

CURRICULUM VITAE

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Date of Birth

November 13, 1931

Education

B.S., Geology, Michigan State University, 1953
Ph.D., Geology, Harvard University, 1962

Positions Held

Exploration and Mining Geologist, Technical Mine Consultants, Athabasca (Uranium City),
Saskatchewan and Blind River, Ontario, 1953-54, and British Columbia and Alaska, 1959.

Photo-Radar Intelligence Officer, United States Air Force in Europe, 1954-56.

Mining and Exploration Geologist, Anglo-American Corporation, South West Africa, South
Africa, and Zambia, 1956-59.

Teaching Fellow and Research Assistant, Harvard University, Cambridge, Massachusetts, 1959-62.

Research Chemist, Shell Development Company, Houston, Texas, and Imperial Valley, California,
1962-65.

Assistant Professor, Department of Geological Sciences, Northwestern University, Evanston,
Illinois, 1965-68.

Associate Professor, Department of Geological Sciences, Northwestern University, Evanston,
Illinois, 1968-70.

Professor of Geochemistry, Department of Earth & Planetary Science, University of California,
Berkeley, California, 1970-present.

Affiliations

Fellow, Geological Society of America.

Fellow, Geochemical Society.

Fellow, European Association for Geochemistry.

Fellow, Mineralogical Society of America.

Fellow, Royal Society of Chemistry (CChem FRSC).

International Association for Mathematical Geology.

International Association of Geochemistry and Cosmochemistry.

American Society for Biochemistry and Molecular Biology

European Association of Organic Geochemists.

American Chemical Society

The Protein Society

Professional Activities

Councilor, Geochemical Society, 1973-76.

Co-chairman, 1977 Gordon Research Conference on Inorganic Geochemistry.

Member, Roebling Medal Award Committee, Mineralogical Society of America, 1980.

Organizer, Co-director, and Chairman, 1985 NATO Advanced Study Institute on Chemical Transport in Metasomatic Processes.

Associate Editor for the Garrels Memorial Issue of *Geochimica et Cosmochimica Acta*, 1990-1992.

Co-organizer and Co-chairman, Pardee Keynote Symposium on New Insights on Organic Metamorphism in the Earth: Annual Meeting, Geological Society of America, Denver, Colorado, October 28, 1999.

Fellowships and Academic Distinctions since 1970

Visiting Professor, The Johns Hopkins University, 1971.

Miller Research Professor, University of California, Berkeley, 1974-75.

Eldred Wilson Memorial Lecturer, University of Arizona, 1976.

Guggenheim Fellow, 1977-78.

Invitational lecturer, Nobel Symposium, Karlskoga, Sweden, 1979.

Visiting Professor, Yale University, 1980.

Hugh Exton McKinstry Memorial Lecturer, Harvard University, 1980.

Harold Hoots Lecturer, Stanford University, 1982, 1984.

Invitational lecturer, "Sediments, Ores, and Cycles", a symposium at Harvard University in honor of Robert M. Garrels, 1983.

Plenary Lecturer, Symposium on Thermodynamics of Geochemical Systems, International Union of Pure and Applied Chemistry Conference on Chemical Thermodynamics, Hamilton, Ontario, 1984.

Elected First Honorary Member, European Association for Geochemistry, 1985.

Invitational lecturer, Symposium on the "Interaction Fluides–Minéraux Etude Experimentale, Modelisation," Société Française de Minéralogie et de Crystallographie, Paris, December 12, 1985 (opening address).

Invitational lecturer, William Smith Symposium on "Two Phase Flow in the Crust and Mantle," Geological Society of London, April 30, 1986.

Plenary Lecturer, Symposium on Correlation and Estimation Techniques, International Conference on Thermodynamics of Aqueous Systems with Industrial Applications, Warrenton, Virginia, May 10-14, 1987.

Invitational lecturer, Hans Eugster Memorial Symposium, The Johns Hopkins University, May 6, 1988.

Invitational lecturer, Tenth Symposium on Thermophysical Properties, National Bureau of Standards, Gaithersburg, Maryland, June 20-23, 1988.

Awarded the Goldschmidt Medal for distinguished research by the Geochemical Society, November 2, 1988.

Inaugural Mineralogical Association of Canada Distinguished Lecturer for Western Canada, March 6-10, 1989.

Invitational lecturer, Organic Geochemistry Division of the Geochemical Society Symposium on Metalliferous Black Shales and Related Ore Deposits, Dallas, Texas, October 27, 1990.

Invitational lecturer, Société Française de Minéralogie et de Crystallographie, Lyon, July 11, 1991.

Keynote Speaker, RIDGE Theoretical Institute, University of Arizona, Tucson, Arizona, January 6-9, 1992.

1992 Geology Mardi Gras Lecturer, Tulane University, New Orleans, Louisiana, February 28, 1992.

Best Paper in Computers and Geosciences Award for 1992 from the International Association for Mathematical Geology.

Geochemical Society Ingerson Lecturer, October 26, 1992

Invitational lecturer, Symposium on Interactions Between the Geosphere and the Biosphere in honor of David A. Crerar, Princeton University, May 22, 1993.

Plenary lecturer, Czechoslovak-French-Polish Conference on Calorimetry and Experimental Thermodynamics with Applications to Contemporary Problems, Prague, Czech Republic, September 4-7, 1993.

1994 Ernst Cloos Scholar and Memorial Lecturer, Johns Hopkins University, Baltimore, Maryland.

Plenary lecturer, 50th Calorimetry Conference, Gaithersburg, Maryland, July 23-28, 1995.

Plenary lecturer, Seminario di Geochimica Ambientale, Castelnuovo di Porto-Roma, Italy, May 23-26, 1996.

Plenary lecturer, 7th International Symposium on Solubility Phenomena, Montanuniversität, Leoben, Austria, July 22-25, 1996.

First Visiting Scientist, International Research Center of Computational Science, Medical School, Second University of Naples, Naples, Italy, June, 1995-July, 1996.

Plenary lecturer, Interaction Fluides-Mineraux dans la Croute Symposium, Ecole Normal Supérieure, Paris, France, October 14-15, 1999.

Invitational lecturer, Hungarian Academy of Sciences Organic Geochemical Workshop 2000, Veszprem, Hungary, October 25-26.

Invitational lecturer, EURESCO Conference on the Geochemistry of Crustal Fluids in Granada, Spain, December 2-7, 2000.

Experience

Field mapping, geophysical surveying, and diamond drilling for uranium in Athabasca (Uranium City), Saskatchewan, and Blind River, Ontario, Canada (one year).

Field exploration for diamonds and uranium in South West Africa (one year).

Underground mapping and mining geology in gold and copper mines near Welkom, South Africa, Kitwe, Zambia, Stewart, British Columbia, and Anchorage and Valdez, Alaska (two years).

Geothermal exploration and development, drilling, logging, and testing geothermal wells in the Salton Sea geothermal system (two years).

Theoretical research and consulting in high temperature/pressure solution chemistry, thermodynamics and kinetics of hydrothermal/geothermal systems, inorganic and organic geochemistry, biogeochemistry, and the chemical interaction of minerals, microbes, and aqueous inorganic, organic, and biochemical species in geochemical processes (42 years).

Graduate and undergraduate university instruction in theoretical geochemistry and biogeochemistry (37 years)

Contributions to Symposia, University Seminars, and International Conferences

1969-70 Penrose Conference, Geological Society of America, Tucson, Arizona.
Gordon Research Conference on Geochemistry, New Hampshire.
U.S. Geological Survey, Washington, D.C.
University of Wyoming, Laramie, Wyoming.
University of California, Riverside, California.
The Anaconda Company, Salt Lake City, Utah.
Kennecott Exploration Company, Salt Lake City, Utah.
Kennecott Copper Corporation, Lexington, Massachusetts.

1970-71 Geophysical Laboratory, Washington, D.C.
Yale University, New Haven, Connecticut.
The Le Conte Geological Club, San Francisco, California.

1971-72 Conference on Development of New Tools for Mineral Exploration,
Princeton University, Princeton, New Jersey.
Science, Systems, and Software, San Diego, California.
Atomic Energy Commission, Washington, D.C..
Scripps Institute of Oceanography, La Jolla, California.
University of California, Los Angeles, California.
University of Toronto, Toronto, Ontario, Canada.

- Gordon Research Conference on Geochemistry, New Hampshire.
- 1972-73 NATO Advanced Study Institute on Feldspars, Manchester, England.
 Arizona State University, Tempe, Arizona.
 California Institute of Technology, Pasadena, California.
 University of British Columbia, Vancouver, British Columbia, Canada.
 University of Washington, Seattle, Washington.
- 1973-74 Gordon Research Conference on Geochemistry, New Hampshire.
 Carleton University, Ottawa, Ontario, Canada.
- 1974-75 Northwestern University, Evanston, Illinois.
- 1975-76 Los Alamos Scientific Laboratory, Los Alamos, New Mexico.
 International School of Earth Sciences, Erice, Sicily.
- 1976-77 Conference on Research Frontiers in Exploration for Non-renewable Resources,
 Pennsylvania State University, State College, Pennsylvania.
 Scripps Institute of Oceanography, La Jolla, California.
- 1977-78 Gordon Research Conference on Geochemistry, New Hampshire.
 Fifth International Conference on Chemical Thermodynamics, Ronneby, Sweden.
 Bat Sheva Seminar on Saline Lakes and Natural Brines, Weizmann Institute, Rehovot,
 Israel.
 Australian National University, Canberra, Australia.
- 1978-79 Chevron Oil Field Research Laboratory, La Habra, California.
 Whiteshell Nuclear Research Laboratory, Pinawa, Manitoba, Canada.
 Carleton University, Ottawa, Ontario, Canada.
 Northwestern University, Evanston, Illinois.
- 1979-80 University of Oslo, Oslo, Norway.
 Chevron Oil Field Research Laboratory, La Habra, California.
 California Institute of Technology, Pasadena, California.
 Gold Symposium, Chevron Resources Company, Denver, Colorado.
 Peninsula Geological Society, Stanford University, Stanford, California.
- 1980-81 University of Iceland, Reykjavik, Iceland.
 Eidgenössische Technische Hochschule, Zürich, Switzerland.
 University of California, Los Angeles, California.
 California Institute of Technology, Pasadena, California.
- 1981-82 Gordon Research Conference on Inorganic Geochemistry, New Hampshire.
 Chevron Oil Field Research Laboratory, La Habra, California.
 Stanford University, Stanford, California.
- 1982-83 Eidgenössische Technische Hochschule, Zürich, Switzerland.
 Gordon Research Conference on the Origin of Life, New Hampshire.
 Penrose Conference on Diagenesis of Clastic Reservoirs, Kona, Hawaii.
 Arizona State University, Tempe, Arizona.
 University of Arizona, Tucson, Arizona.
 University of California, Davis, California.
 Alberta Research Council, Edmonton, Alberta, Canada.

- 1983-84 Gordon Research Conference on Inorganic Geochemistry, New Hampshire.
California Institute of Technology, Pasadena, California.
University of South Florida, St. Petersburg, Florida.
Geothermal Energy Symposium, Società Italiana di Mineralogia e Petrologia, Palermo, Italy.
University of California, Santa Barbara, California.
Instituut voor aardwetenschappen, Rijksuniversiteit, Utrecht, The Netherlands.
ARCO Oil and Gas Company, Dallas, Texas.
- 1984-85 Gordon Research Conference on Modeling of Flow in Permeable Media, New Hampshire.
Eidgenössische Technische Hochschule, Zürich, Switzerland.
University Paul Sabatier, Toulouse, France.
NATO Advanced Study Institute on Chemical Transport in Metasomatic Processes, Corinthia, Greece.
- 1985-86 Penrose Conference on Reservoir Diagenesis, Cannes, France.
- 1986-87 Washington University, St. Louis, Missouri.
U.S. Geological Survey, Denver, Colorado.
U.S. Geological Survey, Reston, Virginia.
Rockwell International Basalt Waste Isolation Project, Richland, Washington.
- 1987-88 Symposium on Chemistry in High Temperature Aqueous Solutions, Electric Power Research Institute and Brigham Young University, Provo, Utah.
Westinghouse-Hanford Basalt Waste Isolation Project, Richland, Washington.
Du Pont Chemical Company, Newark, Delaware.
Lawrence Livermore Laboratory, Livermore, California.
- 1988-89 Eidgenössische Technische Hochschule, Zürich, Switzerland.
Centre de Recherches sur la Géologie de l'Uranium, Nancy, France.
Centre de Sédimentologie et de Géochimie de la Surface, Université Louis Pasteur, Strasbourg, France.
Société Française de Chimie International Symposium on Supercritical Fluids, Nice, France.
University of Calgary, Calgary, Alberta, Canada.
University of Alberta, Edmonton, Alberta, Canada.
University of British Columbia, Vancouver, British Columbia, Canada.
Stanford University, Stanford, California.
- 1989-90 Université Paul Sabatier, Toulouse, France.
Centre de Recherche sur les Mécanismes de la Croissance Cristalline, Marseille, France
University of Indiana, Bloomington, Indiana
University of Arizona, Tucson, Arizona
- 1990-91 Dipartimento di Chimica e Chimica Industriale, University of Pisa, Pisa, Italy
- 1991-92 SUPCRT 91, Geological Society of America Short Course, San Diego, California
Department of Geology and Geophysics, University of California, Berkeley, California
Scripps Institution of Oceanography, La Jolla, California
Department of Earth and Planetary Sciences, Johns Hopkins University, Baltimore, Maryland
Du Pont Chemical Company, Newark, Delaware
Université Paul Sabatier, Toulouse, France

- 1992-93 Department of Chemical Engineering, University of California, Berkeley, California
Department of Pharmaceutical Chemistry, University of California, San Francisco, California
- 1993-94 Department of Earth and Planetary Sciences, Johns Hopkins University, Baltimore, Maryland
Department of Biology, Johns Hopkins University, Baltimore, Maryland
Department of Biochemistry, University of Georgia, Athens, Georgia
- 1994-95 Istituto di Biochimica delle Proteine ed Enzimologia, Naples, Italy
- 1995-96 Area di Ricerca di Napoli, Naples, Italy
Dipartimento di Chimica e Chimica Industriale, University of Pisa, Pisa, Italy
Dipartimento di Agrobiologia e Agrochimica, Università degli Studi della Tuscia, Viterbo, Italy
Swiss Federal Institute (ETH), Zürich, Switzerland
Centre de Geochimie de la Surface, Université Louis Pasteur, Strasbourg, France
Elf Aquitaine Petroleum Research Center, Pau, France
- 1996-97 Earth Resources Systems Center, University of California, Berkeley, California.
College of Chemistry and College of Engineering Industrial Liaison Program
Conference, University of California, Berkeley, California.
- 1997-98 Department of Geology and Geophysics, University of California, Berkeley, California.
- 1998-99 Department of Chemistry and Biochemistry, Texas Tech University, Lubbock, Texas
Department of Earth and Planetary Sciences, Washington University, St. Louis, Missouri
- 2000-01 Department of Geological Sciences, University of California, Santa Barbara, California
School of Earth Sciences, Stanford University, Stanford, California

PUBLICATIONS: HAROLD C. HELGESON¹

Abstracts and Reviews

- 1962 Solution equilibria in a portion of the system PbS-NaCl-HCl-H₂O at elevated temperatures (abstract): *Econ. Geol.*, v. 57, pp. 1016-1017.
- 1965 Review of *Ore Deposits* by Charles F. Park, Jr., and Roy A. MacDiarmid: *Am. Jour. Sci.*, v. 263, p. 550.
- 1966 (with R.M. Garrels and F.T. Mackenzie) Evaluation of irreversible reactions involving minerals and aqueous solutions (abstract): 1966 Annual Meeting, Geological Society of America, *GSA Special Paper* 101, p. 92.

¹ First authors other than Helgeson are indicated in bold face type

- 1968 (with W.R. James) Activity coefficients in concentrated electrolyte solutions at high temperatures (abstract): 155th National Meeting, American Chemical Society, April, 1968, *Abstracts of Papers*, p. S-130.
- 1968 (with R.M. Garrels) Hydrothermal transport and deposition of gold (abstract): 1968 Annual Meeting, Geological Society of America, *GSA Special Paper* 121, p. 33.
- 1969 A chemical and thermodynamic model of sulfide deposition in hydrothermal systems (abstract): 1969 Annual Meeting, Geological Society of America, *Abstracts with Programs for 1969*, v. 1, p. 98.
- 1970 Thermodynamic prediction of the distribution of components and chemical species in the weathering process (abstract): 159th National Meeting, American Chemical Society, February, 1970, *Abstracts of Papers*, p. WATR-14.
- 1970 Review of Thermodynamic Properties of Minerals and Related Substances at 298.15°K (25.0°C) and One Atmosphere (1.103 Bars) and at Higher Temperatures, by Richard A. Robie and David R. Waldbaum: *Am. Mineral.*, v. 55, pp. 325-326.
- 1970 Kinetics of mass transfer in hydrothermal systems (abstract): International Symposium on Hydrogeochemistry and Biogeochemistry, Tokyo, Japan, September, 1970, *Abstracts of Papers*, p. 13.
- 1970 Review of *Properties of Water and Steam in SI-Units*, by Ernst Schmidt, *Am. Mineralogist*, v. 55, pp. 1822-1823.
- 1971 Prediction of the chemical consequences of adiabatic and nonadiabatic expansion in geochemical processes involving aqueous solutions (abstract): 1971 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 3, pp. 769-770.
- 1972 (with **J.R. Wood** and H.P. Eugster) Calculation of the thermodynamic properties of saturated solutions of mixed electrolytes (abstract): *Transactions, American Geophysical Union*, v. 53, p. 531.
- 1972 Thermodynamic constraints on mass transfer in hydrothermal systems at high temperatures and pressures (abstract): *Abstracts, Twenty-Fourth International Geological Congress*, Montreal, 1972, p. 310.
- 1972 Review of *Principles of Chemical Sedimentology*, by Robert A. Berner: *Jour. Geol.*, v. 80, pp. 630-631.
- 1973 (with D.H. Kirkham) Calculation of mass transfer among minerals and aqueous solutions as a function of pressure and temperature (abstract): *Carnegie Conference on Geochemical Transport and Kinetics*, Warrenton, Virginia, June, 1973.
- 1973 (with D.H. Kirkham) Electrostatic properties of H₂O at high pressures and temperatures (abstract): 1973 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 5, p. 664

- 1973 Theoretical calculation of chemical equilibrium and mass transfer among phases in geothermal systems: *National Science Foundation Geothermal Energy Research Seminar*, Pisa, Italy, November 5-11, 1973.
- 1974 (with D.H. Kirkham) Theoretical prediction of the thermodynamic properties of aqueous electrolytes at high pressures and temperatures. III. Equation of state for aqueous species at infinite dilution (abstract): 167th National Meeting, American Chemical Society, March 31-April 5, 1974, *Abstracts of Papers*, p. PHYS-050.
- 1974 Properties of volatiles under metamorphic conditions: *NATO Advanced Study Institute, Volatiles in Metamorphism*, Nancy, France, and Chiareggio, Italy, August 24-September 8, 1974.
- 1974 A theoretical model of the chemical interaction of rocks and aqueous solutions (abstract): *International Association of Geochemistry and Cosmochemistry Symposium on Water-Rock Interaction*, Prague, Czechoslovakia, September 8-13, Abstracts, p. 5.
- 1974 (with D.H. Kirkham) Thermodynamic/electrostatic behavior of H₂O at high pressures and temperatures (abstract): *Proceedings of the Eighth International Conference on the Properties of Water and Steam*, Giens, France, September 23-27, 1974, v. 2, p. 998.
- 1974 (with D.H. Kirkham) Thermodynamic properties of hydrothermal systems at high pressures and temperatures (abstract): 1974 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 6, pp. 788-789.
- 1975 (with H.W. Nesbitt and J.M. Delany) Summary and critique of the thermodynamic properties of rock-forming minerals (abstract): 1975 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 7, pp. 1108-1109.
- 1975 (with **J.V. Walther**) Calculation of the thermodynamic properties of aqueous silica and the solubility of quartz and its polymorphs at high pressures and temperatures (abstract): 1975 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 7, pp. 1311-1312.
- 1976 Thermodynamics of chemical reactions among minerals and aqueous solutions at high pressures and temperatures (abstract): NATO Advanced Study Institute on Thermodynamics in Geology, Oxford, England, September 17-27, 1976, *Collected Abstracts*, p. 10.
- 1976 (with **J.M. Delany**) Thermodynamics of dehydration equilibria to 100 kb and 800°C (abstract): 1976 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 8, pp. 833-834.
- 1977 (with **P. Aagaard**) Thermodynamic and kinetic constraints on the dissolution of feldspars (abstract): 1977 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 9, p. 873.
- 1977 (with **D.K. Bird**) Prediction of the chemical characteristics of geothermal reservoir fluids from authigenic mineral assemblages (abstract): 1977 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 9, pp. 898-899.

- 1977 (with D.H. Kirkham) Calculation of the standard partial molal properties of aqueous electrolytes at high pressures and temperatures (abstract): 173rd National Meeting, American Chemical Society, *Abstracts of Papers*, p. 53.
- 1978 (with **C.J. Frisch**) Metasomatic phase relations in dolomites of the Adamello Alps, Italy (abstract): 1978 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 10, p. 405.
- 1978 Theoretical calculation of the thermodynamics of equilibrium and mass transfer among minerals and aqueous solutions at high pressures and temperatures (abstract): 1978 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 10, pp. 418-419.
- 1979 (with P. Aagaard) A retroactive clock for geochemical processes (abstract): 1979 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 11, p. 442.
- 1979 (with **W.F. McKenzie**) Calculation of the dielectric constant of H₂O and the thermodynamic properties of aqueous species at temperatures to 900°C (abstract): 1979 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 11, p. 476.
- 1980 Thermodynamic and kinetic consequences of substitutional order/disorder in minerals (abstract): 12th General Meeting, International Mineralogical Association, July 4-6, Orleans, France, *Bull. Mineralogie*, v. 104 (1981), p. 161.
- 1980 Reaction rates and mass transfer in geochemical processes (abstract): 26th International Geological Congress, July 7-17, Paris, France, *Abstracts*, v. 1, p. 49.
- 1980 (with **C.J. Bruton**) Calculation of the chemical and thermodynamic consequences of differences in fluid and lithostatic pressure on equilibrium constraints in hydrothermal systems (abstract): 1980 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 12, p. 394.
- 1980 (with **W.F. McKenzie**) Calculated phase relations among silicates, copper iron sulfides, and aqueous solutions at magmatic temperatures (abstract): 1980 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 12, p. 481.
- 1981 Calculation of the thermodynamic properties of mixed layer clays (abstract): 18th Annual Meeting, Clay Minerals Society, October 4-8, University of Illinois, Urbana, Illinois, *Program and Abstracts*, p. 9.
- 1981 (with W.M. Murphy) Calculation of mass transfer among minerals and aqueous solutions as a function of time and surface area in geochemical processes. I. Computational approach (abstract): 10th Geochautauqua on Computer Applications in the Earth Sciences, International Association for Mathematical Geology, Ottawa, Canada, October 23-24, *Abstracts*, p. 15-16.
- 1981 (with **T.S. Bowers**) Thermodynamic and geochemical consequences of immiscibility in the system H₂O-CO₂-NaCl (abstract): 1981 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 13, p. 414.

- 1981 Calculation of the thermodynamic properties of disordered solid solutions (abstract): 1981 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 13, p. 471.
- 1982 (with **K. Jackson**) Chemical and thermodynamic constraints on the hydrothermal transport and deposition of tin (abstract): 1982 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 14, p. 521.
- 1982 (with **P.C. Lichtner**) Chromatographic transport of aqueous species in hydrothermal systems. I. Calculation of concentration profiles and retarded velocities in solutions coexisting with alkali feldspars at magmatic temperatures and pressures (abstract): 1982 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 14, p. 546.
- 1983 Intra- and intercrystalline standard states for minerals (abstract): 1983 Annual Meeting, Geological Association of Canada, *Program with Abstracts*, v. 8, p. A32.
- 1983 (with **J. C. Tanger, IV**) A refined equation of state for aqueous electrolytes at high pressures and temperatures and revised estimates of the partial derivatives of the dielectric constant of H₂O in the critical region (abstract): 66th Canadian Chemical Conference, *Abstracts*, PH13-3.
- 1983 (with **T.S. Bowers**) Metamorphic equilibria in the liquid + vapor region of the ternary system H₂O-CO₂-NaCl at high pressures and temperatures (abstract): *Transactions, American Geophysical Union*, v. 64, p. 347.
- 1983 (with **E.L. Shock**) Thermodynamic calculation of the relative stabilities of amino acids in aqueous solution at high temperature (abstract): 7th International Conference on the Origins of Life and the 4th International Meeting of the Society for the Study of the Origin of Life, July 10-15, 1983, *Abstracts*, p. C1-27.
- 1983 (with **P.C. Lichtner** and K. Preuss) Numerical modeling of fluid flow with simultaneous chemical reaction in hydrothermal systems (abstract): 1983 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 15, p. 627.
- 1984 Some thermodynamic aspects of geochemistry (abstract): *Program and Abstracts of Papers*, IUPAC Conference on Chemical Thermodynamics: The 39th Calorimetry Conference, McMaster University, Hamilton, Canada, p. 121.
- 1984 Mineral deposition and dissolution as a function of fluid pressure in hydrothermal systems (abstract): Abstracts of the 27th International Geological Congress, Moscow, v. 5, p. 290.
- 1984 (with **K.J. Jackson**) Solubility of cassiterite and tin deposition in the Southeast Asian tin belt (abstract): Abstracts of the 27th International Geological Congress, Moscow, v. 5, p. 58.
- 1984 (with **P.C. Lichtner**) Chemical shock fronts induced by advective-diffusive/dispersive flows in hydrothermal systems (abstract): Biannual Meeting, American Geophysical Union, *Eos*, v. 65, p. 1126.
- 1984 (with **E. Oelkers**) Calculation of diffusion coefficients of aqueous species in hydrothermal systems at pressures and temperatures to 5 kb and 1000°C (abstract): 1984 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 16, p. 612.

- 1984 (with **J.C. Tanger**) Revised equations of state for calculating the standard molal thermodynamic properties of aqueous species in hydrothermal systems at pressures and temperatures to 5 kb and 1000°C (abstract): 1984 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 16, p. 673.
- 1984 (with **W.M. Murphy**) Kinetics of transient and steady-state hydrolysis of rock-forming silicates (abstract): 1984 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 16, p. 605.
- 1985 Equilibrium constraints on the distribution of species among minerals and aqueous solutions in magma-hydrothermal systems (abstract), Biannual meeting, European Union of Geosciences, April 1-4, 1985, Strasbourg, France: *Terra Cognita*, v. 5, p. 149.
- 1985 (with **W.M. Murphy**) Mineral dissolution rate control by surface reconstitution (abstract): 1985 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 17, p. 672.
- 1986 (with **E.L. Shock** and D.A. Sverjensky) Calculation of acid dissociation constants and the aqueous solubilities of gases under hydrothermal conditions (abstract): American Geophysical Union, *Eos*, v. 67, p. 388.
- 1986 (with **E.L. Shock**) Thermodynamics of the abiotic synthesis of aqueous organic species at high temperatures (abstract): Fifth ISSOL Meeting and Eighth International Conference on The Origin of Life, *Abstracts*, p. 105-106.
- 1986 (with **E.L. Shock** and D.A. Sverjensky) Prediction of the thermodynamic properties of neutral aqueous species at high pressures and temperatures (abstract): 9th International Union of Pure and Applied Chemistry Conference on Chemical Thermodynamics, Lisbon, Portugal, Book of Abstracts, p. 4.7.
- 1986 Effects of complex formation on the hydrothermal solubilities of minerals as a function of fluid pressure at high temperature (abstract): 1986 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 18, p. 633.
- 1986 (with **E.L. Shock**) Thermodynamic properties of aqueous organic species in the diagenetic environment (abstract): 1986 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 18, p. 749.
- 1986 (with **E.H. Oelkers**) Are hydrothermal solutions really associated at supercritical pressures and temperatures? (abstract): 1986 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 18, p. 709.
- 1986 (with **P.C. Lichtner** and W.M. Murphy) Lagrangian formulation of fluid-rock interaction coupled to fluid flow (abstract): 1986 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 18, p. 672.
- 1987 (with **D.A. Sverjensky** and E.L. Shock) Thermodynamics of aqueous metal complexes at high temperatures and pressures (abstract): Biannual meeting, European Union of Geosciences, April 13-16, Strasbourg, France: *Terra Cognita*, v. 7, p. 128.

- 1987 (with **E.H. Oelkers**) Calculation of dissociation constants for ion pairs in high temperature hydrothermal solutions from conductance data and (independently) Bjerrum's theory of ion association (abstract): 1987 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 19, p. 792.
- 1987 (with **B. Ransom**) Thermodynamic prediction of the relative stabilities of illite and smectite in diagenetic processes (abstract): 1987 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 19, p. 813.
- 1987 (with **D. A. Sverjensky** and E.L. Shock) Prediction of the dissociation constants of aqueous inorganic metal complexes to 1000°C and 5 kb (abstract): 1987 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 19, p. 813.
- 1988 (with E.L. Shock) Description and interpretation of metastable phase relations in hydrocarbon reservoirs (abstract), First International Symposium on the Thermodynamics of Natural Processes, Strasbourg, France: *Terra Cognita*, v. 8, p. 172.
- 1988 (with **B. Ransom**) Hydration states and 3-dimensional order: A new theory of the constitution of mixed-layer clays (abstract), First International Symposium on the Thermodynamics of Natural Processes, Strasbourg, France: *Terra Cognita*, v. 8, p. 174.
- 1988 (with E.L. Shock) Kinetic and thermodynamic constraints on phase relations among minerals, petroleum, and aqueous solutions in diagenetic processes (abstract), European Association for Geochemistry, International Congress of Geochemistry and Cosmochemistry, Paris, France: *Chemical Geology*, v. 70, p. 78.
- 1988 (with E.L. Shock) Calculation of the high-temperature thermodynamic properties of reactions among organic gases, liquids, solids, and aqueous species (abstract): Tenth International Union of Pure and Applied Science Conference on Chemical Thermodynamics, Prague, Czechoslovakia, *Book of Abstracts*, p. B9.
- 1988 (with E.L. Shock) Role of oxidation/reduction reactions in the hydrothermal transport and deposition of petroleum (abstract): 1988 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 20, p. A95.
- 1988 (with **E. H. Oelkers**) Prediction of dissociation constants and limiting equivalent conductances of triple ions in high temperature hydrothermal solutions (abstract): 1988 Annual Meeting, Geological Society of America, *Abstracts with Programs*, v. 20, p. A96.
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(with **S. Gurrieri**, J.P. Amend, and K. Danti) Biogeochemistry of Hot Springs in the Aeolian Islands: Authigenic phase relations in the Baia di Levante, Vulc

(with C.E. Owens, G. J. Afonso, J. M. Dick, and J. P. Amend) Toward a global equation of state for protein unfolding.

(with D. E. LaRowe and J. M. Dick) Biogeochemical insights into the thermal stability of hyperthermophilic microbes.

(with **L. Richard**) Calculation of the standard molal volumes of crystalline and liquid organic compounds as a function of temperature and pressure.

(with L. Richard) A chemical and thermodynamic model of petroleum generation in the Earth.

(with **D. E. LaRowe**) Calculation of the thermodynamic properties of aqueous nucleic acid bases, nucleosides, nucleotides, and nucleic acids at high temperatures and pressures.

(with G.J.Afonso, J. M. Dick, and D. E. LaRowe) Thermodynamic calculation of the relative stabilities of enzymes, DNA, and other biomacromolecules under extreme conditions of temperature and pH.

(with L. Richard and L. C. Price) Calculation of the effect of kerogen diagenesis on the oil generation potential of hydrocarbon source rocks.

(with D. E. LaRowe and J. M. Dick) Thermodynamic and chemical constraints on the biotic and abiotic synthesis of biomacromolecules.

(with **L Richard**) Thermodynamic models of kerogen

(with **L. Richard** and W. F. McKenzie) Thermodynamic description of reactions involving organic sulfur compounds, aqueous fluids, hydrogen sulfide, and minerals in hydrocarbon source rocks.