Geophysical Society of Pittsburgh And the Pittsburgh Association of Petroleum Geologists

Proudly Presents

Monday, April 29, 2024

3000 Westinghouse Dr., Suite 105
Cranberry Twp., PA 16066

Society of Exploration Geophysicists and
American Association of Petroleum Geologists
Distinguished Lecture Program Speaker

Beyond Physics in Geophysics

Presented by:

John Castagna,
Faculty, Applied Seismology, University of Houston
University of Houston

Please RSVP using the PayPal link on the Geophysical Society of Pittsburgh website at: www.thegsp.org
Cost: $35 Members, $40 Non-members ($5 for Students). Meeting Location: 3000 Westinghouse Dr., Suite 105, Cranberry Twp., PA 16066, 412-548-2536

Abstract:

Physics is an essential component of geophysics but there is much that physics cannot know or address. For example, physics alone cannot ascertain that an inverted low seismic impedance is indicative of a coal layer in one stratigraphic interval and the same inverted impedance represents an organic shale reservoir in another. Such geological non-uniqueness often results in the false conclusion from physics that such distinctions from seismic data are not possible. Applying physics to determine what is not possible disregards what information outside of physics can achieve. Seismology only understands relationships controlled by the wave equation and is thus incapable of predicting geological correlations between parameters and seismic attributes that are not governed by the physics of wave propagation. Generally, the more geological information that can be properly incorporated into a geophysical prediction, the better.

For the past quarter-century, explorationists have successfully empirically used seismic multi-attribute regression analysis and neural networks to make predictions that physics alone cannot achieve. More recently, deeper neural networks are being employed to perform a variety of geophysical functions. This machine learning has great promise but can also be readily misapplied and abused when used to directly make predictions, especially given the usual paucity of training data.

An alternative approach is to use machine learning to uncover relationships that may not have been foreseen because they were not readily apparent or addressed using physics alone. Once these relationships are found and understood geologically and geophysically, real, rather than artificial, intelligence can be used to predict rock and fluid properties from seismic data. For example, a simple-minded analysis of reflectivity tells us that changing the impedance contrast across an interface, or for a layer, changes the reflection amplitude of the reflected waveform but not the phase of that event. Thus, physics is readily misapplied to conclude that phase cannot be used to predict rock properties. Yet, multi-attribute analysis case studies tell us that phase is often a powerful attribute for predicting rock properties. Once artificial intelligence tells us that phase is indeed useful in this regard, it allows us to understand why the simple-minded conclusion telling us what NOT to do was wrong. Similarly, multi-attribute analysis tells us that using bandwidth extended seismic data can improve rock properties predictions even though the correlation of such data to synthetic seismograms often decreases with increasing bandwidth. Poorer correlations for bandwidth extended data have been used by those imprisoned by simple physics to conclude that bandwidth extension is not possible. Understanding when and why bandwidth extension can be useful despite such decreases in correlation falls into the realms of information theory and depositional systems in addition to geophysics. As a final example, seismic inversion theory tells us that the amplitude spectrum of the seismic wavelet must be known in order to model reflection seismic data, and thus must be known to invert that data. This apparently incontrovertible fact is very unfortunate since the temporally and spatially varying seismic wavelet spectrum is very poorly known and limits the accuracy of seismic inversion. However, using machine learning to replace the functionality of seismic inversion and inspecting the neural network weights can provide insight into what information is necessary and most robust to successfully accomplish the same task as traditional model-based seismic inversion. Such guidance can then be incorporated into a physics honoring seismic inversion scheme that works without explicit knowledge of the seismic wavelet. This is readily demonstrated with synthetic seismic data.

Biography**:John Castagna**

John Castagna is the Margaret S. and Robert E. Sheriff Endowed Faculty Chair in Applied Seismology at the University of Houston. He has degrees in geology, geochemistry, and geophysics and specializes in exploration geophysics. He has more than 40 years of experience in petroleum exploration including more than 20 years in academia and has published more than 100 papers in areas such as rock physics, direct hydrocarbon detection, multi-attribute analysis, and seismic inversion. Despite his ineptitude in that subject, he loves and values physics.

Monday April 29, 2024

Agenda:

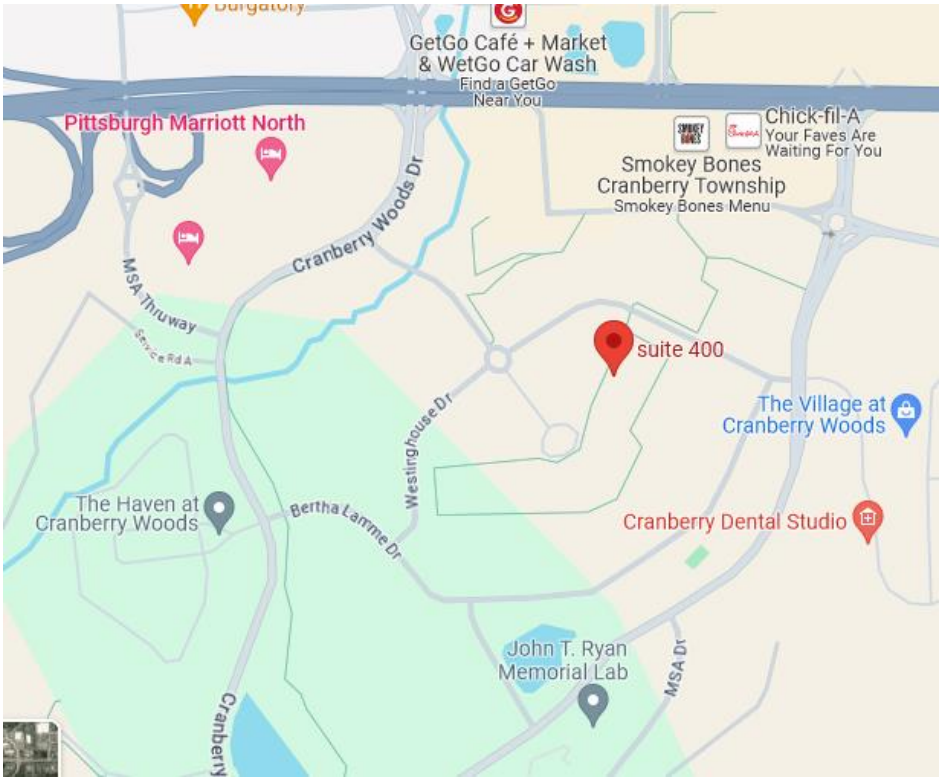
11:15 to 11:45 Social Half Hour
11:45 pm Lunch Buffet
12:00 pm Lecture

$25 for members,
$40 for non-members,
$5 for students.

The auditorium we booked is in building 3000. However, to avoid the main building security check and make it easy, all registrants must first come to Seneca office at Building 2000 first and then walk down to building 3000. We will have Seneca people assisting the direction to the auditorium on the meeting day.

<u>To receive a CEU certificate from this lecture please contact Bill Harbert</u>

This month's lecture will be held at :
Auditorium
Seneca Resources Company LLC
3000 Westinghouse Dr.
Suite 400
Cranberry Twp., PA 16066
Office: 412-548-2536



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Sponsorship Opportunities

The Geophysical Society of Pittsburgh offers sponsorship opportunities. Our monthly meetings occur each first Tuesday of every month beginning in September through May.

Since our inception in 2010, meetings have been very well attended by industry professionals, averaging well over 50 attendees per meeting, peaking at more than 100 for our most highly attended meeting. Not only do our meetings offer exception technical presentations in the field of geophysics, but they provide an outstanding networking opportunity for oil and gas industry professionals working in the Appalachian basin.

Your generous donations will help in the following ways: 1) helping to bring in distinguished lecturers; 2) offsetting part of the cost of the monthly meeting venue; and 3) enabling a Scholarship Program for future Geophysicists to be awarded each year to an outstanding student enrolled in a Geophysics program at one of our local universities.

Your company logo will be boldly displayed during the social hour of each meeting on the front screen, as well as on all meeting announcements and on our website. We are offering corporate sponsorship opportunities at several levels this year, as well as opportunities to sponsor our social hour during the meeting. Please note that a secure payment link is now available on our website for your added enrollment convenience.

Please click HERE to download more information, then return to this page to enroll as a sponsor.

Geophysical Society of Pittsburgh

The Geophysical Society of Pittsburgh successfully hosted the first and second Appalachian Basin Geophysical Symposiums (ABGS), The events were huge successes with great speakers covering the latest innovations in geophysical research, technology and perspectives of the Appalachian Basin. We thank all our generous sponsors, speakers and organizers who made this event possible.

The positive feedback received from our community has prompted the GSP board to make the ABGS an annual event. With the addition of this yearly symposium, *it was determined that the monthly meetings should be reduced to a quarterly basis.*

The goals of this change are twofold:

1. Boost attendance numbers at our general meetings;
2. Focus Appalachian Basin centric talks for the ABGS.

Two of the quarterly meetings will occur in the fall and the other two during the spring. The ABGS will still be held around the beginning of June in tandem with the golf outing. This ensures that our members still have the opportunity to network on a semiregular basis.

We hope these changes help enhance the GSP's ability to promote the science of geophysics as well as promote the fellowship and cooperation among its membership. We look forward to seeing everyone at the first meeting this September.

Sincerely,

The GSP Board

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Your Dues and Sponsorship in Geophysical Society of Pittsburgh go toward:

- *Outstanding Monthly Lecture Series*
- *SEG Distinguished Lecturers*
- *Annual Scholarship Awards*
- *Annual Golf Outing*
- *Short Courses*

Please contact Scott Gorham, Jianli Yang, Joel Starr or Bill Harbert for Sponsorship Opportunities.

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