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PRELIMINARY LIST OF WORKS

IN

INDUCED SEISMICITY RELATED TO FLUID INJECTION

by

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for

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INTRODUCTION

This list of papers and articles from professional and learned journals was assembled to provide a point of departure for hydrogeological and geomechanical studies in the Cold Lake Oil Sands. While the list is fairly extensive, it makes no pretext of being exhaustive; although a substantial effort was made to identify any published work that might pertain to the topic. Those titles marked with an asterisk have been reviewed for relevance and are on open file in the Research Management Division.

The authors welcome any comments or corrections that readers may wish to pass on.

THEORY: GENERATION AND PROPAGATION OF MICROSEISMS

1.

- Aki, K., M. Fehler, & S. Das. 1977 Source mechanism of volcanic tremor; fluid driven crack models and their application to the 1963 Kilavea eruption. Journal of Volcanology and Geothermal Research 2(3): 259-287.
- Burkhardt, H. & R. Vees. 1976 Seismic signals from quarry blasts
 IN: Explosion Seismology in Central Europe: Data and Results.
 ED: Giese, P. Springer-Verlag for Deutsche Geophysikalische
 Gesellschaft., European Seismological Commission, Crustal and
 Upper Mantle Structure in Europe Monograph 1.pp. 62-72.
- Byerlee, J.D. & D. Lockner. 1977 Acoustic emission during fluid injection into rock IN: Acoustic Emission/Microseismic Activity in Geologic Structures and Materials. Proceedings of the First Conference held at Pennsylvania State University, University Park, Pennsylvania, Pa., June 9-11, 1975. ED: Hardy, H.R. Jr. & F.W. Leighton. Trans. Tech. Publications, 1977, Clausthal, Germany. pp. 87-98.
- Byerlee, J.D. 1974 Acoustic emission in rock during fluid injection IN: Advances in Rock Mechanics. Proceedings of the Third International Congress of the International Society of Rock Mechanics held in Denver, Colorado, September 1-7, 1974. The National Academy of Sciences, Washington, DC. 1974. Volume 2. Part A. pp. 633-637.

Cook, N.G.W. 1976 Seismicity associated with mining. Engineering Geology (Amsterdam) 10: 99-122. X

- Cornet, F.H. 1977 Study of acoustic and microseismic emissions associated with a hydrolic fracture IN: <u>Geothermal Energy</u>. A Seminar held in Brussels, Belgium, December 1977. Commission of the European Communities, Luxembourg, Belgium. 1977. EUR 5, 920. pp. 685-691.
- Domenico, P.A. & V.V. Palciauska. 1979 Thermal expansion of fluids and fracture initiation in compacting sediments: Summary. Geology Society of America Bulletin 90(6): 953-979.
- Diab, B. 1976 An explanation of the origin of the energy released during seismicity associated with reservoirs. Engineering Geology (Amsterdam) 10:283-292.
- Duvall, W.I. & D.E. Stephenson. 1965 Seismic energy available from rockbursts and underground explosions. The American Institute of Mining, Metallurgical and Petroleum Engineers Transactions 232(3): 235-240.
- Gupta, H.K., B.K. Rastogi, & H. Narain. 1972 Common features of the reservoir-associated seismic activities. Seismological Society of America Bulletin 62: 481-492.

- Hanson, M.E. 1980 Some results from continuum mechanics analyses of the hydraulic fracturing process. The American Institute of Mining, Metallurgical, and Petroleum Engineers. The Society of Petroleum Engineers Transactions 20(2): 86-94.
- Hodgson, K. & N.G.W. Cook. 1971 The mechanism, energy content and radiation efficiency of seismic waves generated by rockbursts in deep-level mining. IN: <u>Dynamic Waves in Civil</u> <u>Engineering</u>. ED: Howells, D.A., et al. Wiley-Interscience, <u>New York, N.Y.</u> pp. 121-135.
- Ito, H., J. Devilbiss, & A. Nur. 1979 Compressional and shear waves in saturated rock during water-stream transition. Journal of Geophysical Research 84 (No. B9): 4731-4735.
- Kintzinger, P.R. 1976 Seismic signal location program for the Los Alamos Scientific Laboratory's dry hot rock geothermal project. NTIS Report No. LA 6274MS. March 1976. 22 pp.
- Kisslinger, C. 1976 A review of theories of mechanisms of induced seismicity. Engineering Geology (Amsterdam)(2-4): 85-98
- Knapp, R.B. & J.E. Knight. 1977 Differential thermal expansion of pore fluids: fracture propagation and microearth quake production in hot pluton environments. Journal of Geophysical Research 82(17): 2515-2522.

- Knoll, P. 1978 Liquid induced seismic events expression for the behavior of fissured rock as a multi phase system. IN: <u>Grundlagen und Anwendung der Felsmechanik</u>. Proc. Felsmech. Kolloquium. Univ. Karlsruhe, F.R. Germany, February 1978. Trans. Tech. Publications, Aedermannsdorf, Switzerland. 1978. pp. 167-175.
- Konstantinova, A.G., L.G. Mysyna, & V.S. Ivanov. 1965 Analysis of seismo-acoustical processes accompanying strong sudden bursts of coal and gas. Physics of the Solid Earth Bulletin 11: 767-770 (supersedes in part Akademira Nauk SSSR.) Izvestiia. Geophysics Series. Translation of: Akedemiia Nauk. SSSR. Izvestiia. Fizika Zen 11.
- McGarr, A. & G.A. Wiebols. 1977 Influence of mine geometry and closure volume on seismicity in a deep level mine. International Journal of Rock Mechanics and Mining Sciences and Geomechanics Abstracts 14: 139-145.
- McGarr, A. & R.W.E. Green. 1975 Measurement of tilt in a deeplevel gold mine and its relationship to mining and seismicity. The Geophysical Journal of the Royal Astronomical Society 43: 327-345.

McClain., W.C. 1970 On earthquakes produced by underground fluid injection. The United States National Laboratory, Oak Ridge, Tennessee. ORNL-TM 3154. McGuire, R.K. 1978 Seismic ground motion parameter relations. The American Society of Civil Engineers, Geotechnical Engineering Division Journal 104(4): 481-.

Mineiro, A.J.C. 1978 Seismic behavior of earth dams-permanent displacement prediction. Geotecnia (No. 24, November): 89-130.

Morris, R.L., D.R. Grine, & T.E. Arkfeld. 1964 Using compressional and shear acoustic amplitudes for the location of fractures. Journal of Petroleum Technologic (June): 623-635.

Pondit, B. & M.S. King. 1978 Influence of pore fluid salinity on seismic and electrical properties of rocks at permafrost temperatures IN: <u>Permafrost</u>. The Third International Conference held in Edmonton, Alberta, Canada, July, 1978. National Research Council, Ottawa, Ontario, Canada. Volume I. pp. 553-559.

Pollard, D.D. & G.R. Holzhausen. 1979 On the mechanical interaction between a fluid-filled fracture and the earth's surface. Tectonophysics 53: 27-57.

- Ren Jen Sun. 1969 Theoretical size of hydraulically induced horizontal fractures and corresponding surface uplift in an idealized medium. Journal of Geophysical Research 74: 5995-6011.
- Rozsa, R.B. & R. Quong. 1975 In-situ permeability testing transient pulse and steady state. University of California, Lawrence Livermore Laboratory, Berkeley, California. UCRL51731. January 6, 1975(12).
- Savarensky, E.F. & E.M. Antonenko. 1976 Short period seismic noise in engineering seismology and microseismic zoning.
 IN: (No Title). Proceedings of the Fifteenth General Assembly of the European Seismological Commission, Krakow, Poland, September, 1976. Part II. Polish Academy of Sciences, Publication of the Institute of Geophysics A5-116. 1977. pp. 5-20.
- Schuster, C.L. & R.W. Seavy. 1978 Seismic activity generated by hydraulic fracturing IN: <u>The American Society of Mechanical</u> <u>Engineers Technology Conference</u>. Held in Houston, Texas, November 5, 1978. NTIS. SAND-78-0072C 79-13 8K PCA A02/MF A01.
- Shuck, L.Z. & T.W. Keech. 1977 Monitoring acoustic emission from propagating fractures in petroleum reservoir rocks IN: <u>Acoustic</u> <u>Emission/Microseismic Activity in Geologic Structures and</u> <u>Materials</u>. Proceedings of the First Conference held at Pennsylvania State University, University Park, Pennsylvania, Pa. June 9-11, 1975. ED: Hardy, H.R. Jr. & F.W. Leighton. Trans Tech. Publications, 1977, Clausthal, Germany. pp. 309-338.

Simpson., D.W. 1976 Seismicity changes associated with reservoir loading. Engineering Geology (Amsterdam)10: 123-150.

Trombik, M. 1975 Determination of the crack and fissure area around mine openings by measurement of the propagation speed of seismic waves(Czechoslovakia). IN: <u>Mining Geophysics</u>. Seminar of the Czechoslovakian Academy of Sciences, Mining Institute, Prague, Czechoslovakia, November, 1973. Acta Montana IV(32): 231-241.

Warpinski, N.R., D.A. Northrop & R.A. Schmidt. 1978 Direct observation of hydraulic fractures - behavior at a formation interface. Sandia National Laboratories, Albuquerque, New Mexico, U.S.A. Report SAND 78-1935. 19 pp.

Warren, N.W. & G.U. Latham. 1970 An experimental study of thermally induced microfracturing and its relation to volcanic seismicity. Journal of Geophysical Research 75(23): 445-464.

Werner, S.D., L.C. Lee, H.L. Wong, & M.D. Trifunac. 1979 Structural response to travelling seismic waves. The American Society of Civil Engineers, Structural Division Journal 105(11-12): 2547-2564.

Witherspoon, P.A. & J.E. Gale. 1977 Mechanical and hydraulic properties of rocks related to induced seismicity. Engineering Geology 11(1): 23-55. Yerkes, R.F. & R.O. Castle. 1976 Seismicity and faulting attributable to fluid extraction. Engineering Geology (Amsterdam)10: 151-167.

2. INSTRUMENTATION

Dennis, B.R., J.H. Hill, E.L. Stephani & B.E. Todd. 1976 Development of high temperature acoustic instrumentation for characterization of hydraulic fractures in dry hot rock. Los Alamos Scientific Laboratories. Report No. LA-UR-76-493. NTIS. Conference No. 760513-2. 15 pp.

- Evans, K.F., G.R. Holzhausen, & M.D. Wood. 1980 Mapping hydraulic fracture growth by observation of surface deformation - an example.IN: Unconventional Gas Recovery Symposium. Proceedings of the First Annual Symposium held in Pittsburgh, Pa., May 18-20, 1980. The American Institute of Mining, Metallurgical, and Petroleum Engineers, Society of Petroleum Engineering, Dallas, Texas. 40 pp.
- Hardy, H.R. & G.L. Mowrey. 1977 Study of underground structural stability using near surface and down-hole microseismic techniques. IN: <u>Rock Mechanics</u>. Proceedings of an International Symposium held in Zurich, Switzerland, April, 1977. A.A. Balkema, Rotterdam, Holland. 1977. Volume I. pp. 75-92.
- Hardy, H.R. Jr., J.W. Comeau & R.Y. Kim. 1977 Development of a microseismic borehole probe for monitoring the stability of geologic structures. IN: <u>Rock Mechanics</u>. Proceedings of the Eighteenth Symposium held in Keystone, 1977. ED: Wang, F.D., & G.B. Clark. Colorado School of Mines Press, Colorado. pp. 2A5-1-3A5-7. No further information available.

- Hardy, H.R. & F.L. Mowrey. 1976 Study of microseismic activity associated with a longwall coal mining operation using a near surface array. Engineering Geology (Amsterdam) 10:263-281.
- Hutton, P. 1969 Detecting acoustic emission in the presence of hydraulic noise. Non destructive testing:(British). Volume II(No. 2). No further information available. This issue of this volume not available in Alberta.
- Keck, L.J. & R.W. Seavey. 1977 Instrumentation system for massive hydraulic fracture mapping. The United States Atomic Energy Commission, Sandia Laboratories, Albuquerque, New Mexico. SAND-77-0195. April 1977. 57 pp.
- Power, D.V., C.L. Shuster, R. Hay, and J. Twombly. 1975 Detection of hydraulic fracture orientation and dimensions in cased wells. IN: <u>The Fiftieth Annual Meeting of the American Institute of</u> <u>Mining, Metallurgical, and Petroleum Engineers</u>, Society of Petroleum Engineers, held in Dallas, Texas, September 28-October 1, 1975. SPE 5626.
- Schuster, C.L. & L.J. Keck. 1978 Results from a MHF surface electrical potential mapping experiment IN: East Gas Shales Symposium. Proceedings of the First Symposium held in Morgantown, West Virginia, October 17-19, 1977. Sponsored by the Morgantown Energy Research Centre, West Virginia, 1978. NTIS, Springfield, Va. pp. 426-433.

- Schuster, C.L. 1978 Detection within the well bore of seismic signals generated by hydraulic fracturing. IN: <u>The Fifty-Third Annual Fall Conference of the American Institute of Mining, Metallurgical, and Petroleum Engineers, Society of Petroleum Engineers, held in Houston, Texas, October 1-3, 1978. NTIS. United States Department of Commerce. SAND 78-0664C 79-03 81 PCA02/MF A01. CONF -781003-3. Contract EY-76-C-04-0789. 7 pp.</u>
- Wood, M.D., G. Holzhausen, C. Smith., S. Porter, W. Bachmann, & M. Khaw. 1981 A system for mapping and monitoring subsurface processes in enhanced recovery schemes IN: <u>The</u> <u>Future of Heavy Crude and Tar Sands</u>. The First International <u>Conference held in Edmonton, Alberta, Canada, June 4-12,</u> 1979. ED: Meyer, R.F., & C.T. Steele. McGraw-Hill Inc., New York, N.Y.

- Beck, L.A. 1974 Determination of seismic velocity with application to microseismic field studies. Thesis. Pennsylvania State University, Department of Mineral Engineering, Pennsylvania, Pa. 218 pp.
- Greenfield, R.J. 1977 Amplitudes and spectra from underground sources IN: <u>Acoustic Emission/Microseismic Activity in Geologic Structures and Materials</u>. Proceedings of the First Conference at Pennsylvania State University, University Park, Pennsylvania, Pa., June 9-11, 1975. ED: Hardy, H.R. Jr. & F.W. Leighton. Trans. Tech. Publications, 1977, Clausthal, Germany. pp. 405-425.
- Haimson, B.C. 1977 Crustal stress in the continental United States as derived from hydro-fracturing tests. American Geophysical Union Monograph No. 20. 1977a.
- Kintzinger, P.R. 1976 Seismic signal location program for the Los Alamos Scientific Laboratory's dry hot rock geothermal project. NTIS. Report No. LA 6274MS. March, 1976. 22 pp.



4. CASE HISTORIES

- Albright, J.N., R.J. Hanold, & B. Linville (Editors). 1976 Seismic mapping of hydraulic fractures made in basement rocks. IN; Enhanced Oil and Gas Recovery. Proceedings of the Second United States Energy, Research and Development Administration Symposium held in Tulsa, Oklahoma, September 9-10, 1976. Sponsored by the United States Energy, Research and Development Administration and the University of Oklahoma, Tulsa, Oklahoma. Volume II, Gas. pp. C8.1 -C8.13.
- Ball, F.C. & G.R. Downs. 1966 Report of Investigations. Study of possible connection between operation of RMA disposal well and earthquakes in Derby, Colorado area. App. 1. Report of Investigation. Injection well earthquake relationship, Rocky Mountain Arsenal, Denver, Colorado. United States Army Corps Engineers, Omaha, Nebraska. 24 pp.
- Bamford, D. & K.R. Nunn. 1979 In-situ seismic measurements of crack anisotrophy in the carboniferous limestone of northwest England. Geophysical Prospecting 27(2): 322-338.
- Bardwell, G.E. 1966 Some statistical features of the relationship between the Rocky Mountain Arsenal waste disposal and the frequency of earthquakes. Mountain Geologist 3(1): 37-42.
- Buckles, R.S. 1979 Steam stimulation heavy oil recovery at Cold Lake, Alberta. The American Institute of Mining, Metallurgical, and Petroleum Engineers, California Regional Meeting held at Ventura, California, April 18-20, 1979. SPE 7994.

- Choudhury, M.A. 1977 Research and characterization of seismic noise in geothermal areas. IN: <u>Geothermal Energy</u>. Seminar held in Brussels, Belgium, December, 1977. The Commission of the European Communities, Luxembourg, Belgium. EUR 5, 920. 1977. pp. 723-731.
- Combs, T. & Y. Rotstein. 1976 Microearthquake studies of the Coso geothermal area, China Lake, California. IN: Proc. Second U.N. Symp. Develop. Use. Geothermal Res. 2: 909-916.
- Cook, C.E. Jr. 1974 Effect of fracturing fluids on fracture conductivity. IN: <u>The Forty-Ninth Annual Fall Meeting of the</u> <u>American Institute of Mining, Metallurgical, and Petroleum</u> <u>Engineers</u>, The Society of Petroleum Engineering, held in Houston, Texas, October 6-9, 1974. SPE 5114.
- Crow, N.B. & F.W. Kasameyer. 1978 Monitoring natural subsidence and seismicity in the Imperial Valley as a basis for evaluating potential impacts of geothermal production. Presented at the Geothermal Resources Council, the Second Annual Conference, Hawaii, July 25-27, 1978. Volume II. Section 1. p. 125 -128.
- Dietrich, J.H., C.B. Raleigh, & J.D. Bredehoeft. 1972 Earthquake triggering by fluid injection at Rangely, Colorado. IN: <u>Per-</u> <u>colation Through Fissured Rock</u>. Proceedings of the Symposium of the International Society for Rock Mechanics held in Stuttgart, West Germany, 1972. Dtsch. Ges. Erd. Grundbau, Stuttgart, West Germany. p. T2-B.

- Evans, D.M. 1966 The Denver area earthquakes and the Rocky Mountain Arsenal disposal well. Mountain Geologist 3(1): 23-36.
- Handin, J. & C.B. Raleigh. 1972 Man made earthquakes and earthquake control. IN: <u>Percolation Through Fissured Rock</u>. Proceedings of the Symposium of the International Society for Rock Mechanics. Stuttgart, Germany, 1972. Dtsch. Ges. Erd. Grundbau, Stuttgart, Germany. p. T2-D.
- Hollister, J.C. & R.J. Weimer (editor). 1968 Geophysical and geological studies of the relationships between the Denver Earthquakes and the Rocky Mountain Arsenal Well. Part A. Part B. Maps. Colorado School of Mines Quarterly 63(1): 1-251.
- Holzhausen, G.R., M.D. Wood, J.M. Raisbeck, & C.C. Card. 1980 Results of deformation monitoring during steam stimulation in a single well test. IN: <u>Applied Oilsands Geoscience</u> <u>Conference</u>. Proceedings held at the University of Alberta, <u>Edmonton</u>, Alberta, June 11-13, 1980. No publisher given.
- Holzhausen, G.R. & M.D. Woods. 1980 Control and optimization of hydraulic fracturing and in-situ thermal recovery by surface deformation monitoring IN: <u>Applied Oilsands Geoscience</u> <u>Conference</u>. Proceedings held at the University of Alberta, Edmonton, Alberta, June 11-13, 1980. No publisher given.

- Keck, L.J. & C.L. Schuster. 1978 Shallow formation hydrofracture mapping experiment. The American Society of Mining and Metallurgical Engineers Transactions, Journal of Pressure Vessel Technology 100(1): 24-27.
- Liaw, A.L.C. 1977 Microseisms in geothermal exploration: studies in Grass Valley, Nevada. University of California, Berkeley, California. PhD. Thesis. 1977. 188 pp.
- Lockner, D.A. & J.D. Byerlee. 1977 Hydrofracture in Weber Sandstone at high confining pressure and differential stress. Journal of Geophysical Research 82(14): 2018-2026.
- McCann, R.P. 1977 Massive hydraulic fracture mapping and characterization program. Surface potential data for Watenberg 1975-1976 experiments. NTIS. SAND-77-0396 78-06 81 PC A04/MF A01. 55 pp.
- McCann, R.P., R.G. Hay, & L.C. Bartel. 1977 Massive hydraulic fracture mapping and characterization program. First Annual Report. August 1975-July 1976. Sandia Laboratories, Albuquerque, New Mexico. Report No. SAND-77-0286. June 1977. 131 pp.

McClain, W.C. 1971 Seismic mapping of hydraulic fractures. NTIS. Report ORNL-TM 3502. McKananagh, B.M., J.R. Enever, A.F. Siggins, & J. McKay. 1978 Evaluation of the microseismic technique for outbursts warning at West Cliff Colliery, Australia. CSIRO Australia Division Div. Appl. Geomech. Techn. Rep. No. GCM4, 1978 29 pp.

Milne, W.G. & M.J. Berry. 1976 Induced seismicity in Canada. Engineering Geology (Amsterdam) 10:219-226.

Northrop, D.A., N.R. Warpinski, R.A. Schmidt, & C.W. Smith. 1978 Simulation and mineback experiment project. The direct observation of hydraulic and explosive fracturing tests. IN: Enhanced Oil and Gas Recovery and Improved Drilling Methods.
Proceedings of the Fourth United States Department of Energy Symposium held in Tulsa, Oklahoma, August 29-31, 1978. Pet. Pub. Co., Tulsa, Oklahoma. 1978. 14 pp. NTIS CONF-78 0825-2. SAND-78-0682C 79-05 81 PC A021/MF A01.

Ohtake, M. 1974 Seismic activity induced by water injection at Matsushiro, Japan. Journal of Physics of the Earth 22:163-176.

Podio, A.L., A.R. Gregory & K.E. Gray. 1968 Dynamic properties of dry and water saturated green river shale under stress. American Institute of Mining, Metallurgical, and Petroleum Engineers, Society of Petroleum Engineers Transactions 8: 389-404.

- Power, D.V. 1977 Acoustic emissions following hydraulic fracturing in a gas well IN: <u>Acoustic Emission/Microseismic Activity</u> in Geologic Structures. Proceedings of the First Conference held at Pennsylvania State University, University Park, Pennsylvania, Pa., June 9-11, 1975. ED: Hardy, H.R. Jr. & F.W. Leighton. Trans. Tech. Publications, 1977, Clausthal, Germany. pp. 291-308.
- Reynolds, J.J., J.B. Scott, J.L. Popham, & H.F. Coffer. 1961 Hydraulic fracture - field tests to determine areal extent and orientation. JPT; Journal of Petroleum Technology 13(April): 371-376.
- Scopel, I.J. 1964 Pressure injection disposal well, Rocky Mountain Arsenal, Denver, Colorado. Mountain Geologist 1(1): 35-42.
- Schuster, C.L. 1978 Massive hydraulic fracture mapping and characterization program. IN: Enhanced Oil and Gas Recovery and Improved Drilling Methods. Proceedings of the Fourth United States Department of Energy Symposium held in Tulsa, Oklahoma, August 29-31, 1978. Pet. Pub. Co., Tulsa, Oklahoma. 1978. 11 pp. NTIS SAND-78-0666C 79-05 81 PC A02/MF A01. CONF.-780825-1.
- Suzuki, Z. 1975 Induced seismicity at the Kamafusa Dam, Japan. IN: <u>Induced Seismicity</u>. Proceedings of the First International Symposium held at Banff, Alberta, Canada, on September 15-19, 1975.

- Talley Energy Systems, Inc (TESI). 1978 Posthydraulic Fracture Report. Submitted to Sandia Scientific Laboratories, Albuquerque, New Mexico. Report No. PH-001, October 4, 1978.
- United States Army Corps of Engineers. 1966 Injection well earthquake relationship, Rocky Mountain Arsenal, Denver, Colorado. United States Corps of Engineers, Omaha, Nebraska. Rpt. Inv. pp. 1-54.
- United States Geological Survey Staff. 1975 Results of a study to determine seismicity induced by hydrofracture tests in the Pinedale Unit No. 7 Well. United States Geological Survey Staff. Report No. PNE-WW-39. 18 pp. January 1975. Abstract No. 00493. Also United States Energy and Research Development Administration Report Abstracts 75(4):7-8.
- van Poollen, H.K. 1966 Possible connection between RMA disposal well and Derby Earthquakes IN: Injection Well Earthquake Relationship Rocky Mountain Arsenal, Denver, Colorado. United States Army Corps of Engineers, Omaha, Nebraska. Rpt. Inv. 32 pp.
- Wood, M.D. Inc. 1979 Analysis of ground tilts associated with hydraulic fracture formation and explosive Injection, Rock Springs, Wyoming, April-August 1978. Report submitted to Sandia Scientific Laboratories, Albuquerque, New Mexico. 91 pp. United States Department of Energy Contract No. EF 77C 03 14 16. See also reports SAND-78-1885 and SAND-78-1886.

5. APPENDIX: INFORMATION RETRIEVAL SYSTEM

5.1 INFORMATION SOURCES

Alberta Department of Environment Library 9820 - 106 Street, 14th Floor (Oxbridge Place) Edmonton, Alberta

Alberta Department of Energy and Natural Resources Library 9915 - 108 Street, 9th Floor (South Petroleum Plaza) Edmonton, Alberta

Alberta Oilsands Information Centre 10010 - 106 Street, 6th Floor (Highfield Place) Edmonton, Alberta

Cameron Library Sciences, 4th Floor University of Alberta Edmonton, Alberta

Cameron Library Government Documents, 3rd Floor University of Alberta Edmonton, Alberta

Hardy & Associates (1978) Ltd. 4810 - 93 Street Edmonton, Alberta

5.2 KEYWORDS

₿.,

These were words used for "Induced Seismicity Related to Fluid Injection" (19 pp.) and for "Acoustic emission" (25 pp.). These are both partial works and not completed searches.

acoustic (emission, propagation, waves)
fracture/ing
geophysics - (rock properties)
hydraulic (cracking, fracturing)
injection (fluid, gas, water)
midroacoustic
microseisms/ic
natural gas wells, (hydraulic fracturing)
oil (fields, sands, wells)
oil well production (flooding, thermal)
rock-fracture
seismic waves - propagation
seismology
steam injection

5.3 AUTHORS

(useful for further searching)

Byerlee, J.D. Hardy, H.R. Jr. Holzhausen, G.R. Keck, L.J. Kintzinger, P.R. Koerner, R.M. Lockner, D.A. McCann, R.P. Power, D.V. Schuck, L.Z. Schuster, C.L. Witherspoon, P.A. Wood, M.D. 5.4 ABSTRACTS

Applied Science and Technology Index H.W. Wilson Company, New York, N.Y.

Engineering Index, Inc. United Engineering Centre New York, N.Y.



EPA Publications Bibliography United States Environmental Protection Agency Office of Planning and Management Washington, D.C.

Geophysical Abstracts Geoabstracts Ltd. University of East Anglia Norwich, England

Geotechnical Abstracts German National Society of Soil Mechanics and Foundation Engineering Essen, Germany

Petroleum Abstracts Information Services Department University of Tulsa, Tulsa, Oklahoma

United States Government Reports Announcements and Index NTIS United States Department of Commerce

United States Government Published Monthly Catalogue Superintendent of Documents United States Government Printing Office Washington, D.C.

(Alberta Department of Environment Periodicals KWIC Index) (Alberta Department of Energy and Natural Resources KWOC Index)

5.5 COMPUTER SEARCHES

BHR Fluid Engineering Abstracts (Fluidex)

Key Search Words 1. (steam or fluid) and (all inject or all stimulat)

- 2. hydraulic and all fracture
- all seism or all acoustic or all sonic or sonor
 Combine 1 or 2 and 3.

Alberta Oilsands Information Centre Computer Holdings

Key search words: seismic method or steam injection or hydraulic fracturing

Engineering Index

Key search words (same as BHRA Fluid Engineering Abstracts (Fluidex)

Geoarchive

Key search words - (same as BHRA Fluid Engineering Abstracts (Fluidex)

Georef

Key search words (same as BHRA Fluid Engineering Abstracts (Fluidex)

NTIS

Key search words (same as BHRA Fluid Engineering Abstracts (Fluidex)