

MARK D. ZOBACK
Benjamin M. Page Professor of Earth Sciences
Professor of Geophysics, Emeritus
Stanford, University

ACADEMIC HISTORY

1969 B.S. Geophysics, University of Arizona
1973 M.S. Geophysics, Stanford University
1975 Ph.D. Geophysics, Stanford University

PROFESSIONAL EXPERIENCE

1969-1971 Geophysicist at Amoco Production Co.
1971-1973 Research Assistant, Stanford University
1973-1975 Geophysicist, U.S. Geological Survey
1975 Visiting Scientist, Ruhr University, Bochum, Germany
1975-1976 National Research Council Post-Doctoral Fellowship
1976-1984 Geophysicist at U.S. Geological Survey
1976-1980 Chief, In-Situ Stress Measurement Project
1980-1981 Deputy Chief, Office of Earthquake Studies
1981-1984 Chief, Branch of Tectonophysics
1984-2021 Professor of Geophysics, Stanford University
1991-1997 Chairman, Dept. of Geophysics, Stanford University
2012-2021 Senior Fellow, Precourt Institute for Energy, Stanford University

SELECTED UNIVERSITY SERVICE

2012-2013 Chair, Faculty Senate
2012-2021 Founder and Co-Director, Stanford Center for Induced and Triggered Seismicity
2015-2021 Founder and Director, Stanford Natural Gas Initiative
2018-2021 Co-Director, Stanford Center for Carbon Storage

SELECTED HONORS and AWARDS

1984 Fellow, Geological Society of America
1989 Fellow, American Association for the Advancement of Science
1990 Senior Research Scientist Award, Alexander Von Humboldt Stiftung
1998 Elected Fellow, American Geophysical Union
1998 Kenneth Cuthbertson Award for Exceptional Contributions to Stanford University
1998 University Fellow, Stanford University

1999	Elected Honorary Fellow, European Union of Geosciences
1999	Outstanding Alumni Award, Univ. of Arizona Dept. Geosciences
2004	School of Earth Sciences Excellence in Teaching Award
2005	Named Benjamin M. Page Professor of Earth Sciences
2006	Emil Wiechert Medal, German Geophysical Society
2006	New Zealand Geophysics Prize for 2006 (with John Townend)
2008	Walter H. Bucher Medal, American Geophysical Union
2011	Elected Member, National Academy of Engineering
2011	Elected Fellow, American Rock Mechanics Association
2012	Elected Honorary Member, Society of Exploration Geophysicists
2013	Louis Néel Medal, European Geosciences Union
2013	Einstein Chair Professor, Chinese Academy of Sciences
2015	Robert R. Berg Outstanding Research Award, American Association of Petroleum Geologists
2016	American Geosciences Institute Award for Outstanding Contribution to Public Understanding of Geosciences
2019	Best Paper Award 2018, <i>The Leading Edge</i> (with Jens Lund Sneek)
2019	A.I. Levorsen Award, AAPG SW Section (with Jens Lund Sneek)
2021	Honorary Lecturer, Society of Exploration Geophysics
2022	Best Paper Award 2022, URTeC 3722883, Unconventional Resources Technology Conference
2023	Distinguished Lecturer of the Hagler Institute, Texas A&M University
2023	Rolf Emmermann Medal, German Research Centre for Geosciences

SELECTED PROFESSIONAL ACTIVITIES

1988-90	President, Tectonophysics Section, American Geophysical Union
1981-84	Member, National Earthquake Prediction Evaluation Council
1984-	Co-Director, Stanford Rock and Borehole Geophysics Consortium
1987-98	Chairman, Coordinating Committee on Continental Scientific Drilling of International Lithosphere Program
1985-89	Chief Scientist, Cajon Pass Scientific Drilling Project
1990-96	Chair, In-Situ Stress Working Group, KTB Project
1999-00	State of California Board of Education Content Review Panel
1999-06	Chair, Science Advisory Group, International Continental Drilling Program
2000-08	Member, Begleitende Kommission, Heidelberg Academy of Science, World Stress Map Project
2002-06	Science Director, Western Resources Project
2002-03	Member, JOI Board of Directors
2002-08	Member, EarthScope Management Team
2007-11	Chair, Science of Earthquake Studies Advisory Committee, U.S.

	Geological Survey
2009-	Board of Directors, American Rock Mechanics Association
2009-	Board of Directors, Research Partnership for Secure Energy for America
2010-12	Member, NAE Committee on Deepwater Horizon Accident
2011-12	President, American Rock Mechanics Association
2011-12	Member, Secretary of Energy Advisory Board Subcommittee on Shale Gas Development
2012-13	Member, Canadian Academy of Sciences Committee on Shale Gas Development
2013-14	Member, National Academy of Sciences Advisory Board on drilling in the Gulf of Mexico
2016-17	Member, SPE Task Force on Climate Change
2019-2020	Chair, Technical Section of Carbon Capture Utilization and Storage, Society of Petroleum Engineers

Member: American Geophysical Union, Geological Society of Amer., American Assoc. for the Advancement of Science, Seismological Soc. of Amer., American Assoc. of Petroleum Geologists, Society of Petroleum Engineers, American Rock Mechanics Association

PUBLISHED PAPERS

- 1974 Boore, D.M., and M.D. Zoback, Near-field motions from kinematic models of propagating faults. *Bull. Seism. Soc. Amer.*, 64, 321-342.
- 1974 Boore, D.M., and M.D. Zoback, Two-dimensional fault modelling of the Pacoima dam strong-motion recordings of the February 9, 1971, San Fernando earthquakes, *Bull. Seism. Soc. Amer.*, 64, 555-570.
- 1975 Zoback, M.D., High pressure deformation and fluid flow in sandstone, granite, and granular materials, Ph.D. Thesis, Stanford University.
- 1975 Zoback, M.D., and J.D. Byerlee, The effect of cyclic differential stress on dilatancy in Westerly granite under uniaxial and triaxial conditions, *J. Geophys. Res.*, 80, 1526-1530.
- 1975 Zoback, M.D., and J.D. Byerlee, Permeability and effective stress, *Amer. Assoc. Petrol. Geol. Bull.*, 59, 154-158.
- 1975 Zoback, M.D. and J.D. Byerlee, The effect of microcrack dilatancy on the permeability of Westerly granite, *J. Geophys. Res.*, 80, 752-755.
- 1976 Zoback, M.D., and J.D. Byerlee, The effect of high pressure deformation on the permeability of Ottawa sand, *Amer. Assoc. Petrol. Geol. Bull.*, 60, 1531-1542.
- 1976 Zoback, M.D., and J.D. Byerlee, A note on the deformational behavior and permeability of crushed granite, *Inter. J. Rock Mech.*, 13, 291-294.

- 1977 Zoback, M.D., J.H. Healy, and J.C. Roller, Preliminary stress measurements in central California using the hydraulic fracturing technique, *Pure and Appl. Geophys.*, 115, 135-152.
- 1977 Zoback, M.D., F. Rummel, R. Jung, and C.B. Raleigh, Laboratory hydraulic fracturing experiments in intact and prefractured rock, *Inter. J. Rock Mech., Mining Sciences and Geomechanics*, 14, 49-58.
- 1978 Zoback, M.D. A simple hydraulic fracturing technique for determining fracture toughness. *19th U.S. Symposium on Rock Mechanics*, MacKay School of Mines, University of Nevada, 1, 83-85.
- 1978 Zoback, M.D., J.H. Healy, J.C. Roller, G.S. Gohn, and B.B. Higgins. Normal faulting and in-situ stress in the South Carolina coastal plain near Charleston. *Geology*, 6, 147-152.
- 1978 Zoback, M.D., and D.D. Pollard. Hydraulic fracture propagation and the interpretation of pressure-time records for in-situ stress determinations. *19th U.S. Symposium on Rock Mechanics*, MacKay School of Mines, Univ. of Nevada, 1, 14-22.
- 1978 Zoback, M.D., J.C. Roller, and J.H. Healy. In-situ measurement of the earth's stress field. *Earthquake Information Bull.*, 10, 214-219.
- 1979 Zoback, M.D. Recurrent faulting in the vicinity of Reelfoot Lake, northwestern Tennessee. *Bull. Geol. Soc. Amer.*, 90, 1019-1024.
- 1979 Zoback, M.D., and J.C. Roller. Magnitude of shear stress on the San Andreas fault: Implications from a stress measurement profile at shallow depth. *Science*, 206, 445-447.
- 1980 Zoback, M.D., R.M. Hamilton, A.J. Crone, D.P. Russ, F.A. McKeown, and S.R. Brockman. Recurrent intraplate tectonism in the New Madrid Seismic Zone. *Science*, 209, 971-976.
- 1980 Zoback, M.D., H. Tsukahara, and S. Hickman. Stress measurements at depth in the vicinity of the San Andreas fault: Implications for the magnitude of shear stress at depth. *J. Geophys. Res.*, 85, 6157-6173.
- 1980 Zoback, M.L., and M.D. Zoback. Faulting patterns in north-central Nevada and strength of the crust. *J. Geophys. Res.*, 85, 275-284.
- 1980 Zoback, M.L., and M.D. Zoback. State of stress in the coterminous United States. *J. Geophys. Res.*, 85, 6113-6156.
- 1981 Hamilton, R.M., and M.D. Zoback. Tectonic features of the New Madrid seismic zone from seismic reflection profiles. *U.S. Geol. Surv., Prof. Paper 1236-F*.
- 1981 O'Connell, D.R., C.G. Bufe, and M.D. Zoback. Microearthquakes and faulting in the area of New Madrid, Missouri-Reelfoot Lake, Tennessee. *U.S. Geol. Surv., Prof. Paper 1236-D*.

- 1981 Zoback, M.D. In-situ study of the mechanism of reservoir triggered earthquakes in the southeastern United States. *Proceedings of the International Conference on Intra-Continental Earthquakes*, September 17-21, 1981. Ohrid, Yugoslavia, 273-289.
- 1981 Zoback, M.D., and M.L. Zoback. State of stress and intraplate earthquakes in the central and eastern United States. *Science*, 213, 96-109.
- 1982 Seeburger, D.A., and M.D. Zoback. The distribution of natural fractures and joints at depth in crystalline rock. *J. Geophys. Res.*, 87, 5517-5534.
- 1982 Anderson, R.N., and M.D. Zoback. Permeability, underpressures and convection in the oceanic crust near the Costa Rica Rift, Eastern Equatorial Pacific. *J. Geophys. Res.*, 87, 2860-2868.
- 1982 McGarr, A., M.D. Zoback, and T.C. Hanks. Implications of an elastic analysis of in-situ stress measurements near the San Andreas fault. *J. Geophys. Res.*, 87, 7797-7806.
- 1982 Zoback, M.D., and R.N. Anderson. Borehole televiewer imagery of the oceanic crustal layer 2A, Costa Rica Rift. *Nature*, 295, 375-379.
- 1982 Zoback, M.D., and S. Hickman. In-situ study of the physical mechanisms controlling induced seismicity at Monticello Reservoir, South Carolina. *J. Geophys. Res.*, 87, 6959-6974.
- 1982 Zoback, M.D. and B.C. Haimson. Status of the hydraulic fracturing method for in-situ stress measurements. In: *Issues in Rock Mechanics, 23rd Symposium on Rock Mechanics* (Goodman, R.E. and F.E. Heuze, eds.), Soc. Mining Engineers, New York, 1982, 143-156.
- 1983 Hickman, S.H., and M.D. Zoback. The interpretation of hydraulic fracturing stress measurements: *Proceedings, Workshop on Hydraulic Fracturing Stress Measurements*. National Academy Press, Washington, D.C., 1983. 44-54.
- 1983 Moos, D., and M.D. Zoback. In-situ studies of velocity in fractured crystalline rocks. *J. Geophys. Res.*, 88, 2345-2358.
- 1983 Zoback, M.D., State of stress in the lithosphere: IUGG Quadrennial Report. *Reviews of Geophysics and Space Physics*, 21, 1503-1511.
- 1983 Zoback, M.D., A new data source for in-situ stress field orientations. *Nature*, 306, 18.
- 1983 Zoback, M.D., and R.N. Anderson, Permeability, underpressures, and convection in the oceanic crust at Deep Sea Drilling Project Hole 504B. In *Initial Reports Deep Sea Drilling Project* (Cann, J.R., M.G. Langseth, J. Honnorez et al., eds.), 69, U.S. Govt. Printing Office, Washington D.C., 245-254.
- 1983 Anderson, R.N. and M.D. Zoback, The implications of fracture and void distribution from bore-hole televiewer imagery for the seismic velocity of the upper oceanic crust at Deep Sea Drilling Project Holes 501 and 504B. In *Initial Reports Deep Sea Drilling Project* (Cann, J.R., M.G. Langseth, J. Honnorez et al., eds.), 69, U.S. Govt. Printing Office, Washington D.C., 255-270.

- 1983 Zoback, Mark D. and B.C. Haimson, editors, *Hydraulic Fracturing Stress Measurements*, National Academy Press, Washington, D.C., 270 pp.
- 1984 Zoback, M.D., and J.H. Healy. Friction, faulting and in-situ stress. *Annales Geophysicae*, 2, 689-698.
- 1984 Wentworth, C.M., A.W. Walter, J.A. Bartow, and M.D. Zoback. Evidence on the tectonic setting of the 1983 Coalinga earthquakes from deep reflection and refraction profiles across the southeast end of Kettlemen Hills. In *The 1983 Coalinga Earthquakes*, Calif. Dept. of Conservation, Div. Mines and Geol., Serial Publ. 66, 113-126.
- 1984 Wentworth, C.M., M.C. Blake, Jr., D.L. Jones, A.W. Walter, and M.D. Zoback. Tectonic wedging associated with emplacement of the Franciscan assemblage, California Coast Ranges, In *Franciscan geology of Northern California*, ed. M.C. Blake, Jr., Society of Economic Paleontologists and Mineralogists (Pacific section, Bakersfield, CA), 43, 163-173.
- 1984 Newmark, R.L., M.D. Zoback, and R.N. Anderson. Orientation of in-situ stresses in the oceanic crust. *Nature*, 311, 424-428.
- 1984 Zoback, M.L., M.D. Zoback, and M.E. Schiltz, Index of stress data for the North American and parts of the Pacific plate, U.S.G.S. Open-file Report 84-157, 62 pp.
- 1985 Anderson, R.N., M.D. Zoback, S.H. Hickman, and R.L. Newmark. Permeability versus depth in the upper oceanic crust: In Situ measurements in DSDP hole 504B, eastern equatorial Pacific. *J. Geophys. Res.*, 83, 429-444.
- 1985 Hickman, S.H., J.H. Healy, and M.D. Zoback. In-situ stress, natural fracture distribution, and borehole elongation in the Auburn geothermal well, Auburn, New York. *J. Geophys. Res.*, 90, 5497-5512.
- 1985 Zoback, M.D., D. Moos, L. Mastin, and R.N. Anderson. Wellbore breakouts and in-situ stress. *J. Geophys. Res.*, 90, 5523-5530.
- 1985 Stock, J.M., J.H. Healy, S.H. Hickman, and M.D. Zoback. Hydraulic fracturing stress measurements at Yucca Mountain, Nevada and relationship to the regional stress field. *J. Geophys. Res.*, 90, 8691-8706.
- 1985 Zoback, M.D. Scientific drilling to study physical properties and the state of stress in the earth's crust: an opportunity for mid-crustal measurements near the San Andreas fault. In *Observation of the Continental Crust Through Drilling* (ed. C.B. Raleigh), v. 1, Springer-Verlag, Berlin, 132-140.
- 1985 Moos, D., R.N. Anderson, C. Broglia, D. Goldberg, C.F. Williams and M.D. Zoback. The ocean drilling program V: Logging for the ocean drilling program - results from the first two legs. In *Ocean Engineering and the Environment*, Marine Technology Soc. Conf. Record, Nov. 12-14, 1985, San Diego, California. Vol. 1, 1-10.
- 1985 Zoback, M.D., W.H. Prescott and S.W. Krueger, Evidence for lower crustal ductile strain localization in southern New York. *Nature*, 317, 705-707.

- 1985 Prescott, W.H., S.W. Krueger, and M.D. Zoback, Geodetic constraints on strain rates in the vicinity of the 1886 Charleston, South Carolina, Earthquake, *Proc. First Int'l Symp. on Precise Positioning with GPS, Rockville, Md, April 15-19, 1985*; U.S. Dept. Commerce, NOAA, NOS, vol. II, pp. 687-896.
- 1985 Crone, A.J., F.A. McKeown, S.T. Harding, R.M. Hamilton, D.P. Russ, and M.D. Zoback. Structure of the New Madrid seismic source zone, in southeastern Missouri and northeastern Arkansas. *Geology*, 13, 547-550.
- 1985 Newmark, R.L., R.N. Anderson, D. Moos and M.D. Zoback. 27. Sonic and ultrasonic logging of hole 504B and its implications for the structure, porosity, and stress regime of the upper 1 km of the oceanic crust. In *Initial Repts Deep Sea Drilling Project* (Anderson, R.N., J. Honnorez, K. Becker et al., eds.), v. 83, U.S. Govt Printing Office, Washington D.C., 479-510.
- 1985 Hatcher, Jr., R.D., J.K. Costain, L. Glover III, R.A. Phinney, M.D. Zoback, R.T. Williams, P. Talwani, J.B. Diebold, and R.N. Anderson, Rationale for selecting a site for an ultra-deep dedicated scientific drill hole in the southern Appalachians. In *Observation of the Continental Crust through Drilling, I* (eds. C.B. Raleigh), Springer-Verlag, Berlin and Heidelberg, 343-353.
- 1986 Williams, C.F., T.N. Narisimhan, R.N. Anderson, M.D. Zoback, and K. Becker. Convection in the oceanic crust: Numerical simulation from DSDP hole 504 B, Costa Rica Rift. *J. Geophys. Res.*, 91, 4877-4889.
- 1986 Zoback, M.D. and C.M. Wentworth. Crustal studies in central California using an 800-channel seismic reflection recording system. In *Reflection Seismology: A Global Perspective*. Geodynamics Series, v. 13, Amer. Geophys. Un., 183-196.
- 1986 Newmark, R.L., R.N. Anderson, and M.D. Zoback. 33. Orientation of in situ stresses in the Pacific plate: Deep Sea Drilling Project. In *Initial Reports of the Deep Sea Drilling Project* (M. Leinan, D.K. Rea et al., eds.). Washington, D.C., U.S. Government Printing Office, v. 92, 519-525.
- 1986 Zoback, M.D., D. Moos, L. Mastin and R.N. Anderson. Reply to comments by Detournay and Roegiers, *J. Geophys. Res.*, 91, 14163-64.
- 1986 Zoback, M.L., S.P. Nishenko, R.M. Richardson, H.S. Hasegawa, and M.D. Zoback. Mid-plate stress, deformation, and seismicity, in *The Geology of North America, vol. M, The Western North Atlantic Region*, (eds. P.R. Vogt, B.E. Tuchokle) Chapter 18, Geol. Soc. Amer., 297-312.
- 1986 Zoback, M.D., L. Mastin and C. Barton, In-situ stress measurements in deep boreholes using hydraulic fracturing, wellbore breakouts and Stonely wave propagation, in *Rock Stress*, O. Stephansson, ed., Centek Pub., Lulea, Sweden, 289-300, 1986.
- 1986 Nishenko, R. M. Richardson, H. S. Hasegawa, and M. D. Zoback, Mid-plate stress, deformation, and seismicity, in *The Geology of North America, Volume M, The*

- Western North Atlantic region, edited by Vogt, P. R., and B. E. Tucholke, Geological Society of America, 297-312,
- 1987 Wentworth, C.M., M.D. Zoback, A. Griscom, R.C. Jachens, and W.D. Mooney, A transect across the Mesozoic accretionary margin of central California. *Geophys. J.R. Astr. Soc.*, 89, 105-110.
- 1987 Williams, R.T., R.D. Hatcher, Jr., C. Coruh, J.K. Costain, M.D. Zoback, R.N. Anderson, J.B. Diebold and R.A. Phinney. The southern Appalachian ultradeep scientific drill hole: Progress of site location investigations and other recent developments. In *Observation of the Continental Crust through Drilling, II* (eds. H.J. Behr, F.G. Stehli and H. Vidal), Springer-Verlag, New York, 44-55.
- 1987 Prescott, W.H., M.D. Zoback and S.W. Krueger. Comment on "Horizontal deformation in New York and Connecticut: Examining contradictory results from the geodetic evidence" by Richard Snay. *J. Geophys. Res.* 92, 2805-2806.
- 1987 Zoback, M.D., L. Mastin and C. Barton, In situ stress measurements in deep boreholes using hydraulic fracturing, wellbore breakouts, and Stonely wave polarization, In *Rock Stress and Rock Stress Measurements*, Proc. of Conf. in Stockholm, Sweden, 1-3 September 1986, 289-299. (ed. Stefansson, O.) Centrek Publ., Lulea.
- 1987 Zoback, M.D., M.L. Zoback, V.S. Mount, J. Suppe, J.P. Eaton, J.H. Healy, D. Oppenheimer, P. Reasenbergl, L. Jones, C.B. Raleigh, I.G. Wong, O. Scotti, and C. Wentworth, New evidence on the state of stress of the San Andreas fault system, *Science*, 238, 1105-1111.
- 1988 Hatcher, Jr., R.D., R.T. Williams, S.H. Edelman, J.K. Costain, C. Coruh, R.A. Phinney, K. R. Chowdury, E.R. Decker, M.D. Zoback, D. Moos, and R.N. Anderson, The Appalachian ultradeep core hole (ADCOH) project, In *Deep Drilling in Crystalline Bedrock, v. 2*, (A. Boden and K.G. Eriksson, eds.), Springer Verlag, Berlin, 117-154.
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- 1988 Barton, C.A., M.D. Zoback, and K.L. Burns, In situ stress orientation and magnitude at the Fenton geothermal site, New Mexico, determined from wellbore breakouts, *Geophys. Res. Lett.*, 15, 467-470.
- 1988 Bradshaw, G.A. and M.D. Zoback, Listric normal faulting, stress refraction and the state of stress in the Gulf basin, *Geology*, 16, 271-274.
- 1988 Coyle, B.J. and M.D. Zoback, In situ permeability and fluid pressure measurements at ~2 km depth in the Cajon Pass research well, *Geophys. Res. Lett. Special Issue*, 15, 1029-1032.
- 1988 Healy, J. and M.D. Zoback, Hydraulic fracturing stress measurements in the Cajon Pass research well to 2 km depth, *Geophys. Res. Lett. Special Issue*, 15, 1005-1009.

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- 1988 Schmitt, D. and M.D. Zoback, The effect of an exact effective stress law on the hydrofracture breakdown equations, *Proc. Second Int'l Conf. on Hydraulic Fracturing Stress Measurements*, Minneapolis, MN, June 15-18, 1988. (ed. B.C. Haimson, J.C. Roegiers, M.D. Zoback), 425-450.
- 1988 Hickman, S.H., M.D. Zoback and J.H. Healy. Continuation of a deep borehole stress measurement profile near the San Andreas fault, 1. Hydraulic fracturing stress measurements at Hi Vista, Mojave Desert, California, *J. Geophys. Res.*, 93, 15183-15195.
- 1989 Eberhart-Phillips, D., D.-H. Han and M.D. Zoback, Empirical relationships among seismic velocity, effective pressure, porosity and clay content in sandstone, *Geophysics* 54, 82-89.
- 1989 Shamir, G. and M.D. Zoback, Detailed analysis of wellbore breakout in the Cajon Pass scientific drillhole. (Dr. J. Rowley, ed.) *ASME Energy Sources Conference*, v.I2, Houston, 11-15.
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- 1989 Zoback, M.D., W.A. Elders, W.R. Van Schmus, L. Younker, *The Role of Continental Scientific Drilling in Modern Earth Sciences, Scientific Rationale and Plan for the 1990's*, a report to the Interagency Coordinating Group for the Continental Scientific Drilling Program from the Workshop on Continental Scientific Drilling, Stanford University, August, 1988, 151 pp.
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- 1989 Schmitt, D.R. and M.D. Zoback, Laboratory tests of the effects of pore pressure on tensile failure, *Rock at Great Depth*, v. 2, Proceedings Conf., Pau, France, Aug. 1989 (V. Maury and D. Fourmaintraux, eds.), p. 883-890, A.A. Balkema, Rotterdam, 1989, 1076 pp.

- 1989 Shamir, G. and M.D. Zoback, The stress orientation profile in the Cajon Pass scientific drillhole, based on detailed analysis of stress induced borehole breakouts, *Rock at Great Depth, v. 2*, Proceedings Conf., Pau, France, Aug. 1989 (V. Maury and D. Fourmaintraux, eds.), p. 1041-1048, A.A. Balkema, Rotterdam, 1989, 1076 pp.
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