Geophysical Society of Houston

VOL. 35, NO. 5 NEWSLETTER DECEMBER 2000

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Technical Breakfast

Date: Tuesday; December 12, 2000
Time: 7AM - 9 AM.
Where: Building Westlake 4 (Formerly BP Plaza) Room C-306.
Speaker: Mark Weber, President Fugro-LCT

Abstract

Seismic depth migration continues to be an important, but expensive, tool for reducing exploration risks. Newly acquired high-resolution gravity data provides a low cost method to enhance the seismic depth migration process by providing an independently measured constraint to the seismic velocity model. State-of-the-art commercial software tools enable rapid integration of a common gravity and seismic earth model. In many geologic settings integrated density/velocity modeling yields a more accurate velocity model than can be derived from seismic data alone. A case study from Offshore Brazil is presented to illustrate both the steps employed in the data integration process and the resulting improvement in depth migrated seismic data.

Biography

Mark Weber is president of Fugro-LCT Inc. For the past 15 years, including 10 years with Fugro-LCT, he has had a diversified role in potential fields exploration, including land marine and airborne data acquisition and quality control, data processing, software design, and earth modeling interpretations involving integrated seismic, well log and potential fields data. Weber holds a B.S. in geophysical engineering from the Colorado School of Mines

Happy Holidays!

INSIDE THIS ISSUE

GEOPHYSICAL SOCIETY OF HOUSTON

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Editor's Note

To insure your information reaches the GSH society members in a timely manner, it must appear in the in the appropriate newsletter issue. Please note the following deadlines and plan your function's publicity strategy accordingly. Items must be received on or before the corresponding deadline date. Materials may be sent to pattyc@diamondg.com or faxed to 713/783-9780. If you have any questions please call Patty Cardwell-Swords at 713/783-7837.

2000 GSH Newsletter Deadlines

Issue ..... January 2001
Deadline .. December 15, 2000

Membership Report

The GSH would like to welcome its newest members:

Active:
Lorie Bear
Joseph Bruso
Charles Carvill
Roger Casey
Scott Glassman
Francois Hindlet
Terry Moore
James Myron
Edgar Sarmiento
John Tinnin
Robert Vauthrin
Dave Williams
Yafei Wu
Pinar Yilmaz

Associate:
Diego Deiros
Tina Koehn
Xin-Gong Li
Peter Marjason
Pedro Munoz
Francis Rollins
Annette Veilleux

To join the GSH, contact Hugh Hardy at (713) 729-9208.

GeoEvents Calendar

Make reservations by e-mail at reservations@hgs.org and include your member number (found on Bulletin mailing label), or use the phone reservation system at 713/917-0218.

Reservation Codes

Use these codes to make voice mail meeting reservations:

Technical Luncheon	**601**
Data Processing SIG	**602**
Interpretation SIG	**603**
Reservoir SIG	**604**
Potential Fields SIG	**605**
Environmental Applications SIG	**606**
Breakfast	**607**

SEG Foundation Establishes Barbara S. McBride Memorial Scholarship

Barabra Sue McBride passed away in July following a brief illness. She was born on September 27, 1956 in Littlefield, Texas. Ms. McBride was Vice President for South America for ExxonMobil Exploration Company, headquartered in Houston, Texas. She joined Exxon in 1978 and has held a number of assignments in exploration, production, and planning in the U.S. and abroad. Those who knew Barbara were inspired by her common sense and vigor. Ms. McBride was a member of the Society of Exploration Geophysicists and the American Association of Petroleum Geologists. She served as Chairman of the SEG Scholarship Committee and Foundation Trustees and was named an "Outstanding Young Woman of America."

Your tax-deductible contribution may be sent to the SEG Foundation, P.O. Box 702740, Tulsa, OK 74170-2740. All contributions will be matched under the SEG Foundation's "Double Impact Program"

Peter Lang Scholarship Fund

Due to his endeavors in the industry and the community, a scholarship fund has been established in honor of Peter Lang (1926-2000). Corporate and personal contributions can be made through the GSH office at 7457 Harwin Drive, Suite 301; Houston, TX 77036; Attn: Joan Henshaw.

SIG Meeting Announcements

DATA PROCESSING SIG

Topic: AVO
Speakers:
Randy Nickerson,
Amerada Hess
Fred Hilterman,
Geophysical Development Corporation
Bill Goodway,
PanCanadian Petroleum Limited
Antonio Pica,
CGG

Date:	Wednesday, December 20, 2000
Time:	Social 4:00 (This is earlier then usual.) Presentations 4:30 to 6:00
Location:	McMurftry Auditorium, Duncan Hall, Rice University
Organizers:	Turgut Ozdenver, Consultant Alan Foley, GeoCenter

Directions: Enter Rice campus at corner of Main and Sunset Blvd. Park to the right of the large lawn. Duncan Hall is on the right.
A map is on the web at:
http://dacnet.rice.edu/maps/space/

Paper 1: Lower Exploration Risk-Using a maximum likelihood clustering and AVO analysis
Randy Nickerson, Amerada Hess

Paper 2: AVO examples of long-offset 2-D data in the Gulf of Mexico
Fred Hilterman, Geophysical Development Corporation

Paper 3: Rock parameterization & AVO fluid detection using LamÈ petrophysical factors
Bill Goodway, Taiwen Chen; PanCanadian Petroleum Limited, Jon Downton; Scott Pickford.

Lower Exploration Risk-Using a maximum likelihood clustering and AVO analysis

AVO is one of the primary tools used for offshore exploration with varying success. Attributes such as: intercept, gradient, fluid factor, and combinations of these have been used for AVO interpretation. The fluid factor volume has been used successfully in both class 2 and class 3 gas sands. There are potential pitfalls in using the fluid factor without tight geological calibration. In this case study, multiple AVO attributes were clustered using a maximum likelihood system. This has proven to be a more reliable method for saving time and quantifying risk.

The Upper and Middle Miocene section in Southeastern Louisiana has been successfully explored using 3D seismic and AVO analysis. In 1998 a dry hole was drilled using the fluid factor AVO volume (Figure 1). After reviewing the results of this well, it was determined that a better calibration between existing gas fields and dry holes within the survey was required. The study area involved a 185 square mile survey in the state waters of Louisiana. This survey was reprocessed prior to the drilling of the initial well for full AVO analysis. The following attribute volumes were generated for use in this study: original RAP migration, new RAP migration, near angle stack (0 to 15 degrees), middle angle stack (15 to 30 degrees), far angle stack (30 to 45 degrees), fluid factor (derived from cross plotting intercept and gradient, and fluid factor (derived from cross plotting near and far angle stack).

The calibration study looked at all producing fields and dry holes that penetrated the zones of interest within the 3D survey. The results of this study were a series of amplitude thresholds for each AVO attribute that statistically indicated the presence of hydrocarbons . A sampling of prospects and fields within this survey was used as input into an algorithm that groups or clusters horizon amplitudes from different AVO attributes into modes based on similar characteristics. This process should group gas fields into unique modes that are different for tight sands, wet sands, and shales. In this presentation we will describe the initial calibration of wells to various AVO attributes, and expand this calibration using this clustering method.

BIOGRAPHY

Randy Nickerson, a 1980 graduate of Colorado School of Mines, Golden, CO., has worked AVO projects in the Gulf Coast and California for Amerada Hess, Coastal Exploration and North Central Oil Corporation. He is currently working on refining AVO clustering techniques in several areas.

AVO examples of long-offset 2-D data in the Gulf of Mexico
Fred Hilterman, Geophysical Development Corporation

For more than seventeen years, amplitude-versus-offset interpretation (AVO) has been a primary tool for predicting a reservoir's lithology and pore-fluid content. However, the success of an AVO interpretation is constrained by the rock properties of the reservoir and its surrounding media. Class 3 anomalies (bright spots) exhibit large amplitudes on stack data and pore-fluid prediction is routinely accomplished by anomaly/background amplitude analyses. For Class 2 anomalies (amplitude increase with offset), the pre-stack data is needed just to recognize potential reservoirs. Finally, in Class 1 environments (dim out) the presence of hydrocarbons doesn't yield bright spots or amplitude brightening with source-receiver offset. In short, the success for recognizing a hydrocarbon prospect and predicting its fluid content is best for Class 3 environments and poorest for Class 1.

For a mature basin such as the offshore Gulf of Mexico, there is a standard quip that if you want to find a Class 3 anomaly look for a production platform because all bright spots have been drilled. Using this sophomoric logic, there must be plenty of Class 1 reservoirs yet to be found in mature basins. However, how is the risk reduced when trying to predict lithology and pore-fluid content for Class 1 reservoirs? Preliminary AVO modeling showed that using extremely long offsets in seismic data acquisition was the answer for the Miocene play in offshore Texas.

The application of this exploration logic led Fugro-Geoteam and SEI to acquire a 2-D seismic survey in offshore

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Texas using a 9000-m (29,520-ft) streamer to evaluate Miocene sands. Two case studies will demonstrate some of the preliminary findings. In the first study, the pore-fluid content in the Elf-Acquitaine well (Galveston Block A142) is predicted using seismic. This required offsets out to 30,000 ft to evaluate the turbidite sand at 16000-ft depth. The second study addresses the recognition of deep mid-Miocene sands, the determination of tight versus porous sands and the identification of pore-fluid content. This study centers is near the field in Brazos Block A133.

Biography

Fred Hilterman received a geophysical engineering degree and a doctorate in geophysics from Colorado School of Mines. During his tenure with Mobil (1963-1970), his assignments ranged from field work and prospect evaluation to Activity Leader at the Field research Laboratory. In 1973, he joined the University of Houston where he was a Professor of Geophysics. While at UH, Fred co-founded the Seismic Acoustics Laboratory (SAL) and he was Principal Investigator until 1981. At that time, he co-founded Geophysical Development Corporation where he is currently vice-president of development.

Fred was an associate editor for GEOPHYSICS; SEG and AAPG Distinguished Lecturer; Chairman of TLE editorial board; and, Technical and General Chairman of the SEG Annual Meetings. He has been an instructor in both the SEG's and AAPG's Continuing Education Courses since the mid 1970's. Fred was the 1996-97 SEG President.

He received SEG's Best Paper Award, Best Presentation Award, and Virgil Kauffman Gold Medal; CSM's VanDiest Gold Medal and Distinguished Alumni Medal; and Honorary Membership in SEG and GSH. Fred continues to lecture at UH as a Distinguished Research Professor.

Rock parameterization & AVO fluid detection using Lamé petrophysical factors:λ, μ & λρ, μρ.

Bill Goodway*, Taiwen Chen; PanCanadian Petroleum Limited, Jon Downton; Scott Pickford.

Summary

Traditional AVO and petrophysical analysis exploit anomalous variations between seismic compressional wave velocity (Vp) and shear wave velocity (Vs) to indicate changes primarily in pore fluid, as well as lithologic properties. Other methods using AVO, derive Poisson's ratio or P and S reflectivities, i.e.impedance contrasts. This emphasis on seismic velocity and density arises from the Knott-Zoeppritz equations for continuity of displacement (u) and stress (σ(u)) across interfaces between different lithologies for a propagating seismic wave. Displacement and stress are usually derived from a plane wave solution of the acoustic wave equation; $u = Ae^{i\omega(t-x/V)}$. However the underlying physics in the wave equation; $d^2u/dx^2 = \rho/M\ (d^2u/dt^2)$ does not involve seismic velocities, but instead the ratio of rock density (ρ) to its modulus (M). So converting velocity measurements to Lamé parameters (moduli) of rigidity Mu (μ) and "incompressibility" Lambda (λ) offers new insight into the original governing rock property factor ρ/M. In this paper λ is considered to be pure "incompressibility" and not the bulk modulus κ, as λ is the only modulus involved in both the hydrostatic stress-strain relationship and acoustic wave propagation for a fluid (i.e. where rigidity (vanishes). It will be shown that an improved identification of reservoir zones is possible by the enhanced sensitivity to pore fluids from pure incompressibility, as well as lithologic variations represented by fundamental changes in rigidity, incompressibility, and density parameters as opposed to mixed parameters of seismic velocities.

Theory and log analysis motivation

The seismic wave propagation dependence on moduli is not obvious in standard AVO methods that rely on Vp, Vs and density variations. Some authors point out the need for a more physical insight afforded by rigidity μ (Thomsen 1990,Castagna et al. 1993). Castagna also indicates that the link between velocity and rock properties for pore fluid detection, is through the bulk modulus (that is embedded in Vp. As (relates uniaxial and transverse strain to uniaxial stress, it is orthogonal (i.e. independent) to (. This is not the case for (since it implicitly relates a measure of shear strain due to a volume's change in shape in response to hydrostatic stress. This can be seen in the following relationships;

$Vp^2 = (\lambda + 2\mu)/\rho = (\kappa + (4/3)()/($ and $Vs^2 = \mu/\rho$. The proposal here is to use moduli/density relationships to velocities V or impedances I, given as; $Ip^2 = (Vp.\ \rho)2 = (\lambda + 2\mu)\rho$ and $Is^2 = (Vs.\ \rho)^2 = \mu\rho$. These relationships enable extraction of the orthogonal Lamé parameters λ and μ from logs with measured density ρ, or λρ and μρ from seismic without known density. The simple derivations are; $\lambda = Vp^2.\rho - 2Vs^2.\rho$, $\mu = Vs^2.\rho$, and $\lambda\rho = Ip^2 - 2\ Is^2$, $\mu\rho = Is^2$.

Poisson's ratio, $\sigma = \lambda/(2\lambda+2\mu)$ or $2\sigma/(1-2\sigma) = \lambda/\mu$ and $(Vp/Vs)^2 = (\lambda/\mu)+2$, are close to the most sensitive moduli ratio of λ/μ. Unfortunately the non linear complexity of λ in Lamé terms (Thomsen 1990) and the constant 2 in $(Vp/Vs)^2$, reduce the full impact of the relative λ/μ ratio change between lithologies. Incompressibility λ is not directly measurable in rocks unlike rigidity μ, but the extraction can be seen as a form of stripping off the μ sensitive rock matrix to reveal the most sensitive pore

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TABLE 1	Vp(m/s)	Vs(m/s)	((g/cc)	Vp/Vs	$(Vp/Vs)^2$	σ	λ+2μ	μ	λ	(/μ
Shale	2898	1290	2.425	2.25	5.1	0.38	20.37	4.035	12.3	3.1
Gas Sand	2857	1666	2.275	1.71	2.9	0.24	18.53	6.314	5.9	0.9
Avg.change	1.4 %	25 %	6.4 %	27 %	55 %	45 %	9.2 %	44 %	70 %	110 %

(moduli λ, μ are in G Pa's)

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fluid indicator λ.

Table 1, shows the justification and power of the method in petrophysical analysis. Actual Vp, Vs and (values from log data have been combined to give various rock property values and average % change i.e. contrast at the interface for detectability. The unusual behaviour of a very limited Vp change (1.4%) compared to Vs (25%) for this gas sand zone requires some explanation, as most standard measurements concentrate on this non-responsive Vp change. The reason can be seen by comparing the last four columns, where it is apparent that because of Vp's dependence on both λ and μ, the effect of decreasing λ (incompressibility) as a direct response of the gas porosity, is almost completely offset by an increase in μ (rigidity) in going from capping shale to gas sand. However by breaking out λ from Vp and combing it into a λ/μ ratio, average changes of 70% for λ and 110% for λ/μ are by far the most sensitive to the variation in rock properties between shale and gas sand. The best conventional measurements from Poisson's ratio (σ) of 45% and $(Vp/Vs)^2$ of 55% are less sensitive.

Castagna J.P, Batzle M.L, Kan T.K, 1993b "Rock Physics-The link between rock properties and AVO response"

SEG Investigations in Geophysics #8 "Offset-dependent reflectivity- theory and practice of AVO analysis".

Thomsen L,1990 "Poisson was not a geophysicist" TLE Dec., 27-29.

Bill Goodway
AFFILIATION: Geophysical Advisor, PanCanadian Petroleum Ltd.,150-9th Avenue SW, Calgary.
email; william_goodway@pcp.ca
EDUCATION: 1977 B.Sc. (Hons) Geology, University of London.

Since 1985, Bill has been with PanCanadian Petroleum in the Exploration Geophysics department and is presently a Geophysical Advisor involved in all aspects of applied seismic exploration from acquisition design and processing, to experimental special projects and new interpretation methods. He has presented and co-authored a number of papers at CSEG, EAGE and SEG conventions as well as SEG research workshops, on seismic acquisition and processing, borehole geophysics, anisotropy and AVO. Bill has received the CSEG's annual "Best Paper Award" both in 1994 and 1997, the CSEG convention "Best General Paper" award in 1996 and the CSEG convention "Best Technical Paper" award in 1997. In addition, a paper given at the 1994 SEG convention in Los Angeles, was judged in the top 25 presentations. He is a member of the CSEG, SEG, EAGE and APEGGA as well as the SEG Research Committee.

NEAR-SURFACE SIG

Where:	Fugro-South, 6100 Hillcroft. Conference Room # 160.
When:	December 6, 5:30 pm.
Speaker:	Dr. Steve Danbom.

Contact: Mustafa Saribudak, Chair-Near-Surface SIG, at 281-370-7066; ega@pdq.net

Near-Surface Geophysics - a New SEG Book

This presentation is designed to provide a "heads-up" regarding a new SEG publication entitled Near-Surface Geophysics that should be published during 2001. Volume I is a 13-chapter review of various techniques used in geophysical exploration of the near surface while Volume II will contain selected case histories for each of these specific subject matters. I will review the overall design of the two-volume book and will conclude with slides taken from my contribution to Volume I of this book: Chapter 2 - "Special Challenges of the Near-Surface."

SHORT BIOGRAPHY OF STEVE DANBOM

Steve Danbom opened Danbom Geophysics, Inc. this year after a 32-year career with three employers: Conoco, Sun Oil Company, and The University of Oklahoma. He offers geophysical consulting services for both petroleum and near-surface geophysics. His formal education is in Mathematics (B.S., Texas Tech, 1966) and Geophysics (M.S., Texas Tech, 1969; Ph.D., U. of Connecticut, 1975). As a 31-year member of the SEG, Dr. Danbom's involvements include local section officer (Houston and Tulsa), technical program chairman (Midwest Convention), and co-editor of the SEG publication, Shear-Wave Exploration. He has been a teacher for two SEG Continuing-Education courses and served on a National Academy of Sciences committee entitled, "Committee for Non-Invasive Characterization of the Shallow Subsurface for Environmental and Engineering Applications."

POTENTIAL FIELDS SIG

Aeromagnetic signatures of intrabasinal faults, Albuquerque basin, New Mexico: Implications for layer thickness and magnetization

V. J. S. ("Tien") Grauch, U. S. Geological Survey, MS 964, Federal Center, Denver, CO 80225-0046 tien@usgs.gov

Where:	HESS building, 5430 Westheimer, Houston
Date:	Thursday January 18, 2001
Time:	5:30 Social Hour; 6:30 Dinner; 7:30 Presentation
Cost:	$25.00

Contact: Afif Saad, Chair - GSH Potential Fields Group, at 281-342-8575 (afifsaad@netscape.net) or
Bob Van Nieuwenhuise, Co-Chair at 281-679-2208 (Bob.VanNieuwenhuise@pgs.com) by Tuesday, January 16, 2001 for reservations. E-mail is best because we can confirm your reservation. Please HONOR your reservation! We must bill no-shows!

Abstract:

Aeromagnetic profiles over intrabasinal faults in the Albuquerque basin reveal a range of signatures, from symmetric curves with one inflection

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point to asymmetric curves with multiple inflection points. All the signatures can be explained by the juxtaposition of lithologic layers having different magnetic properties. Ground measurements of magnetic susceptibility and total-field magnetic data corroborate this finding. This result contradicts our initial expectation of finding evidence of either enhanced or reduced magnetization along the fault zones, similar to observations of other workers.

The most common asymmetric signature has an apparent low over the fault zone, which can easily mislead interpreters to infer a loss of magnetization at the fault zone. However, geophysical analysis and consideration of geologic and magnetic-property observations imply the curves are produced instead by a thin magnetic layer in the upthrown block offset from a thick magnetic layer in the downthrown block, called a thin-thick layers model. The common occurrence of this signature implies that the aeromagnetic data can indicate thick concentrations of magnetic material on the downthrown sides of faults. Thus, the thin-thick layers signature has importance for understanding subsurface structural development within the basin. Moreover, if higher magnetization also indicates coarser-grained material, the signature could also predict areas of higher hydraulic permeability next to faults.

Biography:

Dr. V. J. S. ("Tien") Grauch received a BA (1975) in geology from Carleton College and a PhD (1986) in geophysics from Colorado School of Mines. She has been employed by the U. S. Geological Survey since 1977, where she is currently a senior research geophysicist. Her research interests include application and interpretation of aeromagnetic and gravity data to hydrogeologic problems, the relation between magnetic sources and geology, interpretation of aeromagnetic data over rugged magnetic terrain, geophysical investigations of the tectonic controls on ore deposits, and development of new interpretation methods. She is a member of SEG, AGU, GSA, and the SEG Gravity and Magnetics Committee.

THE POTENTIAL FIELDS GROUP OF GEOPHYSICAL SOCIETY OF HOUSTON

PRESENTS

THE ANNUAL POTENTIAL FIELDS CHRISTMAS PARTY!

5:30 pm to 8:00 pm
THURSDAY DECEMBER 14, 2000
at
THE LIBRARY of THE UNIVERSITY CLUB
The Galleria, Houston, Texas

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afifsaad@netscape.net

Geophysical Auxiliary of Houston

The Geophysical Auxiliary of Houston invites the wife of any present or past member of the GSH or SEG, the widows of former members of the GSH or SEG, and women members of the GSH or SEG to join us for our 2000-2001 events.

Friday, January 12, we will meet a the **Houston Junior League, 1811 Briar Oak Lane**, always a delightful location, for a luncheon. Maggie's Clothing of Old Town Spring will present a style show with our own GSH members as models. Yearly dues are only $15.00. Call Marinell Williams at 713-467-4517 or Donna Parrish at 281-589-8088 for information on how to join. For more information about the programs and to offer suggestions, please call Georgeann Massell at 281-353-4517.

The GAH encourages social relationships among its members, donates money to the GSH scholarship fund and assists the GSH in any manner possible.

"Strangers are just friends waiting to happen." We look forward to having you join us!

Career Moves

Marc Croes has joined Texas Petroleum Investment Co. as Manager of Geophysics. He can be reached at 713-789-9225. Marc was previously Senior Staff Geophysicist with Baker Hughes E&P Solutions.

Have you recently made a career move? To get your new information to your colleagues via the GSH newsletter, please contact the Editor, Patty Cardwell-Swords, at pattyc@diamondg.com or 713-783-7837.

DECEMBER 2000

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
					1	2
3	4	5	6 **Near-Surface SIG** Fugro-South 6100 Hillcroft 5:30 p.m.	7	8	9
10	11	12 **Technical Breakfast** 7:00 a.m. Bldg. Westlake 4	13	14 **Potential Field** Christmas Party Library of University Club 5:30	15 **NEWSLETTER DEADLINE**	16
17	18	19	20 **Data Processing SIG** Rice University McMurftry Auditorium 4:00 p.m.	21	22	23
24 **Christmas Eve** 31 **New Year's Eve**	25 *Christmas Day Happy Holidays!*	26	27	28	29	30

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