

## JOHN ROBERT CLARK

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### Professional/Technical Record

#### Education:

School	Major and Minor Specializations	Dates Attended	Degree, Year
University of Alabama	Geology, Geography	1966-1970	B.Sc. Geol., 1970
University of Alabama	Geology, Geochem.	1970-1973	M.Sc., 1973
McGill University	Explor. Geochem.	1973-1975	transferred
Colorado School of Mines	Economic Geology, & Explor. Geochem.	1975-1983	Ph.D., May 1983

#### Fields of Specialization:

Oxidation Anomaly Model and Geochemical Characterization of Subsurface Features  
Selective Extractions/Surface Geochemistry  
Instrumental Geochemical Analysis (ICP-MS)  
Exploration Geochemistry  
Economic Geology

#### Career Experience Highlights: (details follow Bibliography)

##### From: To:

6/70	9/70	Petroleum Geologist, Texaco, Jackson district, New Orleans, Louisiana: reworked geology of a Smackover field in Gulf Coast.
1970	1973	Teaching and Research Assistant, University of Alabama.
9/73	4/75	Research Assistant, McGill University, Geology Department, Montreal, Quebec: Developed flameless atomic absorption methods for geochemical analysis.
5/74	8/75	Research Geologist, Noranda Exploration Company, Ltd., Noranda, Quebec: core logging and underground mapping for a study of Orchan Mine.
9/75	8/80	Research Assistant, Colorado School of Mines, Geology Department: Ran the geochemical lab and assisted in teaching of exploration workshops.
10/80	12/81	Student Appointment, U.S. Geological Survey, Branch of Exploration Research: Geochemical methods development.
12/81	5/93	Research Geologist, U.S. Geological Survey, Branch of Geochemistry: Geoch. Coord. AK Min. Resource Potential Program, Project Chief N. MN CUSMAP projects, NAQWA project chief, BLM Wilderness project chief....
5/93	present	General Manger, Enzyme-ACTLABS, LLC: Business management, ICP-MS method development, customer liaison, guest lecturer at numerous meetings....

#### Honors or awards:

Institute of Mining and Metallurgy, Gold Fields of South Africa Premium, May 4, 1994.

#### Selected recent abstracts and presentations are available on the Internet --

<http://www.enzymeleach.com/~bobclark/clarklist.html>

**Special inventions, patents held, techniques or methods developed or improved:**

The **MAGIC organic-extraction system** was developed jointly by myself and John Viets. The process quantitatively separates 24 trace analytes from interfering geological matrices.

The **Enzyme Leach**, a highly discriminating selective extraction for enhancing subtle geochemical anomalies in surficial geological materials, was first envisioned January, 1976. It became a commercial process in 1993. Patents have been issued or are pending in the United States and other countries.

The **oxidation anomaly model** was initially developed between 1989 and 1992, to explain features found with the Enzyme Leach over hydrocarbon and mineral occurrences in the subsurface. Subtle electrochemical cells between the reduced bodies and the atmosphere produce characteristic patterns. The model has undergone substantial refinement while being used commercially since 1993. Many hundreds of these anomalies have been identified, and to date the greatest depth of penetration is just under four miles into the subsurface.

**TerraSol**, a less discriminating alternative to Enzyme Leach, which in turn gives it less depth of penetration for mineral surveys, was developed from 1998 to 2000.

**Specialized training (including postgraduate and Government courses):**

Economic Geology (1970, 1971, 1973, 1974, 1975, 1975, 1977)	1 semester each
Hydrothermal Geochemistry (1976)	1 semester
Phase Equilibria (1978)	1 semester
Analytical Geochemistry (1973)	1 semester
Exploration Geochemistry (1975, 1975, 1976, 1978)	1 semester each
Petrology of Mafic-ultramafic Rocks (1972)	1 semester
Organic Chemistry (1982) (Colo.Sch.Mines)	1 semester
Organic Geochemistry (1983) (Colo.Sch.Mines)	1 semester
Mississippi Valley-Type Deposits Short Course (1982) (USGS)	1 week
Ore Deposits of Park City and Tintic, Utah (1977)	1 week
Low Temperature Geochemistry (1971)	1 semester
Structural Geology of Metamorphic Rocks (1970, 1972)	1 semester
Tectonics (1972)	1 semester
Petrology of Mississippi Valley-Type Deposits (1972)	1 semester
Ore Microscopy (1972, 1979)	1 semester each
Well Log Interpretation (1970) (Texaco)	1 week
Advanced Stratigraphy (1975)	1 semester
Statistical Analysis of Geological Data (1977)	1 semester
Short Course on Uranium Geochemistry (1979) (Colo.Sch.Mines)	4 days
Wilderness First Aid (1985) (USGS)	3 days
Firearms Safety Course (1987, 1989) (USGS); Instructor (1989-1993)	4 days each
GIS Short Course (1988) (NASA)	2 days
Helicopter Safety (1988) (OAS)	2 days

**Membership in professional societies:**

Association of Exploration Geochemists (1978 to present), Councilor 1995-1997

Society of Economic Geologists (1984 to present)

**Lectureships, symposia, invited conference participation:**

- November 1979: Invited guest lecturer at Chevron Research, Richmond, California--Topic: Analytical geochemistry -- MAGIC organic extraction system.
- March 1983: Invited speaker at AIME-SEG meeting in Atlanta, Georgia: Symposium on metamorphism of ores and ores in metamorphic rocks.
- January 1984: Invited lecturer on flameless atomic adsorption (determining analytes in organic solvents), a local Los Angeles area ACS discussion group.
- February 1990: Invited paper on application of Enzyme leach to regional mineral exploration in northern Minnesota, Gold '90 Symposium, joint SEG-AIME program at AIME annual meeting, Salt Lake City, Utah. Paper published in Gold '90 volume.
- February 1990: Invited paper on the history and application of the MAGIC extraction system, Gold '90 Symposium, joint SEG-AIME program at AIME annual meeting, Salt Lake City, Utah. Paper published in Gold '90 volume.
- April 1990: Invited speaker, Mesabi Range Geological Society, Virginia, MN: spoke on the geochemical evidence of mineralized bedrock buried beneath glacial overburden in MN.
- July 1992: Invited article for Explore magazine on detection of bedrock-related geochemical anomalies at the surface of transported overburden.
- Fall 1992: Invited to participate in study of mechanisms of oxidation anomaly formation in overburden in the Atacama Desert of Chile.
- November 1992: Invited lecture on applications of Enzyme leach at Geochemical Exploration Discussion Group, Colorado School of Mines, sponsored by Association of Exploration Spring, 1993: Invited paper published in the Transactions of the Institution of Mining and Metallurgy. After a paper was presented on the results of Enzyme Leach studies in northern Minnesota at the Prospecting in Areas of Glaciated Terrain 1991 conference, the organizers of the meeting, Mike Gallagher and Graham Smith, who are members of the board of the IMM, and the President of the IMM, H.E.K Allen, requested that I publish the corresponding paper in the Transactions rather than in the conference volume. (See Honors, awards... above.)
- Invited to present lecture on the MAGIC extraction system to the Society of Mineral Analysts annual conference, spring, 1993.
- November 1994: Lecture on using Enzyme Leach to detect reduced bodies in subsurface. Denver Geochemical Discussion Group, Colorado School of Mines, November, 1994.
- April 1995: Guest lecturer for Timmins area geological group, Application of Enzyme Leach Technology in Mineral Exploration in the Canadian Shield, Timmins, Ontario.
- March 1996: Guest lecturer, University of New South Wales, Anomaly Models for Interpretation of Enzyme Leach Data, Sydney, Australia.
- October 1996: Invited lecturer, Geochemical Exploration in Tropical and Subtropical Environments, colloquium presented by Queens University, Kingston, Ontario, 29 September - 4 October 1996.
- April 1997: Guest lecturer, Application of Enzyme Leach technology in Mineral Exploration, Alaska Geological Society, Anchorage, AK.
- May 1997: Guest lecturer on application of selective extractions in mineral exploration, provincial workshop, Manitoba Ministry in Industry, Trade, and Mines.
- June 1997: Invited speaker, Trends in analytical geochemistry for mineral exploration, Geoanalysis '97.

**Lectureships, symposia, invited conference participation: (continued)**

- May 1998: Guest lecturer on application of selective extractions in mineral exploration (repeat), provincial workshop, Manitoba Ministry in Industry, Trade, and Mines.
- November 1998: Guest lecturer, University of New South Wales, Application of Enzyme Leach Technology in Mineral Exploration, Sydney, Australia.
- April 1999: Guest speaker, Workshop on selective extractions in geochemical exploration, International Geochemical Exploration Symposium, Vancouver, BC, April, 1999.
- April 1999: Guest lecture, Application of Enzyme Leach and the Oxidation Anomaly Model for Mineral Exploration in The Central Andes, ProExplo '99 meeting, Lima, Peru.
- December 1999: Guest reviewer of geochemical survey term projects for graduate mineral exploration class, New Mexico Institute of Mines and Technology, Geology Department, Socorro, NM.
- March 2000, Invited paper on application of selective extractions in high-latitude mineral exploration, Alaska Miners Congress, Fairbanks, AK.
- May 2000: Invited speaker on selective extractions, Workshop, Geol. Soc. NV 2000 Symp.
- Dec. 2000: Invited lecture, Theory and Practice of the Use of Selective Extractions in Mineral Exploration, Mineral Exploration Short Course, Laurentian University, Sudbury, Ontario.
- December 2002: Invited lecture, Theory and Practice of the Use of Selective Extractions in Mineral Exploration, Mineral Exploration Short Course, Laurentian University, Sudbury, Ontario. Asked to present updated version of lecture.
- May 2003: invited oral paper, Mapping of Reservoirs and Subsurface Structures Using Selective Analysis of the Surface Chemistry of Soil Particles, AAPG annual Meeting, Salt Lake City, UT.
- November 2003: invited lecture, Probing the Subsurface with Selective Extractions of Soils: Models for the Great Basin, Geological Society of Nevada, November general meeting.
- April 2004: invited oral paper: Subsurface Mapping of Hydrocarbon Reservoirs Using Selective Analysis of Soil or Sediment Particle Surfaces, AAPG annual Meeting, Dallas, TX.

**Committees to render scientific judgment:**

- Chairman, Manuscript Review Committee, Branch of Geochemistry, US Geological Survey, May 1985 to May 1987.
- 1987: Member of National Water Quality Assessment Program organizational committee.

**Reviewer:**

- Analytical Chemistry: 1983,1984
- Journal of Atomic Spectroscopy: 1984, 1985, 1987
- Association of Exploration Geochemists: 1991, 1993
- Applied Geochemistry: 1997-1998
- American Association of Petroleum Geologists: 1999

**Academic Honors and Scholarships:**

- H.E.W. Fellowship, Colorado School of Mines, 1978-1981
- Dean's list, University of Alabama
- Sigma Gamma Epsilon (hon. for geologists), University of Alabama (chapter pres., 1970 1971)
- Texaco Scholarship, University of Alabama, 1970

## **Bibliography:**

- Pierce, L. B., Clark, J. R., and Smith, W. Everett, 1972, Preliminary study of potential sites for water-supply reservoirs in west and southwest Alabama: Alabama Development Office, Montgomery, Alabama, Report number Ala-GSA-X996-WRC-72-7, 119 p.
- Clark, J.R., 1973, Petrology and geochemistry of the Seroyer Branch Mafic-ultramafic Complex, Chambers County, Alabama: M.Sc. Thesis, University of Alabama, 122 p.
- Divis, Allan F., and Clark, John R., 1978, Exploration for blind ore deposits and geothermal reservoirs by lithium isotope thermometry-atomic absorption mass spectrometry: Geochemical Exploration 1978, Proceedings 7th International Geochemical Exploration Symposium, Golden, Colorado, Association of Exploration Geochemists, p. 233-241.
- Clark, J. R., and Viets, J. G., 1981, Multi-element extraction system for the determination of eighteen trace elements in geochemical samples: *Analytical Chemistry*, v. 53, p. 61-65.
- Clark, J. R., and Viets, J. G., 1981, Back extraction of trace elements from organometallic-halide extracts for determination by flameless atomic absorption: *Analytical Chemistry*, v. 53, p. 65-70.
- Clark, J. R., and Viets, John G., 1983, Back extraction with three aqueous stripping systems for sixteen elements from organometallic-halide extracts: *Analytical Chemistry*, v. 55, p. 166-169.
- Clark, J. Robert, 1983, Geology and trace-element distributions of the sulfide bodies at Orchan mine, Matagami, Quebec: Ph.D. Thesis, Colorado School of Mines, Thesis No. 2586, 446 p.
- Viets, John G., Clark, J. Robert, and Campbell, W. L., 1983, A rapid sensitive partial leach and organic separation for the determination of Ag, Bi, Cd, Cu, Mo, Sb, Pb, and Zn in surficial geologic materials: *Journal of Exploration Geochemistry*, v. 20, p. 355-366.
- Clark, J. Robert, and Adrian, B. M., 1984, Geochemical map and interpretation for the Fossil Ridge Wilderness Study Area, Gunnison County, Colorado: U.S. Geological Survey Open-File Report 84-399, 15 p., 1 plate.
- Adrian, B. M., Clark, J. R., Arbogast, B. F., and Gruzensky, A. L., 1984, Analytical results and sample locality map of stream-sediment, panned-concentrate, and rock samples from the Fossil Ridge Wilderness Study Area, Gunnison County, Colorado: U.S. Geological Survey Open-File Report 84-419, 27 p., 1 plate.
- Viets, J. G., O'Leary, R. M., and Clark, J. Robert, 1984, Determination of arsenic, antimony, bismuth, cadmium, copper, lead, molybdenum, silver, and zinc in geologic materials by atomic absorption spectrometry: *Analyst*, v. 109, p. 1589-1592.
- Clark, J. R., and Viets, J. G., 1985 The extraction of molybdenum with a multielement liquid organic extraction system: *Analytical Chemistry*, v. 57, p. 2428-2429.
- Dewitt, Ed, Stoneman, R. J., Clark, J. R., Kluender, S. E., 1985, Mineral resource potential of the Fossil Ridge Wilderness Study Area, Gunnison County, Colorado: U.S. Geological Survey, MF-1629-A, 21 p.
- Clark, J. R., 1986, Electrothermal atomisation atomic absorption conditions and matrix modifications for determining antimony, arsenic, bismuth, cadmium, gallium, gold, indium, lead, molybdenum, palladium, platinum, selenium, silver, tellurium, thallium, and tin following back-extraction of organic aminohalide extracts: *Journal of Analytical Atomic Spectroscopy*, v. 1, p. 301-308.

### **Bibliography: (continued)**

- Clark, J.R., and Viets, J.G., 1990, Multielement extraction for determining nineteen trace elements in gold exploration samples: in: Gold'90, Society of Mining Engineers, Chapter 17, p. 175-179.
- Clark, J.R., Meier, A.L., and Riddle, G., 1990, Enzyme leaching of surficial geochemical samples for detecting hydromorphic trace-element anomalies associated with precious-metal mineralized bedrock buried beneath glacial overburden in northern Minnesota: in: Gold'90, Society of Mining Engineers, Chapter 19, p. 189-207.
- Taylor, M.E., Blome, C.D., Williamson, C., Clark, J.R., 1990, Syllabus for firearms safety training: U.S. Geological Survey, Open-File Report 90-92, 35 p.
- Knight, R.J., and Clark, J.R., 1991, Neutron activation analytical results and sample locality map of drill-cuttings from wells in northwestern Minnesota: U.S. Geological Survey, Open-File Report 91-44, 12 p.
- Riddle, G.O., Meier, A.L., Motooka, J.M., Erlich, O., Clark, J.R., Saunders, J.A., Fey, D.L., and Sparks, T., 1992, Analytical results for B-horizon soil samples, from the International Falls and Roseau 1X2 quadrangles, Minnesota/Ontario: U.S. Geological Survey, Open-File Report 92-721, 10 p. and 3.5-inch high-density computer disk.
- Klein, T.L., Day, W.C., Horton, R.J., Clark, J.R., Smith B.D., 1991, Regional geological setting and mineral resources of the Red Lake Indian Reservation, north central Minnesota, in Manydeeds, S.A., Smith, B.D., eds., Mineral Frontiers on Indian Lands, Bureau of Indian Affairs, p. 109-123.
- Porter, S.D., White, K.D., Clark, J.R., to WRD 1992, Distribution of metals and other trace elements in sediment and water of streams in the Kentucky River basin, Kentucky, 1987 through 1990. U.S. Geological Survey Open File Report, 263 p.
- Klein, T.L., Day, W.C., Clark, J.R., Horton, R.J., and Case, J.E., to ETR 1992, Mineral resource assessment of the U.S. portion of the International Falls 1x2 quadrangle, northern Minnesota: U.S. Geological Survey Bulletin, 125 p.
- Day, W.C., Klein, T.L., Horton, R.J., Clark, J.R., Carlson, R.R., and Smith, D.B., 1992, Geology, geophysics, soil geochemistry, and mineral resource assessment for the Red Lake Indian Reservation, northern Minnesota. Bureau of Indian Affairs Administrative Report, BIA-2-93I, 220 p.
- Klein, T.L., Day, W.C., Clark, J.R., Horton, R.J., and Green, G.N., 1992, Assessment of shear zone-hosted gold deposits for the Red Lake Indian Reservation, northern Minnesota, in: Manydeeds, S.A. (ed.), 1992, 1992 Mineral frontiers on indian lands. Bureau of Indian Affairs General Publication, G-92-2, p. 89-103.
- Clark, J.R., 1993. Enzyme-induced leaching of B-horizon soils for mineral exploration in areas of glacial overburden. Trans. Instn. Min. Metall. (Sect. B: Appl. earth sci.), v. 102, p. B19-B29 (invited paper). (See Honors, awards,.... above.)
- Clark, J.R., 1995, Method of geochemical prospecting. United States Patent 5,385,827, 20 pp. (Similar patents filed or issued in other countries and treaty conventions)
- Clark, J.R., 1996, Leach solution containing glucose, galactose, catalase, glucose oxidase, galactose oxidase, ascorbic acid and water soluble metal cyanides and halides. United States Patent 5,491,078, 23 pp. (Similar patents filed or issued in other countries and treaty conventions.)

### **Bibliography: (continued)**

- Clark, J.R., 1997, Concepts and models for interpretation of Enzyme Leach<sup>SM</sup> data for mineral and petroleum exploration: *in*: Enzyme Leach<sup>SM</sup> Models, Sampling Protocol & Case Histories, Activation Laboratories Ltd., Ancaster, Ontario, p. 1-62.
- Yeager, J.R., Clark, J.R., Mitchell, W., and Renshaw, R., 1998, Enzyme leach anomalies associated with deep Mississippi Valley-type zinc ore bodies at the Elmwood Mine, Tennessee. *Jour. Geoch. Expl.*, v. 61, p. 103-112
- Clark, J.R., and Hill, G.T., 2000, Structural Control of Oxidation Anomalies Above Buried Mineral Bodies, *in* Cluer, J.K., Price, J.G, Struhsacker, E.M., Hardyman, R.F., and Morris, C.L., eds., *Geology and Ore Deposits 2000: The Great Basin and Beyond*, Geological Society of Nevada Symposium Proceedings, Vol. II pp. 883-891.
- Hill, G.T. and Clark, J.R., 2000, Enzyme Leach Signatures of the Marigold 8 North and Clay Pit Gold Deposits, Humboldt County, Nevada, *in* Cluer, J.K., Price, J.G, Struhsacker, E.M., Hardyman, R.F., and Morris, C.L., eds., *Geology and Ore Deposits 2000: The Great Basin and Beyond*, Geological Society of Nevada Symposium Proceedings, Vol. II pp. 903-918.

### **Bibliography-Abstracts:**

- Clark, J. R., 1972, Paragenesis of the Jeff Price Mine, Cave-In-Rock District, Illinois: Alabama Academy of Science meeting, Spring 1972 (award for best student paper).
- Clark, J. R., 1973, Geology and geochemistry of the Seroyer Branch mafic-ultramafic complex, Chambers County, Alabama: Southeastern section, Geological Society of America, Abstracts with Programs.
- Clark, J. R., 1973, Selenium anomalies, health hazards and pyrite deposits, Chambers County, Alabama: Southeastern section, Geological Society of America, Abstracts with Programs.
- Viets, J. G., and Clark, J. R., 1978, Selective extraction of trace metals from halide acid solution using Aliquat 336 in methyl isobutyl ketone [abs.]: 176th American Chemical Society National Meeting, September, 1978, Miami, Florida, Abstracts of Papers, p. Hist. 039.
- Viets, J. G., Clark, J. R., and Campbell, W. L., 1978, A rapid, sensitive, partial leach and organic separation for the determination of Ag, Bi, Cd, Cu, Pb, Sb, and Zn by atomic absorption spectrometry [abs.]: Association of Exploration Geochemists, Basin and Range Symposium, Tucson, Arizona, April 9-10, 1979, Programs and Abstracts, p. 32.
- Clark, J. R., and Viets, J. G., 1979, A sulfide-selective leach and multi-element extraction system for the study of primary trace element dispersion patterns [abs.]: AIME National Meeting, Tucson, Arizona, October 16-19, 1979, Program, p. 13.
- Clark, J. Robert, 1983, Orchan Mine, Matagami, Quebec--A series of hydrometamorphic massive sulfide ore bodies (invited paper) [abs.]: Program with Abstracts, AIME Annual Meeting, Atlanta, Georgia, March 6-10, 1983, p. 22.
- Clark, J. Robert, Adrian B. M., Gruzensky, A., and Arbogast, B. F., 1984, A comparison of geochemical sampling and analytical techniques used for precious metal exploration in northeastern Gunnison County, Colorado [abs.]: *in* Exploration for ore deposits of the North American Cordillera, Program with Abstracts, Association of Exploration Geochemists Symposium, Reno, Nevada, March, 1984, p. 43.

### **Bibliography-Abstracts: (continued)**

- Clark, J. R., Meier, A. L., O'Leary, R. M., Riddle, G., Motooka, J., and Erlich, O., 1988, Enzyme leaching of B-horizon soil samples for studying hydromorphic trace-element anomalies in glacial overburden in the International Falls 1 x 2 quadrangle, Minnesota: State of Minnesota Minerals Coordinating Committee, Fifth Annual Current Minerals Activities Forum, Iron World USA, Chisholm, MN, September 29-30, 1988.
- Clark, J. R., Bloom, Duane, Saunders, James A., and Day, Warren C., 1988, Pilot study of the use of soil gases for detection of sulfide-mineralized bedrock covered by glacial overburden in the International Falls 1 x 2 quadrangle, Minnesota: State of Minnesota Minerals Coordinating Committee, Fifth Annual Current Minerals Activities Forum, Iron World USA, Chisholm, MN, September 29-30, 1988.
- Clark, J.R., 1990, Potential for Thunder Bay-type silver deposits in the International Falls quadrangle, MN: U.S. Geological Survey, Executive Announcement, 2 p.
- Clark, J.R., Day, W.C., Klein, T.L., 1990, Geochemical and Geological evidence for lode-gold deposits in Lake of the Woods and Koochiching Counties, near Baudette, MN: U.S. Geological Survey, Executive Announcement, 1 p.
- Clark, J.R., and Viets, J.G., 1990, Multielement extraction for determining nineteen trace elements in gold exploration samples: Program with Abstracts, AIME Annual Meeting, Salt Lake City, Utah, February 26-March 1, 1990, p. 91.
- Clark, J.R., Meier, A.L., and Riddle, G., 1990, Enzyme leaching of surficial geochemical samples for detecting hydromorphic trace-element anomalies associated with precious-metal mineralized bedrock buried beneath glacial overburden in northern Minnesota: Program with Abstracts, AIME Annual Meeting, Salt Lake City, Utah, February 26-March 1, 1990, p. 92.
- Clark, J.R., 1990, Geochemical evidence for precious metal mineralization in the International Falls and Roseau 1°x2° quadrangles, Minnesota: Mesabi Range Geological Society, April 25, 1990, Invited Lecture.
- Clark, J.R., Meier, A.L., and Riddle, G., 1990, Soil geochemistry as a guide to precious metal mineralization in the International Falls and Roseau 1°x2° quadrangles, Minnesota: State of Minnesota Seventh Annual Current Minerals Activities Forum, Chisholm, MN, October 5, 1990.
- Clark, J.R., and Russ, G.P., 1991, A new enzyme partial leach enhances anomalies in pediment soils near buried gold deposits: Fifteenth International Geochemical Exploration Symposium, Association of Exploration Geochemists, Reno, NV, April 29-May 1, 1991.
- Clark, J.R., 1991, Enzyme leaching of B-horizon soils for mineral exploration in areas of glacial overburden. Ninth International Conference on Prospecting in Areas of Glaciated Terrain: Exploration and the Environment, Edinburgh, Scotland, September 2-4, 1991.
- Day, W.C., Klein, T.L., Horton, R.J., Clark, J.R., Smith, B.D., 1992, Preliminary Mineral Resource Assessment of the Red Lake Indian Reservation, north central Minnesota, in Manydeeds, S.A., ed., Bureau of Indian Affairs Energy and Mineral Forum, Lakewood, Colorado, February 6, 1992.
- Clark, J.R., 1992, Detection of bedrock-related geochemical anomalies at the surface of transported overburden. *Explore*, no. 76 (July), p. 1-11.
- Clark, J.R., 1992, Partial leach technique yields clues to bedrock chemistry. U.S. Geological Survey, Office of Mineral Resources Newsletter, vol. 3, no. 3, p.5.

### **Bibliography-Abstracts: (continued)**

- Clark, J.R., 1992, Detection of geochemical dispersion processes by enzyme leaching. Geochemical Exploration Discussion Group, Association of Exploration Geochemists, Colorado School of Mines, November, 1992.
- Clark, J.R., Kretschmer, E.L., 1993, Enzyme Leach *B*-horizon soil anomalies over the buried Mag and Clay Pit ore deposits, Getchell Trend, Nevada, USA. Sixteenth International Geochemical Exploration Symposium, Beijing, China, September, 1993.
- Clark, J.R., 1993, Application of Enzyme Leach Provides Cost-Effective Definition of Surficial Anomalies Related to Deeply Buried Ore Bodies. Northwest Mining Association meeting, Spokane, WA, December, 1993.
- Clark, J.R., 1994, Enzyme Leach Provides Cost-Effective Definition of Surficial Anomalies Related to Deeply Buried Reduced Bodies. Northwest Mining Association meeting, Spokane, WA, December, 1994.
- Clark, J.R., and Cohen, D.R., 1995, Innovative Enzyme Leach provides cost-effective overburden penetration. Seventeenth International Geochemical Exploration Symposium, Townsville, Australia, May, 1995.
- Clark, J.R., 1995, Innovative Enzyme Leach provides cost-effective overburden penetration. Pacific Northwest Mining and Metallurgical meeting, Seattle, WA.
- Clark, J.R., 1996, Unique significant Enzyme Leach anomaly patterns in areas of tropical/subtropical weathering. Geochemical Exploration in Tropical and Subtropical Environments, colloquium presented by Queens University, Kingston, Ontario, 29 September - 4 October 1996, pp. 9.
- Clark, J.R., 1997, Trends in analytical geochemistry for mineral exploration. Geoanalysis '97, Vail, CO, June, 1997. (invited paper)
- Cohen, D.R., Kelley, D.L., Clark, J.R., 1997, Selective geochemical extractions - balancing kinetics vs. Selectivity. Geoanalysis '97, Vail, CO, June, 1997.
- Clark, J.R., Yeager, J.R., Rogers, P., Hoffman, E.L., 1997, Innovative Enzyme Leach Provides Cost-effective Overburden/Bedrock Penetration. Exploration '97 Symposium, Toronto, ON, September, 1997.
- Clark, J.R., 1999, Oxidation Anomalies - A Geochemical Phenomenon Associated with Deeply Buried Reduced Bodies (poster). 19th Int. Geoch. Expl. Symp., Vancouver, BC, April, 1999.
- Clark, J.R., 1999, Oxidation Anomaly Patterns and Genesis Models. 19th Int. Geoch. Expl. Symp., Workshop, April 1999.
- Clark, J.R. 2000, Detection of Blind and Glacially Buried Mineralized Bodies in Alpine and High Latitude Terrains Using Enzyme Leach<sup>SM</sup> Soil Surveys. Alaska Miners Congress, Fairbanks, AK, March 2000.
- Hill, G.T., Clark, J.R., and Lovstrom, K.A., 2001, Complementary Selective Extraction and Vegetation Geochemical Patterns at the I-10 and Dragoon Skarn/Porphyry Deposits, South-central, Arizona. International Geochemical Exploration Symposium, Association of Exploration Geochemists, Santiago, Chile, April, 2001.
- Clark, J.R., Sutherland, D., Hoffman, E.L., Hill, G.T., 2001, Independent Complementary Inorganic and Organic Soil Geochemical Techniques for Mapping Reservoirs and Subsurface Structures. Canadian Society of Petroleum Geologists Annual Meeting, Calgary, AB, June 2001.

**Bibliography-Abstracts: (continued)**

- Clark, J.R., Sutherland, D., Hoffman, E.L., Hill, G.T., Leng, D., 2001, Independent Complementary Inorganic and Organic Soil Geochemical Techniques for Mapping Reservoirs and Subsurface Structures. Ontario Petroleum Institute annual meeting, London, ON, November 2001.
- Clark, J.R., Hill, G.T., and Tompkins, Reed, 2003, Mapping of Reservoirs and Subsurface Structures Using Selective Analysis of the Surface Chemistry of Soil Particles. American Assoc. of Petroleum Geologists annual meeting, Salt Lake City, May, 2003.
- Clark, J.R., Hill, G.T., Lovstrom, K.A., 2003, Subsurface Mapping Using Complementary Selective Extractions and Biogeochemistry at the I-10 Skarn/Porphyry and the Sol Porphyry Deposits, South-central, Arizona. GAC-MAC-SEG meeting, Vancouver, BC, May, 2003.

**Detailed Career Experience:**

<b>Dates</b>		<b>Description of work or position:</b>
<b>From:</b>	<b>To:</b>	
6/70	9/70	Petroleum Geologist, Texaco, Jackson district, New Orleans, Louisiana. Reworked the geology of the Tallahalla Creek field, a Smackover field in Mississippi. Designed numerous seismic surveys, and attended various Texaco technical schools.
1970	1973	Teaching and Research Assistant, University of Alabama, Geology Department; M.Sc. Research Program, a study of a mafic-ultramafic complex in the Alabama Piedmont.
1972	(6 mo.)	Research Assistant, Alabama Geological Survey. Evaluated 32 proposed dam sites; regional geochemical soil sampling; assisted in regional geological mapping.
9/73	4/75	Research Assistant, McGill University, Geology Department, Montreal, Quebec. Worked on new methods of flameless atomic absorption analysis. Initiated Ph.D. research program.
5/74	8/75	Research Geologist, Noranda Exploration Company, Ltd., Noranda, Quebec. Conducted study of Orchan Mines, Ltd. Involved checking the logging on about 35,000 feet of drill core; collecting approximately 4,000 core samples; mapping selected active areas of the mine; gathering evidence regarding the origin of the ore deposit. Managed an exploration camp for Noranda.
9/75	8/80	Research Assistant, Colorado School of Mines, Geology Department. (1) Performed duties of manager of the geochemical laboratory. (2) Integrated economic geology, exploration geochemistry, and analytical geochemistry into a study of Orchan Mine, Matagami, Quebec.

**Detailed Career Experience: (continued)**

<b>Dates</b>		<b>Description of work or position:</b>
<b>From:</b>	<b>To:</b>	
1976	1979	Exploration geochemistry short courses. Assisted Harold Bloom in the presentation of short courses for geologists working in industry. Purpose was to present the theory and methods of exploration geochemistry to industrial scientists who have a limited knowledge of the subject.
1977	1978	Geologist, National Science Foundation research project. Contracted to develop a new method of performing lithium isotope analyses on lithochemical samples that could possibly be used in mineral exploration.
6/78	10/80	Geologic Field Assistant, U.S. Geological Survey, Branch of Exploration Research, Geologist. (1) Exploration geochemistry methods research: Developed new, improved methods of analyzing geochemical samples for mineral exploration purposes. Partial leaches were developed for detecting both secondary (surficial) and primary geochemical dispersion patterns around ore bodies. (2) Co-developed a 24-trace element-organic extraction system that can be used with a variety of sample leach procedures. This extraction system has been widely applied through the world in industry, government, and academia.
10/80	12/81	Student Appointment, U.S. Geological Survey, Branch of Exploration Research. Developed plans for a strategic metals research program. Project goals were established, a five-year outline was developed, budgets were drawn up, manpower utilization planned, and equipment needs and periods of use were projected.
12/82	9/84	Geologist, U.S. Geological Survey, Branch of Exploration Geochemistry. Principle investigator on a geochemical study of a 160 square mile area, the Fossil Ridge Wilderness study area, Gunnison County, Colorado. Trace element anomalies in stream sediment, panned concentrate, and rock samples were used to define large Au-Ag mineralized areas, three of which had not been found by previous prospecting. A geochemical report was prepared which presented the interpretations.
12/81	5/93	Geologist, U.S. Geological Survey, Branch of Exploration Geochemistry and Branch of Geochemistry. Conducting studies of the applications of partial leaches, including enzyme leaches, for surficial samples. Studying mechanisms of trace-element migration through transported overburden and processes of anomaly formation in soils developed on such overburden. This research has been conducted in areas of extensive, complex glacial overburden in the north-central United States, and in the Great Basin, and the Atacama desert of Chile where the bedrock is masked by basin-fill sediments. Different processes of trace-element dispersion and anomaly formation have been identified in both humid and arid climates.

**Detailed Career Experience: (continued)**

<b>Dates</b>		<b>Description of work or position:</b>
<b>From:</b>	<b>To:</b>	
10/83	5/93	Project Chief of International Falls and Roseau, Minnesota, Conterminous United States Mineral Assessment Program (CUSMAP) geochemical projects, U.S. Geological Survey, Branch of Exploration Geochemistry/Branch of Geochemistry. Objective: To detect the presence of base metal sulfides and precious metals mineralized bedrock in Archaean volcanic rocks by geochemical methods. Most of the study area, which covered 1?latitude x 4? longitude (International Falls and Roseau sheets) in northwestern Minnesota, is masked by thick deposits of glacial till and lake sediments. A long-term integrative soil-gas detection procedure was cooperatively tested for the measurement of gases emanating from glacially buried sulfide deposits. Geochemical methods were developed and tested in the study area to ascertain their usefulness for detecting hydromorphic anomalies of trace metals associated with buried mineralization. Regional-scale vegetation sampling was also tested. As a result of the development of a radically-new partial leach procedure, soil anomalies were found that suggest the possibility of a previously unsuspected vein-silver district in northern Minnesota, and other anomalies indicate the likely occurrence of a lode-gold district near Baudette, MN. A geochemical evaluation of the Red Lake Indian Reservation was incorporated into this project in 1991.
10/84	5/87	Manuscript Review Committee (Chairman 5/85 to 5/87), U.S. Geological Survey, Branch of Geochemistry. Responsible for selecting reviewers, and evaluating corrections of manuscripts.
5/87	3/88	Project Chief for stream sediment geochemistry, Illinois River basin and Kentucky River basin National Water Quality Assessment (NAWQA) projects, U.S.G.S. Branch of Geochemistry. The NAWQA Program is intended to establish a baseline for the nation's water quality, and was being conducted jointly with Water Resources Division. Four surface water basins were chosen for the initial phase of the program. Geologic Division was responsible for evaluation of the contaminants in the stream sediments of these basins. As the only geologist assigned to the program, I interacted closely with BGC and WRD personnel in program design and in planning and coordination of these prototype projects.
5/87	3/89	Alaska Mineral Resource Assessment Program (AMRAP) Geochemical Coordinator, U.S. Geological Survey, Branch of Geochemistry. Responsible for supervising AMRAP project chiefs and personnel. During this period, Livengood, Lime Hills, and Bethel projects were at the peak of their field activity. Seldovia was in its initial year, and Gulkana had to be salvaged. Involved in planning these projects, with regard to staffing, helicopter contracts, and budgeting. Progress for each field season was evaluated with the project chief in preparation for planning the next year's work.

**Detailed Career Experience: (continued)**

<b>Dates</b>		<b>Description of work or position:</b>
<b>From:</b>	<b>To:</b>	
1/88	4/88	Member of search committee to find geologist/geochemist to fill new position in the Spokane, WA field office.
5/88	5/92	Instructor, Firearms Safety Course, U.S. Geological Survey, Geologic Division, Central Region. Assist in instruction of Department of Interior employees in the safe handling and proper use of firearms, in case they are attacked by a dangerous animal while doing field work. Responsible for lecture on bear behavior.
5/93	9/03	General Manager of and partner in Enzyme-ACTLABS, LLC, a part of the Actlabs group of service companies. Development and commercialization of analytical geochemical products utilizing ICP-MS: Enzyme Leach <sup>SM</sup> , TerraSol <sup>SM</sup> , other selective extraction methods, a 68-element hydrogeochemical method, a 40-element lithochemical package, a Pb in pharmaceuticals method, a U in urine method,.... Presented dozens of selective extraction workshops. Guest lecturer at various conferences. Conducted extensive research on mapping subsurface features using selective extractions of soils or marine sediments, and on the mechanisms of pattern formation. Activities included personnel management, budgeting, writing business plans, customer interaction, and business development.