

Rory Dunphy, MSc, PGeo

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Senior Geoscientist

Highly experienced in applying geomechanics and natural fracture characterization across a range of areas including Oil & Gas, Geothermal, and Hydrogeology. Hands on experience applying a variety of geomechanical methods to evaluate Oil Sands caprock integrity, explore and appraise unconventional resources, design and evaluate hydraulic fracturing programs, generate pore pressure/frac gradient profiles to safely drill complex wells, interpret and model microseismic event generation, and understand/predict reservoir performance.

In addition to industry, I have a background in research, and experience working in a government/regulatory environment. Utilized expertise in geomechanics and structural geology to inform the development of geothermal legislation, with a specific focus on the regulation of Induced Seismicity relating to geothermal reservoirs. Experience designing data analytics projects and developing screening tools for geothermal exploration.

Truly multi-disciplinary with a high degree of knowledge of rock physics, microseismic, reservoir and completions engineering, and drilling operations. Proven people skills with research management, multi-agency collaboration, and external engagement experience. Expertise in:

- **Fracture Characterization (outcrop, core & log)**
- **Geophysical Log Interpretation**
- **Building 1D & 3D Geomechanical Models**
- **Geomechanical Core Testing Programs**
- **Discrete Fracture Network Modeling**
- **Drilling & Completions Planning and Operations**
- **Critical Stress Analysis & Hydraulic Fracture Modeling**
- **Geothermal Exploration & Regulations**

GEOLOGICAL SURVEY IRELAND/COMPLETIONS GEOSCIENCE CONSULTING Calgary, Alberta July 2021-Present

Geothermal Consultant

Completions Geoscience Consulting has been contracted to work on the National Geothermal Database Project. The goal of this project is to facilitate deep geothermal exploration in Ireland by lowering geological risk. In this role I have responsibility for designing the database, undertaking analysis of potential geothermal resources, identifying critical data and knowledge gaps, identifying research opportunities, advising on policy and, engaging with a broad range of stakeholders from Government, Industry, Academia and members of the public.

- Authoring white paper on Induced Seismicity for “Draft Policy Statement on Geothermal Energy” to be published by Depart of Energy Climate & Communications in December 2021.
- Engaging research institutions to build a program designed to understand fault and fracture permeability, gather stress and geomechanical data, and investigate feasibility of Enhanced Geothermal Systems in Ireland.

COMPLETIONS GEOSCIENCE CONSULTING, Calgary, Alberta Feb 2021-Present

Owner/Principal Consultant

Set up consulting practice that utilizes advanced knowledge of Geomechanics and Natural Fracturing to assist companies in completion optimization of multi-well horizontal unconventional developments. Design multi-disciplinary uncertainty reduction programs for resource evaluation and production predicting projects related to Petroleum and Geothermal sectors.

- Defining the concept of connected effective surface area, a function of stimulated surface area and matrix damage factor, to investigate well spacing for multi-well unconventional pads
- Undertaking Python & data science courses to develop a “favorability” workflow for geothermal projects.

CNOOC INTERNATIONAL (formerly Nexen), Calgary, Alberta

2006 to 2020

Regional Manager - Ireland, Global Exploration Division, Dublin, Ireland

May 2017 to April 2020

Reporting to VP Europe, provided in-country leadership to enable delivery of CNOOC's first operated Deepwater exploration program in the Atlantic Margin. Setup new office space and ensured compliance and alignment with project priorities among cross-functional teams (including Finance, HR, Tax, Legal, HSE).

- Developed a stakeholder and regulatory affairs program that delivered necessary regulatory approvals within a complex legislative environment. Represented the company externally to variety of stakeholders.
- Ensured safe delivery of a HPHT Deepwater well as a leader in the Emergency Response Planning team.

Manager Reservoir Characterization & Modelling, Canadian Division (Calgary, AB) **Apr 2016 to Apr 2017**

Led a team of geoscientists in applying petroleum geomechanics, structural geology, core characterization, geomodelling, and seismic reservoir characterization to support asset teams in the appraisal and development of unconventional plays in NEBC, US and Athabasca Oil Sands Regions. Guided graduate hiring program, oversaw training and development program, and mentored diverse group of technical staff from 30+ year experts to interns.

- Created a caprock integrity evaluation workflow for Oil Sand projects. This workflow resulted in major revision of an operating partner's field development plan in order to address caprock risks identified.
- Designed a method to capture fracture data in a semi-qualitative way so that it could be conditioned for use in data analytics models.
- Enhanced productivity prediction through integrated data analytics, DFN modeling and microseismic/seismic interpretation to understand the impact of different fault sets on stimulated well performance.
- Utilized Petrel as platform to integrate geophysical, stratigraphic, petrophysical, geomechanical, structural, and geochemical data with pressure, production and completion data (DFIT) to identify drivers for differences in production in the Horn River Basin. Resulting products used to assess risk in field development planning.
- Used static and dynamic data to groundtruth and modify stress inversions from 3D seismic.

Liard Asset Team Lead, NEBC – Aurora LNG Project, Canadian Division (Calgary, AB) **Jun 2012 to Mar 2016**

Led a multidisciplinary subsurface team in the appraisal of shale gas acreage intended for LNG upstream supply. Managed risking and sizing of resource, defined production uncertainty range, and established project economics. Directed a 40+ member cross-functional operational team in planning and delivering a multi-well drilling and completions campaign that included regulatory approvals, roads, water disposal, pipeline and gas processing facility construction. Created and maintained buy-in with Executive Leadership on recommended strategy and project progress.

- Conducted Pore Pressure/Frac Gradient analysis on frontier HPHT wells that facilitated getting to target TD on four of the deepest (TVD), highest pressure wells ever drilled in WCSB.
- Delivered 1D geomechanical modelling for the frac design of these wells that led to the successful placement of high rate/high volume fracs at BH pressures in excess of 120MPa.
- Designed a regional study involving seismic interpretation, pore pressure estimation, basin modeling, seismic inversion, structural domain mapping, and regional fracture characterization. Combined with a program of geomechanical testing that was tied to lithofacies and sequence stratigraphy, the results of the study identified a fundamental change in structural style drove variability seen in exploration well results.
- Integrated hydraulic fracture modeling with reservoir modeling to predict high-mid-low outcomes from exploration wells based on static data and geomechanical scenarios. This was effective in quickly understanding the results of exploration wells and facilitating decision making on the entire project.
- Led Nexen involvement in the ITF FRACGAS consortium to develop Finite Element hydraulic fracture simulation capability and improve microseismic monitoring.

CNOOC INTERNATIONAL (Continued)**Senior Geoscientist, NEBC**, Canadian Division (Calgary, AB)**Aug 2008 to May 2012**

Geomechanical & Natural Fracture characterization geologist working in a multidisciplinary design team focused on defining resource and reservoir properties to aid asset teams in exploration, appraisal and development of unconventional shale gas plays in NEBC.

- Used petrophysical code to develop a geomechanical screening tool for unconventional plays. Played a key role doubling acreage from 120000 to 300000 acres in NEBC thru land sales.
- Generated 1D geomechanical models for hydraulic fracture design and optimization.
- Integrated sedimentology with static geomechanical properties to groundtruth seismic inversion for geomechanical attributes in shales. Led to changes in velocity models that were misplacing microseismic events.
- Undertook a large outcrop, core and image log study on shales to investigate impact of natural fractures and thin bedded shales on hydraulic fracture geometry. Combined with a geomechanical core testing program the results, which were validated by both production data and microseismic, influenced well placement strategy.
- Applied Discrete Fracture Network (DFN) tools to seismic discontinuities to scale up critical stress modeling. Bridging the scale gap created a framework to ground truth & interpret microseismic data that was rooted in geology. Key orientations of faults that impacted productivity were identified.
- Involved in first study that used DFN software for hydraulic fracture modelling. The results demonstrated alternate mechanisms for generating “complexity” in hydraulic fracturing beyond stress anisotropy.
- Represented Nexen on JIPs related to geology of hydraulic fracturing. Developed connections to wide network of geomechanical experts in Universities in North America (incl UT, EGI Utah, CSM, UofA).

Geoscientist, Canadian Division (Calgary, AB)**May 2006 to Jul 2008**

Applied geomechanics within a multidisciplinary resource exploitation team to create field development plans, plan and drill multi-well development pads and collaborate with production team to address well performance issues. Analysis led to high-grading properties and identifying exploration opportunities to align with CBM growth strategy.

- Utilised DFIT data and geomechanical modelling to build a model that predicted permeability based of effective stress. Resulted in high-grading and relinquishment of acreage, optimizing future capital spend.
- Designed a core based geomechanical research project with UBC and UofA to understand the effects of matrix shrinkage on long term productivity prediction in CBM reservoirs.
- Represented Nexen on the ARC Enhanced Permeability JIP advisory committee.
- Responsible for geomechanical studies to assess wellbore stability risks and completions design optimization.

CBM SOLUTIONS LTD, Calgary, AB**Jun 2004 to Apr 2006****Coalbed Methane Geologist**

Led teams working on drilling rigs in WCSB to deliver core evaluation programs safely and cost effectively for various E&P companies. Produced resource evaluation reports for clients including laboratory analysis of coal and shale.

Education

- **Master of Science by Research (MSc)**, Geology, University of Dublin, Trinity College, Ireland
 - Integrated structural domain mapping, natural fracture characterization, and stress to understand productivity variations in fractured aquifers in the post-Silurian rocks for Ireland.
- **Bachelor of Arts in Natural Sciences (BA Mod)**, Geology, University of Dublin, Trinity College, Ireland

Professional Memberships: APEGA, AAPG, SPE (Former Regional Section Chairperson)

Select Conference Papers:

- **Dunphy, R.** & Blake, S. 2021. *Enabling Deep Geothermal Development in Ireland*. GeoEnergy Europe “Uses of Geothermal Energy” Workshop. Aug 31st 2021.
- **Dunphy, R.** 2018. *Ireland – A New Country Entrant Perspective*. Keynote Talk, SPE & PESGB Ireland Annual Oil & Gas Evening. April 26, 2018.
- Green, S., Clarke, S., Hillier, C., **Dunphy, R.**, Thurston, D. 2017. *Using Traditional Methods to Predict Pore Pressure in Devonian Black Shale Basins of North East British Columbia*. CSPG Convention, Calgary, May 15-17th, 2017
- **Dunphy, R.**, Dola, J., & Gale, J. 2012. *Natural Fracture Stratigraphy of Gas Shales in the Horn River Basin, NEBC, Canada: Relation to Lithostratigraphy and Implications for Hydraulic Fracture Growth*. AAPG Annual Convention and Exhibition, April 22-25th, 2012, Long Beach, California. AAPG Search and Discovery Article #90142.
- **Dunphy, R.** & Campagna D. 2011. *Fractures, Elastic Moduli & Stress: Geological Controls on Hydraulic Fracture Geometry in the Horn River Basin*. Recovery 2011 CSPG, CSEG, CWLS Convention, Calgary, May 9-11th, 2011
- Reine, C. & **Dunphy, R.** 2011. *Weighing In On The Seismic Scale: The Use of Seismic Fault Measurements For Constructing Discrete Fracture Networks in the Horn River Basin*. Recovery 2011 CSPG, CSEG, CWLS Convention, Calgary, May 9-11th, 2011
- Hulsley, M., Slatt, R., & **Dunphy, R.** 2011. *Lithofacies Characterization and Sequence Stratigraphic Framework of Some Gas-Bearing Shales Within the Horn River Basin, Northeastern British Columbia*. AAPG Annual Convention and Exhibition, April 10-13th, 2012, Houston, Texas. AAPG Search and Discovery Article #90124.
- Rogers, S., Elmo, D., **Dunphy, R.** & Bearinger D. 2010. *Understanding Hydraulic Fracture Geometry And Interactions in the Horn River Basin Through DFN and Numerical Modeling*. Canadian Unconventional Resources & International Petroleum Conference, CSUG/SPE, Expanded Abstracts, SPE 137488