

Carl H. Sondergeld

Professor and Curtis Mewbourne Chair

Mewbourne School of Petroleum and Geological Engineering
University of Oklahoma
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Education:

Ph.D., 1977, Geophysics, Cornell University
M.A., 1973, Geology, Queens College of the City of New York
B. A., 1969, Geology, Queens College of the City of New York

Patents:

I am principal or co-author on 14 patents.

Employment:

(2003-present) The University of Oklahoma, (Norman). Professor and Curtis Mewbourne Chair, Mewbourne School of Petroleum and Geological Engineering. Specializing in the areas of rock physics, petrophysics, unconventional shale reservoirs, seismic reservoir modeling, well logging, technical communications and computing.

(2010-present) Adjunct Professor, Conoco School of Geology and Geophysics

(2006-2010) The University of Oklahoma, (Norman). Associate Dean, College of Earth and Energy and Professor and Curtis Mewbourne Chair, Mewbourne School of Petroleum and Geological Engineering

(2002-2003) The University of Oklahoma, (Tulsa/Norman). UNOCAL Professor, Mewbourne School of Petroleum and Geological Engineering. Specializing in the areas of rock physics, petrophysics, seismic reservoir modeling and well logging.

(1999-2002) The University of Oklahoma, (Tulsa/Norman). Professor, Mewbourne School of Petroleum and Geological Engineering. Specializing in the areas of rock physics, petrophysics and seismic reservoir modeling.

(1999) BP Amoco, (Tulsa/Houston). Employed as an expert in rock physics and AVO. Worked in the prediction of reservoir quality in exploration and exploitation.

(1981-1999) Amoco Production Company, (Tulsa Research). Special Research Associate working in the area of rock physics. Efforts include studies of the causes of anisotropy in shales,

analysis of in-situ stress through anelastic strain relaxation, shear wave birefringence and circumferential velocity analysis; application of acoustic tomography to the measurement of elastic anisotropy; development of techniques to measure the properties of unconsolidated materials; teaching rock properties courses; populating and maintaining a corporate rock properties database, access and modeling software; developing and supporting use of a field portable rock properties laboratory (GEM). Responsible for the development of an internal software product to model rock physics responses, fluid substitution and offset synthetic generation. Past activities have included laboratory automation, system and equipment design, studies of attenuation, shear wave birefringence, anelastic effects on reflections, lithology inversion, the design and deployment of an array sonic logging tool, the interpretation and application of data derived from sonic and dipole sonic tools.

(1980-1983) Visiting Staff Scientist at Los Alamos National Laboratory. Attempted to investigate scale effects on the acoustic emission and mechanical behavior of rock.

(1977-1981) Visiting Fellow at CIRES, University of Colorado. Carried out research in experimental rock mechanics to understand failure mechanisms and processes. Applied acoustic emission and holographic techniques to studies of rock deformation. Research was aimed at applying this knowledge to the understanding of earthquakes.

(1979-1981) Adjunct Professor, University of Colorado, Boulder Ph.D. thesis guidance for graduate student (Mr. Lou Estey), taught seminars in plate tectonics, heat flow and rock mechanics.

(1980-1981) Consultant, Integrated Sciences Inc. Interpretation of rock burst signals for the design of a coal mine roof stability monitoring system.

(1980) Consultant, Occidental Oil Shale Company. Studied the mechanical properties of oil shale.

(1974-1977) Research Assistant at Cornell University. Investigated two phase thermal convection in porous media. Applied results to mineralization in porphyry deposits and geothermal problems.

(1969-1972) Research Assistant at Lamont Doherty Geological Observatory and Queens College. Determined equation of state parameters on synthetic mantle mineral candidates. Synthesized polycrystalline mineral specimens by hot-pressing techniques. Subsequently used these specimens in ultrasonic measurements to determine equation of state parameters.

Military Service:

Honorable Discharge U. S. Army Reserves

Awards:

Engineering College, Brandon Griffith Award, 2012
SEG Distinguished Lecturer Fall 2010

Engineering College, Brandon Griffith Award, 2009
MPGE Professor of the Year, MPGE, 2004, 2008, 2009, 2010, 2012, 2013
Switzer Award for Coaching the Petrobowl Team, 2010
Amoco Cash R&R award: Developing and teaching the Seismic Rock Properties Course, 1990.
Amoco Production Company Presidential Special Technical Award for developing the
Geoscience Evaluation Modules, 1988

Coaching:

Winning OU SPE Petrobowl Teams 2007, 2008, 2010

Societies:

Society of Exploration Geophysicists, Society of Petroleum Engineers

Services:

(1983-1984) Thesis advisor for Joyce Kelly (M.S.), University of Tulsa.
(1984-1988) Supplemental Physics classes for Tulsa High School Students (adopt a school program).
(1989-1992) Joint Oceanographic Institute, Downhole Measurement Panel.
(1992-1994) National Science Foundation, Earth Science Proposal Review Panel.
(1993-1996) Interagency Continental Scientific Drilling Panel.
(1995-1996) Thesis advisor for Andrew Shatilo (Ph. D.), University of Tulsa.
(1997-2000) Associate editor for Rock Properties, Geophysics.
(1999-present) National Science Foundation, Deep Continental Drilling Panel.
(2004, 2009) National Science Foundation Committee of Visitors
(2006-present) Faculty Advisor for Student SPE Chapter.
(2007) External Advisor University of United Arab Emirates, Al Ain

Editor:

Liebermann, R. C. and C. H. Sondergeld, Experimental Techniques in Mineral and Rock Physics, The Schreiber Volume, PAGEOPH, 141, 2/3/4, 209-657,1993.

Publications:

Sondergeld, C. H., B. L. Isacks, M. Barazangi and S. Billington, 1977, A search for velocity anomalies near the deep portions of the inclined seismic zone of the Tonga Island Arc, Bull. Seism. Soc. Amer., 67, 537- 541.

Sondergeld, C. H. and D. L. Turcotte, 1977, An experimental study of two-phase convection in a porous medium with applications to geological problems., J. Geophys. Res., 82, 2045-2053.

Sondergeld, C. H. and D. L. Turcotte, 1978, Flow visualization studies of two phase convection in a porous layer., PAGEOPH 117, 321-330.

Sondergeld, C. H. and E. Schreiber, 1978, The effect of annealing upon the elastic properties of hot-pressed MgO polycrystals, J. Amer. Ceram. Soc, 61, 535-537.

Sondergeld, C. H. and D. L. Turcotte, 1979, A laboratory study of mineral deposition in a boiling environment., *Econ. Geol.* 74, 109-115.

Sondergeld, C. H. and E. Schreiber, 1979, An examination of the elasticity of hot-pressed MgO, *Phys. Chem. Minerals*, 5, 21-31.

Sondergeld, C. H., L. A. Granryd and H. A. Spetzler, 1979, Compressional velocity measurements for a highly fractured lunar anorthosite, *Proc. Lunar Planet. Sci. Conf.* 10th, 2147-2154.

Sondergeld, C. H., Effective noise discriminator for use in acoustic emission studies., 1980, *Rev. Sci. Instrum.*, 51, 10, 1342-1344.

Sobolev, G. A., H. A. Spetzler A. V. Koltsov and C. H. Sondergeld, 1980, Ultrasonic radiation of a crack in a strained rock specimen, *Izvestiya, Earth Physics*, 16,11 819-828.

Sondergeld, C. H., I. C. Getting, H. A. Spetzler and G. A. Sobolev, 1980, Velocity changes associated with generalized triaxial deformation of pyrophyllite, *PAGEOPH*, 118, 975-989.

Sondergeld, C. H. and L. H. Estey, 1981, Acoustic emission study of microfracturing during the cyclic loading of Westerly granite, *J. Geophys. Res.*, 86, B4, 2915-2924.

Spetzler, H., C. H. Sondergeld and I. C. Getting, 1981, The influence of strain rate and moisture content on rock failure, in *Anelasticity in the Earth*, eds. F. D. Stacy, M. S. Paterson, and A. Nichols, pp. 108-112, American Geophysical Union, Washington, D.C.

Sondergeld, C. H., 1981, Desirable sample dimensions for detailed acoustic emission studies., *Geophys. Res. Lettr.*, 8, 7, 695-697.

Sobolev, G., H. Spetzler, A. Koltsov and C. Sondergeld, 1981, Ultrasonic fracture radiation in a rock specimen under compression, in *The Soviet- American Exchange in Earthquake Prediction*, eds. H. Spall and D. W. Simpson, USGS Report 81-1150, pp. 275-293.

Spetzler, H. A., G. A. Sobolev, C. H. Sondergeld, B. G. Salov, I. C. Getting, and A. Koltsov, 1981, Surface deformation, crack formation, and acoustic velocity changes in pyrophyllite under polyaxial loading, *J. Geophys. Res.* 86, B2, 1070-1080.

Sondergeld C. H. and L. H. Estey, 1982, Source mechanisms and microfracturing during uniaxial cycling of rock, *PAGEOPH*, 120, 151-166.

Sobolev, G. A., A. A. Semerchan, B. G. Salov, H. A. Spetzler, C. H. Sondergeld, V. N. Bananov, A. V. Koltsov, V. F. Los, R. M. Nasimov, A. V. Ponomarev, I. R. Stakhovskii, V. A. Terentev and I. M. Turetskii, 1982, Precursors of the destruction of a large sample, *Izvestiya, Earth Physics*, 18, 8, 572-580.

Sondergeld, C. H., L. H. Estey, P. M. Halleck, T. N. Dey and J. D. Blacic, 1984, Monitoring of acoustic emissions during the uniaxial deformation of large samples., in Third Conference on Acoustic Emission/Microseismic Activity in Geologic Structures and Materials eds. R. Hardy and F. Leighton, pp. 147-158, Trans Tech Publ., Clausthal Germany.

Sondergeld, C. H., L. A. Granryd and L. H. Estey, 1984, Acoustic emissions during compression testing of rock., in Third Conference on Acoustic Emission/Microseismic Activity in Geologic Structures and Materials eds. R. Hardy and F. Leighton, pp. 131-145, Trans Tech Publ., Clausthal Germany.

Rai, C. S. and C. H. Sondergeld, 1987, Laboratory observations of shear wave propagation in anisotropic media, 57th Annual Internat. Mtg. Soc. Expl. Geophys., Expanded Abstracts, 87, Session W2.9.

Smith, M. L., C. H. Sondergeld and J. O. Norris, 1991, The Amoco array sonic logger., The Log Analyst, 32, 3, 201-214.

Sondergeld, C. H. and C. S. Rai, 1991, GEM: A new concept in quantitative core characterization, SEG workshop on Lithology: Relating Elastic Properties to Lithology at all Scales, July28-Aug1, St. Louis, Mo, pp210-212.

Sondergeld, C. H. and C. S. Rai, 1992, Laboratory observations of shear-wave propagation in anisotropic media., The Leading Edge, 11, 2, 38- 43.

Sondergeld, C. H. and C. S. Rai, 1993, A new concept in quantitative core characterization., The Leading Edge, 12, 7, 774-779.

Sondergeld, C. H. and C. S. Rai, 1993, A new exploration tool: Quantitative core characterization., PAGEOPH, v. 141, 2/3/4, 249-268.

Sondergeld, C. H. and C. S. Rai, 1993, Rock Properties: the missing link in exploration and exploration, 55th Mtg. Eur. Assoc. Expl. Geophys.,session D001.

Sondergeld, C. H. and C. S. Rai, 1993, A new exploration tool: Quantitative core characterization., at Exploration Spring Technology Conference , AEPT, May 3, Evaluation of Slimhole Continuous Coring as an Exploration Tool.

Shatilo, A., C. Sondergeld and C. Rai, 1995, Relationship between ultrasonic P-wave attenuation, porosity, permeability and clay content in Glenn Pool sandstone, 66th Annual Mtg. Soc. Expl. Geophys., Expanded Abstracts, 882-885.

Phillips, D. H., C. H. Sondergeld, R. E. Sigal, R. F. Larese, E. S. Lewis, P. R. Manoogian, V. I. Kuznetov, and R. K. Razyapov, 1996, Seismic response to porosity and permeability variations at

Priobskoye field, Western Siberia, 66th Annual Internat. Mtg., Soc. Expl. Geophys., Expanded Abstracts, 616-618.

Falkenstein, B. A., D. H. Phillips, C. H. Sondergeld, R. E. Sigal, R. F. Larese, E. S. Lewis, W. S. Guidros, V. N. Vysotski, V.I. Kuznetov, and R. K. Razyapov, 1997, Priobskoye field and the preliminary evaluation of recent 3-D seismic to delineate high productivity zones using amplitude or interval velocity, Western Siberia, Russia, 67th Annual Internat. Mtg., Soc. Expl. Geophys., Expanded Abstracts, 1041-1042.

Zhang, J., C. S. Rai and C. H. Sondergeld, 1998, Mechanical strength of reservoir materials: key information for sand prediction, SPE 49134.

Shatilo, A., C. Sondergeld and C. Rai, 1998, Ultrasonic attenuation in Glenn Pool rocks, northeastern Oklahoma, Geophysics, 63, 2, 465-478.

Margesson, R.W. and C. H. Sondergeld, 1999, Anisotropy and amplitude versus offset: a case history from the West of Shetlands, in Petroleum Geology of northwest Europe: Proceeding of the 5th Conference, edited by A. J. Fleet and S. A. R. Boldy, Geological Society, London 635-643.

Dellinger, J. A, D. Vasicek and C. H. Sondergeld, 1998, Kelvin notation for stabilizing elastic constant inversion, Proceedings of the 8IWSA, proceedings of the IFP.

Kendall, R., S. A. Hall, J-M. Kendall and C. Sondergeld, 1998, Analysis of anisotropic velocities in a fractured, vuggy carbonate and AVOA, 68th Annual Mtg. Soc. Expl. Geophys., Expanded Abstracts, 334-337.

Sengupta, M., C. Rai and C. Sondergeld, 1998, Sensitivity studies in forward AVO modeling, 68th Annual Mtg. Soc. Expl. Geophys., Expanded Abstracts, 204-207.

2000

Hall, S. A., R. R. Kendall, J-M Kendall, and C. Sondergeld, 2000, Analysis of anisotropic velocities in a core sample and AVOA from a fractured vuggy carbonate reservoir, submitted to Geophysics.

Sondergeld, C. H., C. S. Rai, R. W. Margesson and K. Whidden, 2000, Ultrasonic measurement of anisotropy in the Kimmeridge shale, 69th Annual Mtg. Soc. Expl. Geophys., paper RPB7.1, Expanded Abstracts, 1858-1861.

2001

Smith, T. M. and C. H. Sondergeld, 2001, Examination of AVO in Eastern deep water Gulf of Mexico, Geophysics, 66, 6, 1864-1876.

2002

Jarrard, R. D., C. H. Sondergeld, M. A. Chan and S. N. Erickson, 2002, Petrophysics of the Cretaceous Ferron Sandstone, Central Utah, AAPG Memoir, edited by T. C. Chidsey, R. D. Adams and T. H. Morris, AAPG, Tulsa, OK ,91-113.

2003

Smith, T. M., C. H. Sondergeld and C. Rai, 2003, Gassmann fluid substitutions: A tutorial, Geophysics, 68, 2, 430-440.

2004

Al-Tahini, A. M., C. H. Sondergeld and C. S. Rai, The effect of cementation on static and dynamic properties in Juaf and Unayzah formations of Saudi Arabia, SPE 90448 Annual Technical Conference, Houston, 26-29 September, 2004.

Dastidar, R., Rai, C. and Sondergeld, C.,2004, Integrating NMR with other petrophysical information to characterize a turbidite reservoir, SPE 89948 Annual Technical Conference, Houston, 26-29 September 2004.

2005

Dastidar, R., Rai, C., Sondergeld, C. and Shahreyar, R., 2005, Effect of depositional environment on the petrophysical attributes, SPWLA 46th Annual Logging Symposium, June 26-29.

Sondergeld, C. H., 2005, Review of “Quantitative Interpretation of Seismics” by Avseth, A., T. Mukerji and G. Mavko, EOS, 86, 40, p369.

Dastidar, R., C. Rai and C. Sondergeld, 2005, NMR defines petrophysical properties, Amer. Oil and Gas Reporter, Nov. 76-81.

Sondergeld, C. H. and C. S. Rai, 2005, Observations of velocity and resistivity changes during the freeze-thaw cycles in Berea sandstone, SEG extended abstract, 24, 1509.

2006

Dastidar, R., Rai, C., Sondergeld, C. and Shahreyar, R., 2006, NMR response of two clastic reservoirs: influence of depositional environment, Petrophysics, 47, 3, 214-222.

Dastidar, R., C. H. Sondergeld and C. S. Rai, 2006, Petrophysical Data Integration for Improved Reservoir Description, Gulf Coast Section of Society of Economic Paleontologist and Mineralogist (GCSSEPM), 26th Annual GCSSEPM Foundation Bob F. Perkins Research Conference, Houston, 3-6 December 2006. (accepted)

Sondergeld, C. H., 2006, Review of “Seismic Inversion” by M. Sen, SPE.

Dastidar, R., C. H. Sondergeld and C. S. Rai, 2006, NMR Desaturation and surface relaxivity measurements on clastic rocks, SPE 099629, Europe/EAGE Annual Conference and Exhibition held in Vienna, Austria, 12–15 June 2006.

Al Tahini, A.M., C. H. Sondergeld and C. S. Rai, 2006, The effect of cementation on the mechanical properties of sandstones, SPE Reservoir Evaluation and Engineering, 9, 4, 308-316

2007

Dastidar, R., C. H. Sondergeld and C. S. Rai, 2007, An improved empirical permeability estimator from Mercury injection for tight clastic rocks, Petrophysics, 48, 3, 186-190.

Sondergeld, C. H. and C. S. Rai, 2007, Velocity and resistivity changes during the freeze-thaw cycles in Berea sandstone, Geophysics 72, 2 E99-E105.

Al Tahini, A.M., C. H. Sondergeld and C. S. Rai, 2007, The effect of cementation on the ultrasonic velocities in sandstones, Geophysics 72, 2, E53-E58.

2008

Tran, D. T., C. S. Rai, and C. Sondergeld, 2008, Changes in crack aspect ratio concentration from heat treatment: A comparison between velocity inversion and experimental data, Geophysics 73, 4, E123-E132.

2009

Smith, T. M., C. M. Sayers and C. H. Sondergeld, 2009, Rock Properties in low porosity/low permeability sandstones, The Leading Edge, 28, 48-59.

Sondergeld, C. H. and C. S. Rai, 2009, Data integration aids in shale plays, Exploration and Production, Sept. 1, pp 36-37.

2010

Ambrose, R. J., Hartman, R. C., Diaz-Campos M., Akkutlu, Y., and Sondergeld, C. H. 2010. New considerations for shale gas in place calculations, SPE 131772 presented at the SPE Unconventional Gas Conference, Pittsburgh, Pennsylvania, 23-25 February.

Kale, S. V., Rai, C. S., and Sondergeld, C. H. 2010. Petrophysical characterization of Barnett shale, SPE-131770, Presented at the SPE Unconventional Gas Conference, Pittsburgh, Pennsylvania, 23-25 February

Civan, F., C. S. Rai and C. H. Sondergeld, 2010, Intrinsic shale permeability determination by pressure-pulse measurements using a multiple-mechanism apparent-gas-permeability non-Darcy model, SPE-135087, SPE Annual Tech. Conf. and Exhibit, Florence, Italy, Sept 19-22.

Castano, A. F., C. H. Sondergeld and C. S. Rai, 2010, Estimation of uncertainty in microseismic event location associated with hydraulic fracturing, SPE-135325, , San Antonio, Texas, Nov 2-3.

Curtis, M., R. J. Ambrose, C. H. Sondergeld and C. S. Rai, 2010, Structural characterization of gas shales on the micro- and nano-scales, SPE-137693, Canadian Unconventional Resources and International Petroleum Conference, Calgary, Alberta, Canada, Oct 19-21.

Civan, F., C. S. Rai and C. H. Sondergeld, 2010, Shale-gas permeability and diffusivity inferred by improved formulation of relevant retention and transport mechanisms, Trans. Porous Media, 2011.

Smith, T., C. Sondergeld and A. O. Tinni, 2010, Microstructural controls on electrical and acoustic properties in tight gas sandstones; some empirical data and observations, The Leading Edge 29, 12, 1470-1474.

Curtis, M., C. H. Sondergeld, R. J. Ambrose and C. S. Rai, 2010, Microstructural investigation of gas shales in two and three dimensions using nanometer scale resolution imaging, accepted AAPG.

Ambrose, R. J., R. C. Hartman, M. Diaz-Campos, Y. Akkutlu, and C. H. Sondergeld, 2010, New considerations for shale gas in place calculations, SPE-131772 presented at the SPE Unconventional Gas Conference, Pittsburgh, Pennsylvania, 23-25 February.

Sondergeld, C. H., K. E. Newsham, T. E. Comisky, M. C. Rice and C. S. Rai, 2010, petrophysical considerations in evaluating and producing shale gas resources, SPE-131768, Unconventional Gas Conference, Pittsburgh, Pennsylvania, 23-25 February.

Sondergeld, C. H., R. J. Ambrose, C. S. Rai and J. Moncrieff, 2010, Micro-structural studies of gas shales, SPE-131771, Unconventional Gas Conference, Pittsburgh, Pennsylvania, 23-25 February.

Sondergeld, C. H. and C. S. Rai, 2010, Nanoscale imaging visualizes shale gas plays, Exploration and Production, pp. 51-52.

Kale, S. V., Rai, C. S., and C. H. Sondergeld, 2010, Petrophysical characterization of Barnett shale. SPE-131770, Presented at the SPE Unconventional Gas Conference, Pittsburgh, Pennsylvania, 23-25 February

Kassis, S. M. and C. H. Sondergeld, 2010, Fracture permeability of gas shale: Effects of roughness, fracture offset, proppant, and confining pressure. SPE-131376 , CPS/SPE International Oil & Gas Conference and Exhibition in China, 8–10 June 2010 Beijing, China.

Civan, F., C. S. Rai and C. H. Sondergeld, 2010, Intrinsic shale permeability determination by pressure-pulse measurements using a multiple-mechanism apparent-gas-permeability non-Darcy model, SPE-135087, SPE Annual Tech. Conf. and Exhibit, Florence, Italy 19-22.

Chitrala, Y., C. Moreno, C. Sondergeld and C. Rai, 2010, Microseismic mapping of laboratory induced hydraulic fractures in anisotropic reservoirs, SPE-138441, San Antonio, Texas, Nov 2-3.

Moreno, C., Y. Chitrala, C. Sondergeld and C. Rai, 2010, Analysis of nanoseismicity during laboratory hydraulic fracturing experiments, SEG extended Abstract, Presented at Annual Meeting, Denver, Colorado, Oct 19-23.

Castano, A. F., C. H. Sondergeld and C. S. Rai, 2010, Estimation of uncertainty in microseismic event location associated with hydraulic fracturing, SPE-135325, San Antonio, Texas, Nov 2-3.

Curtis, M., R. J. Ambrose, C. H. Sondergeld and C. S. Rai, 2010, Structural characterization of gas shales on the micro- and nano-scales, SPE-137693, Canadian Unconventional Resources and International Petroleum Conference, Calgary, Alberta, Canada, Oct 19-21.

Civan, F., C. S. Rai and C. H. Sondergeld, 2010, Shale-gas permeability and diffusivity inferred by improved formulation of relevant retention and transport mechanisms, Trans. Porous Media, 1-20.

Smith, T., C. Sondergeld and A. O. Tinni, 2010, Microstructural controls on electrical and acoustic properties in tight gas sandstones; some empirical data and observations, The Leading Edge 29, 12, 1470-1474.

Tran, D. T. , A. Pagoulatos, C. H. Sondergeld, N. Nguyen-Canh, and J.C. Roegiers, 2010. Quantify uncertainty of rock failure parameters from laboratory triaxial testings using conventional and multistage approaches, ARMA paper 10-263, presented in 45th U.S. Symp. Rock Mech., Salt Lake City, Utah.

2011

Sondergeld, C. H. and C. S. Rai, 2011, Elastic anisotropy of shales, The Leading Edge, 30, 3, 324-331.

Curtis, M., C. H. Sondergeld, R. J. Ambrose and C. S. Rai, 2011, Microstructural investigation of gas shales in two and three dimensions using nanometer scale resolution imaging, (accepted by AAPG)

Chitrala, Y., C. Moreno, C. Sondergeld and C. Rai, 2011, Microseismic mapping of laboratory induced hydraulic fractures in anisotropic reservoirs, (submitted to SPEJ)

Sondergeld, C. H., C. S. Rai and M. E. Curtis, Haynesville and other shales, AAPG Haynesville Shale Memoir (accepted 2011).

Tinni, A., C. H. Sondergeld, C. S. Rai and H. Simo, 2011, Effective pressure and microstructure on resistivity formation factor and seismic wave velocities, SPE -147432.

Curtis, M. E., R. J. Ambrose, C. H. Sondergeld and C. S. Rai., 2011, Investigation of the relationship between organic porosity and thermal maturity in the Marcellus shale, SPE-144379.

Curtis, M. E., R. J. Ambrose, C. H. Sondergeld and C. S. Rai., 2011, Transmission and scanning electron microscopy investigation of pore connectivity of gas shale on the nanoscale, SPE-144391.

Chitrala, Y., C. Moreno, C. Sondergeld and C. Rai, 2011, Microseismic and microscopic analysis of laboratory induced hydraulic fractures, SPE-147321.

Odusina, E., C. Sondergeld and C. Rai, 2011, An NMR study on shale wettability, SPE-147371.

Tinni, A., C. H. Sondergeld, C. S. Rai and H. Simo, 2011, Effective pressure and microstructure control on resistivity formation factor and seismic wave velocities, SPE -147432.

Metwally, Y. and C. H. Sondergeld, 2011, Measuring low permeabilities of gas-sands and shale using a pressure transmission technique, Int. J. Rock Mech and Min. Sci., 48, 1135-1144.

2012

Chitrala, Y., C. H. Sondergeld and C. S. Rai, 2012, Acoustic emission studies of hydraulic fracture evolution with different frac fluid viscosities, ARMA 12-597, 46th US Rock Mechanics / Geomechanics Symposium, Chicago 24-27 June.

Chitrala, Y., C. H. Sondergeld and C. S. Rai, 2012, Microseismic studies of hydraulic fracture evolution at different pumping rates, SPE-155768, Americas Unconventional Resources Conference held in Pittsburgh, Pennsylvania, USA, 5-7 June 2012

Sondergeld, C. H., M. E. Curtis and C. S. Rai, 2012, Application of FIB/SEM and Argon ion milling to the study of foliated fine grained organic rich rocks, Microscopy and Microanalysis Conference, Phoenix Arizona, August. Microscopy and Microanalysis / Volume 18 / Supplement S2 / July 2012, pp 622-623, <http://dx.doi.org/10.1017/S1431927612004965>

Curtis, M. E., B. J. Cardott, C. H. Sondergeld and C. S. Rai., 2012, The development of organic porosity as a function of thermal maturity, SPE-160158, presented at the annual SPE ATCE, San Antonio, Texas, 8-10 Oct .

Damani, A., A. Sharma, C. Sondergeld and C. Rai, 2012, Mapping of hydraulic fractures under triaxial stress conditions in laboratory experiments using acoustic emissions, SPE159604, presented at the annual SPE ATCE, San Antonio, 8-10 Oct.

Kumar, V., C. H. Sondergeld and C. S. Rai, 2012, Nano- to macro- mechanical characterization of shale, SPE 159804, presented at the annual SPE ATCE meeting, San Antonio, 8-10 Oct.

Tinni, A., E. Fathi, R. Agarwal, C. Sondergeld, Y. Akkutlu and C. Rai, 2012, Shale permeability measurements on plugs and crushed samples, SPE 162235, Canadian Unconventional Resource Conference, 30 Oct-1 Nov.

Sulucarnain, I., C. H. Sondergeld and C. S. Rai, 2012, An NMR Study of shale wettability and effective surface relaxivity, SPE 162236, Canadian Unconventional Resource Conference, 30 Oct-1 Nov.

Kumar, V., M. E. Curtis, N. Gupta, C. H. Sondergeld and C. S. Rai, 2012, Estimation of elastic properties of organic matter and Woodford shale through nano-indentation measurements, SPE 162778, Canadian Unconventional Resource Conference, 30 Oct-1 Nov.

Curtis, M. E., B. J. Cardott, C. H. Sondergeld and C. S. Rai., 2012, Development of organic porosity in the Woodford shale with increasing thermal maturity, *Int. J. Coal Geology*, 103, 26-31.

2013

Simo, H., M. Pournik and C. H. Sondergeld, 2013, Proppant crush test: A new approach, SPE 164506, SPE Production and Operations Symposium held in Oklahoma City, Oklahoma, USA, 23–26 March.

Lines, L., K. Innanen, F. Vasheghani, J. Wong, C. Sondergeld, S. Treitel and T. Ulrych, 2103, Experimental measurements of Q-contrast reflections, *Geophys. Prospect.*, 62, 190-195.

Curtis, M. E., C. H. Sondergeld and C. S. Rai., 2013, Relationship between Organic Shale Microstructure and Hydrocarbon Generation, SPE164540.

Damani, A., A. Sharma, C. H. Sondergeld and C. S. Rai, 2013, Acoustic mapping and microscopic analysis of laboratory induced hydraulic fractures under triaxial stress, ARMA 13-586, 12pp.

Sondergeld, C. H., C. S. Rai, Y. Chitrala and A. Damani, 2013, Insights from laboratory studies of hydraulic fracturing, Chapter 1, in *Natural Gas and Petroleum*, ed. by C. Cranganu, pp 1-12, Nova Science Publishers, Inc., New York.

Shukla, P., V. Kumar, M. Curtis, C. Sondergeld and C. S. Rai, 2013, Nanoindentation studies on shales, ARAM-13-578, American Rock Mechanics Association, 47th US Rock Mechanics/ Geomechanics Symp, San Francisco, CA, 23-26 June.

Bocangel, W., C. Sondergeld and C. Rai, 2013, Acoustic mapping and characterization of organic matter in shales, SPE166331.

2014

Tinni, A., E. Odusina, I. Sulucarnian, C. Sondergeld and C. Rai, 2014, NMR response of brine, oil and methane in organic rich shales, SPE168971.

Goergen, E. T., M. E. Curtis, J. Jernigen, C. Sondergeld and C. Rai, 2014, Integrated Petrophysical Properties and Multi-scaled SEM Microstructural Characterization, SPE:1922739.

Curtis, M. E., E. T. Goergen, J. Jernigen, C. H. Sondergeld and C. S. Rai, 2014, Mapping of Organic Matter Distribution on the Centimeter Scale with nanometer resolution, URTeC: 1922757

Mighani, S., C. S. Sondergeld and C. Rai, 2014, Efficient Completions in Anisotropic Shale Gas Formation, URTeC: 1934272

Ghosh, S., C. S. Rai and C. H. Sondergeld, 2014, Experimental Investigation of Proppant Diagenesis, SPE171604

Tinni, A., C. Sondergeld, C. Rai, 2014, Particle size effect on porosity and specific surface area measurements of shales, SCA2014-A908

Tinni, A., C. Sondergeld, C. Rai, 2014, NMR T1-T2 Response of Moveable and Non-Moveable Fluids in Conventional and Unconventional Rocks, SCA2014-A105

Kumar, V. C. H. Sondergeld and C. S. Rai, 2014, Mechanical properties of shale through nanoindentation, Journal of Petroleum Science and Engineering (submitted)

Grant Support:

Mechanisms of deformation and failure appropriate to lunar conditions, NASA, 2/1/77-4/30/79, amount \$289,464.

A study of the process of microfracturing in rock, NSF, 3/1/79 - 2/28/81, amount \$63,700.

Large scale rock fracture experiment, USGS, 4/1/79 - 3/31/80, amount \$84,969.

Large scale rock fracture experiment, USGS, 4/1/80 - 3/31/81, amount \$47,128.

Mechanisms of deformation and failure appropriate to lunar conditions, NASA, 5/1/79-1/31/80, amount \$100,000.

A study of acoustic emission precursors associated with cyclic loading of rock, NSF, 11/1/80 - 10-31-81, amount \$41,175.

Grant from DOE/Noble Engineering, 2003, for "Modification of Mobile Hydrate Characterization Laboratory", jointly with Prof. Rai, \$71,557

Numerous IC³ projects with various oil companies. Over the last four years (2000-2003) raised close to \$800,000.

Donation of Anadarko Mobile Core Facility, 2004, \$2MM.
Devon Energy, Multidisciplinary study of the Barnett Shale, 2005, funded \$1.2MM.
Devon Energy, Fracture study of Barnett Shale, 2007, funded \$3.1MM
Devon Energy, Microstructural Studies of Gas Shales, (new dual beam FIB/SEM)
Gift from Apache (\$1MM + 1.5MM over 3 yrs)
Gift from Cimarex (\$675K/yr for 4 years)
Devon Support (\$400k/yr for 4 years)
Unconventional Gas Shale Consortium (2011 ...year 1(\$2,800,00/yr)
Unconventional Gas Shale Consortium(2012...year 2(\$3,600,00/yr...)
Unconventional Gas Shale Consortium(2013...year 2(\$3,200,00/yr...)
HilcorpMicrostructural study of the Utica Shale... \$67,000
DevonWoodford pore structure study...\$43,000
OU-FEI Research Cooperative...donation of 1 Magellan FIB/SEM instrument, 1 wide beam Argon milling system, and 1 QEMscan instrument, and half time employee (~\$4MM)
OU-Green Imaging Technologies-Oxford-Maran Research Cooperative...access to beta code, new instrumentation and accessories; develop new applications for NMR to shales
OU-Agilent Cooperative...donation of 1 GT300 Nanoindentation system

Consortia:

(2001-present) Experimental Rock Physics Consortium (with Dr. Chandra Rai). Industrial consortium supporting research in rock physics. Currently 8 sponsors. Funding to date is \$1,500,000.

(2011-present) Unconventional Shale Gas Consortium (with Dr. Chandra Rai). Industrial consortium supporting research in shales. Currently 8 sponsors. Annual funding \$3,200,000.

Amoco Internal Reports

Progress in sonic wavetrain modeling, 1981, Sondergeld, C. H., T81-E-18.
Study of anelastic normal incidence reflections from a planar surface, 1982, Sondergeld, C. H., P. R. Gutowski and M. L. Smith, F82-E-7.
Lithology discrimination and porosity estimation using Vp and Vs: Applications to sonic wavetrain logs, 1983, Sondergeld, C. H., A. L. Frisillo and J. O. Norris, T83-E-2.
User guide for the intelligent interface controller and Nicolet-Hewlett Packard interface, 1985, Sondergeld, C. H., T85-E-14.
User guide for the AO7 tool simulator, 1985, Sondergeld, C. H., T85-E-40.

Sonic wavetrain processing, 1985, Gutowski, P. R., M. L. Smith, C. Sondergeld and D. E. Wagner, F83-E-5.

Introduction to Sonic wavetrain logging, 1986, Sondergeld, C. H., J. O. Norris and M. L. Smith, T86-E-38.

Velocity systematics, 1986, Sondergeld, C. H., T86-E-5.

Laboratory observations of shear wave propagation in anisotropic media, 1986, Sondergeld, C. H. and C. S. Rai, F86-E-11.

Geophysical Evaluation Module (GEM) operators manual, 1988, Sondergeld, C. H. and C. S. Rai, T88-E-0033.

The Amoco sonic logger, 1989, M. L. Smith, C. H. Sondergeld and J. O. Norris, T89-E-36.

Rock Properties Database and Analysis System (RDAS)-User Notes, 1991, C. H. Sondergeld, T91-E-55.

Slimhole Advanced Drilling System (SHADS) Technical Manual, 1991, Mount, H. B., C. S. Rai, R. W. Scott, D. B. Skidmore, C. H. Sondergeld and D. R. Spain, F91-G-7.

Mechanical strength of reservoir material key information for sand control, 1993, Zhang, J., C. S. Rai and C. H. Sondergeld, F422-89-01.

ASR tests on six cores from Amoco Champlin 320C #1 AH well, Zhang, J. and C. H. Sondergeld, Report 94-1.

Seismic signature of diagenesis in sandstones, 1994, Sondergeld, C. H., R. E. Larese and C. S. Rai, F94-G-51.

In-situ stress estimation and anelastic strain recovery (ASR) experience, 1994, Sondergeld, C. H. and J. Zhang, F94-G-62.

Scanning minipermeameter, 1994, Sigal, R. F., B. R. Spears, C. Sondergeld and H. Xu, GRN9411.

Reservoir characterization, including crosswell seismic, towards the application of horizontal wells to improve waterflood performance, 1994, Vassiliou, A., H. Tan, L. Coltharp, R. Chambers and C. Sondergeld, F94-G-58.

Shale anisotropy, 1995, Sondergeld, C. H., F95-G-32.

Elastic properties of clays, 1995, Sondergeld, C. H., J. Zhang and L. Bemore, F95-G-58.

Velocity systematics, 1995, Sondergeld, C. H., F95-G-55.

Preliminary results of ASR and CVA tests on cores from Amoco Riddle "D" 4-A well, 1995, Zhang, J., and C. H. Sondergeld, Report 95-1.

In-situ stress determination with anelastic strain recovery (ASR) technology, Zhang, J., C. Sondergeld and Z. A. Moschovidis, Report 95-3.

GEM measurements and anisotropy in the Conn D2-8 Well, 1995, Sondergeld, C. H., Report 95-4.

Mechanical strength analysis for MUC-11 well, Eastern Venezuela Basin, 1995, Zhang, J. and C. H. Sondergeld, TS#128.

ASR and CVA tests on cores from Boekelermeer #1 well, 1996, Zhang, J. and C. H. Sondergeld, Report 96-1.

Anisotropy and AVO in West of Shetlands, 1996, Margesson, R. W. and C. H. Sondergeld, F96-G-42.

Correlation between static and dynamic moduli, 1996, Zhang, J., L. K. Britt, C. H. Sondergeld, Z. A. Moschovidis, G. Brewton, N. McInnis, T. M. Smith and G. Weir, F96-P-88.

Progress in 4-D seismic methods during 1996, 1996, G. Ruckgaber, M. O'Brien, R. Alford, R. Chambers, N. Haskel, K. Newsham, S. Nissen, K. Rockwood, M. Ross, C. Sondergeld and H. Tan, F96-G-39.

Anisotropy measurements on core, 1996, Sondergeld, C. H., J. Dellinger and J. Zhang, F96-G-45.

Progress in 4-D seismic methods during 1997, 1997, G. Ruckgaber, M. O'Brien, T. Kragas, C. Sondergeld, K. Newsham, K. Rockwood, D. Bruce and G. Riggert, F97-G-44.

Recent developments in 4-D seismic methods, 1997, G. Ruckgaber, M. O'Brien, K. Newsham, T. Kragas, K. Newsham, K. Rockwood, C. Sondergeld, and G. Riggert, F97-G-20.

On the potential of mapping source rock from seismics, 1997, Sondergeld, C. H., F97-G-53.

Vp, Zp and Fluid saturation, 1997, Sondergeld, C. H., F97-G-54.

Sensitivity studies in AVO forward modeling, 1997, Sengupta, M., C. S. Rai and C. H. Sondergeld, F97-G-49.

Report on new developments for measuring rock properties of percussion sidewall cores and drill cuttings, 1997, Morris, S. A., R. Sigal and C. Sondergeld, F97-G-02.

Time-Lapse seismic analysis of legacy surveys at Eugene Island Block 273, 1998, Ruckgaber, G., M. O'Brien, T. Kragas, C. Sondergeld, D. Bruce and G. Riggert, F98-G-13.

Anisotropic velocity analysis of a fractured and vuggy carbonate, Campeche Bay, Mexico, 1998, Kendall, R., C. H. Sondergeld, S. Hall and J-M. Kendall, F98-G-04.

Quantifying uncertainty in AVO modeling, 1998, Sondergeld, C. H., C. S. Rai and A. K. Dey, F98-G-26.

Correlation between static and dynamic moduli (Final Phase), 1998, Zhang, J., L. K. Britt and C. H. Sondergeld, F98-P-46.

Anisotropic study of sidewall plugs from North Herschel, 1998, Sondergeld, C. H., Report 98-1.

Nonbright pay and AVO signatures, 1998, Sondergeld, C. H., C. S. Rai, M. Sen, and C. Chung, F98-G-27.

Course Manuals:

Petrophysics of Unconventional Reservoirs, 2011-present, C. H. Sondergeld

Petrophysics, 2002- present, C. H. Sondergeld

Well Logging for Geological Applications, 2002-present, C. H. Sondergeld.

Acoustic Logging, 2001-present, C. H. Sondergeld.

Velocity Analysis and Interpretation, 2001-present, C. H. Sondergeld

AVO Fundamentals, 2001-present, C. H. Sondergeld

Seismic Rock Properties, 1984 - present, Sondergeld, C. H. and C. S. Rai.

Seismic Rock Properties for Petrophysicists, 1990- present, Sondergeld, C. H. and C. S. Rai.

Applied Rock Properties, 1998 - present, Sondergeld, C. H. and C. S. Rai.

In-Situ Stress Analysis, 1996, Sondergeld, C. H.

Shear Logging Tools, 1996, Sondergeld, C. H.

Web pages:

EPTG Geoscience Rock Properties Web Pages, 1996-2000, Sondergeld, C. H. and J. Wirtz

RDAS Software manual, 1998, Sondergeld, C. H.

URMS software manual, 1998 - 2000, Sondergeld, C. H.

Newsletters:

Rock Properties Newsletter (1996-2000) C. H. Sondergeld and C. S. Rai published quarterly.

Software:

RDAS (Rock Properties Database and Analysis System)...This is a major piece of the software which provides for management and access to the largest rock properties database of its kind in the world. The system allows users to access and analyze data from locations anywhere in the world. This software and database are considered part of the "prize" by BP in the recent merger with Amoco.

URMS (Unified Rock Modeling Software)...This is another merger "prize". This collection of software is tightly coupled to allow interprocess communication between rock modeling modules and seismic modeling modules. Capabilities permit fluid substitution (homogeneous and patchy), exact and linearized half-space reflectivity modeling which include anisotropy and attenuation. Consequences of uncertainty in input model parameters can be examined and quantified. Anisotropic calculations include those for moduli, phase, and group velocities as well as the long wavelength effects of isotropic or anisotropic layers. Full offset synthetic generation is also incorporated. These modules permit importing logs, editing, fluid substitution and convolution with wavelets to generate offset synthetics for P and SV waves. Incorporated in the system are the appropriate PVT calculators for hydrocarbons and brines, the proper mixing facilities for mineral properties. This package provides a very rapid and efficient assessment of AVO and other seismic signatures.

I have been responsible for development and design of these packages and have coded major elements in each.

Masters Students:

Ashraf Al Tahini, MS Spring 2003

Aristotelis Pagoulatos, MS Fall 2004

Dung Tran, MS Fall 2005

Anup Hunnur, MS Spring 2006

Andreas Castano, MS Fall 2009

Isaac Aso, MS Fall 2009

Alvaro Ortiz, MS Fall 2010

Camillo Moreno, MS Spring 2011

Yashwanth Chitralla, MS Spring 2011

Elijah Odussina, MS Spring 2011

Sodana Kiv, MS Spring 2012

Ali Oussen Tinni, MS Spring 2012

Wara Bocangel, MS Fall 2012

Ismail Sulucarian, MS Spring 2012

Qinglu Cheng, MS Spring 2013

Sayantan Ghosh, MS Spring 2013

Akash Damani, MS Spring 2013

Priyvrat Shukla, MS 2013

Abhishek Sharma, MS 2013

Murad Asgarov, MS 2013

PhD students:

Rahul Dasditar, PhD Spring 2007

Ali Oussen Tinni, PhD...current