Leon Thomsen

Resume

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Education:

Ph.D. (1969) Columbia University (geophysics)
B.S. (1964) California Institute of Technology (geophysics)

Experience:

Delta Geophysics:
(2008-) Chief Scientist

Lawrence Berkley National Laboratory
(2008-) Visiting Scientist

University of Houston
(2008-) Research Professor

KMS Technologies:
(2008-2010) Executive Advisor

Amoco → BP:

(2001-2008) Senior Advisor, Exploration and Production Technology (retired 5/08)
(1999-2008) Principal Geophysicist, Upstream Technology, Houston
(1998-1998) Principal Geophysicist, Strategic Exploration, Houston
(1995-1998) Senior Geophysical Associate, Strategic Exploration, Houston
(1991-1995) Special Research Associate, Tulsa Research Center
(1986-1991) Research Associate, Tulsa Research Center
(1982-1986) Staff Research Scientist, Tulsa Research Center
(1980-1982) Senior Research Scientist, Tulsa Research Center

State University of New York, Binghamton

(1977-1980) Associate Professor of Geophysics (with academic tenure)
(1972-1977) Assistant Professor of Geophysics

Temporary appointments:

(1970-1972) Research Fellow, California Institute of Technology, Pasadena
(1969-1970) Chargé de Recherche, Centre Nationale de la Recherche Scientifique, Paris

Accomplishments

The challenge of an industrial *scientist* is to find ideas that are useful to corporate strategy. During my industry career, I helped to lead 4 major paradigm-shifts in exploration geophysics. In chronological order:

Polar anisotropy. When I joined Amoco in 1980, seismic anisotropy was hardly recognized in exploration (despite the obvious anisotropy of all sedimentary rocks), due to its mathematical complexity. The appropriate approximation was found in Thomsen (1986a), which has become the most frequently cited paper in the history of **Geophysics**. The parameterization established there has become the universal basis for analysis of seismic anisotropy; a typical Google search of the term "Thomsen parameter" returns hundreds of thousands of hits. Now, 20+% of the presentations at SEG meetings involve seismic anisotropy.

As a late outgrowth of these ideas, I and a colleague (Thomsen and Dellinger, 2003) found the approximation needed to solve an exotic problem first posed over 100 years ago. This discovery may turn out someday to be actually useful.

Azimuthal anisotropy. In 1980, most geophysicists understood the term "anisotropy", to mean *polar* anisotropy, because of the layered structure of sedimentary rocks. But the presence of oriented fractures in the subsurface removes the azimuthal symmetry, and invalidates the assumption. Such fractured reservoirs may be detected from the surface using the seismic signatures of azimuthal anisotropy: P-wave AVOAz and S-wave splitting. We discovered these in early 1981, but kept them secret until we introduced the critical concepts to the industry in a now-famous "Amoco Anisotrophy Session" at the SEG convention (*c.f.* Thomsen, 1986b). Now, these ideas have become implemented throughout the industry, especially since wide-azimuth marine acquisition has become feasible. Further, these ideas lie at the heart of current research on shale gas prospects, since the shales are seismically and hydraulically anisotropic, fractured or not.

In 1981, I was the Amoco inventor of using isotropic (and polar anisotropic) P-AVO to detect hydrocarbons directly. This work has underlain countless Amoco/BP discoveries since then. But, this was research inspired by rumors that Mobil had discovered this phenomenon, so I don't count this among my own inventions.

Converted-Wave imaging. In 1995, I left Amoco's Research center to join its worldwide Exploration department, to better *implement* these ideas. However, I and a few colleagues quickly fell upon new ideas, utilizing converted waves (from the newly-invented 4C Ocean Bottom Seismometers) in novel ways to image, for the first time, Amoco's Valhall reservoir through the cloud of gas in the overburden which had long precluded conventional P-wave imaging. Anisotropy turned out to be crucially important to this advance; and all previous converted-wave analysis had been isotropic. The ideas that I developed in Thomsen (1999) (C-waves, γ_{eff}, diodic velocity, vector fidelity, vector reciprocity) are now the universal basis for analysis of converted-wave seismics.

Electromagnetic exploration. In early 2004, I began to think about using seismic-style impulses of EM energy to directly detect hydrocarbons at depth. In late 2004, it became public knowledge that ExxonMobil and Statoil had built up large staffs of specialists and

had spent large sums to successfully use *continuous*-source EM for the same purpose, BP assembled a small "skunk works" EM team, and acquired the world's first successful field-scale impulsive-source marine EM survey in late 2006 (*c.f.* Thomsen, *et al,* 2007). Since it is clearly better to detect the weak subsurface signal while the source is *off*, it is my prediction that this mode of EM exploration will replace the continuous-source methods, as this technology matures.

The challenge of a *post-industrial* scientist is to continue to make useful contributions, despite the restrictions of ongoing obligations to former employers. I retired from BP April 30, 2008, and founded **Delta Geophysics**, a consultancy helping clients worldwide to create and apply advanced geophysics (cf. http://www.deltageophysics.net/). I also joined the **University of Houston** as Research Professor. In these roles, I have continued to challenge conventional thinking:

Seismic Fluid Substitution. Since 1951, exploration geophysicists have understood the effects of variable fluid content on seismic velocities through the work of Biot and Gassmann. Their formulae are applied many times daily, for example to understand the effects of time-lapse changes in seismic data. However, the experimental support for the theory is very thin, and Thomsen (2010) shows that the theory is not quite correct either, even within its own assumptions. As a result, every fluid-substitution calculation done in the last 60 years should be re-thought. A new generation of rock physics experimentation will be required to understand the expected values of the new parameter introduced in this refinement.

Anisotropic AVO: Since 1980, AVO has been an important technology for risk reduction in the exploration for hydrocarbons. It is almost universally conducted using the assumption of isotropy. But: does it make sense to analyze the Amplitude Variation with Angle while ignoring the Velocity Variation with Angle? Thomsen (1993) concluded: probably not, since the (neglected) anisotropic term is potentially as large as the (retained) isotropic terms. But for all this time, there has been no feasible method for estimating the required parameter. In 2013, Lin and Thomsen (2013) discovered such a method, implying that every AVO analysis done in the last 30 years should be re-thought. UH has applied for a patent based on this work.

Seismic-style EM exploration: The 2006 survey mentioned above was inconclusive, but the need to respect BP's proprietary information stymied further progress after I retired. However, in the research environment at UH, Thomsen (2014) and Neese and Thomsen (2014, 2015) showed how to use seismic-style processing to directly estimate apparent resistivity in the subsurface from ISEM moveout, without mathematical inversion of the data. This work will Disrupt the billion-dollar EM exploration industry. UH has applied for a patent based on this work.

Honors:

Honoree, SEG-GSH Symposium, March 2015**.**

President, Society of Exploration Geophysicists, 2006-2007. The SEG is the international society of applied geophysicists, with over 33,000 members in 130 countries; the SEG President is the *defacto* head of the profession, worldwide.

Kapitsa Medal, Russian Academy of Natural Sciences, 2004.

Foreign Member, Russian Academy of Natural Sciences, 2004.

European Association of Geoscientists and Engineers, **Honorary Member**, 2003.

AAPG's Beydoun Memorial Award: Best International Poster, Cairo 2002, presented to P. Heppard, D. Ebrom, M. Mueller, T.Harrold, and L. Thomsen

The Milton **Dobrin Memorial Lecturer**, U. Houston, March 2001.

Thomsen (1999) was selected by **Geophysics** as one of its best three papers for 1999.

Geophysical Society of Houston, **Honorary Member**, 1999.

European Association of Exploration Geoscientists, **Best Paper**, 1997 Annual Meeting.

SEG's **Reginald Fessenden Award**, 1993.

Lynn and Thomsen (1990) was selected by **Geophysics** as one of its best eleven papers for 1990.

Thomsen (1988) was selected by **Geophysics** as one of its best eight papers for 1988.

Thomsen (1986a) was elected by **Geophysics** as one of its best eight papers for 1986. (This paper was identified in 2004 as the single most-cited manuscript in the history of **Geophysics**.)

Thomsen (1985), the first of my work released by Amoco, was specially selected by **Geophysics** for inclusion in its Golden Anniversary issue.

SEG Foundation Scholarship (1960-64); partial tuition at Caltech

Patents

Alford R., H. B. Lynn, and L. Thomsen, Seismic Surveying Technique for the Detection of Azimuthal Variations in the Earth's Subsurface, filed 1984, issued 1989 (U.S. Pat. 4,817,061).

Bodine, J. H., J. Bork, R. Alford, H. Wright, and L. Thomsen, A Method of Seismic Exploration including Processing and Displaying Seismic Data to Quantitatively Distinguish among Seismic Events, filed 1984, issued 1987 (U.S. Pat. 4,646,239).

Hanson, K., C. Crowe, A. Frisillo, C. Sondergeld, and L. Thomsen, A Method for Identifying and Separating the Effects of Elastic and Anelastic Formation Properties in Seismic Data, filed 1985, issued 1988 (U.S. Pat. 4,729,101).

Hanson, K. E., T. J. Taylor, and L. Thomsen, Shear Wave Velocity Estimation, filed 1989, issued 1993 (U. S. Pat. 5,265,016).

Hanson, K., and L. Thomsen, A Method of Seismic Exploration Including Processing and Displaying Shear Wave Seismic Data, issued 1988 (U.S. Pat. 4,755,972).

Hanson, K., L. Thomsen, C. Sondergeld, and C. Rai, Means for Obtaining Shear-wave Velocities, filed 1986, issued 1988 (U.S. Pat. 4,754,439).

Thomsen, L., Detecting and Resolving Formation Anisotropy from Seismic Data, filed 1986, issued 1990 (U.S. Pats. 4,888,743, and 4,933,913).

Scott, D. R. and L. Thomsen, Methods for Estimating Burial Conditions of Sedimentary Materials, filed 1988, issued 1992 (U. S. Pat. 5,081,612).

Thomsen, L., K. E. Hanson, and M. V. Brumbaugh, Detecting and Resolving Azimuthal Anisotropy from Nonpolarized Sources (Method of Geophysical Exploration), issued 1992 (U.S. Pat. 5,136,554).

Mueller, M. C., L. A. Thomsen, and I. Tsvankin Reflected Shear Wave Seismic Processes, filed 1995, issued 1998 (U. S. Pat. 5,835,452).

Thomsen, L. Converted-Wave Processing in Many-layered Anisotropic Media, filed 1998, issued 2000 (U. S. Pat. 6,128,580).

Crider, R. and L. Thomsen, Selection of Seismic Modes through Amplitude Characteristics, filed 1999, issued 2001 (U. S. Pat. 6,263,284).

Thomsen, L., Vector Recomposition of Seismic 3D Converted-Wave Data, filed 1999, issued 2001 (U. S. Pat. 6,292,754) (Azeri Pat. i2003 0239).

Thomsen, L. and J. A. Delinger, High resolution determination of polar anisotropy, issued 2005 (U.S. Patent 6,944,094).

Strack, Kurt M.; L. A. Thomsen, and C. H. Stoyer,, Method for identifying subsurface features from marine transient controlled source electromagnetic surveys, filed 2005, issued 2006 (U. S. Pat. 11,064,063).

Strack, Kurt M.; Thomsen, Leon A.; Reuter, H., Method for acquiring transient electro-magnetic survey data, filed 2005, issued April 10, 2007 (U.S. Patent 7203599)

Strack, Kurt M.; Reuter, H., and Thomsen, Leon A.; Integrated earth formation evaluation method using controlled source electromagnetic survey data and seismic data, filed 2006, issued February 5, 2008 (U.S. Patent 7328107).

Smith, M. J., B. D. Ritchie, and L. Thomsen, System and Method for CSEM exploration in polar regions, filed July 2005, issued May 2008 ((U.S. Patent 7,376,515).

Thomsen, L. A., Allegar, N. C., Dellinger, J. A., Jilek, P., Johnson, D. T., Xia, G., System and Method for Using Time-Distance Characteristics in Acquisition, Processing, and Imaging of t-CSEM Data, issued February 18, 2009 (U.S. Patent 7,502,690, 7941273).

Martinez Y.; N. Allegar]; L. Thomsen; C. Stoyer, Method for Determining Electromagnetic Survey Sensor Orientation , filed February 2009, issued April 2010 (US 2010102820, WO 2010047885)

Thomsen, L. and R. Lin, Extracting Polar Anisotropy Parameters from Seismic Data and Well Logs, filed U.S. Pat. Off. September 2013.

Neese, J. W. and L. Thomsen, System and method for processing electromagnetic survey data, filed U.S. Pat. Off. October 2014.

Notable Recent Presentations:

Thomsen, L., Geophysics in a Time of Cheap Oil: Keynote Address, CSEG Doodletrain, Calgary, November 2015. https://www.youtube.com/embed/kAibn_zSBXY?modestbranding=1&autoplay=1&showsearch=0

Thomsen, L. and D. L. Anderson, 2014. Invited: Seismic Anisotropy in Global Geophysics, Theory of the Earth: a Special Session in Honor of Don L. Anderson, American Geophysical Union, San Francisco, December, 2014.

Thomsen, L., 2014. Anisotropy in Shale Resource Plays: AVO, FWI, and Surface Waves, Keynote Address: 16th International Workshop on Seismic Anisotropy, Natal, November, 2014.

Thomsen, L., 2014. Vector seismics in hydrocarbon exploration, Keynote Address: CGG Multicomponent Symposium, Calgary, September, 2014.

Thomsen, L., 2014. Anisotropic Rock Physics in Reservoir Characterization, SEG Development and Production Forum, Santa Rosa, June, 2014. (Repeated at SEG: Best of D&P Forum, 2014).

Thomsen, L. 2013. Invited: Can we use Conventional Seismics in Unconventional Resource Plays?, Australian SEG, Melbourne, August, 2013.

Thomsen, L. 2012. Anisotropic Rock Physics: A Tutorial, 15th International on Workshop on Seismic Anisotropy, Bahrain, April 2012.

Thomsen, L., Summary Address Geophysical Society of Houston Spring Symposium, March, 2010.

Thomsen, L., The Role of Geophysics in Fueling the Transition to a Sustainable Energy Future, Los Alamos National Laboratory invited presentation, April 2009.

L. Thomsen, "… in the Minds of the Explorers!", The Presidential Address at the SEG Annual Meeting, San Antonio, September 2007.

L. Thomsen, D. Meaux, S. Li, C. Weiss, N. Allegar, K. Strack, Novel Marine ElectroMagnetics: Results From a Field Trial in Egypt, Invited: Recent Advances and the Road Ahead Session, SEG Annual Meeting, San Antonio, September, 2007. (This marks the first time that a sitting SEG President has delivered a RARA talk.)

Books

Thomsen, L., 2014. Seismic Anisotropy in Exploration and Exploitation, the SEG/EAGE Distinguished Instructor Short Course #5 Lecture Notes, 2nd Edition, Soc. Expl. Geoph., Tulsa.

Committee on Fracture Characterization and Fluid Flow, National Research Council, Rock Fractures and Fluid Flow: Contemporary Understanding and applications, Nat. Acad. Press, Washington, D. C., 1996.

Thomsen, L., On the Fourth-Order Anharmonic Equation of State of Solids, Ph.D. Thesis, Columbia University, 1969.

Refereed Publications (not including numerous Amoco/BP proprietary publications)

Neese, J. W. and L. Thomsen, 2015. Robustness of the EM-Radon Transform, Europ. Assoc. Geosci. Engrs. Conv. Expnd. Absts., 76, Madrid.

Thomsen, L. and D. L. Anderson, 2015. Weak elastic anisotropy in global seismology, The Interdisciplinary Earth: A Volume in Honor of Don L. Anderson, Eds. G. R. Foulger, M. Lustrino, and S. King, Geological Society of America Special Paper

514 and American Geophysical Union Special Publication 71, pp. 39-50.

Neese, J. W. and L. Thomsen, 2014. Seismic processing of numerical EM data, **Soc. Expl. Geoph. Annl. Mtg. Expnd. Absts., 84.**

Thomsen, L., 2014. Electromagnetics and seismics: the deep connections, **Soc. Expl. Geoph. Annl. Mtg. Expnd. Absts., 84.**

Thomsen, L., and R. Lin, 2014. High-Resolution Anisotropy from AVO, **Europ. Assoc. Geosci. Engrs. Conv. Expnd. Absts., 75**, We102-15. Also presented at Stanford, TUDelft.

Lin, R. and L. Thomsen, 2013d. Extracting Polar Anisotropy Parameters From Seismic Data And Well Logs, **Soc. Expl. Geoph. Annl. Mtg. Expnd. Absts., 83,** 310-314.

Thomsen, L., 2013c. Weak Elastic Compliance Anisotropy, accepted for publication, **GEOPHYSICS.**

Thomsen L,, 2013b. Can we use Conventional Seismics in Unconventional Resource Plays?. **ASEG Extended Abstracts**,1–2, dx.doi.org/10.1071/ASEG2013ab363

Far, M. E., L. Thomsen, C. M. Sayers, 2013a. Seismic Characterization of Reservoirs with Asymmetric Fractures, **GEOPHYSICS**, **78**, N1–N10.

Far, M. E., L. Thomsen, and C. M. Sayers , 2012b. Inversion of asymmetric fracture parameters using synthetic AVOA data, **Soc. Expl. Geoph. Annl. Mtg. Expnd. Absts.**, **82,** 1-5.

Far, M. E., C. M. Sayers, L. Thomsen, D. Han, and J. P. Castagna, 2012a. Seismic Characterization of Naturally Fractured Reservoirs Using Amplitude Versus Offset and Azimuth Analysis**, Geop. Prospg., 61**(2), 427-447.

Thomsen, L., 2012b. On the use of isotropic parameters $\lambda, E, \nu,$ to understand anisotropic shale behavior, **Istanbul International Geophysical Conference and Oil & Gas Exhibition,** September**, Soc. Expl. Geoph. Conv. Expnd. Absts**.(2013), **83,** 320-324.

Thomsen, L., 2012a. On the Fluid Dependence of the Parameters of Anisotropy**, Soc. Expl. Geoph. Conv. Expnd. Absts., 82**. Also in **Europ. Assoc. Geosci. Engrs. Conv. Expnd. Absts., 74,** and **Proc. 15 Intl. Wkshp. Seis. Anisotropy, Bahrain,** April.

Strack, K.M., Hanstein, T., Stoyer, C.H., and Thomsen, L., 2011, Time Domain Controlled Source Electromagnetics for Hydrocarbon Applications, in The Earth's Magnetic Interior, IAGA Special Sopron book series, Petrovský, E., Herrero-Bervera, E.; Harinarayana, T. and Ivers, D. (Eds.), 101- 115

Thomsen, L. 2010d. Anisotropy in the 21st Century: Resolution and Symmetry". **Soc. Expl. Geoph. Conv. Expnd. Absts., 80**.

Thomsen, L. 2010c. On the Fluid Dependence of Rock Compressibility: Biot-Gassmann Refined. **Soc. Expl. Geoph. Conv. Expnd. Absts., 80**, 2447-2451.

Tsvankin, I., J. Gaiser, V. Grechka, M. van der Baan, and L. Thomsen, 2010. Anisotropy, Ch. 2 in **Geophysics Today**, pp. 15-31. Soc. Expl. Geoph, Tulsa.

Tsvankin, I., J. Gaiser, V. Grechka, M. van der Baan, and L. Thomsen, 2010b. Seismic anisotropy in exploration and reservoir characterization: An overview,

Geophysics, **75**(5), 75A15-75A29.

Thomsen, L., 2010a. Weakly Anisotropic Elastic Compliance, **Europ. Assoc. Geosci. Engrs. Conv. Expnd. Absts., 72**. Also in Proc. 14 Intl. Wkshp. Seis. Anisotropy, Perth, April 2010.

Dellinger, J., F. Muir, B. J. VerWest, I. Tsvankin, L. Thomsen, T. Alkhalifah, K. Larner, C. M. Sayers, G. Ball, P. R. Williamson, P. A. Sexton, S. Xu, R. W. Vestrum, D. C. Lawton, R. Schmid, K. Hawkins, R. Leggott, G. Williams, H. Kat, I. F. Jones, M. L. Bridson, and N. Bernitsas, Incorporating Anisotropy, Ch. 8 in Prestack Depth Migration and Velocity Model Building, Soc. Expl. Geoph., Tulsa, 689-836, 2008.

Xia, G., L. Thomsen, and O. Barkved, Fracture Detection from Seismic P-wave azimuthal AVO analysis – application to Valhall LoFS data, **Proc. Intl. Symp. In-situ Rock Stress, Intl. Soc. Rock Mech.,** Trondheim, 2006. Also: 12IWSA Proceedings, **J. Seis. Expl.,** 2007.

Helbig, K., and L. Thomsen. 75+ years of seismic anisotropy, **Geophysics**, **70**(6), 2005.

Bouska, J., T. Lyon, R. Johnston, D. Buddery, D. Howe, M. Mueller, L. Thomsen, D. Ebrom, Acquisition Design of the First 4 Component 3D Ocean Bottom Seismic in the Caspian, **Europ. Assoc. Geosci. Engrs. Conv. Expnd. Absts., 67**, B003, 2005.

Ebrom, D., P. Heppard, M. Albertin, S. Viceer, P. Garossino, L. Thomsen. Vp/Vs from Two Different Mode Converted Arrivals**, EAGE/SEG Research Workshop - Multicomponent Seismic - Past, Present and Future**, A33, 2005

Barkved, O.I., J.H. Kommedal, and L. Thomsen, The role of multi-component seismic data in developing the Valhall Field, Norway, **Europ. Assoc. Geosci. Engrs. Conv. Expnd. Absts., 66**, 2004.

Lyon, T., J. Bouska, R. Johnston, M. Mueller, L. Thomsen, Reducing structural uncertainty on the Azeri Field using Ocean Bottom Seismic: Offshore Azerbaijan, **Soc. Expl. Geoph. Expdd Absts 23**, 468-471, 2004.

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Bouska, J., T. Lyon, R. Johnston, D. Howe, M.C. Mueller, L. Thomsen, and D. Ebrom, Acquisition Design of the First Four-Component 3D Ocean Bottom Seismic in the Caspian, **Soc. Expl. Geoph. Conv. Expnd. Absts., 74**, 2004.

Ebrom, D., P. Heppard, L. Thomsen, M. Mueller, T. Harrold, L. Phillip, and P. Watson, Effective stress and minimum velocity trends, **Soc. Expl. Geoph. Conv. Expnd. Absts., 74**, 1815-1618, 2004.

Ebrom, D., P. D. Heppard, M. Tompkins, and L. Thomsen, Compaction, Stresses, and Velocity in High Overpressure. **AAPG Annual Meeting***,* 2004.

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Gretener, P. and L. Thomsen, AVO and Poisson's Ratio, **The Leading Edge**, **22**(1), 70-72, 2003.

Thomsen, L, and J. Dellinger, On shear-wave triplication in polar-anisotropic media, **J. appl. Geoph., 54,** 289-296, 2003.

Holmes, G. M., and L. Thomsen, Seismic fracture detection at a Middle East offshore carbonate field, **Abu Dhabi International Petroleum Exhibition and Conference**, SPE-78507, 2002.

Heppard, P. D., D. Ebrom, M. Mueller, L. Thomsen, and T. Harrold, Using Shear and Vp/Vs to Predict Overpressure in Petroleum Basins, **AAPG Datapages: Search and Discovery,** 2002e.

Sava, P., J. Etgen, and L. Thomsen. "Wave-equation MVA applied to 4-D seismic monitoring, **Stanford Exploration Project**, **112**, 15–21, 2002d.

Ebrom, D., Heppard, P., and Thomsen, L., Numerical modeling of PS moveout as a function of pore pressure, **Soc. Expl. Geoph. Conv. Expnd. Absts., 72**,1634-1637, 2002b.

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Arnaud, J., J. Dellinger, L. Ikelle, H. Lynn, C. MacBeth, L. Thomsen, and I. Tsvankin, SPECIAL SECTION: The Ninth International Workshop on Seismic Anisotropy (91WSA), **GEOPHYSICS, 66**, 1294-1312, 2001.

Thomsen, L., Barkved, O. I., & Rosland, B. O. The 3D/4C OBS Survey at Valhall. Offshore Technology Conference. doi:10.4043/10937-MS, 1999k.

Arnaud, J., K. Helbig, P. Rasolofosaon, and L. Thomsen, The Eighth International Workshop on Seismic Anisotropy (81WSA), **GEOPHYSICS,** 64(6),1949, 1999j.

Jack, I. and L. Thomsen, Recent advances show the road ahead for the electric oilfield very clearly, **Soc. Expl. Geoph. Conv. Expnd. Absts., 69**, 1982-1983, 1999i.

Dellinger, J, R. Clarke, S. Brandsberg-Dahl, and L. Thomsen, Alford rotation after *Tensor* Migration, **Europ. Assoc. Geosci. Engrs. Conv. Expnd. Absts., 61**, 6-43, 1999g. Also: **Soc. Expl. Geoph. Conv. Expnd. Absts., 72**, 982-985, 2002c.

Wilson, D. C., L. Thomsen. C-Wave Moveout - Using Isotropic Homogeneous Algorithms for Anisotropic Inhomogeneous Data**, Europ. Assoc. Geosci. Engrs. Conv. Expnd. Absts., 61**, 1-46, 1999f.

Mueller, M. C., O.I. Barkved, L. Thomsen. A Strategy for Vector Interpretation of Multicomponent Ocean Bottom Seismic Data**, Europ. Assoc. Geosci. Engrs. Conv. Expnd. Absts., 61**, P-067, 1999e.

Barkved, O. I., M.C. Mueller, L. Thomsen. Vector Interpretation of the Valhall 3D/4C OBS Dataset**, Europ. Assoc. Geosci. Engrs. Conv. Expnd. Absts., 61**, 6-42, 1999d.

Thomsen, L., Converted-Wave Reflection Seismology over inhomogeneous, anisotropic media, **GEOPHYSICS**, **64**(3), 678-690,1999c.

Thomsen, L, I. Tsvankin, and M. Mueller, Coarse-Layer Stripping of Azimuthal Anisotropy from Reflection Shear-wave data, **Geophysics**, **64**(4), 1126-1138, 1999b.

Brzostowski, M., X. Zhu, S. Altan, L.Thomsen, O. Barkved, and B. Rosland, 3D converted-wave processing over the Valhall field, **Europ. Assoc. Geosci. Engrs. Conv. Expnd. Absts., 61**, 6-43, 1999a. Also: **Soc. Expl. Geoph. Conv. Expnd. Absts.,, 69**, 695-698, 1999a.

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Thomsen, L. Optimizing 3D Seismic Surveys: Off-the-Shelf? Or Out-of-the-Box?, **Offshore Technology Conference**, OTC 8720, 1998.

Thomsen, L. Optimizing 3D Seismic Surveys, **Sea Technology**, 39(8), 98-101, 1998.

Kommedal, J., O. Barkved, and L. Thomsen, Acquisition of 4-component OBS data - a case study from the Valhall Field, **Europ. Assoc. Geosci. Engrs. Conv. Expnd. Absts., 59**, B047, 1997e.

Thomsen, L., O. Barkved, W. Haggard, J. Kommedal, B. Rosland, Converted Wave Imaging of Valhall Reservoir, **Europ. Assoc. Geosci. Engrs. Conv. Expnd. Absts.**, **59**, B048, 1997d.

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Student Theses Advised, University of Houston:

2012 Mehdi Eftekhari Far
Ph.D. Thesis: Seismic Characterization of Naturally Fractured Reservoirs

2013 Rongrong Lin
M.S. Thesis: Extracting polar anisotropy parameters from seismic data and well logs (Patent applied for)

2015 John W. Neese
M.S. Thesis: Seismic-Style Processing Of Numerical EM Data (Patent applied for)

Courses Taught:

Seismic Waves in Hydrocarbon Exploration (UH)
Seismic Waves in Hydrocarbon Exploration (SEG-online course)
Understanding Seismic Anisotropy in Exploration and Exploitation: *Hands On* (AAPG, BGP, BHPB, CGG, CNOOC, CSEG, EAGE, GSH, Noble, NTNU, SEG, Shell, SPG India, TGS, UH)
Electromagnetic methods for Exploration & Production (w/ K. Strack) (Saudi Aramco)

Professional Society Affiliations:

American Geophysical Union (Lifetime Member)
American Physical Society (Lifetime Member)
European Association of Geoscientists and Engineers (Honorary Member)
Geophysical Society of Houston (Honorary Member)
Sigma Xi
Society of Exploration Geophysicists (Lifetime Member)

Professional Service (partial listing):

2015- Board of Directors, SEAM Inc.
2016- Vice Chair, Board of Directors, SEAM Inc.
2008-10 Advisory Board to Dean of Natural Sciences and Mathematics, Univ. of Houston
2008-10 Board of Directors, SEG Global, Inc. (Treasurer, 2010-11)
2006-07 President, SEG
2005-06 President-Elect, SEG
2004-08 Advisory Board to Director, Lamont-Doherty Earth Observatory
2004- SEG Foundation Trustee Associate
2003-04 Vice President, SEG
2002-05 American Geophysical Union Development Committee
2002 SEG/EAGE Distinguished Instructor
2001-04 National Science Foundation Geosciences Advisory Board
1998-00 Chair, SEG Research Committee.
1997 SEG Distinguished Lecturer
1991- Editorial Board, **Journal of Seismic Exploration**.
1991-96 National Academy of Sciences Committee on Fracture Characterization and Fracture Flow.
1986-88 External Evaluation Committee (Chair, '87), Division of Earth Science, Lawrence Berkeley National Laboratory