

Curriculum Vitae and Resume

Michael D. Lewan

1. CONTACT INFORMATION

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2. EDUCATION

Northern Illinois University, Geology 1/67-1/71 B.S. 1971 (S.S. Goldich, advisor)

Michigan Technology University, Geology/Geochemistry 1/71-6/72 M.S. 1972
(Metasomatism and weathering of the Presque Isle serpentinized peridotite, Marquette, Michigan; A.P. Ruotsala, advisor)

University of Cincinnati, Geochemistry/Sedimentology/Mineralogy 9/75-9/78 Ph.D.
1980 (Geochemistry of vanadium and nickel in organic matter of sedimentary rocks; J.B. Maynard, Advisor)

3. PROFESSIONAL EXPERIENCE

Lewan GeoConsulting Corporation

From: 6/2014 To: Present

Consulting Geochemist and Geologist-Provides expertise in defining petroleum systems with respect to identifying source rocks, delineating pods of active source rocks, establish organic facies, determining timing and extent of petroleum generation, calculating petroleum charge, evaluation of potential migration pathways, and petroleum genetic correlations.

From 10/2022 To: 6/2023

OUTCROP WEATHERING OF PETROLEUM SOURCE ROCKS AND BLACK SHALES:

Field and geochemical laboratory criteria for evaluating and collecting unweathered samples.

Book by Michael D. Lewan, Mill City Press, due out and available through Amazon and Barnes and Noble at the end of June, 2023. 137 text pages with 60 figures and 40 data tables.

From: 3/2022 To: present

RMAG Mentor for Abdul Hamid, Bacha Khan University, Pakistan.

RMAG: Geochemistry Skills for Basin and Petroleum System Assessments: a 3 course series;

1) stages of petroleum formation, 2) Determining petroleum charge, and 3) Determining timing and extent of petroleum Formation (kinetics). April 5, 13, and 19, 2022.

United States Geological Survey

From: 6/2014 To: Present

USGS Emeritus-Continuing research projects on petroleum geochemistry on unconventional shale plays (Barnett Shale, Eagle Ford Shale, and Bakken Shale), and conducting hydrous pyrolysis experiment to monitor changes in petrophysical and rock properties of source rocks with increasing thermal maturation.

From: 10/96 To: 6/2014

Petroleum Processes Research Project Chief -Maintain a current perspective on cutting-edge research relevant to issues concerning processes critical to recognizing and assessing undiscovered conventional and unconventional petroleum resources. Provide research directions and establish collaboration with other outside research organizations to better leverage USGS research efforts. Maintain BASIS+, distribute OE budgets, address task-member concerns, and attend to various other administrative responsibilities. SIR funded and requiring ~10% of total working time (Science Center Director, Christopher Potter and Charles Blome, Supervisor).

From: 10/11 To: 6/2014

Petroleum Processes Research Project, Task 3 - This task addresses the main issues of 1) establishing geological and geochemical criteria to differentiate indigenous from exogenous shale oil accumulations, 2) evaluating the significance and prediction of organic- and lithofacies of source rocks that host unconventional petroleum accumulations, and 3) understanding the organic carbon limits and geophysical properties of source rocks responsible for unconventional shale accumulations. Emphasis is being placed on the Eagle Ford in the Gulf Coast, Bakken in the Williston Basin, and Niobrara in the Rocky Mountain region for upcoming assessments. SIR funded, with ~40% research time (Michael Lewan, Project Chief and Science Center Director, Christopher Potter, Charles Blome, Supervisor).

From: 10/11 To: 6/2014

Petroleum Processes Research Project, Task 5 - Develop a better understanding of the processes and mass balance of biological and abiological degradation of petroleum (oil and gas) in low-temperature (<80°C) accumulations and in the environment (anthropogenic spills, natural seeps and tar sands) by using new and established correlation techniques and laboratory degradation experiments. This task includes both field and laboratory studies. Current emphasis is on the BP Deepwater Horizon oil spill. SIR funded, with ~15% research time (Michael Lewan, Project Chief; and Paul Lillis, Task Leader).

From: 10/11 To: 6/2014

Petroleum Processes Research Project, Task 7 - Determine the controls on petroleum quality (e.g., API gravity, GOR, sulfur content) from quantitative analysis of generated products (oil and gas) from hydrous pyrolysis experiments on oil-prone source rocks. Compositional variations and relative proportions of oil and gas generated will be integrated into kinetic models to predict petroleum quality within petroleum systems and their assessment units. SIR funded, with 20% research time (Michael Lewan Task Leader, Science Center Director Christopher Potter, Supervisor).

From: 10/99 To: 6/2014

NOGA, Gulf Coast Framework Study, Task 1 - Define petroleum systems of the onshore Gulf Coast and provide geochemical expertise on gas-oil-source rock correlations, source-rock characterization, timing of petroleum generation, and assistance in defining assessment units. SIR funded, with ~10% research time (Russell Dubiel, Project Chief).

From: 10/96 To: 6/2014

Group Leader-Assist group members (one GS-14s, and four GS-13s) in determining and achieving critical results that are in line with Program objectives and annually rate their performance in achieving results. SIR funded, with 0% research time, but ~5% of total

working time (Science Center Director, Christopher Potter, Supervisor).

From: 10/05 To: 9/11

Petroleum Processes Research Project, Task 2 - This task had five objectives that involve experimentally determining 1) reliable kinetic parameters for gas generation from gas-prone source rocks that can be used in burial histories, 2) whether transition metals in gas-prone source rocks are a critical control on rates and composition of gas generated from source rocks, 3) key factors (e.g., water chemistry and rock mineralogy) and mechanisms (e.g., radical and catalytic) that control rates of gas generation from oil cracking, 4) whether molecular and isotopic compositions of thermogenic gas generated in laboratory pyrolysis experiments can differentiate thermogenic gas generated by gas-prone source rocks from oil cracking, and 5) reliable kinetic parameters for oil cracking that can be used in burial history models. SIR funded, with ~50% research time (Michael Lewan, Project Chief and Science Center Director, Christopher Potter, Supervisor).

From: 10/05 To: 9/11

Petroleum Processes Research Project, Task 4 - Evaluate new geochemical parameters for determining geochemical correlation parameters and the effects of thermal maturity on them with emphasis on $\delta^{34}\text{S}$, Os/Re isotope signatures, and biomarkers (i.e., ladderanes). SIR funded, with ~15% research time (Michael Lewan, Project Chief; and Paul Lillis, Task Leader).

From: 3/06 To: 9/11

Oil Shale Assessment, Task 2 - Characterize oil shales and evaluate various retorting laboratory-pyrolysis methods in evaluating yields, quality of products, and byproducts of environmental concern. Currently, mentoring/supervising Mendenhall Post-Doc, Justin Birdwell, on experimental work concerned with *in situ* retorting. SIR funded, with ~15% research time, but ~10% (Ron Johnson, Project Chief).

From: 3/11 To: 7/11

National Oil and Gas Assessment (NOGA), Paradox Basin Assessment, Task 1 - Define petroleum systems and assessment units within the Paradox Basin with major emphasis on evaluating published burial history curves. I assisted geologists with oil correlation and interpretation of available source rock data. *Expertise volunteered*, with ~10% research time (Katherine Whidden, Assessment Leader).

From: 4/10 To: 12/10

World Petroleum Assessment, Libya/Tunisia Assessment - Define petroleum systems within Libya and Tunisia with major emphasis on evaluating previous estimates in the Sirte Basin. I help geologists construct burial history curves and conduct oil correlation studies to define total petroleum systems and their assessment units. As lead geochemist, I also provide direction and assistance to individuals compiling data bases for the task. *Expertise volunteered*, with ~10% research time (Katherine Whidden, Assessment Leader).

From: 3/06 To: 9/09

National Oil and Gas Assessment (NOGA), Williston Basin Assessment, Task 1 - Define petroleum systems of the Williston Basin with major emphasis on evaluating previous estimates of large resources within the Bakken Shale. I help geologists construct burial history curves and evaluate appropriate kinetic parameters for evaluating the timing of oil and gas

generation within assessment units. As lead geochemist, I also provide direction and assistance to individuals compiling data bases for the task. SIR funded, with ~25% research time (Lawrence Anna, Assessment Leader).

From: 10/96 To: 10/03

Experimental Petroleum Expulsion– Conduct laboratory pyrolysis experiments to determine the timing and extent of petroleum expulsion from source rocks bearing major types of kerogen (Type-I, -II, -IIS and -III) at various stages of thermal maturation. As Project Chief, I designed and conducted experiments to determine the geological factors (pressure, water availability, kerogen type, mineral matrix) that control timing and extent of petroleum expulsion. Experiments focused on quantifying our ability to determine geologic factors responsible for the occurrence and timing of gas generation from gas-prone source rocks and oil cracking in reservoirs. Research efforts were maximized through collaborative studies with universities and research institutes. SIR Funds and OF from collaborators, with ~40% research time.

DATES From: 9/98 To: 7/06

Principal Investigator of US-Polish Skłodowska/Curie Joint Fund Project- In collaboration with M. Kotarba (Krakow University of Mining and Metallurgy), studied and defined petroleum systems of the Polish Carpathians.

DATES From: 10/98 To: 10/03

World Energy, Iraq Modeling Task – Defined and evaluated Iraqi Jurassic and Silurian petroleum systems in terms of generation, expulsion, and migration of petroleum. I identified source rocks in systems and their timing of petroleum generation (kinetics) and petroleum charge values in defining pods of active source rocks from which secondary migration models were developed. As initiator of the task, I also provided direction and assistance to individuals employing basin modeling programs and secured contracts for the acquisition of data from outside vendors.

DATES From: 10/95 To: 9/98

Material Balance Approach to Petroleum Assessment, USGS: As Project Chief, I directed and worked with M. Henry, D. Higley, and J. Pitman in developing a material balance method for assessing undiscovered petroleum using migration catchments in the Illinois basin to calibrate petroleum charge and losses (residual, erosional, and leakage).

DATES From: 10/95 To: 9/98

Suppressed Vitrinite Reflectance Study, USGS, Project Chief C. E. Barker: Designed a rapid hydrous pyrolysis technique to determine whether the reflectance of vitrinite in a given sample is suppressed. The suppression of vitrinite reflectance causes severe problems in reconstructing thermal histories and evaluating stages of petroleum generation within sedimentary basins.

DATES From: 6/98 To: 1/99

Deep Gas Studies, USGS, Project Chief Ted Dyman: Conducted studies with Allison Henry (summer student) on gas/oil ratio (GOR) determinations from pyrolysis experiments and on kinetic model predictions of deep gas generation.

DATES From: 4/98 To: 3/99

Effects of Hydrostatic Pressure on Oil Expulsion, USGS: Collaborative study with Fang

Hao (China University of Geosciences) on the effects hydrostatic pressures up to 30,000 psi have on the expulsion of oil from the Woodford Shale.

DATES From: 10/97 To: 9/98

Kinetic Study of the Wilcox Type-III Kerogen: Collaborative study with F. Behar (Institute Francais du Petrole) on the timing and extent of petroleum generation from type-III kerogen determined by three different laboratory pyrolysis methods.

DATES From: 7/97 To: 11/98

Compound-Specific $\delta^{13}\text{C}$ Study of Light Hydrocarbons: Collaborative study with F. Gelin (Royal Dutch Shell) on the use of $\delta^{13}\text{C}$ of specific light hydrocarbons in oils and condensates as correlation and maturity parameters.

DATES From: 6/97 To: 9/98

Role of Smectite in Petroleum Formation: Collaborative study with M. Dolan and J. Curtis (Colorado Sch. Mines) on the catalytic and inhibitor effects of smectite and its conversion to illite on petroleum generation in nature and laboratory experiments.

DATES From: 1/97 To: 9/97

North Slope Alaska Oil-Rock Correlation study, Project Chief K. Bird: With P. Lillis, developed a hydrous pyrolysis method to generate and obtain expelled oils from limited amounts of potential source rocks from the North Slope for correlation with seep and produced oils.

DATES From: 10/96 To: 9/98

$\delta^{13}\text{C}$ of Geochemistry of Low-Molecular Weight Organic Acids in Oil-Associated Waters: Collaborative study with R. Dias and K. Freeman (Penn State) on factors responsible for the $\delta^{13}\text{C}$ of organic acids in oil field waters and waters collected from hydrous pyrolysis experiments.

DATES From: 9/96 To: 8/98

Isotopic Responses and Exchange of Hydrogen and Nitrogen in Kerogen during Oil Generation: Collaborative study with A. Schimmelmann (Indiana University) on the influence of water on the δD and $\delta^{15}\text{N}$ signatures of thermally maturing kerogen, bitumen, and oil.

DATES From: 3/96 To: 4/98

Effects of Thermal Maturation on K-Ar and Rb-Sr Isotopic Signatures of Petroleum Source Rocks: Collaborative study with S. Chaudhuri (Kansas State Univ.) and N. Clauer (Centre de Geochimie-Surface) on whether or not thermal maturation of organic matter in shale alters age dates determined on clay minerals.

DATES From: 6/95 To: 9/96

Petroleum System of the Dead Sea Basin: Collaborative study with E. Tannenbaum (Israel Nat. Oil Co.) and H. Ramini (Jordan NRA) on typing of oils and tars around the Dead Sea and determining kinetic parameters for oil generation from their Type-IIS kerogen bearing source rocks.

DATES From: 1/93 To: 12/96

Diagenetic and Catagenetic Transformations and Release of Biomarkers: Collaborative study with M. Koopmans and J. Sinninghe-Damste (University of Utrecht/NIOZ) on the release and alteration of S and O bound biomarkers in Type-IIS kerogen during thermal maturation.

DATES From: 10/93 To: 6/96

Mechanisms of Petroleum Generation in the Green River Fm. of the Uinta Basin: Collaborative study with T. Ruble and P. Philips (Univ. of Oklahoma) on the timing and composition of oils generated from various organic facies in the Green River Fm.

DATES From: 7/93 To: 9/96

Characterizing Thermogenic Gas from Different Rank Coals: Collaborative study with M. Kotarba (Krakow University of Mining and Metallurgy) on determining the quantity, isotopic signature, and molecular composition of thermogenic gas generated from different rank Polish coals.

DATES From: 6/93 To: 9/94

Experimental Study of Petroleum Generation in the New Albany Shale: Collaborative study with John Guthrie (Indiana University) on the timing and composition of oils generated from different members of the New Albany Shale, Illinois basin.

DATES From: 10/93 To: 9/95

Fundamentals of Petroleum Formation Study, USGS: As Project Chief, I designed and conducted hydrous pyrolysis experiments on coal, oil shale, and marine source rocks to determine optimum conditions for simulating generation of oil and gas. Expelled oils and gases were shown to have physical, chemical, and isotopic compositions similar to natural oils and gases.

DATES From: 8/92 To: 9/94

Role of Organic Acids in Geological Processes, USGS: Edward Pittman (Amoco Research Center) and I organized and edited a 14-chapter book (#30) on the role of organic acids in rock and mineral weathering, soil formation, subsurface porosity enhancement, and transport of ore metals (published by Springer-Verlag). I contributed two chapters (#31 and #32) and edited the remaining 12 chapters for clarity and scientific content.

DATES From: 8/92 To: 9/93

Cooperative Monterey Organic Geochemistry Study, USGS, Project Chief Caroline Isaacs: Worked with Project Chief in defining research directions concerning organic facies, depositional environments, thermal maturity, and petroleum-generation kinetics of the Monterey Formation.

DATES From: 2/91 To: 12/92

Establish Hydrous Pyrolysis Laboratory, USGS: As Project Chief and sole investigator, I established a fully-operative hydrous pyrolysis laboratory for experimental research on generation and expulsion of petroleum from source rocks.

Colorado School of Mines, Golden, CO

From: 1/95 To: 9/07

Adjunct Professor, Department of Geology and Geological Engineering, Colorado School

of Mines: Taught graduate courses entitled “Organic Geochemistry of Fossil Fuels” (GEGN/CHGC 527) or “Petroleum Geochemistry Seminar”(GEOL 696A) every other year with Paul Lillis and John Curtis. I also serve as thesis and dissertation advisor and committee member as needed (Science Center Director, Supervisor).

Amoco Production Co. Research Center, Tulsa, OK

DATES From: July 1989 To: February 1991

Supervisor of Geochemistry Group: Supervised the activities of eight scientists and three technologists; Activities included establishing objectives, quarterly reviews, and determining annual salaries and budgets.

DATES From: 4/85 To: 7/89

Research Associate Scientist, Geochemistry Group: Research studies on effects of reactor-wall-composition and carburization on products from hydrous pyrolysis, detection and evaluation of suppressed vitrinite types, petroleum potential and kinetics of oil generation of the Lower Oil Shale Group of Scotland, kinetics for biomarker maturity transformations, evolution of organic acids, CO₂ H₂ S, and H₂ from source rocks as a cause of secondary porosity, effects of radiation damage in the Cambrian Alum Shale of Scandinavia, petroleum potential of resinites as a source of condensates, organic facies and source-rock potential of the Old Red Sandstone in northern Scotland, mathematical approaches to determine kinetic parameters for oil generation from non-isothermal anhydrous pyrolysis experiments, effects of water chemistry on the silica polymorph transformations, source rocks and petroleum charge in the Gulf of Suez, and effects of gamma radiation on sedimentary organic matter.

DATE From: 3/82 To: 4/85

Staff Research Scientist, Geochemistry Group: Research studies on kerogen classification based on petrographic and chemical properties, catalytic and inhibitory effects of clay minerals in generation and expulsion of oil from source rocks, petroleum potential, thermal history, and subsidence of the Truckee Formation in the Carson Sink, Nevada, effects of thermal maturation on stable organic carbon isotopes of organic components in thermally maturing source rocks, 5) expulsion efficiencies and kinetics of oil generation from source rocks, trap integrity related to tar occurrences in the Monterey Formation of offshore Santa Maria, California, and stratigraphic lithofacies and organic facies of the Monterey Formation of southern California.

DATE From: 3/81 To: 3/82

Senior Research Scientist Geochemistry Group: Research studies on utility of infrared spectrometry in evaluating type and maturity level of kerogens, field criteria for recognizing style and degree of outcrop weathering, and petroleum potential of coals from the Cretaceous Blackhawk Formation.

DATE From: 5/80 To: 3/81

Research Scientist (Senior Grade), Geochemistry Group: Studied compositional changes and methane content of Cretaceous coals (Mesaverde and Williams Fork Formations) ranging from sub-bituminous to anthracite rank in the Piceance Basin, Colorado.

DATE From: 11/78 To: 5/80

Research Scientist, Geochemistry Group: Research studies on Woodford Shale stages of petroleum formation, hydrothermal oxidation of kerogens in shear zones of the Meade Peak Member of the Phosphoria Formation in the Wyoming, subsidence, thermal history, and petroleum generation of the Monterey Formation in the Santa Maria Basin and offshore California, and depositional units and their source rock potential in the Renova Formation of the Tertiary basins in southwestern Montana.

DATE From: 8/77 To: 12/77

Extended-Summer Research Scientist, Geochemistry Group: Studied the effects of water on pyrolysis of organic-rich shale, and developed the method referred to as hydrous pyrolysis for simulating natural petroleum formation.

DATE From: 7/76 To: 9/76

Summer Research Scientist, Geochemistry Group: Established a kerogen isolation procedure and analytical procedure for accurately determining oxygen content of kerogen.

DATE From: 2/75 To: 9/75

Research Scientist, Geochemistry Group: Studied the factors controlling gas content of coal beds and the economics of coalbed degasification, oil generation and migration from pre-Miocene source rocks in the San Joaquin Basin, and source rock potential of the Syrian Gothlandian graptolitic shale.

Shell Oil Co., New Orleans, LA

DATE From: 12/73 To: 2/75

Exploration Geochemist/Geologist: Determined the presence of economical microbial gas in the offshore of Louisiana on the basis of gas composition and stable carbon isotopes. Evaluated the applicability of fluorescence spectrometry of surface sediments in locating subsurface oil accumulations. Recognized presence of Jurassic-sourced oil on the continental slope of the Gulf of Mexico.

DATE From: 7/72 To: 12/73

Exploration Geologist: Conducted detail study of structure, stratigraphy, and petroleum reservoirs of Eugene Island 110 field, offshore Louisiana. Constructed regional isopach maps of sediment thickness overlying salt in the Pleistocene shelf and slope of offshore Louisiana and Texas. Developed a regional model for Pleistocene sedimentation in offshore Louisiana. Conducted regional study on relationships between hydrocarbon mix (i.e., oil/gas) and structural styles, trapping mechanisms, and geographic location of the reservoirs.

U. S. Geological Survey, Cooke City, MT

DATE From: 7/70 To: 9/70

Field Assistant, Project Chiefs W. H. Nelson and H. J. Prostka: Assisted in mapping and sampling volcanic and sedimentary rocks of the Wapati and Lamar River Formations in the Absaroka Wilderness Area of Wyoming. Acknowledged for assistance on USGS Map GQ1564, Dead Indian Peak Quadrangle.

4. SIGNIFICANT RESEARCH ACCOMPLISHMENTS

Development of Low-temperature hydrous pyrolysis for determining the amount and character of retained oil in mature source rocks for unconventional shale oil plays. Work was initiated with Mark Sonnenfeld of Whiting Petroleum on Niobrara cores from the Denver Basin.

Determined active pod of Bakken Shale source rock in the Williston Basin: A new type of unconventional play in the Middle Member of the Bakken Shale emerged on the eastern side of the Williston Basin in North Dakota. The geological model used for 2008 USGS assessment was considered to be a thermal-maturity trap with oil generated from the Upper and Lower Bakken members being the in situ source of the oil accumulations. Controversy emerged in the industry and publications that this model may not be applicable. This was investigated for the 2013 re-assessment of the Bakken Shale by supplementing the originally used geochemical data base with additional composite core samples collected from 31 wells representing different levels of thermal maturity. A detailed study of these samples using thin-section petrography, isolated-kerogen elemental analyses, and hydrous pyrolysis experimental results indicated that the questioned accumulations were not in the active pod of source rock. This indicated that the oils migrated from mature Bakken Shale down dip. This migration cannot be explained by buoyancy and required a different geological model. The working model for the 2013 assessment involved an over-pressuring drive during down-dip oil generation that moved up dip by propagating existing fractures during uplift of the eastern side of the basin. This effort resulted in a new trapping style for unconventional tight-reservoirs, which helped document and define new assessment units for the 2013 assessment.

New method to determine the fate of spilled oil from the of BP Deepwater Horizon Incident: An estimated 4.9 million barrels of crude oil were released between April 20 and July 15, 2010 from the ruptured Macondo-1 wellhead of the BP Deepwater Horizon (DWH) drilling rig in the Gulf of Mexico. Seventeen percent of this spilled oil was directly recovered from the ruptured wellhead, with the critical question being where has the remaining 4.1 million barrels of spilled oil gone. I and a team of geochemists and geologists addressed this question by looking at the composition and content of asphaltenes in spilled and original oils. This new approach provided a more complete and accurate evaluation of the amount of original-oil lost and the processes most responsible for the losses within the first 80 days of the incident. Bench- and roof-top experiments involving evaporation, photo-oxidation, microbial degradation, dissolution, dispersion, and burning indicate that the combined effects of photo-oxidation and evaporation were responsible for the greatest losses and account for 61 ± 3 vol% of original-oil lost from the surface spilled oils during the incident. This mean percentage is considerably larger than the 37 to 50 % evaporative losses used in the Federal Government's oil budget estimates, and almost twice the evaporative losses based solely on GC-amenable hydrocarbons. These results provide the fundamentals for a more quantitative understanding of the fate of DWH spilled oil, and also brings into question whether delaying the rise of released oil to the surface with dispersants was advantageous (#104).

Designing and Testing the Uniaxial Core Confinement Apparatus: Generation of oil within a source rock is a volume-increase reaction that results in the expulsion of oil from the rock. If pyrolysed rock is not confined perpendicular to its bedding fabric as it is during natural maturation in the subsurface, tensile fractures occur as open partings parallel to the bedding

fabric. In natural petroleum generation, rocks overlying a thermally maturing source rock provide sufficient overburden pressures to prevent open tensile fractures from developing. Laboratory experiments designed to simulate natural oil generation typically have a uniform pressure around the source rock as it is being pyrolysed. Without a uniaxial confinement comparable to natural overburden confinement, open tensile fractures parallel to bedding fabrics develop in the pyrolysed rock. These expansion partings render the recovered rock too friable and porous for comparisons with naturally matured rocks in the subsurface. As a result, the physical and chemical properties of recovered rock from a pyrolysis experiment cannot be compared with rock that has undergone natural thermal maturation and oil generation. Justin Birdwell and I designed an apparatus to maintain a maximum uniaxial confining pressure on cores during laboratory pyrolysis experiments. The apparatus provides a means of evaluating petroleum production from a source rock or oil shale with the recovery of an intact core that can be used to study various petrophysical properties of the matured rock that are comparable to naturally matured rock. The apparatus is currently being used in a study of the Woodford Shale and Green River Mahogany Shale (#98, #99).

Differentiating Adsorbed Gas from Generated Gas: The use of isotopically light δD water in hydrous pyrolysis differentiated pre-existing hydrocarbon gases adsorbed gases in high-rank coals from generated gases (#102, #106). This along with the collaborative studies with other research groups (#51, #58) showed that unlike $\delta^{13}C$, interpretations of δD needed to consider the isotopic composition of pore waters during oil and gas generation. Hydrous pyrolysis showed that kerogen type and thermal maturity had a significant effect on the adsorption of methane (#107).

Development of Sequential Hydrous Pyrolysis: The ability of hydrous pyrolysis to generate expelled oil for correlations has been plagued by the large amount of sample needed to conduct numerous experiments at different time and temperature conditions. This limitation has been alleviated with a method I developed call sequential hydrous pyrolysis. This method involves heating one sample in a series of increasing time and temperature conditions. At the end of each experiment, the generated gases and expelled oils are collected for routine analysis of geochemical correlation parameters. The method has been used in characterizing natural gases from the Menilite Shale in the Polish Carpathians (#91), an MS thesis by Lucy Ko on Rocky Mountain tight-gas sand source rocks, natural gas accumulations from Early Paleozoic source rocks in offshore Baltic (in #96), and Nigerian coal and coaly shale studies (#110). The method also provides information on petroleum charge of a source rock and the gas:oil ratios it is capable of generating. This accomplishment has provided the petroleum industry with a state-of-the-art method for evaluating the potential of source rocks and making scientifically sound geochemical correlations with a minimal amount of sample.

Effects of Mineral and Metals on Petroleum Formation: Hydrous pyrolysis was used to determine the effect of smectite and its conversion to illite on oil generation. Results showed that oil generation prior to oil formation inhibits the conversion and significantly reduces oil formation (#103). The effects of thermal maturation on the Re-Os (#95, #101) and K-Ar geochronology (#100, #81) were found not to be significant as determined by hydrous pyrolysis. Hydrous pyrolysis showed that transition metals in a source rock were not capable of catalytically enhancing gas generation at low temperatures (#84) as had been previously proposed. Hydrous pyrolysis documented that the proportionality of V to Ni remained essentially the same between bitumen retained in a source rock and its expelled oil (#6).

Thermal Stability and Sequestering of Biomarkers: In collaboration with other research groups, hydrous pyrolysis determined the thermal stability of ladderanes in anammox bacteria (#86), thiophenes in source rocks (#34), and hopanes and terpanes in high-sulfur kerogen bearing limestone (#39, #44). The importance of sequestration of biomarkers in immature kerogens was demonstrated by hydrous pyrolysis (#36, #37, #40, #47).

Effects of Thermal Maturation on $\delta^{34}\text{S}$: Hydrous pyrolysis was used to evaluate the distribution of $\delta^{34}\text{S}$ in inorganic (pyrite, aqueous H_2S) and organic phases (kerogen, bitumen, expelled oil, and generated gas) of a high-sulfur kerogen-bearing source rock during thermal maturation (#77, #80).

Organic Acids and Secondary Porosity Generation: The role of organic acid generation from a source rock in the generation of secondary porosity was evaluated by hydrous pyrolysis (#32). $\delta^{13}\text{C}$ of organic acids generated from different kerogen types was also evaluated by hydrous pyrolysis (#61). The findings showed that porosity development was possible in close proximity of thermally maturing source rocks but not possible by diffusion on a regional scale.

Petroleum Potential of Living Organic Matter: Hydrous pyrolysis showed that *Azolla* in the Arctic regions was a potential source of gas and not oil. Conversely, *Scenedesmus* algae was a potential source of quality oil that could be used as a renewable energy resource (#109).

Gas Generation from Coals: Hydrous pyrolysis experiments on coals ranging in rank from lignite to anthracite showed that gas generation from gas-prone kerogen (Type-III) was essentially complete by the time coals were buried and heated sufficiently to achieve a vitrinite reflectance of 1.5 to 2.0 %Ro (#70, #106). The quantities of gas generated from these coals and a series of low total-organic-carbon (TOC <1.0 wt%) shales and mudstones provided a quantitative evaluation of gas-prone source rocks. The evaluation indicated that large volumes of TOC-lean shale or mudstone could not be considered viable gas-prone source rocks and that their position to potential reservoirs was also an important factor. These findings showed that the Baxter/Hilliard/Steele shale of the Greater Green River Basin and the thick organic-lean shale sections in the Gulf Coast Tertiary are not sources of gas. These findings also have implications regarding sources of tight-sand gas and were presented at the 2009 International Meeting of Organic Geochemistry (Bremen, Germany) with a publication in preparation. Another important implication of this research is that unconventional gas sweet spots may be related to the proximity of potential reservoirs to amounts and ranks of coal. This accomplishment has provided the industry and scientific community with cutting-edge research on evaluating gas-prone source rocks for defining gas-rich petroleum systems.

Geochemical Correlations and Petroleum Quality: Hydrous pyrolysis of a Brazilian source rock showed that it generated oil and gas that was similar to natural crude oils produced offshore Brazil. Similarities included API gravity, gas:oil ratios, and SARA fractional analyses. The study also showed that the Green River Type-I kerogen was not analogous to the Brazilian Type-I kerogen (#108). Hydrous pyrolysis on the Polish Menilite Shales showed good correlations with produced crude oils in the region (#72). Source rocks and their oil types in the Alaska Arctic National Wildlife Refuge were determined in part by hydrous pyrolysis (#53).

Indirect Method of Determining Hydrous Pyrolysis Kinetic Parameters: In the early applications of hydrous pyrolysis kinetics, proxies were used to avoid the time-consuming kinetic experiments (3-4 weeks) and the need for several kilograms of sample. In other words, the hydrous pyrolysis kinetics for the Type-IIS kerogen in the Phosphoria Retort Shale were used to determine timing of oil generation for other source rocks with Type-IIS kerogen like the Naokelekan/Sargalu (#71), Smackover (#64), Phosphoria (#69 and #73) and Rodessa (South Florida assessment). Similarly, hydrous pyrolysis kinetics for the Type-II kerogen in the Woodford Shale were used to determine timing of oil generation for other source rocks with Type-II kerogen like the Mowry (#69 and #73) and Eagle Ford (#64). The original study (#65) that compared kinetic parameters from hydrous pyrolysis and Rock Eval was initiated with the idea that some correlation between the kinetic parameters would allow one to determine hydrous pyrolysis kinetics from a relation with the Rock-Eval kinetics. This study showed that no correlation existed, but it did show that an excellent correlation existed between the organic sulfur content of a kerogen and its kinetic parameters. This relation was based on six source rocks that had oil-prone kerogen (i.e., Type-I, -II, and -IIS) representing a wide range of organic sulfur contents. This relation has been confirmed with source rock samples from the Polish Menilite Shale that contain organic facies with both Type-II and Type-IIS kerogen (#79). This relation provides a rapid and inexpensive means to derive hydrous pyrolysis kinetics on the basis of organic-sulfur content of immature kerogen isolated from source rocks. This new method was applied in the modeling of the Western Canadian Sedimentary Basin (#90) and can now be used in any assessment unit where source rock samples are available. It is currently being applied to organic facies of the Eagleford/Boquillas shales in the Gulf Coast (in progress). In addition, a subsequent study has shown how hydrous-pyrolysis kinetic parameters determined by organic sulfur content of kerogen can be tested with a single hydrous-pyrolysis experiment (#92). Overall, this accomplishment provides industry and the scientific community with more accurate and sample-specific hydrous-pyrolysis kinetics for immature source rocks in a timely manner.

Implementing Petroleum Generation Kinetics (2000-2010): This effort was the first to get assessment geologists familiar and comfortable with using oil and gas generation kinetics in their 1-D basin models to determine timing of oil and gas generation and the cracking of oil to gas. Prior to FY2003, burial histories were based solely on vitrinite reflectance or its surrogate time-temperature index (e.g., Uinta Basin assessment). Although vitrinite reflectance was and still is an excellent index of the thermal history experienced by a rock, it was demonstrated in the scientific literature of the mid-1980s that petroleum generation kinetics were better predictors of oil and gas generation (#11). This approach using petroleum generation kinetics for different kerogen types became common practice in 2-D and 3-D burial history reconstructions by industry and universities in the early 1990s, but it was not used by USGS Energy Resource Program (ERP) until it was employed in the Iraq modeling study (#71). Subsequently, this kinetic approach was employed in the Greater Green River assessment in collaboration with Laura Roberts and Thomas Finn (#73). Publication of these results required some rewriting of the assessment write-ups concerning timing of oil and gas generation and the publication received the Rocky Mountain Association of Geologists Best paper award in 2004. Subsequent assessments involving Rocky Mountain basins (#83), Williston Basin, and Gulf Coast (#56, #64) have used petroleum generation kinetics in their burial histories. Hydrous-pyrolysis kinetics were also used to establish the source of the Athabasca tar sands in Alberta (#90, #94) and timing of overpressures in the Uinta Basin

(#35, #58, #68). The difference in timing of oil generation between Type-II and Type-IIS facies of the Menilite Shales as determined by hydrous-pyrolysis kinetics explained the occurrence of high- and low-sulfur crude oils in the Polish Carpathians (#79). Hydrous-pyrolysis kinetics were successfully applied to the Mesopotamian basin of Iraq in documenting the importance of early oil generation and its relationship to development of structural traps (#71). Most importantly, this accomplishment documented the significant differences between non-isothermal open-system (Rock Eval) derived kinetics and those derived by hydrous pyrolysis (#65, #79, #94).

Initiation of 4-D Modeling Effort: The first 4-D modeling effort in ERP was on the Mesopotamian basin in Iraq as a subtask in the World Energy project with J. Pitman and Doug Steinshouer. It started in FY2000 and kinetic parameters derived from hydrous pyrolysis were successfully applied to show early oil generation from the Jurassic source rocks (#71). To explore more 4-D modeling efforts in the ERP, it was determined that the Western Canadian Sedimentary Basin (WCSB) would be a good area because of the discrepancy between Canadian and US estimates of oil and gas resources and Canada's significant resource supply to the US. The WCSB model showed that the source of the northern Alberta tars sands was from an early oil generating Type-IIS kerogen in the Jurassic (#90 and #94). This accomplishment was a collaborative effort with Debra Higley in providing the ERP with in-house expertise on 4-D basin modeling that represents the future in scientifically based resource assessments (#78).

Petroleum Charge: The quantity of oil expelled from a pod of active source rock into a petroleum system is referred to as petroleum charge. This quantity is critical in determining the petroleum potential and economic ranking of petroleum systems (#29). I have shown through laboratory pyrolysis experiments and a material-balance study of the Illinois basin that previously employed methods for determining petroleum charge are exaggerated by more than one order of magnitude (#33, #60). These exaggerated petroleum charges have lured petroleum geologists over the last 15 years into believing that most petroleum systems are over-charged. This research shows that this is not the case and that more realistic values can be determined through the coupling of hydrous pyrolysis experiments and material balance studies of well-constrained petroleum systems. As an example, the petroleum charge for the Illinois basin is more than 1 trillion bbls of oil according to previously employed Rock-Eval methods and only 78 billion bbls of oil according to the new method. This drastically changes the way petroleum geologists and geochemists look at petroleum charge, trapping efficiency, and migration losses of petroleum systems. These findings represent the scientific basis for arguing against enormous quantities of oil still residing in sedimentary basins as advocated by some in the Bakken Shale of the Williston Basin.

Secondary-Migration Catchments: Through study of the Illinois Basin (#60), I have shown that petroleum systems can be divided into subunits on the basis of their secondary migration pathways as determined by buoyancy. The subunits constitute catchments that define the lateral and vertical limits of migrated petroleum from a given volume of mature source rock identified within a catchment. Based on relationships among volumes of mature source rock, discovered in-place petroleum, and critical geological attributes (e.g., faulting and erosion) of each catchment within a petroleum system, anomalous catchments can be recognized as having a greater potential for undiscovered petroleum. These catchments can be defined with a minimal amount of data (e.g., structure contour maps)

and serve as an excellent way of determining assessment units in which geological-framework and process studies can be integrated and built upon. An important part of any resource assessment is determining where undiscovered petroleum migrates and accumulates within a petroleum system.

Role of Water in Petroleum Formation: Through a comprehensive series of experiments (#24, #25, #28, #38, #48, #49, #50, #51, #58, #67, #82, #93), I have shown that water is an important component in the generation and expulsion of oil from source rocks. This role of water is especially important because most laboratory pyrolysis experiments used to derive parameters to calculate extent and timing of petroleum formation have been based on dry (anhydrous) pyrolysis experiments. Based on comparisons of anhydrous and hydrous experiments and D₂O experiments, I have conclusively shown that H₂O dissolved in the bitumen of a maturing source rock provides hydrogen to the cracking reactions with excess oxygen occurring as CO₂. My experiments with a liquid gallium-indium alloy and steam have also shown that dissolved H₂O in the bitumen of a maturing source rock is essential in the formation of an immiscible oil phase that is expelled from a source rock as it is generated. An important implication of this work is that availability of water to a maturing source rock is an important factor in determining whether or not an expelled oil is generated. Therefore, only mature source rock that has access to water will be effective in generating expelled oil within a basin. In addition, this work has initiated a new area of study in geochemistry and chemistry devoted to the chemical reactions between water and organic matter. A two-day symposium at the American Chemical Society 1999 National Meeting was devoted to this subject, which in addition to petroleum geochemistry included topics concerning origin of life, extraction of organics from meteorites, and quantum molecular modeling. Results from this research are also being considered in developing new methods for in situ oil-shale retorting.

Role of Sulfur Radicals in Oil Generation: Experimental study (#41) showed that free radicals generated by the cleavage of sulfur-carbon bonds in bitumen and kerogen significantly increase the rate of oil generation. Simply explaining the higher rates as a result of weaker sulfur-carbon bonds releasing their hydrocarbon moieties at lower thermal maturities was not feasible from a mass-balance assessment. However, breakage of these weaker bonds at lower thermal maturities served as radical initiators in oil generation.

Hydrous Pyrolysis Laboratory (1991-1992): Established a world-class hydrous-pyrolysis laboratory in ERP for simulating natural petroleum generation. This laboratory has gained world recognition, which has resulted in many collaborative research efforts with organic geochemists all over the world. Currently, 74 researchers representing 36 research organizations and 13 countries have collaborated on research issues in this laboratory. Travel and living expenses for all of these visiting scientists were covered by their research organizations. These collaborative efforts have helped the USGS extend research efforts beyond its current staffing, funding, and expertise.

Amoco Production Co. Research Center, Tulsa, OK

Radiation Effects on Petroleum Source Rocks (1991): A study of uranium-rich black shales and experimentally irradiated petroleum source rocks showed that radioactivity reduces the petroleum-generating potential of a kerogen through crosslinking, and does not enhance thermal maturation as previously thought (#16, #19).

Utility of Pre-Silurian Vitrinite-Like Macerals (1990): First study documenting the occurrence

of vitrinite-like macerals in pre-Silurian rocks, the utility of their reflectance as a thermal maturity index, and the suppressed relationship between them and post-Silurian vitrinite (#17).

Resinites as a Source of Terrestrial Oil (1987): Experiments and field studies showed that resinite in coals and coaly shales may contribute distinct compounds to an oil but does not contribute significantly to the quantity of oil generated (#14).

Petrographic Evaluation of Primary Oil Migration (1987): Petrographic study of naturally and experimentally matured source rocks showed the importance of source rocks having a sufficient amount of TOC to form a continuous bitumen network and the importance of net volume increases to facilitate primary migration and expulsion (#15).

Biomarker Transformations (1986): Implied biomarker transformations (isomerization, aromatization, and side-chain cracking) were studied through a series of hydrous pyrolysis experiments. Results showed that reactions are more complicated than originally inferred and that simple kinetic solutions could only be obtained for the side-chain cracking reaction. A reversal in the isomerization parameter was first recognized in the experiments and latter observed in natural maturation sequences (#13).

Organic Geochemistry of Vanadium and Nickel (1984): Developed understanding and model of the depositional conditions (pH, redox, chlorophyll degradation, $\alpha\text{H}_2\text{S}$) and chemical constraints (ligand field energies, cation size and valence) responsible for the concentration and proportionality of vanadium and nickel in oils and bitumens of source rocks (#6, #7, #10).

Dichotomy in Amorphous Kerogen $\delta^{13}\text{C}$ (1986): Two broad but distinct types of amorphous oil-prone kerogen based on $\delta^{13}\text{C}$ was documented through the Phanerozoic. The differences were attributed to whether the source of CO_2 was from atmospheric equilibrated with open-ocean waters or from decaying organic matter in restricted epi-continental seas (#12).

Differentiating Oil Generation from Vitrinite Reflectance (1985): Established that a simple relationship previous prescribed between oil generation and vitrinite reflectance was not always valid and had significant consequences when high-organic sulfur kerogen was the dominant source of oil in a basin (#11).

Recognition of So-called Suppressed Vitrinite Reflectance (1985): Hydrous pyrolysis experiments documented that macerals identified as vitrinite in some source rocks did not change in reluctance to the same extent as true vitrinite in coal. A hydrous pyrolysis method was established to make these distinctions (#11).

Variability of Oil Yields from Coals (1984): Field and experimental study on different coal lithotypes in the Blackhawk Fm. to determine factors that control whether or not a coal is capable of generating oil.

Effects of Thermal Maturation on Organic $\delta^{13}\text{C}$ Signatures (1983): First experiments to demonstrate how $\delta^{13}\text{C}$ Signatures of organic phases in expelled oils (saturates, aromatics, and resins) and source rocks (bitumen and kerogen) change and to what degree with thermal maturation (#9).

Outcrop Weathering of Petroleum Source Rocks (1980): Field and laboratory criteria were

established to recognize and evaluate degree and type of outcrop weathering on petroleum source rocks (#6).

Development of Hydrous Pyrolysis (1979): Pioneered the development of hydrous pyrolysis in simulating the generation and expulsion of petroleum from source rocks (#5, #8).

Coalbed Methane (1975): Conducted first Amoco study that recommended several initiatives in the development of coalbed methane in the US.

University of Cincinnati, Department of Geology, OH

Shale Classification (1978): Devised the only existing laboratory classification of fine-grained sedimentary rocks on the basis of petrography, chemical composition, and x-ray diffraction (#4).

Shell Oil Co., New Orleans, LA

Gulf Coast Offshore Biogenic Gas (1974): Conducted first Shell study that demonstrated economical biogenic gas accumulations in the Gulf Coast Offshore (West Delta).

New Oil Types in Gulf Coast Pleistocene (1973): Conducted first Shell study that recognized a new high-sulfur oil type in the offshore Pleistocene of the Gulf Coast. This finding initiated thought on sub-salt Jurassic-sourced oil plays.

Michigan Technology University, Houghton, MI

Differentiating Precambrian Metasomatism from Paleosol Development (1977): An extensive alteration zone of the serpentinized periphery of a peridotite was shown to be the result of CO₂-rich metasomatic fluids replacing the serpentine and not a Precambrian paleosol as originally assumed (#1, #2).

5. SCIENTIFIC LEADERSHIP

2011-present: Initiated, designed, and lead collaborative study with Michael A. Miller (Chief Petrophysicist, Cimarex Energy Co.) on petrophysical characterization of source rocks as they thermally mature based on hydrous pyrolysis of the Woodford Shale. The study involves subjecting immature Woodford Shale cores to different levels of thermal maturity with hydrous pyrolysis. The cores are confined perpendicular to bedding fabric during with a uniaxial confining rig (USGS patent pending) during the experiments to simulate overburden pressures in the subsurface. The recovered cores are being characterized by CT scans (David James, Weatherford Labs); dielectric properties (John Scales, Colorado School of Mines); NMR and resistivity (Kate Washburn, Weatherford Labs); porosity, FTIR, BET, MICP, and FIB SEM (Carl Sondergeld, University of Oklahoma); and geochemical source rock characterization (USGS Denver). The objective of this collaborative effort is to determine the petrophysical properties of source rocks that best define their potential for unconventional shale petroleum accumulations at different stages of petroleum formation.

2010-2014: Initiated study addressing the question, where did the 4.9 million barrels of spilled oil go from the BP Deepwater Horizon incident. This in-progress study involves looking at the chemical components of spilled oils in open and coastal waters, and coastal

sediments taken during the incident. The objective is to determine the amount of original spilled oil they represent. I am coordinating this effort with members of the Energy Resources Team (i.e., A. Warden, R. Dias, Z. Lowry, T. Hannah, P. Lillis, S. Harris, and B. Marshall) in terms of the analytical analyses and the Crustal Imaging and Characterization Team (R. Kokaly, T. Hoefen, G. Swayze, C. Mills, and G. Plumlee) in terms of sample collection and site descriptions. Preliminary results based on asphaltene contents of the spilled oils show that more than 60 wt% of the spilled surface oil was degraded within the first 81 days of the incident. This collaborative research is in progress and represents the only scientific study currently dealing specifically with the spilled oil and its degradation.

1996-2014: Initiated and provided direction to the Petroleum Processes Research Project. As Project Chief, I have renewed the project's tasks and direction in 2001, 2005, and 2011 with redirecting the research efforts from oil-formation processes to gas-generation processes. I have encouraged and initiated collaborative research with outside scientific research groups to broaden ERP's expertise and leverage ERP's funding, staffing, and time. Through this effort and a dedicated staff, I feel the Petroleum Processes Research Project has gained global recognition in the field of petroleum geochemistry. The project provides assessment geologists, industry, and scientific community with tools and a knowledge base to define petroleum systems and understand how they develop.

1994-1995: Organized and lead geologists from the Illinois State Geological Survey, Indiana Geological Survey, and Kentucky Geological Survey in a feasibility study on a petroleum mass-balance study of the Illinois Basin. This effort involved working with state geologists in coordinating and integrating well, geochemical, structural, and stratigraphic data from the three states. The study was completed in a year (#33) and showed that a petroleum material-balance assessment was possible with appropriate petroleum charge values. This collaborative effort set the stage for the more comprehensive material-balance study on the Illinois Basin in 2002 (#60).

1992-1994: In the late 1980s through the early 1990s, organic acids became an active research topic in rock weathering and silicate-mineral diagenesis. Ed Pittman and I, in an effort to bring together our expertise on the subject and that of others, took the lead in outlining 13 chapters on various aspects of organic acids in geological processes and contacted experts to write on these chapters. It is noteworthy that the book was not a merely a compilation of papers on organic acids, but a book designed with specific topics and solicited authors. Our leadership in this effort resulted in a 14 chapter book involving 24 authors. The book was entitled "Organic Acids in Geological Processes" and was published by Springer-Verlag (#30). The book was well received by the scientific community (see review by K. H. Freeman, *Geochim. Cosmochim. Acta* 62, p.730-731), and 472 copies have been sold. The book became available in paper cover in July of 2012.

6. SCIENTIFIC AND PUBLIC SERVICE

a. CURRENT MEMBERSHIPS IN PROFESSIONAL SOCIETIES.

1978-1991	Tulsa Geological Society, member
1984-present	The Society of Organic Petrology, member
1973-present	Geological Society of America, member
1972-present	Geochemical Society, member
1998-1990	Geochemical Society, Board of Directors

1969-present	Organic Geochemistry Division of Geochemical Society (GS), member
1986-1989	Organic Geochemistry Division of GS, Member-at-large
1986-1988	Organic Geochemistry Division of GS, Best Paper Award Com. Member
1988-1989	Organic Geochemistry Division of GS, Best Paper Award Chairman
1991-1993	Organic Geochemistry Division of GS, Nominating Committee Member
1996-1997	Organic Geochemistry Division of GS, Chairman Elect
1997-1998	Organic Geochemistry Division of GS, Chairman
1984-present	American Association of Petroleum Geologists, member
1988-1991	Tulsa Geological Study Group, invited member
1992	Gordon Research Conference on Organic Geochemistry, Vice Chairman
1994	Gordon Research Conference on Organic Geochemistry, Chairman/Organizer
1994-present	American Association for the Advancement of Science, member.
2003-present	Rocky Mountain Association of Geologists
2005-present	The Geological Study Group (Denver, CO)
2010	Gordon Research Conference on Organic Geochemistry, Unconventional Petroleum Resources Session Chair and organizer.

b. TECHNICAL PRESENTATIONS

First Author

- 2019 Scientific research in Understanding the origin of petroleum, AAPG Hedberg Conference, The Evolution of Petroleum System Analysis, March 4-6, Houston, TX (*poster*).
- 2019 New insights on the origin of petroleum through hydrous pyrolysis experimentation, Denver Earth Resources Library, February 21, Denver, CO (*invited quarterly speaker*).
- 2018 Low-Temperature hydrous pyrolysis(LTHP) on oil-field core samples for estimating original oil in-placeretained oil in mature source rocks and tight reservoirs, Hedberg conference, Austin, Texas march 4, 2018 with Chesapeake Energy coauthors.
- 2017 Determining timing and extent of oil generation: 7th International Symposium on Hydrocarbon Accumulation Mechanisms and Petroleum Resources Evaluation, China University of Petroleum, Beijing, October 21 (*invited speaker*).
- 2015 Current status on oil-generation kinetics: Unconventional Natural Gas Institute-UGTEP Training Program, Golden, CO, July 10 (*invited speaker and panel member*).
- 2014 Application of hydrous pyrolysis in petrophysical and geochemical studies of source rocks at various thermal maturities: Denver Well Logging Society, Golden, CO, October 14 (*invited talk*).
- 2014 Critical Relationships between vitrinite reflectance and petroleum formation: American Association of Petroleum Geologists Rocky Mountain Section Annual Meeting, Denver, CO, July 20-22, Abstract No. 1969208 (*invited keynote speaker*).
- 2014 Workshop on Stages of Petroleum Formation: New insights on old paradigms: Half-day class in Petroleum Engineering Department, Colorado School of Mines, Golden, CO, February 4 (*invited lecture*).
- 2013 Stages of Petroleum Formation: New insights on old paradigms: Tulsa Geological Society, Tulsa, OK, September 3 (*invited dinner talk*).
- 2013 Application of uniaxial confining-core clamp with hydrous pyrolysis in petrophysical and geochemical studies of source rocks at various thermal maturities: Unconventional Resource Technology Conference, Denver, CO, August 12-14,

- Abstract 1571475.
- 2013 Mapping the extent and distribution of oil formation in the Upper Bakken Formation, Williston Basin: American Association of Petroleum Geologists 2013 Annual Convention, Pittsburgh, PA, May 19-22, Abstract No. 1555879.
- 2013 Defining the Pod of Active Bakken Source Rock: Geochemistry and Petrography: Colorado School of Mines Bakken Consortium: Golden, CO, April 16 (*invited speaker*).
- 2013 Asphaltene composition and content as a measure of oil losses related to the Deepwater Horizon oil spill: Gulf of Mexico Oil Spill & Ecosystem Science Conference, New Orleans, LA, January 22.
- 2013 Analogues between water in granite melts and petroleum Formation: Woods Hole Oceanographic Institution 2013 Geodynamics Seminar Series: Simulating the Earth-What we learn from analog experiments: Woods Hole, MA, March 7 (*invited keynote speaker*).
- 2012 Analogues between water in granite melts and petroleum Formation: Department of Geoscience Seminar, Colorado State University, Ft. Collins, CO, November 12 (*invited speaker*).
- 2012 Expulsion efficiencies and timing of oil generation from different source-rock facies in the Eagleford Group and Boquillas Formation: West Texas Geological Society, Midland, TX, August 14 (*invited luncheon speaker*).
- 2012 Stages of petroleum formation: New insights on old paradigms, Rocky Mountain Association of Geologists Summer Speaker Series, Denver, CO July 16 (*invited dinner speaker*).
- 2012 Expulsion efficiencies and timing of oil generation from different source-rock facies in the Eagle Ford Group and Boquillas Formation as determined by hydrous pyrolysis: w/ Jessica Little and Michael Formolo, American Association of Petroleum Geologists 2012 Annual Convention, Long Beach, CA, April 22-25, Abstract No. 1235412.
- 2011 Petroleum charge in sedimentary basins: Chevron Oil Co. Basin Analysis Workshop, April 26, Houston, TX (*invited*).
- 2011 Determining kinetics of oil generation: Chevron Oil Co. Basin Analysis Workshop, April 26, Houston, TX (*invited*).
- 2011 Experimental studies on the origin of thermogenic gas: Chesapeake Energy Co. Workshop, March 22, Oklahoma City, OK (*invited half-day lecture*).
- 2011 Asphaltene content as a measure of oil losses related to the Deepwater Horizon oil spill: w/A. Warden, R. F. Dias, Z. K. Lowry, T. L. Hannah, P. G. Lillis, R. Kokaly, T. M. Hoefen, G. A. Swayze, C. Mills, S. H. Harris, G., S. Plumlee, and B. D. Marshall, 25th International Meeting on Organic Geochemistry, September 18, Interlaken, Switzerland (*submitted w/Director's approval*).
- 2010 Lower organic carbon limits and upper thermal maturity limit for methane generation from Type-III kerogen in coals and fine-grained rocks: The Society of Organic Petrology (TSOP) Annual Meeting, September 14-16, Denver, CO, Abstracts and Program, p. 14 (*invited keynote*).
- 2010 Upper Thermal Maturity Limit for Gas Generation from Humic Coals as Determined by Hydrous Pyrolysis: American Association of Petroleum Geologists Annual Convention, April 14, New Orleans, LA, Abstract Volume 19, p. 147 (*poster presentation*).
- 2009 Determining lower organic carbon limits and upper thermal maturity limits for economic methane generation from Type-III kerogen in coals and fine-grained rocks:

- 24th International Meeting on Organic Geochemistry, September 8, Bremen, Germany, Abstract Issue of IMOG, No. 034 (*oral presentation*).
- 2009 Vanadium, nickel, and uranium associations with petroleum and source rocks: Goldschmidt Conference, Vancouver, July 14, Abstract Issue of GCA, A748 (*invited keynote*).
- 2008 Source of heavy oils and tars in the Athabasca oil sands based on geochemistry and 4-D basin modeling: Goldschmidt Conference, Vancouver, July 14, Abstract Issue of GCA, A538 (*invited keynote*).
- 2008 Evaluating products and yields of Green River Oil Shale by Fisher Assay, Rock-Eval, Micro-scale Sealed Vessel, and Hydrous pyrolysis: AAPG Annual Convention, San Antonio, April 21, Book of Abstracts, vol. 17, p. 120 (*oral presentation*).
- 2008 Gas generation from oil-prone source rocks containing Type-II and IIS kerogen as determined by hydrous pyrolysis: AAPG Annual Convention, San Antonio, April 21, Book of Abstracts, vol. 17, p. 120 (*invited*).
- 2007 Evaluating transition-metal catalysis in gas generation from Polish and German Kupferschiefer by hydrous pyrolysis: 23rd International Meeting on Organic Geochemistry, Torquay, England, September 9, Book of Abstracts, pp. 359-360 (*poster*).
- 2007 Comparison of kinetics for oil generation from oil shales as determined by Rock Eval and hydrous pyrolysis: 27th Oil Shale Symposium Golden, CO, October 15.
- 2006 Evaluating oil-shale product yields and compositions by hydrous pyrolysis: 26th Oil Shale Symposium Golden, CO, October 17, (*presented w/R. J. Hill*).
- 2006 Implications of hydrous pyrolysis experiments on thermogenic gas from source rocks: Shale Gas Symposium, Rocky Mountain Assoc. Geol., Denver, September 25 (*invited*).
- 2006 Thermogenic gas generation by hydrous pyrolysis: Shale Gas Consortium Workshop, Colorado Energy Research Institute, Golden, May 9 (*invited*).
- 2005 Determining petroleum charge in the Illinois Basin: Paleozoic Forum, Brazilian Association of Petroleum Geologists, Rio de Janeiro, Brazil, August 31 (*invited*).
- 2005 Geochemistry of the New Albany Shale, Illinois Basin: Public luncheon talk at Thomasson Partner Associates, Denver, CO, July 27 (*invited*).
- 2005 Experimental studies on Sources, Amounts, and Kinetics of Thermogenic Gas: AAPG Hedberg Conference on Tight Gas Sands, Vail, CO, April 25 (*invited*).
- 2005 Role of Petroleum Generation kinetics in Constraining Basin Models: Chevron/Texaco Hydrocarbon Charge Evaluation Workshop, Houston, TX, July 12 (*invited*).
- 2004 Petroleum Generation Kinetics and Petroleum Charge: Petrobras Basin Modeling Workshop II, Rio de Janeiro, Brazil, November 8 (*invited*).
- 2003 Correlation between oil generation kinetics by open-system compositional pyrolysis and hydrous pyrolysis: Petroleum potential of organic facies of the Oligocene Menilite shales of the Polish Carpathians: Hydrous pyrolysis approach: 21st International Meeting on Organic Geochemistry, Krakow, Poland, September 9, Book of Abstracts Part I, p.342-343 (*poster*).
- 2003 University of Cincinnati, Department of Geology Colloquium (January 24), "Origin of Petroleum: A Crustal Process of Societal importance", Cincinnati, OH (*invited*).
- 2002 American Chemical Society 223th National Meeting (April 7), "High-pressure effects on generation of expelled oil in hydrous pyrolysis experiments", Orlando, FL, GEOC#36 (*invited w/abstract*).
- 2002 Rocky Mountain Association of Geologists, Symposium on Innovative Gas Exploration Concepts (October 1), "Fundamental issues on thermogenic gas generation from source-rock maturation and reservoir-oil cracking, Denver, CO", (*invited*

- w/ext.abstract*).
- 2002 Gulf Coast Association of Geological Societies 52nd Annual Convention (October 30), "New insights on timing of oil and gas generation in the central Gulf Coast Interior Zone based on hydrous pyrolysis kinetic parameters", Austin, TX (*presented*).
- 2001 20th International Meeting on Organic Geochemistry, EAOG (September 14), "Comparison of petroleum formation kinetics by hydrous pyrolysis and Rock Eval pyrolysis", Nancy, France, Abstract Volume I, O/015/05, p.202-203(*presented w/abstract*),.
- 2001 American Association of Petroleum Geologists Annual Conference (June 2) "Role of Organic Geochemistry in Defining and Evaluating Petroleum Systems", Denver, CO, RMAG Short Course #3 Notes, Petroleum Systems Approach to Exploration and Development, v.84, p.17-19 (*invited w/abstract*).
- 2000 American Association of Petroleum Geologists International Conference (October 15) "Timing and Extent of Petroleum Formation as Determined by Rock-Eval and Hydrous Pyrolysis Kinetic Parameters", Bali, Indonesia, AAPG Bulletin, v.84, no. 9, p. 1454 (*presented w/abstract*),.
- 2000 CSIRO, Petroleum Division (October 23): "Material Balance Approach to Petroleum Systems: "New Albany Shale/Chesterian of the Illinois Basin"; North Ryde, Australia (*invited*).
- 2000 CSIRO, Petroleum Division (October 24): " Timing and Extent of Petroleum Formation as Determined by Rock-Eval and Hydrous Pyrolysis Kinetic Parameters "; North Ryde, Australia (*invited*).
- 1999 American Chemical Society 217th National Meeting (March 27), "Thermodynamics of Reactions Involving H₂O and Hydrocarbon Radicals between 27 and 374 °C"; Anaheim, CA, v.44, no. 2, p 420 (*invited w/abstract*).
- 1999 AAPG Hedberg Conference on Natural Gas Formation and Occurrence (June 6-10), "Generated gas volumes and gas:oil ratios from kerogen during oil formation as determined by hydrous pyrolysis", Durango, CO (*invited w/extended abstract*).
- 1998 Van Tuyl Lecture Series, Colorado School of Mines (December 3), "Research issues concerning kinetics and mechanisms of petroleum generation and expulsion"; Golden, CO (*invited*).
- 1998 Geological Society of America Annual Meeting (October 25), "Research issues concerning kinetics and mechanisms of petroleum generation and expulsion"; Toronto, Canada, v. 30 (*presented w/abstract*).
- 1998 Basin Mod (Platt River Associates) User Group Meeting (September 30), " Material-Balance Approach to Petroleum Systems: New Albany Shale/Chesterian of the Illinois Basin"; Boulder, CO (*invited*).
- 1998 American Association of Petroleum Geologists Annual Convention (May 20): "Material-Balance Approach to Petroleum Systems: New Albany Shale/ Chesterian of the Illinois Basin"; Salt Lake City, UT, v.7 (*invited w/extended abstract*).
- 1998 Gas Research Institute, Deep Gas Forum (April 30 "Research Issues in Understanding the Origin and Controls on Deep Gas Generation"; Denver, CO (*invited*).
- 1997 Indiana University, Department of Geosciences Colloquium (November 19): "Material Balance Approach to Petroleum Systems: "New Albany Shale/Chesterian of the Illinois Basin"; Bloomington, IN (*invited*).
- 1997 Unocal Technology Conference (October 29-31): Keynote "A Material-Balance Approach to Determining Amounts of Undiscovered Oil in Petroleum Systems"; Houston, TX (*invited Keynote*).
- 1997 Geological Society of America Symposium on Organic Perspectives on Geological

- Processes, (October 25): “Effects of Organic Thermal Maturation on Geological Processes”; Salt Lake City, UT, v. 29, no. 6, pp. A18-A19 (*invited w/abstract*).
- 1997 Van Tuyl Lecture Series, Colorado School of Mines (September 11): “Role of Smectite in Petroleum Formation”; Golden, CO (*invited*).
- 1997 Rocky Mountain Association of Geologists, Luncheon Speaker (August 15): “Petroleum Formation in Senonian carbonate source rocks of the Dead Sea”; Denver, CO (*invited*).
- 1997 American Association of Petroleum Geologists Annual Meeting (April 7), “Petroleum formation in Senonian carbonate source rocks of the Dead Sea basin”, Dallas, TX, v. 6, pp. A69 (*presented w/abstract*).
- 1997 Colorado School of Mines, Department of Chemistry and Geochemistry Colloquium (February 25): “Mechanisms and Processes of Petroleum Formation”; Golden, CO (*invited*).
- 1997 Netherlands Institute of Sea Research (NIOZ), Department of Marine Biogeochemistry and Toxicology Colloquium (January 8): “Mechanisms and Processes of Petroleum Formation”; Den Burg, The Netherlands (*invited*).
- 1997 Sigma Xi Chapter of the Colorado School of Mines (January 21): “Understanding the Mechanisms and Processes of Petroleum Formation - How much Petroleum Remains in Sedimentary Basins?”; Golden, CO (*invited*).
- 1996 Geological Society of America Symposium on Organic Geochemistry-Linking the Biosphere and the Geosphere” at Annual Conference (October 27), “Research Issues in Petroleum Geochemistry”; Denver, CO (*invited w/abstract*).
- 1996 Twelfth International Symposium on Analytical and Applied Pyrolysis, Pyrolysis 96 (October 16): “Role of Free Radicals and Water in Simulating Natural Petroleum Generation by Laboratory Pyrolysis”; Venice, Italy, Abstract L17, p. 37 (*invited Keynote w/abstract*).
- 1996 Houston Advanced Research Center, Workshop (February 21) “Geochemistry in the 90’s-Solving Problems Collaboratively in an Era of Declining R&D Budgets” The Woodlands, TX (*invited*).
- 1995 Mobil Exploration and Production Technology Center, Workshop on Petrophysical Geochemistry (October 30) “Petrographic Study of Primary Migration in Source Rocks”; Dallas, TX (*invited Keynote*).
- 1995 East Meets West Conference and Exhibition, Modern Exploration and Improved Oil and Gas Recovery Methods, (September 12), “Assessing the Amounts of Petroleum Expelled from Source rocks in Sedimentary Basins by Hydrous Pyrolysis”; Krakow, Poland, Abstracts Book, p. 158 (*invited Keynote w/abstract*).
- 1995 Illinois State Geological Survey, Understanding Our Earth Seminars (May 3): “Determining Ultimate Petroleum Potential of Sedimentary Basins”; Champaign, IL (*invited*).
- 1994 Gordon Research Conference on Organic Geochemistry (August 17) "Comparative Study of Pyrolysis Methods and Their Relationship to Natural Hydrocarbon Generation"; Holderness School, NH (*invited*).
- 1994 American Association of Petroleum Geologists Annual Convention (June 15): "Determining Ultimate Petroleum Potential of Sedimentary Basins by Hydrous Pyrolysis"; Denver, CO, v. 3, p. 197 (*presented w/abstract*).
- 1994 American Association of Petroleum Geologists Annual Convention (June 13): “Effects of Weathering on the Reflectance of Vitrinite in the Mowry Shale, Steinaker Reservoir”; Denver, CO, v. 3, p. 197 (*presented w/abstract*).
- 1994 Fuel Science Seminar Series, University of Kentucky, Center for Applied Energy

- Research, (April 13), "New Developments in the Role of Water in Petroleum Formation"; Lexington, KY (*invited*).
- 1994 National School of Geology, Lorraine Institute of Geosciences (February 23) "Interaction of Water and Organic Matter during Thermal Maturation"; Nancy, France (*invited*).
- 1993 Tenth Annual Meeting of the Society for Organic Petrology (October 10), "Identifying and Understanding Suppressed Vitrinite Reflectance through Hydrous Pyrolysis Experiments"; Norman, OK, v. 10, p. 1-3 (*invited w/abstract*).
- 1993 Basin Mod (Platt River Associates) User Group Meeting (October 7), "A Qualitative Understanding of Petroleum Generation through Hydrous Pyrolysis"; Denver, CO (*invited*).
- 1993 Wyoming Geological Association Luncheon (September 10), "Assessing the Petroleum Potential of Sedimentary Basins through Laboratory Experimentation"; Casper, WY (*invited*).
- 1993 American Chemical Society 206th National Meeting (August 24), "Hydrocarbon Gas Generation from Different Kerogen Types subjected to Hydrous Pyrolysis"; Chicago, IL, Abstract No. 32 (*presented w/abstract*).
- 1993 U.S. Geological Survey National Assessment Workshop (July 7), "A Material Balance Approach to Petroleum Assessments"; Vail, CO (*invited*).
- 1993 Geological Survey of Israel Seminar (June 15), "Application of Laboratory Experiments to Assessing Petroleum Potential of the Dead Sea"; Jerusalem, Israel (*invited*).
- 1993 Israel National Oil Company Seminar (June 14), "Application of Laboratory Experiments to Assessing Petroleum Potential of the Dead Sea"; Tel Aviv, Israel (*invited*).
- 1993 Hedberg Conference, American Association of Petroleum Geologists (April 23), "Geochemistry of Organic Facies and Lithologic Facies in the Monterey Fm., Southern California"; New Orleans, LA, Abstract Vol., p.37 (*invited*).
- 1993 American Chemical Society 205th National Meeting, Division of Geochemistry (March 29), "The Inhibitory Effect of Smectite on Petroleum Expulsion in Hydrous Pyrolysis Experiments"; Denver, CO, Abstract No. 58 (*presented w/abstract*).
- 1992 Future of Energy Gases USGS Workshop, (October 19) "Origin of Thermogenic Gas"; Palo Alto, CA (*presented*).
- 1992 American Chemical Society 204th National Meeting, Division of Fuel Chemistry (August 27), "Water as a source of hydrogen and oxygen in petroleum formation by hydrous pyrolysis"; Washington, DC, Abstract No. 91 (*presented w/abstract*).
- 1992 American Chemical Society 204th National Meeting, Division of Fuel Chemistry (August 26) "Nomenclature for Pyrolysis Experiments involving H₂O"; Washington, D.C, Abstract No. 70 (*presented w/abstract*).
- 1992 Gordon Research Conference on Organic Geochemistry (August 12), "The Role of Water in Petroleum Formation"; Holderness School, NH (*invited*).
- 1992 Eighth Annual USGS V. E. McKelvey Forum on Mineral and Energy Resources, (February 18), "Role of Water in Petroleum Formation"; Houston, TX, U.S. Geological Survey Circular 1074, p. 46-47 (*invited Keynote w/abstract*).
- 1991 Mobil Research and Development Corporation (December 6), "Thermal Interaction of Water and Sedimentary Organic Matter during Petroleum Formation"; Dallas, TX (*invited*).
- 1991 13th World Petroleum Congress (October 22), "Primary Migration and Expulsion as Determined by Hydrous Pyrolysis"; Buenos Aires, Argentina (*invited*).

- 1991 Geological Society of America Annual Meeting (October 20), "Retardation of the Thermal Decomposition of Organic Matter in Shales under Hydrous Conditions"; San Diego, CA, v.23, no.5,p. 24 (*J.Winters presented on my behalf w/abstract*).
- 1991 Chevron Oil Field Research Company (June 10), "Petrographic and Experimental Studies on Petroleum Generation"; La Habra, CA (*invited*).
- 1991 American Association of Petroleum Geologists Annual Convention (April 10), "Oil Generation and Expulsion as Determined by Hydrous Pyrolysis"; Dallas, TX, v. 75, no. 3, p. 620 (*invited w/abstract*).
- 1990 Department of Geology Colloquium, University of Cincinnati, "Organic Sedimentary Geochemistry and its Economic Consequences"; Cincinnati, OH (*invited*).
- 1990 Gordon Research Conference on Organic Geochemistry (August 15), "The Role of Organic Acids in Geological Processes"; Plymouth, NH (*invited*).
- 1990 American Chemical Society 199th National Meeting, "Variability of Oil Generation from Coals of the Blackhawk Formation as Determined by Hydrous Pyrolysis"; Boston, MA, Abstract No. 42 (*presented w/abstract*).
- 1989 Geological Society of America Annual Meeting, "Generation and Expulsion of Aliphatic Acid Anions during Petroleum Formation as Determined by Hydrous Pyrolysis"; St. Louis, MO (*presented*).
- 1989 American Chemical Society 197th National Meeting, "Hydrous Pyrolysis Study of Oil and Tar Generation from Monterey Shale"; Dallas, TX, Abstract No. 21 (*presented w/abstract*).
- 1989 Department of Geology Colloquium, University of Oklahoma, "Stages of Hydrocarbon Generation as Determined by Hydrous Pyrolysis"; Norman, OK (*invited*).
- 1989 Gordon Research Conference on Analytical Pyrolysis, (June 20) "Fundamental Aspects and Applications of Hydrous Pyrolysis"; New Hampton, NH (*invited*).
- 1989 Department of Chemistry Colloquium, University of Maryland, "Kinetics of Hydrocarbon Generation"; College Park, MD (*invited*).
- 1988 Department of Chemistry Colloquium, Woods Hole Oceanographic Institution, "Kinetics of Biomarker Reactions"; Woods Hole, MA (*invited*).
- 1987 French Petroleum Institute (IFP) Conference on Migration of Hydrocarbons in Sedimentary Basins, (June 17) "Petrographic Study of Primary Petroleum Migration in the Woodford Shale"; Carcans, France (*invited*).
- 1987 Department of Geology Colloquium, University of Illinois, "Simulating Natural Petroleum Generation by Hydrous Pyrolysis"; Urbana, IL (*invited*).
- 1986 Department of Geology Colloquium, Stanford University, "Kinetics and Stages of Hydrocarbon Generation as Determined by Hydrous Pyrolysis"; Stanford, CA (*invited*).
- 1986 American Chemical Society 192nd National Meeting, "Organic Sulfur in Kerogens from Different Lithofacies of the Monterey Formation"; Anaheim, CA, Abstract No. 94 (*presented w/abstract*).
- 1986 Gordon Research Conference on Organic Geochemistry (August 21), "Kinetics of Hydrocarbon Generation as Determined by Hydrous Pyrolysis"; Plymouth, NH (*invited*).
- 1985 American Chemical Society 190th National Meeting, "Effects of Thermal Maturation on Steroid Hydrocarbons as Determined by Hydrous Pyrolysis of Phosphoria Retort Shale"; Miami Beach, FL (*presented*).
- 1984 Department of Geology Colloquium, University of Texas, "Simulating Hydrocarbon Generation in Sedimentary Basins"; Austin, TX (*invited*).
- 1984 Gordon Research Conference on Organic Geochemistry (August 22),"Laboratory Simulation of Burial Maturation by Pyrolysis"; Plymouth, NH (*invited w/abstract*).

- 1984 The Royal Society (London) Conference on Geochemistry of Buried Sediments (June 28), "Evaluation of Petroleum Generation by Hydrous Pyrolysis Experimentation"; London, UK (*invited*).
- 1983 Geophysical Laboratory of the Carnegie Institute, "Determining Mechanisms of Primary Migration and Hydrocarbon Expulsion by Hydrous Pyrolysis"; Washington, D.C. (*invited*).
- 1982 Norwegian Petroleum Society Conference on Stable Carbon Isotopes in Hydrocarbon Exploration, "Effects of Thermal Maturation on Stable Organic Carbon Isotopes"; Stavanger, Norway (*invited w/abstract*).
- 1982 SEPM Research Colloquium, AAPG Annual Meeting, "Organic Geochemistry of Vanadium and Nickel in Organic Matter of Sedimentary Rocks"; Calgary, Alberta (*invited*).
- 1982 7th Annual Mid-American Student Conference in Earth Science, Ohio State University, "Generation of Oil-Like Pyrolysates from Shales"; Columbus, OH (*invited*).
- 1981 Department of Geosciences Colloquium, University of Tulsa, "Describing and Classifying Shales"; Tulsa, OK (*invited*).
- 1979 Geological Society of America Annual Meeting, "Vanadium and Nickel in Oil-to-Source-Rock Correlations"; San Diego, CA, v. 11, no. 7, p. 466 (*presented w/abstract*).
- 1977 Cincinnati Mineral Society Colloquium, "Origin and Attributes of Cone-in-Cone Limestones in Shales"; Cincinnati, OH (*invited*).
- 1973 19th Annual Institute on Lake Superior Geology, "Geochemistry of Ca/CO₂ Metasomatism at Presque Isle, Marquette, Michigan"; Madison, WI (*presented w/abstract*).
- 1972 18th Annual Institute on Lake Superior Geology Technical Program, "Weathering and metasomatism of the Presque Isle Serpentinized Peridotite, Marquette County Michigan"; Houghton, Michigan (*presented w/abstract*).

Co-Authored Abstracts

- 2017 Lillis, P.G. and Lewan, M.D., 2017, Are Tertiary coals from central and southern Alaska source rocks for oil. AAPG Pacific Section Annual Meeting, Anchorage, Alaska.
- 2015 Dralus, D., Lewan, M.D., and Peters, K., Kinetics of the Opal-A to Opal-CT phase transition in low- and high-TOC siliceous shale source rocks. American Association of Petroleum Geologists Annual Conference 2015, Denver, CO, June 1-3 (*oral presentation*).
- 2014 Spigolon, A.L.D., Lewan, M.D., Penteadó H.L.B., Coutinho, L.F.C. and Mendonça Filho, J.G. "Changes in oil properties with the advance of thermal maturation induced by hydrous pyrolysis for a Brazilian source rock containing Type I kerogen" 14th Latin American Congress on Organic Geochemistry (ALAGO), Buzios, Rio de Janeiro, Brazil, November 2-5 (*oral presentation: Conference Best Paper Award*).
- 2013 Spigolon, A.L.D., Lewan, M.D., Mendonça Filho, J.G., Penteadó H.L.B., and Coutinho, L.F.C., "New Insights on changes in the oil quality during petroleum formation by hydrous pyrolysis on a Brazilian Source Rock containing Type-I kerogen" 26th International Meeting on Organic Geochemistry, Tenerife, Canary Islands, Spain, September 16, (*poster presentation*).
- 2013 Ruble, T.E. and Lewan, M.D., "Programmed-pyrolysis derived petroleum yield determinations calibrated with hydrous pyrolysis: A case study of Green River source rocks" American Association of Petroleum Geologists Rocky Mountain Section Meeting, Salt lake City, UT, September 14, p. 64, (*oral presentation*).

- 2013 Nierop, K.G.J., Sap, M., Dekker, R., Speelman, E.N., Lewan, M.D., de Leeuw, J.W., and Reichart G-J. "Temperature induced transformations of *Azolla* specific biomarkers by hydrous pyrolysis" 26th International Meeting on Organic Geochemistry, Tenerife, Canary Islands, Spain, September 16, (*poster presentation*).
- 2013 Birdwell, J.E., Lewan, M.D., and Miller, M., "Geochemical changes and fracture development in Woodford Shale cores following hydrous pyrolysis under uniaxial confinement" Unconventional Resource Technology Conference Proceedings, Denver, CO, August 12-14, Abstract No. 1581355 (*oral presentation*).
- 2012 Więclaw, D., Lewan, M.D., Kotarba, M.M. "Content and Stable Isotopes of Organic Sulfur in hydrous pyrolysis products from Menilite Shales" 2nd International Conference Alpine-Petrol 2012 on Geology, Ecology and Petroleum Prospectives of the Carpathians and other Alpine Regions in Europe, Krakow, Poland, September 26, p.37-38 (*oral presentation*).
- 2012 Little, J., Formolo, M.J., Lewan, M.D., "Correlating Oil in Austin Chalk Reservoirs with Turonian-Cenomanian Source-Rock Facies Using Biomarkers, Organic Sulfur Compounds, and Hydrous Pyrolysis" American Association of Petroleum Geologists 2012 Annual Convention, Long Beach, CA, April 22-25, Abstract No. 1235079 (*oral presentation*).
- 2012 Lee, C., Lewan, M. D., Brocks, J. J., "Molecular fossil taphonomy: insights into lipid preservation using a different kind of hy-py" *CalPaleo* 14th August 2012, Riverside, CA (*oral presentation*).
- 2011 Ko, T. (Lucy), Lewan, M. D., N. B. Harris, N. B., "Characterization of Gas Generated by Sequential Hydrous Pyrolysis of Potential Gas-Prone Source Rocks for Tight-Gas Reservoirs in the Rocky Mountain Area" Annual AAPG Meeting Houston, TX, April 10-13 (*poster*).
- 2010 Sap, M., Speelman, E. N., Lewan, M. D., Sinninghe Damsté, J. S., and Reichart, G-J, "Determination of thermal stability of speci_c biomarker lipids through hydrous pyrolysis of the freshwater fern *Azolla*", European Geosciences Union, Vienna, Austria, May 2-7 (*poster*).
- 2010 Birdwell, J.E., Lewan, M.D., "Leaching of hazardous substances from retorted oil shale during high temperature water flushing", Paper No.134-4, Geological Society of America Annual Meeting, Denver, CO, November 1-3 (*oral presentation*).
- 2010 Hill, R., Birdwell, J.E., Lewan, M.D., "Evaluating byproducts of environmental concern in water generated during hydrous pyrolysis of oil shale", Paper No. 134-5, Geological Society of America Annual Meeting, Denver, CO, November 1-3 (*oral presentation*).
- 2010 Justin Birdwell and M. D. Lewan, Laboratory Simulation of in situ oil shale retorting conditions to assess product yields and composition: 30th Oil Shale Symposium, October 18-22, Colorado School of Mines, Golden, p. 27 (*oral presentation*).
- 2010 Tingwei (Lucy) Ko, M. D. Lewan, and N. B. Harris, Characterization of gas composition evolved from different source rocks in tight-gas reservoirs in the Rocky Mountain area: Examples from Piceance Basin, Colorado, and Jonah Field, Wyoming, USA: The Society of Organic Petrology (TSOP) Annual Meeting, September 14-16, Denver, CO, Abstracts and Program, p. 13 (*oral presentation*).
- 2010 Regina Binotto, N. Del Valle Franco Rondón, M. D. Lewan, E. Vaz dos Santos Neto, J. Graciano Mendonça Filho, and A. L. D. Spigolon, Insights on biomarker parameters of the Tremembé Formation (Type-I kerogen), Brazil, based on hydrous pyrolysis experiments: The Society of Organic Petrology (TSOP) Annual Meeting, September 14-16, Denver, CO, Abstracts and Program, p. 32 (*poster*).

- 2010 Wang, Y. Session, A., and Lewan, M., Compound-specific hydrogen isotope composition of lipids in Eocene Green River Formation: Gordon Research Conference on Organic Geochemistry, Holderness School, NH (*poster*).
- 2009 Pribil, M. J., Ridley, W. I., Kotarba, M. J., and Lewan, M. D., Copper isotopes of Kupferschiefer Shales and generated oils by hydrous pyrolysis: Goldschmidt Conference, Vancouver, July 14, Abstract Issue of GCA, A1052 (*invited oral presentation*).
- 2007 Hill, R. J. and Lewan, M. D., Role of pressure on extent of petroleum generation: 23rd International Meeting on Organic Geochemistry, Torquay, England, September 9, Book of Abstracts, pp. 33-34.
- 2007 Behar, F., Lorant, F., and Lewan, M. D., Role of NSO compounds in primary cracking and on kinetic parameters determined by open- and closed-system pyrolysis: 23rd International Meeting on Organic Geochemistry, Torquay, England, September 9, Book of Abstracts, pp. 367-368.
- 2007 Jaeschke, A., Lewan, M. D., Schouten, S., and Sinninghe-Damsté, J., Effects of diagenesis and catagenesis on ladderane lipids as determined by hydrous pyrolysis: 23rd International Meeting on Organic Geochemistry, Torquay, England, September 9, Book of Abstracts, pp. 999-1000.
- 2006 Hill, R. J. and Lewan, M. D., Evaluating oil-shale byproducts of environmental concern by hydrous pyrolysis: 26th Oil Shale Symposium, Golden, CO, October 17.
- 2006 Higley, D. K., Lewan, M. D., Roberts, L. N. R., and Henry, M. E., Petroleum generation history of the Western Canadian Sedimentary basin, based on a 4-D Petroleum System Model: Rocky Mountain Natural Gas 2006, COGA-RMAG, Denver, CO August 8.
- 2005 Amrani, A., Lewan, M. D., and Aizenshtat, Z., Stable-sulfur isotope partitioning during simulated petroleum formation as determined by hydrous pyrolysis of Ghareb Limestone, Israel: 22nd International Meeting on Organic Geochemistry, Seville, Spain, September 26, Book of Abstracts, v. 1, p. 288-289.
- 2005 Amrani, A., Ward, S. A., Lewan, M. D., and Aizenshtat, Z., The $\delta^{34}\text{S}$ values of the early-cleaved sulfur upon thermal alterations as determined by closed and open system pyrolysis: 22nd International Meeting on Organic Geochemistry, Seville, Spain, September 26, Book of Abstracts, v. 1, p. 290-291.
- 2005 Amrani, A., Tannenbaum, E., Lewan, M. D., Vairavarmurthy, M. and Aizenshtat, Z., Carbon and sulfur transformations in hydrous pyrolysis experiments of Senonian (Ghareb) bituminous rock: source of Dead Sea area asphalts and oil shows: 22nd International Meeting on Organic Geochemistry, Seville, Spain, September 26, Book of Abstracts, v. 1, p. 286-287.
- 2005 Cruse, A. M. and Lewan, M. D., Experimental investigation of the kinetics of bitumen generation. 2005 Goldschmidt Conference, Moscow, ID, May 21-25, *Geochimica et Cosmochimica Acta*, v.68, No. 10S, p. A499.
- 2005 Kotarba, M. J., Lewan, M. D., Wieclaw, D., and Curtis, J. B., Stable carbon isotope fractionation and organic sulfur content in hydrous pyrolysis immiscible oils, bitumens and kerogens from the Oligocene Menilite Shales: 22nd International Meeting on Organic Geochemistry, Seville, Spain, September 26, Book of Abstracts, v. 1, p. 387.
- 2004 Grauch, R. I., Lewan, M. D., Lamothe, P. J., Landis, G. P., and Emsbo, P., Element partitioning into generated petroleum and hydrothermal fluids as determined by hydrous pyrolysis of Retort Shale: Geological Society of America Annual Meeting, Denver, CO, November 7-10, Abstracts and Programs, v. 36, no.5, p. 199-200.

- 2003 Barker, C. E., Lewan, M. D., Pawlewicz, M. J., and Carlson, C. L., The influence of extractable organic matter on vitrinite reflectance: Implications to liquid hydrocarbon or bitumen impregnation as a suppression mechanism: 21st Annual Meeting of the Society for Organic Petrology, v.21, Sydney, Australia, September 27, p. 25-28.
- 2003 Curtis, J. B., Kotarba, M., Lewan, M. D., and Wieclaw, D., Petroleum potential of organic facies of the Oligocene Menilite Shales of the Polish Carpathians: Hydrous pyrolysis approach: 21st International Meeting on Organic Geochemistry, Krakow, Poland, September 9, Book of Abstracts Part I, p.71-72.
- 2003 Luniger, G., Schouten, S., Sinninghe Damste, J. S., Lewan, M. D., and Schwark, L., Reconstruction of upper Oligocene Enspel Maar lake ecosystem via biomarker and isotope analysis (*Poster*): 21st International Meeting on Organic Geochemistry, Krakow, Poland, September 8, Book of Abstracts Part I, p.230-231.
- 2003 Tannenbaum, E. and Lewan, M. D., Tectonic control of petroleum generation from upper Cretaceous (Senonian) source rocks in the Middle East and North Africa (*Poster*): 21st International Meeting on Organic Geochemistry, Krakow, Poland, September 9, Book of Abstracts Part II, p.19-20.
- 2003 Luniger, G., Schouten, S., Sinninghe Damste, J. S., Lewan, M. D., and Schwark, L., Molecular and isotopic evidence for upper Oligocene C4-plant evolution from Lake Enspel sediments (*Poster*): 21st International Meeting on Organic Geochemistry, Krakow, Poland, September 10, Book of Abstracts Part II, p.307-308.
- 2003 Barker, C. E., Lewan, M. D., Pawlewicz, M. J., and Carlson, C. L., The influence of extractable organic matter on vitrinite reflectance: Implications to liquid hydrocarbon or bitumen impregnation as a suppression mechanism: Abstracts of 20th Annual Meeting of the Society for Organic Petrology, v. 20, Washington, D. C., September 21-24, p.83-86.
- 2003 Willette, D. C., Lewan, M. D., and Curtis, J. B., Evaluating geological factors responsible for generation of natural gas and pyrobitumen through pyrolysis of Smackover oil: 225th American Chemical Society National Meeting, New Orleans, LA, March 27.
- 2002 Tannenbaum, E. and Lewan, M. D., Regional Upper Cretaceous (Senonian) petroleum source rocks in the Middle East and North Africa: GSA Annual Meeting, Denver, CO, October 28, Abstracts with Programs Vol. 34, No. 6, Abstract No: 41908.
- 2001 Steinshouer, D., Pitman, J., and Lewan, M. D., Petroleum Migration Model of Lower Cretaceous and Middle Tertiary Reservoirs in Iraq: AAPG Annual Conference, Denver, CO, June 2, RMAG Short Course #3 Notes, Petroleum Systems Approach to Exploration and Development, p.23-34.
- 2001 Ruble, T. E., Lewan, M. D., Philp, R. P, and Borehan, C. J. , Modeling Oil Generation in the Green River Petroleum System, Uinta basin: Significance of appropriate experimental kinetics: American Association of Petroleum Geologists Annual Meeting, Denver, CO, June 3-7, Program and Abstracts, v.10, p. A174.
- 2000 Pitman, J., Lewan, M. D., and Steinshouer, D., Prediction of secondary petroleum migration pathways in the Jurassic petroleum system, Iraq: American Association of Petroleum Geologists International Conference, Bali, Indonesia (*Poster*) October 15-18, AAPG Bull. v.84, no. 9, p. 1475.
- 2000 Ruble, T. E., Boreham, C., Lewan, M. D., and Greenwood, P., Adopting a unified approach to examine petroleum generation kinetics: Australian Organic Geochemistry Conference 2000, North Ryde, NSW, Australia, July 11-15.
- 2000 Harrell, J. A. and Lewan, M. D., Ancient petroleum seeps at Gebel Zeit, Egypt: The

- 51st Annual Meeting of the American Research Center in Egypt, Berkeley, CA, April 28-30.
- 2000 Ruble, T. E., Boreham, C. J., Lewan, M. D., Greenwood, P. F., Faiz, M., and Sherwood, N. R., Adopting a unified approach to examine petroleum generation kinetics: Australian Organic Geochemistry Conference, Townsville, Queensland, Australia, July 12-14.
- 1999 Koopmans, M. P., Sinninghe Damste, J. S., and Lewan, M. D., Release of biomarkers from sulfur-rich kerogens with hydrous pyrolysis: American Chemical Society, Geochemistry Division, 217th National Meeting, Anaheim, CA, March 25-30, v.44, no.2, p.364.
- 1999 Schimmelmann, A., Lewan, M. D., and Wintsch, R. P., American Chemical Society 217th National Meeting, Hydrogen Stable Isotope Ratios of Kerogen, Bitumen, Oil, and Water in Hydrous Pyrolysis: Anaheim, CA, March 25-30, v.44, no.2, p. 380.
- 1998 Al-Gailani, M., Lewan, M. D., and Ahlbrandt, T. S., Sulfur versus API gravity relationships of Iraqi crude oils: GeoArabic, v. 3, pp. 40-41.
- 1998 Clauer, N., Toulkeridis, T., Chaudhuri, S., and Lewan, M. D., Effects of hydrous pyrolysis on the K-Ar and RB-Sr isotopic signatures in clays: Clay Mineral Society.
- 1998 Kotarba, M. J., and Lewan, M. D., Thermogenic gases from the Polish bituminous and brown coals: hydrous pyrolysis and isotopic approach: American Chemical Society, Geochemistry Division, 215th National Meeting, Dallas, TX, March 29-31, 1994. Abstract No. 12.
- 1998 Ruble, T. E., Philp, R. P., Lewan, M. D., and Mueller, E., Organic geochemical characterization of key source facies in the Green River petroleum system, Uinta, basin, Utah: American Association of Petroleum Geologists Annual Meeting, Salt Lake City, UT, May 17-28, 1998, Program and Abstracts, v. 7.
- 1998 Harrell, J., and Lewan, M. D., Ancient petroleum wells at Gebel Zeit, Egypt: Geological Society of America Annual Meeting, Toronto, Canada, October 25-29, 1998, Abstracts with Program, v. 30.
- 1997 Pitman, J. K., Henry, M. E., and Lewan, M. D., Diagenesis and secondary migration in Mississippian sandstones, Illinois basin- Influence of faults and fractures: American Association of Petroleum Geologists Annual Meeting, Dallas, TX, April 6-9, 1997, Program and Abstracts, v. 6, pp. A93.
- 1997 Dias, R. F., Freeman, K. H., Lewan, M. D., and Franks, S. G., 1997, Kerogen maturation and the $\delta^{13}\text{C}$ of organic acids in oil-associated waters: American Association of Petroleum Geologists Annual Meeting, Dallas, TX, April 6-9, Program and Abstracts, v. 6, pp. A27-A28.
- 1996 Ahlbrandt, T. S., Okasheh, O. A., and Lewan, M. D., A Middle East basin center hydrocarbon accumulation in Paleozoic rocks, eastern Jordan, western Iraq, and surrounding regions: AAPG International Conference, Vienne, Austria, Sept. 7.
- 1996 Barker, C. E., Lewan, M. D., and Pawlewicz, M. J., A simple hydrous pyrolysis technique to detect suppressed vitrinite reflectance: 13th Annual Meeting of The Society for Organic Petrology, Abstracts and Program, v. 13, pp. 36-38.
- 1996 Barker, C. E., Lewan, M. D., Bone, Y., and Marshallsea, S. J., Paleotemperature and hydrous pyrolysis studies of petroleum generation next to dikes, western onshore Gippsland basin, Australia: 13th Annual Meeting of The Society for Organic Petrology, Abstracts and Program, v. 13, pp. 41-43.
- 1996 Ahlbrandt, T. S., Okasheh, O. A., and Lewan, M. D., A Middle East basin center hydrocarbon accumulation in Paleozoic rocks, eastern Jordan, western Iraq, and surrounding regions: AAPG/EAGE Research Symposium on Compartmentalized

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- 1994 Koopmans, M. P., Sinninghe-Damste, J. S., Lewan, M. D., and de Leeuw, J.W., Distinct precursors for pristane and phytane in the marine environment--Impact on the rationale and use of the pr/ph ratio: American Chemical Society, Geochemistry Division, 208th National Meeting, Washington, D.C., August 21-25, 1994. Abstract No. 97.
- 1994 Ruble, T.E., Lewan, M. D., and Philp, R.P., Recognition of distinctive Green River source facies by hydrous pyrolysis--Important implications for basin models: in *Organic Geochemistry: Developments and Applications to Energy, Climate, Environment, and Human History* (eds. J. O. Grimalt and C. Dorronsoro), A.I.G.O.A. Publishers, pp.188-191.
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- 1993 Koopmans, M.P., Lewan, M.D., Sinninghe Damste, J.S., and DeLeeuw, J.W., Formation and destruction of sedimentary organically-bound sulphur—implications for paleoenvironmental reconstruction: Geological Society of America Program with Abstracts, v. 25, no. 6, p. A20.
- 1993 Koopmans, M.P., Lewan, M.D., Sinninghe Damste, J.S., and deLeeuw, J.W., Maturity-related changes in abundance and composition of organic sulphur compounds and sulphur-containing geomacromolecules studied by hydrous pyrolysis: Abstracts and Program for Posters, 16th International Meeting on Organic Geochemistry, Stavanger, Norway, Falch Hurtigtrykk Publ., p125-128.
- 1992 Freeman, D. H., Lewan, M. D., and Majeed, B. S., Simulating natural maturation of vanadyl porphyrins in Wooford Shale by hydrous pyrolysis: American Chemical Society, 204th National Meeting Book of Abstracts, Fuel Chemistry Division Abstract No. 122.
- 1992 Freeman, D. H., Majeed, B. S., and Lewan, M. D., Soret band porphyrin structure index, easily measured via 3rd derivative UV/VIS spectroscopy: American Chemical Society, 204th National Meeting Book of Abstracts, Geochemistry Division Abstract No. 57.
- 1992 Whitney, G., and Lewan, M. D., Diagenesis in a bottle - experimental strategies for studying thermal maturity of clays and organic matter *in* Carter, L. M. H., ed., USGS Research on Energy Resources - 1992: U.S. Geological Survey Circular 1074, p. 81.

c. RENDERING SCIENTIFIC JUDGEMENT

Committees and Boards

- 1985 DOE Peer Review Committee for Unconventional Deep Gas Projects and Funding; Washington, D.C.
- 1987-1991 Editorial Advisory Board for Energy & Fuels an American Chemical Society

Journal

- 1992-1993 Member of Future of Energy Gas Team organized by the Office Chief (Gary Hill) to define, organize, conduct, and publish a significant and relevant body of research on natural gas within a period of one year.
- 1993 Advisor to the Technical Program Committee of the 1994 American Association of Petroleum Geologists, Annual Meeting, Denver, CO, (Edward Dolly, Technical Program Coordinator).
- 1993 Panel Discussion Member of AAPG Hedberg Conference on "Facies Variations and Hydrocarbon Source-Rock Potential: The Cooperative Monterey Organic Geochemistry Study" (April 22-23), New Orleans, LA: (Caroline Isaacs, Conference Convener).
- 1994 Member of Future Studies Team for the Energy Branches of OEMG (elected by members of the OEMG Energy branches).
- 1994 Workshop to define a Geotechnical Facility for Environmental Research at the Superconducting Super Collider Site, Lawrence Berkeley Laboratory, University of California, Berkeley, CA (September 1-2, Larry Myer, Organizer).
- 1994 Member of Research Peer Review Panel, which involved working with other members in reviewing, ranking and funding of new and continuing projects.
- 1994 Outside participant in the Natural Gas Planning Team, commissioned by Regional Geologist, Tom Fouch, to devise tasks and staffing for topics concerning natural gas.
- 1995 Member of Research Peer Review Panel, which involved reviewing accomplishments and efforts of the research staff and proposing promotions.
- 1995 Member of Energy Team Program Council, which involved working with other members in reviewing, ranking and funding of new and continuing projects.
- 1995 Member of Chief Scientist Search Committee for Energy Program, commissioned by Regional Geologist, Thomas Fouch, to review and recommend candidates for the Chief Scientist position.
- 1996 Member of Energy Program Publications Committee commissioned to establish guidelines for the funding of future publications and ranking of manuscripts submitted for in-house publication.
- 1996 Topic leader and member of workshop sponsored by Houston Advanced Research Era of Declining R&D Budgets" (February 21) in The Woodlands, TX (Director of Geotechnology Research, Manik Talwani).
- 2001 Outside Member of Research Grade Evaluation Panel for USGS Biological Resources, which involved working with other members in evaluating and ranking individuals considered for promotion (invited by Susan Haseltine).
- 2004 DOE Workshop Panel Member on Application of Synchrotron Radiation to Petroleum Geochemistry (August 5-6), Brookhaven National Laboratory (Organizer, B. Manowitz).
- 2005 Workshop Panel Member for Paleozoic Basin Forum, Brazilian Association of Petroleum Geologists (September 1- 2), Copaccabanna, Brazil (Organizer, Marcio Rocha Mello).
- 2005 Evaluate academic record of Cynthia Riediger for Full Professor promotion by University of Calgary Promotion Committee (requested by Vice Dean John Murphre).
- 2001-2006 Member of Distinguished Lecture Committee for American Association of Petroleum Geologists (invited by Paul Weimer, Committee Chair).
- 2006-present Advisory Member of The Research Partnership to Secure Energy for America/RPSEA for the Colorado School of Mines and the U. S. Geological Survey

- (invited by Dag Nummedal).
- 2005-present Member of Geochemistry Advisory Panel/GAP for USGS Central Geological Discipline (invited by Regional Geologist and currently Regional Executive, R. Updike).
- 2009 Evaluate academic record of Simon George for Full Professor (Level E) promotion by Macquarie University, Sidney (requested by Charlotte Simon).
- 2013 Evaluation of academic record of Miejun Li for promotion to Full Professor in the Geosciences College, China University of Petroleum, Beijing, China (requested by Dr. Liu Guangdi).

Formal Manuscript/Proposal Reviews from 1991 through 2015

Organic Geochemistry: 47 reviews
Geochimica et Cosmochimica Acta: 25 reviews
American Association of Petroleum Geologists Bulletin: 15 reviews
Energy & Fuels: 9 reviews
American Chemical Society-Petroleum Research Funds: 7 reviews
International Journal of Coal Petrology: 3 reviews
Chemical Geology: 5 reviews
Nature: 4 reviews
Geology: 4 reviews
Economic Geology: 2 reviews
Journal of Analytical and Applied Pyrolysis: 3 reviews
Earth & Planetary Science Letters: 2 reviews
Environmental Science and Technology: 1 review
Precambrian Research: 1 review
Planetary and Space Science: 1 review
Chemical Reviews: 1 review
Geothermics: 1 review
Applied Geochemistry: 1 review
SPE Journal: 1 review
Department of Energy Basic Research Proposals: 1 review
German Research Foundation Research Proposals: 1 review
National Science Foundation Research Proposals: 10 reviews

d. LECTURESHIPS AND OTHER ACADEMIC SERVICE

Lectureships

- 2013 China University of Petroleum (CUP, Beijing) Lecture Series (November 14-15) included 5 lectures over two days on (1) Stages of Petroleum Formation: New insights on old paradigms, (2) Timing and Extent of Petroleum Formation, (3) Hydrous pyrolysis Experimental Insights on Gas Generation, (4) Role of Water in Petroleum Formation, and (5) Petrophysical Properties of Maturing Source Rocks (funded by CUP).
- 2005 Organic Geochemistry of Fossil Fuels (GEGN/CHGC 527)-Department of Geology and Geological Engineering, Colorado School of Mines, Spring Semester (7 three-hour lectures).
- 2003 Organic Geochemistry of Fossil Fuels (GEGN/CHGC 527)-Department of Geology and Geological Engineering, Colorado School of Mines, Spring Semester (7 three-hour lectures).

- 2001 Organic Geochemistry of Fossil Fuels (GEGN/CHGC 527)-Department of Geology and Geological Engineering, Colorado School of Mines, Spring Semester (6 three-hour lectures).
- 2000 Petroleum Geochemistry Seminar (GEOL 698B)-Department of Geology and Geological Engineering, Colorado School of Mines, Spring Semester (5 two-hour lectures).
- 1999 Organic Geochemistry of Fossil Fuels (GEGN/CHGC 527)-Department of Geology and Geological Engineering, Colorado School of Mines, Spring Semester (5 three-hour lectures).
- 1998 Petroleum Geology (GEOL 5350)-Department of Geological Science, University of Colorado at Boulder, Fall Semester (2 two-hour lectures on kinetics of petroleum formation (course taught by Paul Weimer and Jack Edwards)).
- 1997 Organic Geochemistry of Fossil Fuels (GEGN/CHGC 527)-Department of Geology and Geological Engineering, Colorado School of Mines, Spring Semester (5 three-hour lectures).
- 1995 Organic Geochemistry of Fossil Fuels (GEGN/CHGC 527)-Department of Geology and Geological Engineering, Colorado School of Mines, Spring Semester (5 three-hour lectures).
- 1992 American Association of Petroleum Geologists Distinguished Lecturer (*funded by AAPG*) "Understanding Generation and Expulsion of Hydrocarbons in Sedimentary Basins through Experimentation":
 University of Tennessee, Dept. of Geosciences Colloquium (April 6), Chattanooga, TN
 University of Georgia, Dept. of Geology Colloquium (April 7), Athens, GA
 Louisiana State University, Dept. of Geology & Geophysics Colloquium (April 8), Baton Rouge, LA.
 University of Miami, School of Marine & Atmospheric Sciences Luncheon Meeting (April 9), Miami FL.
 University of Texas at Dallas, Geosciences Program Colloquium (April 10), Dallas.
 University of Oklahoma, Dept. of Geology & Geophysics Colloquium (April 4), Norman, OK.
 University of Nebraska, Dept. of Geology Colloquium (April 15), Lincoln, NE.
 Northern Illinois University, Dept. of Geology Colloquium (April 17), Dekalb, IL.
- 1991 American Association of Petroleum Geologists Distinguished Lecturer (*funded by AAPG*), "Understanding Generation and Expulsion of Hydrocarbons in Sedimentary Basins through Experimentation":
 Rocky Mountain Association of Geologists Luncheon meeting (Nov.1), Denver, CO.
 New Mexico Institute of Mining and Technology seminar (Nov. 4), Socorro, NM.
 University of New Mexico seminar (November 5) Las Cruces, NM.
 University of New Mexico seminar (November 6, 1991 Albuquerque, NM.
 Nevada Geological Society monthly dinner meeting (Nov. 7), Reno, NV.
 Montana Geological Society Luncheon meeting (November 11), Billings, MT.
 Montana College of Mining and Technology seminar (November 12), Butte, MT.
 Institute of Sedimentary and Petroleum Geology seminar (November 13),

Calgary, Alberta
Edmonton Geological Society Luncheon meeting (November 14), Edmonton,
Alberta.
Saskatchewan Geological Society Luncheon meeting (November 15), Regina,
Sask.

Theses and Dissertations

- 1982-1985 Ph.D. Dissertation Committee for O.I. Ece, Department of Geosciences,
University of Tulsa, "Depositional Environment, Stratigraphy, Petrology,
Paleogeography, and Organic Thermal Maturation of the Excello Shale"
(advisor, J. B. Comer).
- 1986-1987 M.S. Thesis Committee for S. J. Nichols, Estimating Kinetic Parameters of Oil
Generation from Nonisothermal Experiments; Department of Applied
Mathematics, University of Tulsa, (advisor, P. Cook).
- 1988-1989 M.S. Thesis Committee for P. Beach, Effects of Variations in Oxic and Anoxic
Depositional Conditions on Organic Matter in the Antrim Shale, Michigan;
Department of Geosciences, University of Tulsa, (advisor, C. E. Barker).
- 1988-1991 Ph.D. Dissertation Committee for A. Bakal, Geochemistry of Nitrogen in Crude
Oils; School of Geology and Geophysics, University of Oklahoma, Norman,
OK (advisor, P. Philp).
- 1989-1992 Ph.D. Dissertation Committee for D. A. Wavrek, Role of Sulfur in Petroleum
Alteration; Department of Geosciences, University of Tulsa, (advisor, C. E.
Barker).
- 1994 Ph.D. Dissertation Examiner for Raymond, Michels, Etude De Experimentable
L'Influences de la Pression D'Effluents et de la Pression D'Eau sur les
Mecanismes de Maturation Thermique de la Matiere Organique; National
School of Geology, Lorraine Institute of Geosciences, Nancy, France
(requested by Bernard Durand/President).
- 1994-1966 Ph.D. Dissertation Committee for Timothy Ruble, Geochemical Investigation of
the Mechanisms of Hydrocarbon Generation and Accumulation in the Uinta
Basin, Utah; School of Geology and Geophysics, University of Oklahoma,
Norman, OK (advisor, R. Paul Philp).
- 1994-1997 Ph.D. Dissertation Committee for Martin Koopmans, Diagenetic and Catagenetic
Transformations of Sequestered Biomarkers; Department of Marine
Biogeochemistry, Netherlands Institute of Sea Research (NIOZ), Texel, The
Netherlands (invited by Jaap Sinninghe Damste, Dissertation Advisor).
- 1995 Ph.D. Dissertation Examiner for Paul Karlert, Pyrolytic Elimination Reactions of
Alkyl Esters and Their Application to the Reconstruction of Thermal
Histories of Sediments; Curtin University of Technology, Perth, Australia,
(invited by advisor, Robert Kagi).
- 1996-1997 Co-Advisor of M.S. for Michael Dolan, The Role of Smectite in Petroleum
Formation: Comparing Natural and Experimental Thermal Maturation;
Department of Geology and Geological Engineering, Colorado School of
Mines, Golden, CO (co-advisor, J. Curtis).
- 1996-1998 Ph.D. Dissertation Committee for Dorothy Payne, A New, Fully Coupled,
Reaction Transport-Mechanical Approach to Modeling the Evolution of
Methane Reserves in the Piceance Basin; Department of Chemistry, Indiana
University, Bloomington, IN (advisor, Peter Ortoleva).
- 1996-2000 Ph.D. Dissertation Committee for Robert Dias, Isotopic Studies of Organic Acids

- in Oil Associated Waters; Department of Geosciences, Penn State University (advisor, Kate Freeman).
- 1998-2000 M.S. Committee for Eric J. Nelson, The modeling, sensitivity analysis, and kinetics of source rock maturation along a megaregional restoration in the northern Gulf of Mexico Basin; Department of Geology, University of Colorado, Boulder (advisor Paul Weimer).
- 2003-2004 M.S. Committee for Adriana Blesa, Geology and mineralization of the Esquel area, Patagonia, Argentina; Department of Geology and Geological Engineering, Colorado School of Mines (advisor M. Hitzman and J. Hedenquist).
- 2002-2008 Ph.D. Dissertation Committee for Ira Pasternack, The Lewis Shale petroleum system, eastern Greater Green River Basin, Wyoming and Colorado; Department of Geology and Geological Engineering, Colorado School of Mines (advisor N. Hurley and J. Curtis).
- 2002-2005 Mendenhall Post-Doctoral Research Advisor/Supervisor, Characterization, kinetics, and role of bitumen as an intermediate to petroleum formation: U.S. Geological Survey.
- 2001-2004 M.S. Thesis Committee for Jerda Smeltzer, Ammonia release from organic decomposition of alkaline thermal spring cyanobacterial mats: Implications for early diagenetic solution chemistry and silica phase transformations, Department of Geology, Missoula, MT (advisor N. Hinman).
- 2006-2009 Ph.D. Dissertation Committee for Andrea Jaeschke, Geological fate and diagenesis of ladderanes; Department of Marine Biogeochemistry, Netherlands Institute of Sea Research (NIOZ), Texel, The Netherlands (invited by Jaap Sinninghe Damste).
- 2009 Ph.D. Dissertation. Requested outside reviewer of Dissertation by Lyndon John Berwick, Characterization of Aquatic natural organic matter by micro-scale sealed vessel pyrolysis, Curtin University of Technology, Perth, Australia (invited by Jenifer K. Rogers).
- 1998-2010 Co-advisor of Ph.D. Dissertation for Donna Willette, Geological Factors controlling oil cracking in reservoirs; Department of Geology and Geological Engineering, Colorado School of Mines (co-advisor John Curtis).
- 2009-2010 M.S. Thesis Committee for Tingwei (Lucy) Ko, Characterization of Gas Generation by Sequential Hydrous Pyrolysis of Potential Gas-Prone Source Rocks for Tight-gas Reservoirs in the Rocky Mountain Area; Department of Geology and Geological Engineering, Colorado School of Mines (co-advisor Nick Harris).
- 2010 Ph.D. Dissertation Committee for Estelle Ricard, ICP-MS Dating of Accumulated Hydrocarbons in Geological Reservoirs with the Uranium/Thorium/lead System: University De Pau et Des Pays De L'Adour, IPREM-UMR-5254, Pau, France (invited by Olivier Donard).
- 2012 M.S. Thesis Committee for David Thul, Niobrara source rock maturity in the Denver Basin: A study of differential heating and tectonics on petroleum prospectivity using program pyrolysis: Department of Geology and Geological Engineering, Colorado School of Mines (advisor Steven Sonnenburg).
- 2013-2014 Ph.D. Dissertation Committee for Mohammed Al Duhailan, Theoretical and Experimental Insights on Petroleum-generated Microfractures in Organic-rich Shales: Department of Geology and Geological Engineering, Colorado

- School of Mines (advisor Steven Sonnenburg).
- 2017 M.S. Thesis Committee for Keerthikanand Mohanraj, Mahogany oil shale Green River Formations geochemical property changes with hydrous pyrolysis induced thermal maturation, Department of Petroleum Engineering, Colorado School of Mines (advisor Azra Tutuncu).
- 2022 M.S. Thesis Committee for Aigerim Zhumazhanova. Effects of igneous intrusions on gas content, composition, and origin in coalbed gas play in Central Kalahari Karoo Basin, Botswana, Department of Geology and Geological Engineering, Colorado School of Mines (advisor A. Milkov).

e. TECHNICAL TRAINING PROVIDED

- 2017 Two-day Course on “Determining kinetics and extent of petroleum Formation”, China University of Petroleum, Beijing, China, Included with the 7th International Symposium on Hydrocarbon Accumulation Mechanisms and petroleum Resources Evaluation, October 23-24.
- 2014 Advanced 1-day Course on “Determining kinetics and extent of petroleum Formation”, 14th Latin American Congress on Organic Geochemistry (ALAGO), Buzios, Rio de Janeiro, Brazil, November 1.
- 1995-2007 Every other year in the Spring semester, John Curtis, Paul Lillis, and I taught a class entitled Organic Geochemistry of Fossil Fuels (GEGN/CHGC 527) in the Department of Geology and Geological Engineering, at the Colorado School of Mines. This class was offered free of charge to USGS staff wishing to audit the class.
- 1999 Petroleum Geochemistry Short Course-Part I: What are Petroleum and Kerogen, and How are They Characterized? (February 10), Central Energy Team one-day course.

f. SPECIAL ASSIGNMENTS

- 2009-2012 Research Advisor to a Mendenhall Postdoctoral Fellow, Dr. Justin Birdwell , Experimental and Environmental Study of *In-Situ* Oil-Shale Retorting.
- 2006-2010 Chair of USGS Geological Discipline Geochemistry Advisory Panel (GAP)
- 2004-2006 USGS Geochemistry Advisory Panel (GAP) organized by Geological Discipline Regional Geologists (Randy Updike) to evaluate current and future capabilities of USGS geochemistry efforts in Denver.
- 2002-2004 Research Advisor to a Mendenhall Postdoctoral Fellow, Dr. Anna Cruse, Experimental study of bitumen generation and its role in petroleum formation.
- 1992-1993 *Member of Future of Energy Gas Team* organized by the Office Chief (Gary Hill) to define, organize, conduct, and publish a significant and relevant body of research on natural gas within a period of one year.

g. OTHER TECHNICAL ACTIVITIES

Symposium and Session Organizer

- 2019 Co-chair and organizer of AAPG Hedberg Conference Session “Characterization of Source Rocks” in The Evolution of Petroleum System Analysis, March 4-6, Houston, TX.
- 2015 Energy and Mineral Division, Unconventional Resources, American Association of Petroleum Geologists Annual Conference 2015, “Pluses and Minuses of Current Kinetics for petroleum Formation”, Denver, CO, June 1-3 (*invited oral presentation*).
- 2013 Co-chair and organizer with John B. Curtis of four Geochemistry Sessions in the Unconventional Resource Technology Conference (August 12-14), Denver, Colorado.
- 2010 Chair and organizer of Unconventional Resources Session for Organic Geochemistry Gordon Research Conference (August 1-6), Holderness School, New Hampshire.
- 2009 Goldschmidt Conference, Coordinator with Barbra Sherwood-Lollar of Theme 9: Earth's Resources I: Origin and Sustainable Exploitation of Oil/Water/Gas systems (June 21-26), Davos, Switzerland.
- 2005 Goldschmidt Conference, Symposium S52, Molecular and isotopic indicators of petroleum processes from source to trap". Co-organizer with Ronald Hill, (May 24) Moscow, ID.
- 2002 American Chemical Society, Society, Geochemistry/Fuel Chemistry Division Symposium on “Advances and Applications in Analytical Pyrolysis/Thermochemolysis” Co-organized with D. Clifford and C. Snape at 223rd National Meeting (April 7-9), Orlando, FL.
- 2002 American Association of Petroleum Geologists Annual Meeting (March 12) Houston, TX; “Basin Models-Input Sensitivity and Implications” Chairman and Organizer with M. Hertle of SEPM Theme 4.
- 2000 Gordon Research Conference on Organic Geochemistry (August 14) Holderness School, NH; “Depositional Settings of Petroleum Source Rocks” Session Organizer.
- 1999 American Chemical Society, Geochemistry/Fuel Chemistry Division Symposium on “The Role of Water in Organic Reactions” Co-organized with G. Cody at 217th National Meeting (March 24-25) Anaheim, CA.
- 1998 Geological Society of America Symposium on “Research Issues in Petroleum and Environmental Organic Geochemistry” Co-organized with B. Sherwood-Lollar at Annual Conference (October 27) Toronto, Canada.
- 1996 Geological Society of America Symposium on “Organic Geochemistry-Linking the Biosphere the Geosphere” Co-organized with K. K. Kvenvolden at Annual Conference (October 27) Denver, CO.
- 1995 Geological Society of America Symposium on “Dynamics of Aqueous and Hydrocarbon Fluids in Sedimentary Basins” Co-organizer with J. K. Pitman at Annual Conference (November 5) New Orleans.
- 1994 Gordon Research Conference on Organic Geochemistry (August 15-19) Holderness School, NH; Chairman and Organizer of Conference.
- 1992 Gordon Research Conference on Organic Geochemistry (August 12), Holderness School, NH; "Thermal Interactions of Water and Organic Matter Session" Session Organizer.
- 1992 Gordon Research Conference on Organic Geochemistry (August 10-14), Holderness School, NH; Poster Session Organizer as Conference Vice-Chair.
- 1990 Gordon Research Conference on Organic Geochemistry (August 15), Holderness School, NH; "The Role of Organic Acids in Geological Processes" Session Organizer.

In-House Company Reports (Proprietary)

- Lewan, M. D. and Shahin, A. N., Evaluation of source rocks in the Gulf of Suez, 1989. Amoco Research Report F89-G-1, 89p.
- Lewan, M. D., 1988, Petroleum potential of resinites from the Niglintak M-10 well, Beaufort Sea. Amoco Research Report T.S. 88-5103CI, 10p.
- Lewan, M. D. and Buchardt, B., 1988, Organic geochemistry and source rock potential of the Cambro-Ordovician Alum Shale in southern Scandinavia. Amoco Research Report F88-G-4, 87p.
- Nichols, S. J. and Lewan, M. D., 1987, A study of six mathematical approaches to determine kinetic parameters from non-isothermal pyrolysis experiments. Amoco Research Report T87-G-10, 35p.
- Fisher, J. B. and Lewan, M. D., 1986, Porosity-generating agents evolved during source rock maturation as determined by hydrous pyrolysis II: Chemical evolution of gases and their associated aqueous phase. Amoco Research Report F86-G-19, 44p.
- Lewan, M. D., 1986, Organic facies of the Old Red Sandstone, northern Scotland. Amoco Research Report T.S. 86-5180C0, 41p.
- Torkelson, B. E. and Lewan, M. D., 1985, Estimation of generation-expulsion factors for type-II kerogens. Amoco Research Report F-85-G-19, 23p.
- Fisher, J. B. and Lewan, M. D., 1984, Porosity-generating agents evolved during source rock maturation as determined by hydrous pyrolysis I: Aliphatic acids. Amoco Research Report M84-G-25, 51p.
- Lewan, M. D., 1984, Influence of thermal maturation on source-rock parameters as determined by hydrous pyrolysis of Woodford Shale. Amoco Research Report M84-G-22, 131p.
- Lewan, M. D., Redding, J. D., and McDonald, J. H., 1984, Variability of petroleum yield and composition within three coal seams of the Blackhawk Formation, Utah. Amoco Research Report F84-G-18, 49p.
- Lewan, M. D., 1984, Organic facies and geochemistry of the Monterey Formation in southern California. Amoco Research Report M84-G-17, 138p.
- Lewan, M. D. and Robison, V. D., 1982, Development of semi-quantitative infrared analysis of kerogen types and their level of thermal maturity. Amoco Research Report M82-G-3, 33p.
- Lewan, M. D., 1980, Evaluation of outcrop weathering and its influence on geochemical parameters. Amoco Research Report M80-G-16, 37p.
- Lewan, M. D. and Torkelson, B. E., 1980, Geology and organic facies of the Renova Formation in southwestern Montana. Amoco Research Report M80-G-9, 42p.
- Lewan, M. D., 1976, Natural and analytical factors controlling the oxygen content of kerogens. Amoco Research Report M76-G-2, 41p.
- Lewan, M. D., 1975, Investigation on the feasibility of coalbed degasification on a commercial scale. Amoco Research Report M75-G-10, 21p.
- Lewan, M. D., 1975, Geochemistry and geology of the Kreyenhagen Shale, California. Amoco Research Report T.S. 75-9359CQ, 37p.
- Lewan, M. D., 1974, Regional study of hydrocarbon-mix distribution of offshore fields, Gulf of Mexico. Shell E&P Report SR-184, 28p.
- Lewan, M. D., 1974, Molecular and isotopic composition of Gulf Coast offshore natural gas and the significance of biogenic gas. Shell E&P Report SR-178, 23p.
- Davis, E. L. and Lewan, M. D., 1974, Application of fluorescence spectrometry for detection of submarine oil seeps. Shell E&P Report SR-163, 10p.
- Lewan, M. D., 1974, Compositional differences between crude oils in Pleistocene and pre-

Pleistocene reservoirs of the Gulf Coast. Shell E&P Report SR-157, 11p.
Thomson, A., Lewan, M. D., and Burns, 1973, Model for Pleistocene sedimentation in the offshore of Louisiana. Shell E&P Pleistocene Folio, 40p.
Lewan, M. D., 1972, Field study of Eugene Island 110 fields. Shell E&P Report SR-120, 23p.

7. OUTREACH AND INFORMATION TRANSFER

USGS Website

Provided text and figures to Eric Morrissey (USGS Reston) for "Organic Origins of Petroleum" website, 4/03/2008 (<http://energy.usgs.gov/GeochemistryGeophysics/GeochemistryResearch.aspx>). The site provides a general tutorial on the origins of petroleum with reference to research efforts being worked on within the USGS ERP.

Media Reviews and Citations

Oil on the Brain, Petroleum's Long Strange Trip to Your Tank (2007; Broadway Books) by Lisa Margonelli, Describes Lewan's research on petroleum generation (p.80-81).
Salon.com (August 18, 2008) "Did you hear that Alaska has more oil than the Middle East" by Peter Dizikes, Lewan on inorganic and organic origin of petroleum.
Geotimes (October 2005, p.28-32) "Feuding over the Origin of Fossil Fuels" by Lisa Pinsker, extensively cites work by Lewan on the origin of petroleum.
Geotimes (February 2005, p.12) "Mummy Tar in Ancient Egypt" mentions work by Lewan and Harrell on mummy tar biomarker study in 2002.
British Petroleum Horizon (November 2004) "Unresolved debate on origins of oil" quotes M. Lewan on the topic of inorganic origin of oil.
NewScientist (17 August, 2002, p. 17) "You can squeeze oil out of a stone" mentions work done at the USGS by M. Lewan and how it relates to inorganic origin of petroleum.
AAPG Explorer (November, 2002, p. 6) "Gas origin theories to be studied" mentions work done at the USGS by M. Lewan and how it relates to inorganic origin of petroleum.
Flying Colors Media, (2000), "HEADJAM Crude Energy" educational video featuring experimental work conducted by M. Lewan on the generation of petroleum. Available free to the public through Phillips Petroleum.
Nature, News and Views, "Sulphur greases the wheels"(January 8, 1998, p.128-129) discusses Nature paper entitled "Sulphur Radical Control on Petroleum Formation" by M. D. Lewan.
Chemical & Engineering News, News of the Week, "Sulfur-radical theory may aid oil exploration" (January 12, 1998, p.16) discusses Nature paper entitled "Sulphur Radical Control on Petroleum Formation" by M. D. Lewan.
Science News, This Week, "Sulfur speeds oil formation in lab"(January 10, 1998, p.23) discusses Nature paper entitled "Sulphur Radical Control on Petroleum Formation" by M. D. Lewan.
Petroleum Geochemistry and Geology, popular textbook by John M. Hunt (1996, W.H. Freeman Co., p.711) extensively cites work by M. D. Lewan concerning oil generation and kinetics.
Geochimica et Cosmochimica Acta, Book Reviews (1998, v. 62, p.730-731) reviews the book "Organic Acids in Geological Processes" edited by E. D. Pittman and M. D. Lewan.
Chemical & Engineering News, Science/Technology, "Water's effect on petroleum formation studied"(September 7, 1992, p. 30-31) discusses findings presented by M. D. Lewan at the American Chemical Society 204th National Meeting (August 27); "Water as a source of hydrogen and oxygen in petroleum formation by hydrous pyrolysis."
Offshore/Oilman, Advanced Technology, "Water's role in oil formation"(November, 1992, p. 19) discusses findings presented by M. D. Lewan at the American Chemical Society 204th National Meeting (August 27); "Water as a source of hydrogen and oxygen in petroleum

formation by hydrous pyrolysis”.

Science News, featured article "Water, Water Everywhere"(February 20, 1993, p. 121-125) discusses findings presented by M. D. Lewan at the American Chemical Society 204th National Meeting (August 27); "Water as a source of hydrogen and oxygen in petroleum formation by hydrous pyrolysis”.

Partners/Collaborators (1991-2015)

California Institute of Technology, Pasadena, CA: Clumped Isotopes in hydrocarbon gases Generated from hydrous pyrolysis (John Eiler with G.S. Ellis).

CNRS – Université de Pau es des Pays de l'Adour, Pau cedex, France: Application of the U-Th and Pb geochronometers for dating petroleum generation and source rock age with emphasis on the New Albany Shale Petroleum System of the Illinois Basin (Christophe Pecheyran and Georgia Sanabria).

Woods Hole Oceanographic Institute, Woods Hole, MA: Evaluation of vanadium isotopes in crude oil and organic-rich source rocks as a new paleoredox and oil-exploration tool (Sune Nielsen and Indra Sen).

CNRS – Laboratoire d'Hydrologie et de Géochimie de Strasbourg, France: K-Ar dating of smectite illitization in the Kreyenhagen Shale : natural and experimental maturation (N. Clauer).

School of Geology and Geophysics, University of Oklahoma: Experimental study of the effects of thermal maturation on petrophysical properties of Woodford Shale (Carl Sondergeld).

Department of Geology, Federal University of Rio de Janeiro: Experimental study on prediction of quality and timing of petroleum generation based on compositional kinetic models for Type- I kerogen (André Durante Spigolon and Joao Mandonça Fiho).

Department of Chemistry and Biochemistry, Old Dominion University: Investigate the potential of whole *Scenedesmus* Green Algae and Algaenan (isolated from *Scenedesmus* Green Algae) to produce oil under hydrous pyrolysis conditions (W. Obeid and P. Hatcher).

Division of Geological and Planetary Sciences, Caltech: Compound-specific hydrogen isotope composition of lipids in the Eocene Green River Formation (Ying Wang and Alex Session).

Department of Earth Sciences-Geochemistry, Utrecht University, The Netherlands: Determination of thermal stability of specific biomarker lipids through hydrous pyrolysis of the freshwater fern *Azolla* (Merel Sap, Eveline N. Speelman, and Gert-Jan Reichart).

Stanford Rock Physics Laboratory, Department of Geophysics, Stanford University: Study on chemical interactions between silica and pore waters related to the conversion of opal-CT to quartz (D. Dralus and K. Peters).

French Petroleum Institute/IFP, Department of Geology and Geochemistry, Paris France: Studies on the role of water in thermal maturation and petroleum generation of Mahogany oil shale (Stephanie Roy).

Babcock & Brown Energy, Inc., Denver, Colorado: Applying hydrous pyrolysis to *in situ* oil-shale retorting (Dave Cox).

Department of Geophysics, Colorado School of Mines: Spectral induced polarization of Woodford Shale at various thermal maturities induced by hydrous pyrolysis (W. Woodruff and A. Revil).

PETROBRAS – CENPES: Hydrous pyrolysis experiments on lacustrine source rock from the Tremembé Formation (Oligocene) containing Type-I kerogen and high smectite content (Regina Binotto).

Departamento de Geologia/CCMN/IGEO, Universidade Federal do Rio de Janeiro (UFRJ): Hydrous pyrolysis experiments on lacustrine source rock from the Tremembé Formation (Oligocene) containing Type-I kerogen and high smectite content (Noelia del Valle Franco Rondón).

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Department of Geology, University of Ilorin, Nigeria: Hydrous pyrolysis petroleum yields and compositions of Nigeria lignite and associated shale, Anambra Basin (Samuel Akande).

Department of Earth Sciences-Geochemistry, Utrecht University, Netherlands: Thermal stability of specific biomarker lipids of the freshwater fern *Azolla* through hydrous pyrolysis (Merel Sap, Eveline Speelman, and Gert-Jan Reichart).

Department of Earth Sciences, University of Durham: cooperative study on the use of Os/Re isotopes in oil typing and age dating (David Selby, w/Paul Lillis).

French Petroleum Institute/IFP, Department of Geology and Geochemistry: cooperative studies on (1) kinetics of gas and oil generation from humic coals and (2) formation of intermediate bitumen in petroleum generation (F. Behar and F. Lorant).

Centro de Investigaciones en Recursos Geologicos, Consejo Nacional de Investigaciones Cientificas y Tecnaicas: cooperative study on recognizing commercial hydrothermal oil in the Cuyo Basin, Argentina (H. J. Villar).

Saudi Aramco Research and Development Center: cooperative study of oil and gas typing to a Jurassic source rock in Saudi Arabia using hydrous pyrolysis (P. Jenden).

Department of Geology and Geophysics, Yale University: cooperative study on the effects of thermal maturation induced by hydrous pyrolysis on the $\delta^{13}\text{C}$ of individual alkanes (N. Pedentchouk).

Casali Institute of Applied Chemistry and Department of Chemistry, The Hebrew University of Jerusalem: cooperative study on partitioning of sulfur and its stable isotopes during thermal maturation (Z. Aizenshtat and A. Amrani).

Department of Geosciences, University of Colorado: cooperative study on thermal maturation and petroleum generation in the northern Gulf Coast (P. Weimer and E. Nelson).

University of Mining and Metallurgy, Department of Fossil Fuels, Krakow, Poland: cooperative projects on (1) habitat and origin of coalbed gas and hydrocarbon generation potential of Polish coals, (2) Menilite petroleum generation kinetics, and (3) transition-metal catalysis in gas generation (M. Kotarba).

School of Geology and Geophysics, University of Oklahoma: cooperative project on the kinetics and composition of expelled oils from source rocks bearing Type-I kerogen in the Uinta basin, Utah (P. Philp and T. Ruble).

Department of Marine Biogeochemistry, Netherlands Institute for Sea Research: cooperative projects on (1) diagenetic transformations of sulfur-bound biomarkers in source rocks bearing Type-II kerogen in the Gessoso-Solfifera Formation of northern Italy (J. Sinninghe -Damste and M. Koopmans,) and (2) geological fate and digenesis of ladderanes (J. Sinninghe -Damste and a. Jaeschke).

Department of Geosciences, Pennsylvania State University: cooperative project on isotopic signature of organic acids generated from source rocks bearing various types and quantities of kerogen (K. Freeman and R. Dias).

Geology/Geochemistry Division of the French Petroleum Institute, IFP: cooperative project on yields and kinetics of oil generation from Wilcox Lignite (Texas Gulf Coast) by hydrous and anhydrous closed-system pyrolysis methods (F. Behar and F. Lorrant,).

Department of Geology and Geological Engineering, Colorado School of Mines: cooperative projects on (1) role of smectite in petroleum formation as determined by natural and experimental thermal maturation (J. Curtis and M. Dolan), (2) factors controlling oil cracking (J. Curtis and D. Willett), (3) mineralization and pyrobitumen of the Esquel gold deposit (Adriana Blesa, M. Hitzman and J. Hedenquist), (4) petroleum-generation kinetics of the Bakken Shale (Hui Jin and S. Sonnenberg), (5) sources of tight-gas reservoirs in the Rocky Mountains (T. Ko and N. Harris), and (6) theoretical and experimental insights on oil expulsion (m. Al Duhailan and S. Sonnenberg).

Biogeochemical Laboratories, Indiana University: cooperative projects on (1) isotopic responses and

exchange of hydrogen and nitrogen in kerogen during thermal maturation and oil generation (A. Schimmelmann,), and (2) FTIR absorption thermal maturity indices (G. P. Lis, M. Mastalerz, A. Schimmelmann).

Department of Marine Chemistry and Geochemistry, Woods Hole Oceanographic Institution:

Cooperative project on development of geochemical oil compositions for derivation of an equation of state (J. Whelan and P. Meulbroek,).

Department of Petroleum Geology, China University of Geosciences: cooperative project on the effects of high pressure on petroleum expulsion (Fang Hao,).

GeoDesign, London: cooperative project on sulfur versus API gravity relationships for typing Iraqi oils (M. Al-Gailani).

Department of Geology, Kansas State University, and Centre de Geochimie de la Surface, CNRS-ULP: cooperative project on effects of thermal maturation on the K-Ar and Rb-Sr isotopic signatures of clay minerals (S. Chaudhuri, KSU).

Shell International Exploration and Production B. V., The Netherlands: cooperative project on development of correlation and maturity parameters based on $\delta^{13}\text{C}$ of light hydrocarbons in oils (F. Gelin,).

Department of Geology, University of Toledo: cooperative project on archaeology of early Roman oil wells in Egypt (J. Harrell,).

Illinois State Geological Survey, Kentucky Geological Survey, and Indiana Geological Survey: cooperative project on feasibility of a material-balance assessment of petroleum in the Illinois basin (D. Morse, ISGS; T. Hamilton-Smith, KGS; and J. Comer and N. Hasenmueller, IGS).

Israel National Oil Co. and Ministry of Energy and Mineral Resources of Jordan: cooperative project on kinetics and composition of oils and tars expelled from source rocks in the Dead Sea basin (E. Tannenbaum, and H. Ramini).

National Resources Authority of Jordan: cooperative project on recognizing and characterizing the Risha Field of eastern Jordan as part of a larger basin-centered gas accumulation (O. Okasheh, NRA).

Central Intelligence Agency, Economic Security Group: World Energy project defining areas of petroleum generation and pathways of oil migration in Iraq (A. Bennett).

8. INVENTIONS, PATENTS HELD

2012 Patent application on "apparatus for uniaxial confinement of rock-cores during petroleum formation in laboratory pyrolysis" was been filed (patent pending) on April 4. M.D. Lewan and J. E. Birdwell are the inventors of the apparatus, which is designed to simulate subsurface overburden pressures during thermal maturation studies of oil shale and source rock cores during laboratory experiments (#98, #99). The apparatus will provide intact rock cores at various pyrolysis levels of thermal maturation that are more comparable to subsurface samples in terms of the rocks petrophysical and mechanical properties and oil expulsion efficiencies.

1977 Hydrous pyrolysis is a method I helped developed and pioneer for simulating natural petroleum formation in the laboratory with John C. Winters (#5) and Jack Williams at the Amoco Production Company Research Center in Tulsa, OK. This method provides insights into the mechanisms of petroleum generation within and expulsion from source rocks. The method is particularly useful in determining kinetics of oil generation, evaluating source-rock expulsion efficiencies, correlating oils to their source rocks, and calibrating thermal maturity indices. This pyrolysis method has also been applied to the study of mineral diagenesis (e.g., Roaldset et al., 1998, *Clay Minerals*, v. 33, p. 147-

158; and #100), generation of aqueous organic acids (e.g., Barth et al., 1989, *Organic Geochemistry*, v. 14, p. 69-76; and #32), organic compounds in meteorites (e.g., M. A. Sephton et al., 1999, *Planetary and Space Science*, v. 47, p. 181-187) and radiogenic dating of petroleum formation (e.g., #95 and #102).

9. HONORS, AWARDS, RECOGNITION, ELECTED MEMBERSHIPS

- 2018 The Society for Organic Petrology 2018 Best Refereed Paper in Coal and Organic petrology. Published in the AAPG Bulletin, "Understanding and distinguishing reflectance measurements of solid bitumen and vitrinite using hydrous pyrolysis: Implications to petroleum assessment" with coauthor Paul Hackley.
- 2017 A.I. Levorsen Memorial Award Best Paper with Paul Lillis, AAPG Pacific Section Meeting, Are Tertiary coals from central and southern Alaska source rocks for oil?, Anchorage, Alaska.
- 2016 AAPG Robert R. Berg Award for Outstanding Research, to be presented at the AAPG Annual Convention in Calgary, Alberta.
- 2014 Outstanding Scientist Award from the Rocky Mountain Association of Geologists: Citation given in November issue of the Outcrop, p. 43.
- 2012 Certificate of Appreciation from the USGS Director (M. McNutt) for work on the response, recovery, and restoration of the Gulf Coast Deepwater Horizon oil spill.
- 2004 Rocky Mountain Association of Mountain Geologists Best Paper Award for "Timing of oil and gas generation of petroleum systems in the Southwestern Wyoming Province" in *Mountain Geologist* with Laura Roberts as first author and Thomas Finn.
- 2004 Department of Interior, Meritorious Award for Scientific Excellence in pioneering simulation of petroleum generation by hydrous pyrolysis.
- 1997 SEPM Honorable Mention for oral presentation given by coauthor Robert Dias at Dallas Annual AAPG Meeting entitled "Kerogen Maturation and the $\delta^{13}\text{C}$ of Organic Acids in Oil-Associated Waters".
- 1996 Vice Chairman of the Organic Geochemistry Division of the Geochemical Society.
- 1994 Elected to Future Studies Team by members of the USGS Energy Program
- 1994 SEPM Honorable Mention for oral presentation given at Denver Annual AAPG Meeting entitled "Effects of Weathering on the Reflectance of Vitrinite in the Mowry Shale, Steinaker Reservoir, Utah".
- 1993 Elected by conferees to be Chairman of the 1994 Gordon Research Conference on Organic Geochemistry
- 1992 Invited by the Program Committee to give the Keynote Speech at the Eighth Annual USGS McKelvey Forum on Minerals and Energy Resources.
- 1992 Elected by conferees to be Vice-Chair of the 1992 Gordon Research Conference on Organic Geochemistry.
- 1991 George C. Matson Memorial Award for the Best Paper presented at the 1991 American Association of Petroleum Geologists Annual Convention. Paper is entitled "Generation and Expulsion of Oil as Determined by Hydrous Pyrolysis".
- 1991 1991-1992 American Association of Petroleum Geologists Distinguished Lecturer. Lecture is entitled "Understanding Generation and Expulsion of Hydrocarbons in Sedimentary Basins through Experimentation".
- 1988 Elected to the membership of the Tulsa Geological Study Group, Tulsa, Oklahoma

- 1985 Best Paper Award, Organic Geochemistry Division of the Geochemical Society, for paper entitled, "Evaluation of Petroleum Generation by Hydrous Pyrolysis Experimentation".
- 1977 Cincinnati Mineral Society Award, Cincinnati, Ohio, for excellence in mineralogical studies.
- 1977 Fenneman Research Fellowship, Department of Geology, University of Cincinnati, for outstanding graduate studies.
- 1976 American Chemical Society Petroleum Research Fund (PRF 947-AC2), Department of Geology, University of Cincinnati for research on vanadium and nickel in sedimentary organic matter.
- 1970 Bear Creek Mining Company Grant, Department of Geology, Michigan Technological University for research on metasomatism of a serpentized peridotite.
- 1969 Field Geologist Award, Department of Geology, Northern Illinois University, for outstanding performance as a summer field camp student.

10. BIBLIOGRAPHY

According to the freely downloadable "Publish or Perish" (<http://www.harzing.com/pop.htm>), papers by "Lewan, M. D." have received 6,931 citations as of March 27, 2018, with an exceptional **h-index** of 46 (Hirsch, 2005, PNAS 102, no. 6, 16569-16572).

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2. Lewan, M. D., 1977, Chemistry and mineralogy of Precambrian paleosols in northern Michigan-Discussion: Geological Society of America Bulletin, v. 88, no. 9, p.1375-1376.
3. Potter, P. E., Lewan, M. D., and others, 1977, Studies for students: A question set for sands and sandstones: Brigham Young University Geological Studies, v. 24, no. 2, p. 1-8.
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