confusing wavelet-related data processing effects and geologic interpretations. We know that the frequency bandwidth of S-wave reflection signals tends to be only one-half that of frequency bandwidth of P-wave reflection signals. The conversion of P and S data to depth domain makes the two data sets to have equivalent spectral distributions of spatial wavelengths. The generation of equvalent-wavelet P and S images is important for the reflection archtecture and reflection attributes in these respective data volumes to be interpreted in terms of stratigraphic relationships and lithological distributions.**

**It was observed that incident full-elastic seismic wavefield reflected four different wave modes, P, fast-S (SH) , slow-S (SV) and C. These four wave modes reflect independent stratal surfaces and image geologic architecture and facies. Further analysis showed that P-wave and S-wave do not always reflect from the same stratal boundaries. At inline coordinate 2100 and crossline coordinates of 10,380, 10430, 10480 and 10,520 the P-wave stratigraphy shows coherency at time slice 796 m/s and C-wave stratigraphy shows coherency at time slice 1964 m/s at the same inline coordinate and crossline coordinates of 10,400 to 10470. At inline cordinate 2800 and crossline coordinate 10,650, P-wave stratigraphy shows coherency at time slice 792 ms and C-wave stratigraphy shows coherency at time slice 1968 ms.**

**Efforts are still being made to establish effective and appropriate criteria to be used to segregate P and S seismic sequences and facies into similar and dissimilar categories. Also, more work is needed to correlate P and S seismic sequences and facies with log-based models and formulate a rule-set for vector-wavefield seismic stratigraphy.**

## EXPERIMENTAL

**The analysis is being carried out on PCs, utilizing the software provided by the Seismic Micro-Technology, Inc; (SMT).**
**The main service software package provided by Seismic Micro-Technology, Inc; (SMT) include 2d/3dPAK data interpretation, 2d/3d Seismic Interpretation, The Kingdom Suite SynPAK, The Kingdom Suite VuPAK, The Kingdom Suite TracePAK, The Kingdom Suite ModPAK , and the EarthPAK.**

## RESULTS AND DISCUSSION

**The P and C waves often image different stratal surfaces.The propagation of incident full-elastic seismic wavefield generates four different wave modes, P-wave, SH-wave (horizontal shear wave), SV-wave (vertical shear wave) and C-wave (converted shear wave). These four wave modes reflect independent stratal surfaces. SH, SV, and C are three independent shear wave seismic modes. An upgoing SH mode can be produced by only a downgoing SH mode. The upgoing and downgoing modes are called SH-SH (SH down and SH up). SV is also called SV-SV, meaning SV down and SV up. C is a converted shear wave, meaning it is a special SV mode created by a downgoing P-wave. This is called P-SV, meaning P down and SV up.**
**Coherency numerically measures lateral similarity of reflection waveforms in a defined data window. If the wavelet reflecting from an extensive interface has the same waveshape across the image space, the lateral coherency is high. On the other hand , if that interface is cut by a channel or incisement, for instance, the reflecting wavelet changes its waveshape at the edges of the channel. In such a case, lateral coherency is low across those narrow parts of the image space where the channel edges are. In a map of coherency, channels and incisements are shown as trends of low lateral wavelet coherency.**
**From our study it was observed that at inline coordinate 2100 and crossline coordinates of 10,380, 10430, 10480 and 10,520 the P-wave stratigraphy shows coherency at time slice 796 ms and C-wave stratigraphy shows coherency at time slice 1964 ms at the same inline coordinate and crossline coordinates of 10,400 to 10470. At inline cordinate 2800 and crossline coordinate 10,650, P-wave stratigraphy shows coherency at time slice 792 ms and C-wave stratigraphy shows coherency at time slice 1968 ms.**
**This implies that full science of reservoir characterization can be achieved by incorporating the principles and applications of vector-wave field seismic data in which geologic systems are interpreted using both P-wave and shear (S) wave images of subsurface stratigraphy.**

## CONCLUSION

**Since conventional seismic stratigraphy is limited when characterizing oil resevoirs because its concepts and principles have been developed and demonstrated using only P-wave seismic data, and at the same time have been verified using only P-wave technology; the complete science of reservoir characterization can be realized only by expanding its principles and applications to vector-wavefield seismic data in which geologic systems are interpreted using both P-wave and S-wave images of geologic sequences. This statement is based on the results of this study which showed that in some instances, spatially coincident P and S seismic profiles do not exhibit the same reflection sequences or the same lateral variations in seismic facies character. It is further concluded that in a complex geologic environment, it is necessary that sedimentary record be described by one set of P-wave seismic sequences(and facies) and also by a second, distinct set of S-wave seismic sequences (and facies). A full comprehension of geologic environment (reservoir architecture and heterogeneities) cannot be made until both P and S wave images are unified in seismic stratigraphy interpretations. The application of both P and S wave images to oil reservoir characterization is the current trend in most oil and gas companies and will sooner or later overtake the conventional seismic stratigraphy of only the P-wave imaging.**

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