

William Laurence Power

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Citizenship: USA and Australia
Family Status: Married, 3 children

Professional Experience

December 2015 to present

Power Geoscience Pty Ltd
Perth, Western Australia
Senior Consultant

Self-employed consultant in the minerals and oil and gas industries. Specialist areas include analysis of fault stability, fault seal potential, induced seismicity, and faulted and fractured reservoir characterization. Also expert in the area of *in situ* stress estimation and applications to geomechanical problems such as pore pressure and fracture gradient estimation, borehole stability and drilling performance, and reservoir behaviour during production. Exploration consulting in oil and gas and minerals areas, specializing in multidisciplinary integration of variable and disparate data, including potential field data (gravity, magnetics) with the aim of providing maximum constraint on exploration targets and reducing risk.

January 2009 to November 2015 (~ 7 years)

Baker Hughes – GMI Geomechanics Services
Perth, Western Australia
Senior Geomechanics Specialist

Consulting for the oil and gas industry in the area of borehole geophysics and petrophysics, with specific emphasis on the state of stress and rock mechanics. Application of rock mechanics and continuum mechanics principles to analysis of wellbore stability, solids production prediction (sanding), compaction and subsidence, prediction of pore pressure and fracture gradient, and the behaviour and development of faulted and fractured reservoirs. Central activities included the development of integrated geomechanical models to describe the *in situ* stresses (the current day state of stress), the rock strength, and the pore pressure in oil and gas fields, by multidisciplinary integration of drilling experiences, wellbore log and image data, geological setting, geophysical surveys, and other incidental data including microseismicity. Some work/consulting for geothermal projects (Indonesia), and for storage and sequestration of CO₂ (Australia).

Major Achievements – Successful consulting work for a wide variety of client companies in a wide variety of geological environments, and in a wide variety of roles/projects, ranging from wildcat exploration through to development, production, and abandonment. Experience with analysis of wellbore stability, sand production, fractured reservoirs, pore pressure and fracture gradient prediction, and fault stability. Successful presentation of results to client teams in Vietnam, Malaysia, Indonesia, New Zealand, India, and Australia. Presented papers and results at technical conferences and workshops (Society of Petroleum Engineers, American Association of Petroleum Geologists, and Indonesian Petroleum Association).

March 2007 to December 2008 (~ 2 years)

Task Geoscience (Asia) Pty Ltd
Ardross, Western Australia
Senior Structural Geologist

Petroleum industry structural geology. Validation and analysis of borehole image data, including analysis of sedimentary facies, folding, fracturing, and faulting in oil and gas reservoirs, dominantly located in Gulf of Mexico region. Extensive

geological/geophysical technical writing and reporting. Some work with Task Geoscience's specialized software, and some 3D presentation of results and conclusions.

Major Achievements – Learned how to analyze and process borehole image data. Learned structural geology procedures and tasks relevant to petroleum exploration and production.

January 2002 to March 2007 (~5 years)

Fractal Geoscience and Geoinformatics Exploration Australia
West Perth, Western Australia

Senior Structural Geologist/Training Coordinator

Geological and geophysical consulting, dominantly for the minerals and minerals exploration industries. Validation, preparation, and analysis of disparate geological and geophysical data, including drilling logs, geological mapping, geochemical sampling, geophysical surveys (from industry and government sources). Collection, validation, and management of company geological databases. Forward and inverse modelling of gravity and magnetics potential field data. Training and supervision of data collection and validation project teams. Geological/geometrical 3D modelling of prospect to regional scale mineral exploration areas.

Major Achievements – Completed major projects in mineral exploration (chiefly gold and copper) in Alaska, New Zealand (North Island), Western Australia, British Colombia, and Ontario.

November 1997 to December 2001 (~4 years)

Fractal Geoscience and Fractal Graphics
Nedlands, Western Australia

Senior Structural Geologist/Training Coordinator

Geological consulting including fieldwork, 3D geological/geometrical modelling, and geological and geophysical analysis for mineral exploration, development, and production companies. Prepared and presented training courses for industry, private, and university audiences. Major short course topics included field operations (geological mapping and assessment) in open pits and underground mines; 3D geological modelling and the preparation/validation of geological data for modelling activities; and advanced analysis of potential field data (gravity and magnetics). The emphasis of the consulting work included applications to geotechnical analysis (fractured rock masses), resource estimation, and near mine and greenfields exploration.

Major Achievements – Presented short courses for clients including University of Western Australia and St Ives Gold. Further developed strategies for capture and validation of geological data in the mining and resource industry. Member of Fractal Graphics/Taylor Wall and Associates team that finished first place in GoldCorp Challenge competition. As part of the Fractal Graphics/Fractal Geoscience team, developed a new and comprehensive strategy for capture, validation, and full utilisation of exploration and mining data in resource projects.

May 1989 to October, 1997 (~8 years)

CSIRO Divisions of Geomechanics and Exploration and Mining
Melbourne, Victoria and Nedlands, Western Australia

Research Scientist/Structural Geologist/ Consulting Geologist

The main responsibilities and research efforts were 1) numerical simulation of rock deformation and the structural control of ore deposits, using finite element and finite difference methods, and 2) studies of the structure, character, and syntax of exploration and mining data (geological and geophysical data). Some work with field, theoretical and laboratory studies of the properties of fault zone materials. Designed and maintained custom software for mining company use in the numerical simulation of rock deformation. Also worked on joint projects with CSIRO Division of Information Technology which involved the evaluation and design of geological modelling software. In 1994 and 1995 was on part time secondment to Fractal Graphics, at that time one of the leading consulting companies in Western Australian mineral exploration.

Major Achievements – Contributed new understanding of how a major research effort in CSIRO could be applied to industry problems. Prepared and presented shortcourses for mining companies including Western Mining Corporation. As part of a multi-disciplinary team, completed a comprehensive study of the character and syntax of exploration and mining data. This basic knowledge was used to evaluate software and tools of the resources industries.

Education

Brown University, Providence, Rhode Island, USA

Ph. D. Geology and Geophysics, 1989

Thesis topic involved quantitative characterization and interpretation of natural fault and fracture surface roughness (geometrical roughness), with application to rock friction and earthquake mechanics. Knowledge of the geometrical roughness properties of fault zones was used to analyze fault zone evolution, the development of seismic versus aseismic fault zones, and the dependence of deformation mechanisms on scale.

University of California Santa Barbara, California, USA

M.A. Geological Sciences, 1986

Thesis topic involved the mechanics of low-angle extensional faulting in the southern Basin and Range Province of the southwest United States (SE California). This topic involved the development of the so-called “cordilleran metamorphic core complexes”. This degree program also included extensive coursework and practical teaching experience.

California Institute of Technology Pasadena, California, USA

B.S. Geology, 1980

Strong background in physics, mathematics, and field studies. Emphasis on quantitative approaches to geological problems. Extensive field experience as part of the course work and also strong exposure to basic physics and chemistry.

Skills

Analysis of Faults and Rock Discontinuities

I have specialist experience with analysis of faults and other rock discontinuities. This includes aspects of fault zone evolution, fault seal, critically stressed fracture arrays, analysis of paleostress and strain history using fault and fracture observations, and the implications of geological history and stress on structures.

Technical and Business Writing

Highly skilled at both academic and technical/business style writing and reporting. Experienced with scripting and design of multimedia and web-based company presentations. Experience with writing of software user manuals and training manuals.

Public Speaking and Teaching

Widely experienced with public and consulting style technical and business presentations, and also with presentation of training courses in university and industry environments.

Geological Mapping

30 years experience with geological mapping in a wide variety of environments, including extensive experience in both brownfields and greenfields exploration. Experience in mining environments including open pit and underground.

Software and Computer Skills

Recent software experience includes over three years work with the JewelSuite Geomechanics and 3D software (Baker Hughes).

I am also highly proficient with former GMI software (now part of Baker Hughes) including GMI Imager, GMI WellCheck, GMI SFIB, GMI Caliper, GMI MohrFracs, and GMI Model Builder. I am also experienced with other image log processing and analysis software, including TerraStation and Techlog.

Earlier additional experience includes work with software for geoscientific modeling and analysis including GIS (ArcInfo/MapInfo), 2D and 3D geological analysis (FracSIS, Vulcan, Surpac), and GoCad (Paradigm Geophysical). I am able to learn new software rapidly, as a result of experience with design and construction of FracSIS (see publications and work experience with CSIRO).

Languages

Native speaker of English, but also familiar with spoken and written Spanish, including moderate amount of geological vocabulary.

Training Courses

QGIS and Geoscientific GIS Operations

March 2018

Advanced Image Analysis and Structural Geology

Baker Hughes/RDS Internal Course – July 2013

3D Geomechanical Analysis and Finite Element Applications

Baker Hughes/RDS Internal Course – April 2013

Fundamentals of Project Management - PMBOK

IIL Learning and Baker Hughes – September 2012

Pore Pressure and Fracture Gradient Prediction

GMI Geomechanics Services Internal Course – June 2011

Sand/Solids Production Prediction

GMI Geomechanics Services Internal Course - Nov 2009 and Feb 2010

Naturally Fractured Reservoirs: Geologic and Engineering Analysis

Lawrence W. Teufel, Petroskills - August 2009

GMI Image Analysis Software

GMI Geomechanics Services Internal Course - Feb 2009

Advanced Diploma of Core Energetics Psychotherapy

Australian Institute of Core Energetics, Perth and Sydney - 2004

Telephone Counselling

Lifeline WA, Perth, Western Australia - 2003

Surpac Software

Surpac Software International, Perth, Western Australia - 1998

Regolith Geology and Geochemistry

Louisa Lawrence, Louisa Lawrence and Assoc, Perth, Western Australia - 1997

Awards

Outstanding Reviewer of the Year 2011

Geophysical Journal International

GoldCorp Challenge, First Place Team Member 2001

As part of Fractal Graphics/Taylor Wall Associates Team

Basic Research Award, 1989

US National Committee for Rock Mechanics

Ian Campbell Award for Field Geology, 1980

California Institute of Technology

Professional Organizations

Society of Petroleum Engineers SPE (currently inactive)

Geological Society of America GSA

American Geophysical Union AGU

Australian Institute of Geoscientists AIG

Australasian Institute of Mining and Metallurgy AUSIMM (currently inactive)

American Association of Petroleum Geologists AAPG

Partial List of Consulting Clients and Study Areas

2019 Gold exploration, Yilgarn craton, Leonora/Laverton area, Western Australia.

Fieldwork in association with CSA Global

2018 & 2019 Fault Seal, Vulcan Sub-Basin, offshore Western Australia

2018 Regional geology of the Birimian age gold mineralization, West Africa, including underground geological mapping and analysis of gold mineralization and associated paleoseismicity

2017 Gold mineralization, Sulawesi, Indonesia, Independent Technical Assessment and Review report

2017 Gold mineralization, Yilgarn Craton, Western Australia, Independent Technical Assessment and Review report

2015 ConocoPhillips Australia, Bayu Undan Field (geomechanical model updates and further wellbore stability analysis)

2015 Origin Energy, Offshore/Onshore Otway Basin, Victoria, Australia (geomechanical model and wellbore stability)

2014 Chevron Australia, Northwest Shelf Australia (gas production and CO₂ storage and sequestration (geomechanical modelling, rock mechanics, wellsite planning, wellbore stability, fault and fracture stability)

2013-2014 Todd Energy, Mangahewa Field (Geomechanical model update, wellbore stability, and fracture stimulation design), Onshore, Taranaki, New Zealand

2013 Star Energy, Wayang Windu Project – Geothermal Energy (Geomechanical model), NW Java, Indonesia

2013 OMV, Maari Field (Geomechanical model and wellbore stability update), Offshore Taranaki, New Zealand.

2013 Conoco Phillips, Bayu Undan Field (Geomechanical model and wellbore stability), Offshore, Northern Australia

2013 Pan Orient Energy, Cataka Prospect, (Geomechanical model and wellbore stability), Onshore Northwest Java, Indonesia

2012 Pertamina Hulu Energy, Kilo Field, (Geomechanical model and wellbore stability), Offshore Northwest Java, Indonesia

2012-2014 Otto Exploration, Offshore and Onshore Projects (Pore pressure and fracture gradient estimation), Philippines

2012 Cairn Energy, Ravva Field (Geomechanical model, wellbore stability, fault stability), Offshore East India

2012 Oilex, Cambay Field (Pore pressure and fracture gradient estimation), Onshore, NW India

2012 Santos, Sangu Field (Geomechanical Model and wellbore stability), Offshore Bangladesh

2011-2012 Karoon Gas, Tumbes Basin (Pore pressure and fracture gradient estimation), Offshore Peru

2011-2012 Petronas, Tangga Barat, Melor, Laho Fields (Geomechanical model and wellbore stability), Offshore Malaysia

2010 Petronas, Dulang Field (Geomechanical Model and Sand Production Prediction), Offshore Malaysia

2010 JOB Medco Indonesia, Senoro Field (Geomechanical model, fracture permeability, wellbore stability), Sulawesi, Indonesia

2009 Petronas, Temana Field (Geomechanical Model and sand production prediction), Offshore Malaysia

2009 Japan Vietnam Petroleum Corporation (JVPC) Rang Dong Field (Geomechanical model and fracture permeability), Offshore Vietnam

2007 and 2008 Petroleum exploration projects, mainly Gulf of Mexico, USA

2004 Geoinformatics Exploration and Kennecott, Great Basin, Nevada and Utah, USA

2003/2004 Glass Earth Limited, Coromandel/Taupo Region, North Island, New Zealand

2003 Mystery Creek Resources, Nixon Fork Gold Region, Alaska, USA

2002/2003 Heritage Resources, Eskay Creek gold belt, British Colombia, Canada

2001/2003 St Andrew Goldfields, Eastern Timmins/Abitibi, Ontario, Canada

2000/2001 Gold Corp – Gold Corp Challenge Entry, Western Ontario, Canada

1998/1999 Mt Magnet Gold, NL, Western Australia

1998 Australian Resources, Gidgee Goldfield, Western Australia

1997 Western Mining, Leinster Nickel Operations

1997 Nimbus Resources, Dreadnought Prospect Area, Coolgardie, Western Australia

1997 Grenfell Resources, Tarcoola Ridge Prospect, South Australia

1996/1997 New Hampton Goldfields, Kalgoorlie/Kambalda

1996 Otter Gold, Tanami Region, Western Australia

1996 Lone Star Exploration, Awak Mas Project Site, Sulawesi, Indonesia

Volunteer and Community Activities

Lifeline Western Australia

Perth, Western Australia

Telephone Counselor

First point of contact crisis telephone counseling. Experience with problems including suicide, relationship issues, self-esteem, and mental health issues. Also work with addictions, sexual trauma and sexual abuse, and domestic violence. Experience referring to other social service agencies.

Major achievements – completed approximately 250 hrs of telephone counseling, an average of approximately 5 hours per fortnight. Achieved accreditation with merit in December 2004. Became part of the training team for new telephone counselors in March, 2005.

Surf Lifesaving Australia

Scarborough, Western Australia

Director of Lifesaving and Bronze Medallion Training Instructor

Patrolling member of the club from 1995 to 2002. Surf lifesaving clubs in Australia provide beach water safety, first aid, and basic training in surf awareness and water safety to the public. Competitive sports activities are also part of membership for active club members.

Major achievements – Director of Lifesaving supervising a group of 150 club members engaged in patrol activities on weekends and public holidays in 1999/2000 and 2000 and 2001 seasons. Bronze medallion training instructor for new patrolling members for 2000/2001 and 2001/2002 seasons.

Selected Publications

Published Papers:

- Murray, T. M., Power, W. L., Johnson, T. J., Christie, G. J., and Richards, D. R., 2019. Validation and analysis procedures for juxtaposition and membrane fault seals in oil and gas exploration. Accepted manuscript, August 2019, Geological Society London Special Publications, DOI: 10.1144/SP496-2018-171.
- Ong, S. H., Power, W. L., Sitio, A., Tanjung, E., 2015. Geomechanics improves drilling operations and reduces non-productive times (NPT) in Kilo Field, offshore Northwest Java. Presented at the SPE Asia Pacific Oil and Gas Conference and Exhibition, Bali, Indonesia, 20-22 October, 2015.
- Power, W. L., Tjengdrawira, A., Aprianto, S., Suwono, S., Rachman, S. G., Wijanarko, M., Febrianto, D. H., Baasir, A., and Hasanusi, D., 2012. In-situ stresses, rock strength, fluid pressure, and implications for wellbore stability and oil and gas development in the Senoro and Tiaka Fields, Sulawesi, Indonesia, presented at the Indonesian Petroleum Association Thirty-Sixth Annual Convention & Exhibition, Jakarta, May 2012.
- Power, W. L., Sano, T., Ooi, D. C., Castillo, D., Magee, M., and Burgdorff, K., 2010. In situ stress and rock strength in Rang Dong Field – off shore Vietnam – implications for drilling in basement rocks, Society of Petroleum Engineers Technical Conference and Exhibition, Ho Chi Minh City, Vietnam, November 1-3, 2010, SPE Paper No. 135737, 14 p.
- Power, W. L., and Durham, W. B., 1997, Topography of natural, man-made, and artificial fractures in granitic rocks: implications for studies of rock friction and fluid migration, *Int J Rock Mech Min Sci & Geomech Abstr*, v 34, p 979-989.
- Power, W. L., and Tullis, T. E., 1995. A Review of the fractal character of natural fault surfaces with implications for friction and the evolution of fault zones, in: *Fractals in the Earth Sciences*, Editors C. C. Barton and P. R. LaPointe. Plenum Press, New York, p. 89-105.
- Power, W. L., Lamb, P., and Horowitz, F. G., 1995. From Data Bases to Visualisation - data transfer standards and data structures for 3D geological modelling, *APCOM XXV 1995 Conference*, Brisbane, Australia, July, 1995, p. 65-70.
- Lin, T., Ward, M. O., Power, W. L., and Landy, D. M., From Data Bases to Visualisation - providing a user friendly visual environment for creating 3D solid Geology Models, *APCOM XXV 1995 Conference*, Brisbane, Australia, July, 1995, p. 11-20, 1995.
- Cartwright, I., Power, W. L., Oliver, N. H. S., Valenta, R. K., and Mclatchie, G. S., 1994. Fluid migration and vein formation during deformation and greenschist facies metamorphism at Ormiston Gorge, central Australia, *J. Metamorphic Geology*, v. 12, p. 373-386.
- Power, W. L., and Tullis, T. E., Euclidean and fractal models for the description of rock surface roughness, *Journal of Geophysical Research*, v. 96, p. 415-423, 1991.
- Power, W. L., and Tullis, T. E., The relationship between slickenside surfaces in fine-grained quartz and the seismic cycle, *Journal of Structural Geology*, v. 11, p. 879-893, 1989.
- Power, W. L., Tullis, T. E., and Weeks, J. D., Roughness and wear during brittle faulting, *Journal of Geophysical Research*, v. 93, p. 15268-15278, 1988.

Abstracts and Other Short Publications

- Power, W. L., and Cox, S. J. D., The great Australian lineament debate - what is important?, Clare Valley Conference, 25-29 September, *Geological Society of Australia, Abstracts*, v. 40, p. 139-140, 1995.
- Power, W. L., R. P. A. Perriam, K. Crossing, and M. Muir, Deformation modelling of the Sand King Region, Western Australia, *Geological Society of Australia, Abstracts*, v. 37, p. 359-360, 1994.
- Power, W. L., and Mason, R. A., Paleostress versus in situ or current stress, Papua New Guinea, *Terra Nova* v. 3, *Terra Nova Abstract Supplement* 5, p. 31, 1991.
- Power, W. L., and T. E. Tullis, Fractal character of natural fault surface roughness: implications for gouge formation and fault zone evolution, *Geological Society of America, Abstracts with Programs*, v. 20, p. A299, 1988.
- Power, W. L., Low-angle normal faults - low differential stress at mid-crustal levels?, in *Heat & Detachment in Crustal Extension on Continents and Planets*, a conference convened by the Lunar and Planetary Institute, Houston, Texas. p. 113-114, 1985.
- Power, W. L., Low-angle extensional faulting and inferred stress regime, Riverside Mountains, California, *Geological Society of America, Abstracts with Programs*, v. 16, p. 329, 1984.

Unpublished Reports and Training Course Manuals

- Power, W. L., Principles of Geological Modelling in Mine Environments (Shortcourse Manual), Unpublished Report by Fractal Geoscience, January, 2002, 32 pps.
- Power, W. L., Mason, R. A., Panizza, N. R., and Archibald, N. J., A shortcourse Covering Geological Mapping Methods in Underground Excavations, Unpublished Report by Fractal Geoscience, November, 2001, 30 pps.
- Power, W. L., Geological Information Systems for a Data-Rich World (Shortcourse Manual), Unpublished Report by Fractal Geoscience, June, 2001, 32 pps.
- Holden, D. J., Archibald, N. J., and Power, W. L., Shortcourse Manual – Advanced Analysis of Potential Field Data, Unpublished Report by Fractal Geoscience, March, 2001, 40 pps.
- Power, W. L., Panizza, N. R., and Archibald, N. J., Geological Operations in Open Cut Excavations, A short course manual, Unpublished Report by Fractal Geoscience, October, 2000, 34 pps.
- Power, W. L., and Archibald, N. J., Geology of the Windich Pit Excavation, Mt. Weld Area, Granny Smith Mine, Laverton, Western Australia, Fractal Graphics Report 95-09/1, September, 1995, 9 pps.
- Power, W. L., Archibald, N. J., and Nichols, S., Deformation Modelling of the Kanowna Belle Region, Exploration and Mining Report 155C, CSIRO Exploration and Mining, July, 1995, 55 pps.
- Power, W. L., Enever, J. R., and Edgoose, J. J., In-situ stresses at the Ok Tedi Mine Site, Papua New Guinea, CSIRO Division of Geomechanics, Internal Report, New Series No. 57, March, 1991.
- Power, W. L., Ord, A., and Hobbs, B. E., Computer Modelling of Structural and Related Controls on Ore Deposits, CSIRO Division of Geomechanics, Internal Report New Series no. 44, October, 1990, 18 pps.
- Hobbs, B. E., Power, W. L., and Ord, A., Western Mining Short Course, CSIRO Division of Geomechanics, June/July 1990, 151 pps.