1 Detailed Curriculum Vitæ

Murad AbuAisha

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EDUCATION

University of Sorbonne, Paris, France — September 2024 | July 2025
Professorship in Sciences of the Universe (Geomechanics and Thermodynamics)
Thesis: Energy features of underground exploitation by fluid circulation

University of Grenoble, Grenoble, France — March 2011 | May 2014
Ph.D. degree in Geomechanics
Thesis: Enhanced Geothermal Systems (EGS): Hydraulic fracturing in a thermo-poloelastic framework

University of Joseph Fourier, Grenoble, France — September 2009 | July 2010
Master's degree in Mechanics of Solid Materials
Thesis: Digital image correlation: Strain localization and landfill clay barrier reinforcement

University IUG, Gaza, Palestinian Territories — September 2004 | February 2009
Bachelor's degree in Civil Engineering
Graduation project: Design of an artificial island

PROFESSIONAL EXPERIENCE

MINES Paris — Paris, France
Center of Geosciences — Fontainebleau, France
Researcher-Teacher (Recently associate professor) — May 2017 | Present
Projects: Participating in and mounting several projects with industrial partners: STORENGY, GEOSTOCK, TEREGA, TOTAL, AIRLIQUIDE. Academic partners include other members of the Paris Sciences & Lettres (PSL) university, the university of Pau, and the university of Lorraine

- Uniformity of thermodynamic state of gas stored in underground salt caverns, particularly hydrogen
- Computational Fluid Dynamics (CFD) modeling with turbulent flows
- Conjugate hate transfer and the boundary layer theory
- Mass exchanges between cavern phases: Gas, residual brine, and rock salt
- Non-isothermal two-phase hydrogen permeation in the saturated rock salt
- Geothermal effects on the gas dissolution kinetics in the cavern residual brine during cycling
- Gas humidification kinetics as a function of cycling frequency
- Carbon dioxide sequestration in geological media and induced seismicity
- AI-driven geothermal exploration (new research theme)

University of Calgary — Calgary, Canada
Postdoctoral researcher — November 2014 | May 2017
Project: Modeling and simulating Hydraulic Fracturing (HF) for petroleum industry using continuum and discontinuum approaches and related induced seismicity

- The finite and the discrete element methods to describe linear/nonlinear deformations as well as fracturing of rock formations
- Darcian flow and fluid compressibility law for fluid diffusion in the reservoirs and fracture leakoff
- Tracking and simulating the induced hydraulic fracturing seismicity due to fault activation either by dynamic effects or by fluid pressure changes
- Parallel programming using C++ on a Linux environment and High Performance Computing (HPC) simulations
- Two years of teamwork experience at the department of Geoscience, University of Calgary

French National Center of Scientific Research (CNRS) — Grenoble, France
Ph.D. research engineer — March 2011 | March 2014
Project: Enhanced Geothermal Systems (EGS)

- Hot Dry Rock (HDR) reservoir enhancement by Hydraulic Fracturing (HF), in terms of production, impedance, and efficiency of thermal recovery
- Developing a fully coupled HF thermo-poroelastic framework with all the required partial differential equations
- Writing a finite element FORTRAN 90 code to simulate fluid circulation and heat transfer in enhanced large-scale geothermal systems
- Several finite element meshing approaches and implicit time integration schemes for stable solutions of fluid flow and heat transfer
- Navier-Stokes equation for complex flow, fluid Newtonian/non-Newtonian characteristic and Darcian/non-Darcian nature of flow
- Fair knowledge of the physics of fluid flow in dual-porosity media and possible phase changes
- Experience with physically coupled phenomena and numerically challenging stabilization techniques, i.e. forced heat convection
- ABAQUS and COMSOL expertise, analytical solutions and field data treatment for validation of the numerical approaches
- Three-year experience of teamwork at the Laboratoire 3SR, Grenoble, France

Laboratory 3SR Grenoble, France
Master's internship in material mechanics February 2010 | July 2010
Project: Tensile strength of clays: Applications to landfill clay barriers

- Clay reinforcement by fibers
- Strain localization phenomenon
- Laboratory tests
- Validations using the 3-dimensional digital image correlation

SKILLS

Competencies

- Reservoir geomechanical modeling
- Finite and discrete element methods
- Fluid thermodynamics
- Dissolution kinetics of gas in the aqueous phases
- Kinetics of gas humidification
- Non-isothermal two-phase flows
- Partial differential equations
- Coupled physical phenomena
- Fluid flow mechanics in fractured media and tight reservoirs
- Parallel coding in C++ Linux
- FORTRAN 90, Matlab and Python languages
- **Training in "Supervising Ph.D. students" (PSL)**
- **Training in "Choose teaching methods adapted to the targeted learning" (PSL)**
- **Training in "How do I make sure that the way I teach is appropriate?" (PSL)**
- **Training in "Design an educational slideshow" (PSL)**
- Courses in "Interpersonal communications and relations of work"
- Courses in "Time management and personal organization of work"
- Commercial numerical software: ABAQUS and COMSOL

Language Skills

- Fluent in written and spoken **English** and **French**
- Other known languages include: Arabic; Hebrew; and Aramaic

SUPERVISING AND COLLABORATION ACTIVITIES

My supervising and co-supervising activities span over a period of 6 years, and include graduate and undergraduate students. **To enhance my supervising activities I followed a 16-hour training ("Supervising Ph.D. students") proposed by MINES Paris PSL**. I can summarize these activities as follows:

- **Graduate students:**
  Ph.D. students: My co-supervising experience of my first Ph.D. student (Firas Tayeb) included a close follow-up of his research activities on a continuous basis (some times every week). This experience included helping him understand the state of art, guiding him into finding the most suitable yet easy to understand references. It encompassed helping him develop the mathematical models and analyzing the final results. Indeed the common work was valued in terms of scientific papers where my contribution included helping him through the writing procedure.

  1. September 2024 - September 2027: Rania Chaabi (co-supervising 35%). Title: Fluid-rock interaction in the context of underground hydrogen storage. The Ph.D. funding was obtained through the TTI.5 institute of MINES Paris. This Ph.D. will start soon.
  2. November 2023 - November 2026: Khashayar Khezri (co-supervising 30%). Title: Dynamic fracturing in a THM framework: Upscaling applications to geo-energy production and induced seismicity. The Ph.D. funding was obtained through the Marie-Curie doctoral network funded by Horizon Europe (2021-2027) work program (SMILE). The Ph.D. student is registered in the doctoral school GRNE.
  3. November 2019 - February 2024: Firas Tayeb (co-supervising 60%). Title: Thermodynamics of underground fluid storage: Application to salt caverns. The funding of the Ph.D. was obtained through a doctoral contract from MINES Paris, and Ph.D. student was registered in the doctoral school GRNE.

  Collaboration with PostDocs

  1. November 2023 - September 2024: Angeline Defay (collaboration at 50%). Title: Numerical modeling of hydrogen permeation in the rock salt. This PostDoc was funded by an InterCarnot action in collaboration with the GeoRessources laboratory (Lorraine University).

  Master's internships

  1. February 2018 - July 2018: Parth Nigam (co-supervising 50%). Numerical modelling of rock dynamic fracture and study of fluid-driven fracture: FEM and XFEM framework.

- **Undergraduate students:**

  1. September 2022 - November 2022: Joris Landais, Boris Perrot, Antoine Laforgue, Maxence Lamarque, Lenny Hucher (five students of mini-project UE-14 with supervising 100%). Title: Tightness of underground salt caverns to hydrogen. The EU-14 is a supervising-teaching unit in the first semester of training at the school (Mines Paris).
  2. June 2021 - September 2021: Jacobo Gomez Solana (option student of ground and underground applications with co-supervising 50%). Title: Energy storage by compressing CO_2 using hydraulic pumps. A research project in collaboration with ENGIE.
  3. June 2020 - September 2020: Soufian Zagouri (foreigner option student from the university Mohammed VI polytechnic (Morocco) with co-supervising 50%). Title: Mining through high pressure water jetting: Definition of the pilot testing campaign of SABRE 2020 field tests.

TEACHING ACTIVITIES

Since I started working at the school of mines (MINES Paris), my teaching load was around 35 hours/year. To enhance my teaching skills, I followed several training sessions proposed by the university PSL:

1. Choose teaching methods adapted to the targeted learning
2. How do I make sure that the way I teach is appropriate?
3. Design an educational slideshow

My teaching activities are as follows:

- **At MINES Paris (2017-present):**

  1. November 2023: Courses in the MIG (general engineer profession). Title: Prospective study of a strategic resource: Underground gypsum exploitation in Maurienne. Students delivered a report at the end of this option.
  2. September 2022 - November 2022: Mini-project UE-14. Title: Tightness of underground salt caverns to hydrogen.
  3. September 2021 (one week): Geology field internship for second year students. Title: Geosciences in urban context - Ile de France region.

4. November 2018 (one week): Courses in the MIG (general engineer profession). Title: Hydrogen storage in salt caverns. Students delivered a report at the end of this option.
5. September 2017 (one week): Geology field internship for second year students. Geological lecture on rock fracturing - Sisteron region.

At the university of Calgary I was mostly invited by local professors as an "invited lecturer", the courses I taught included:

- **At the university of Calgary - Alberta - Canada (2014-2017):**
  1. Introduction to induced seismicity.
  2. Structural engineering.

RESEARCH PROJECTS

Since I enrolled in my PostDoc at the university of Calgary, I was a member of the Microseismic Industry Consortium (URL). It is a novel applied-research geophysical initiative dedicated to the advancement of research, education and technological innovations in microseismic methods and their practical applications for resource development. This consortium is a team of industry partners, government agencies, and faculty members.

From the moment I began working at MINES Paris, I contributed to several flagship projects. My history since 2017 of participating in and mounting projects can be listed in the following points:

1. February 2024 to February 2029: **Contribution** to the Horizon European project (FrHyGe). This is a grand project that tries to benefit from the German experience of underground hydrogen storage. Title: Full qualification in France of large-scale Hydrogen underground storage and replication from Germany to all European countries. It includes influential European industrial and academic partners, i.e. GEOSTOCK, STORENGY, ESK GMBH, STORENGY DEUTSCHLAND GMBH, and ECOLE NATIONALE SUPERIEURE DES MINES DE PARIS. The total received funding for this project mounted to 110 k€ and will help fund several doctoral and postdoctoral subjects.
2. October 2023: **Participating in mounting** a Horizon Europe project. Title: G-AIDANCE: Geothermal AI-driven advisory network for comprehensive exploration. My contribution included defining the framework of WP6 related to studying the risk of induced seismicity due to fluid injection. *Unfortunately this projected has not been selected.*
3. November 2023 for 10 months: **Contribution** to the project InterCarnot H2toSALTCAV in collaboration with the laboratory GeoRessources of Lorraine university. Title: Hydrogen storage in salt caverns for energy transition. My research on hydrogen migration in rock salt helped forming the proposition of this project. The idea was to enlarge our current research to include mechanical loading effects on gas transfer in rock salt. The total received funding for this project mounted to 83 k€ and helped fund the PostDoc of Angeline Defay listed previously.
4. September 2023 for 3 years: **Participating in mounting** a Marie-Curie doctoral proposal through the SMILE network (https://smile-msca-dn.eu/). This proposal was accepted and gave rise to the Ph.D. of Khashayar Khezri listed previously.
5. January 2023 for 2 years in two phases: **Piloting** a CITEPH project concerning tightness of salt caverns to the stored hydrogen. In this project we are working with many industrial partners including: TOTALENERGIES; STORENGY; TEREGA; and GEOSTOCK. My contribution to this project include the entire piloting, which encompasses participating in doing research, analyzing results, and writing deliverables. The total received funding for this project mounted to 260 k€.
6. September 2019 to September 2020: **Contribution** to the HyTREND project (Hydrogen for a carbon-free energy transition). It is a Power to X unifying project from the Carnot M.I.N.E.S institute, funded by the (national research agency) ANR. My contribution to this project included writing deliverables and conducting laboratory work. At the laboratory scale, we conducted gas cycling tests in a storage pilot to understand humidity effect on gas thermodynamics. The total received funding for this project mounted to 200 k€.
7. September 2018 to August 2020: **Contribution** to the STOPIL project. Title: Development of an industrial pilot for hydrogen storage in a salt caverns in France. Phase 1: feasibility study. This project included working with many industrial partners especially, STORENGY, GEOSTOCK, AIRLIQUIDE, INERIS, and BRGM. My contribution to this project was manifested in leading WP2 and WP3. We used the laboratory storage pilot to perform cycling tests and try to understand the uniformity of gas thermodynamic state while conducting different cycling scenarios. The total received funding for this project mounted to 453 k€.

8. May 2017 to April 2020: **Contribution** to the ROSTOCK-H project. Title: Risks and opportunities of geological hydrogen storage in salt caverns in France and Europe. This project was held by AIRLIQUIDE, it had another industrial partners including: INERIS, GEOSTOCK, and University of Lorraine. My contribution to this project included the complete design of a laboratory gas storage pilot that was equivalently used in other projects, and in performing different research applications. The total received funding for this project mounted to 225 k€.

ADMINISTRATIVE TASKS

Aside from my teaching and research activities, I was elected by my center colleagues as a representative in the Laboratory Council "Conseil de Laboratoire". My duties therein include presenting my colleagues' needs and complains in front of the council board and try to reply to them suitably.

PUBLICATIONS

Papers in peer reviewed journals:

1. **AbuAisha M.** (2024). An experimental approach to calibrate the two-phase hydrogen percolation van Genuchten model in intact and damaged saturated rock salt. *Paper is under preparation*
2. **AbuAisha M.**, & **Tayeb F.** (2024). Gas humidification kinetics during cycling in underground salt caverns: A case study of Helium and Methane. *Paper is under preparation*
3. **Tayeb F.**, Rouabhi A., & **AbuAisha M.** (2024). Effect of cycling frequency on kinetics of hydrogen humidification in salt caverns. *Paper is under preparation*
4. **AbuAisha M.**, Rouabhi A., Hadj-Hassen F., Eaton D., **Tayeb F.**, & Valtz A. (2023). Geothermal effects on CO_2 dissolution kinetics in brine: A non-dimensional model for underground storage in salt caverns. Journal of Natural Gas Science and Engineering **(IF 5.3)**, 117, 205076. https://doi.org/10.1016/j.jgsce.2023.205076
5. **Tayeb F.**, Rouabhi A., **AbuAisha M.**, & Valtz A. (2023). Kinetics of CO_2 dissolution for underground applications. Geoenergy Science and Engineering **(IF 5.4)**, 230, 212061. https://doi.org/10.1016/j.geoen.2023.212061
6. **AbuAisha M.**, Rouabhi A., Billiotte J., & Hadj-Hassen F. (2021). Non-isothermal two-phase hydrogen transport in rock salt during cycling in underground caverns. International Journal of Hydrogen Energy **(IF 7.2)**, 46(9): 6632-6647. https://doi.org/10.1016/j.ijhydene.2020.11.152
7. **AbuAisha M.**, & Billiotte J. (2021). A discussion on hydrogen migration in rock salt for tight underground storage with an insight into a laboratory setup. Journal of Energy Storage **(IF 8.9)**, 38, 102589. https://doi.org/10.1016/j.est.2021.102589
8. **AbuAisha M.**, & Rouabhi A. (2019). On the validity of the uniform thermodynamic state approach for underground caverns during fast and slow cycling. International Journal of Heat and Mass Transfer **(IF 5.4)**, 142, 118424. https://doi.org/10.1016/j.ijheatmasstransfer.2019.07.074
9. **AbuAisha M.**, Eaton D., Priest J., Wong R., Loret B., & Kent A.H. (2018). Fully coupled hydro-mechanical controls on non-diffusive seismicity triggering front driven by hydraulic fracturing. Journal of Seismology **(IF 1.6)**, 23, 109-121. https://doi.org/10.1007/s10950-018-9795-0
10. **AbuAisha M.**, Eaton D., Priest J., & Wong R. (2017). Hydro-mechanically coupled FDEM framework to investigate near-wellbore hydraulic fracturing in homogeneous and fractured rock formations. Journal of Petroleum Science and Engineering **(IF 5.4)**, 154, 100-113. https://doi.org/10.1016/j.petrol.2017.04.018
11. **AbuAisha M.**, Loret B., & Eaton D. (2016). Enhanced Geothermal Systems (EGS): Hydraulic fracturing in a thermo-poroelastic framework. Journal of Petroleum Science and Engineering **(IF 5.4)**, 146, 1179-1191. https://doi.org/10.1016/j.petrol.2016.07.027
12. **AbuAisha M.**, & Loret B. (2016). Influence of hydraulic fracturing on impedance and efficiency of thermal recovery from HDR reservoirs. Geomechanics for Energy and the Environment **(IF 5.1)**, 7, 10-25. https://doi.org/10.1016/j.gete.2016.02.001
13. **AbuAisha M.**, & Loret B. (2016). Stabilization of Forced Heat Convection: Applications to Enhanced Geothermal Systems (EGS). Transport in Porous Media **(IF 2.9)**, 112, 229-252. https://doi.org/10.1007/s11242-016-0642-x
14. Plé O., Tourabi A., & **AbuAisha M.**. (2013). 3-Dimensional digital image correlation for strains determination in clayey soil. Applied Mechanics and Materials, 353-356, 463-466. https://doi.org/10.4028/www.scientific.net/AMM.353-356.463
15. Plé O., Ha Le T.N., & **AbuAisha M.**. (2011). Landfill clay barrier: fibre reinforcement technique. Advanced Materials Research, 378-379, 780-784. https://doi.org/10.4028/www.scientific.net/AMR.378-379.780

Conferences:

1. **AbuAisha M.**, Rouabhi A., Hadj-Hassen F., Eaton D., **Tayeb F.**, & Valtz A. (2023). Thermal effects on the kinetics of gas dissolution in brine: A case study of CO_2 storage in salt caverns (a non-dimensional model). DECOVALEX 2023, November 2023, Troyes, France.
2. **AbuAisha M.**, Rouabhi A., Billiotte J., & Hadj-Hassen F. (2022). Hydrogen migration in rock salt during cycling in underground caverns. CouFrac2022, November 2022, Berkeley, United States.
3. **AbuAisha M.**, & Rouabhi A. (2022). Is the hypothesis of a uniform thermodynamic state still valid in hydrogen underground caverns during fast cycling? CouFrac2022, November 2022, Berkeley, United States.
4. Hytrend, un projet power to X de l'Institut Carnot M.I.N.E.S. Christian Beauger, Pascaline Pre, Alain Thorel, Anthony Chesnaud, Charly Lemoine, **AbuAisha M.** et al. Énergie renouvelable et ressources, les enjeux de demain : de l'ingénierie aux territoires, Institut Mines-télécom, Avril 2021, France.
5. **AbuAisha M.**, Eaton D., Priest J., & Wong R. (2016). Simulating HF using FDEM: Effects of pre-existing joints, induced microseismicity and fluid diffusion. Seismological Society of America - Annual meeting, April 2016, Reno, United States.
6. **AbuAisha M.**, Eaton D., Priest J., & Wong R. (2016). Simulating hydraulic fracturing using finite-discrete element method (FDEM): Effects of pre-existing joints and lateral stress gradient, Geoconvention 2016, March 2016, Calgary, Canada.
7. **AbuAisha M.**, Eaton D., Priest J., & Wong R. (2015). Review of hybrid continuum / discontinuum methods for geomechanical modelling of hydraulic fracture growth. Geoconvention 2015, May 2015, Calgary, Canada.
8. **AbuAisha M.**, & Loret B. (2016). Stimulation of Geothermal Reservoirs: Impedance and Efficiency of Thermal Recovery. The 40^{th} Workshop on Geothermal Reservoir Engineering, January 2015, Stanford, CA, United States.
9. **AbuAisha M.**, & Loret B. (2014). Permeability enhancement of HDR reservoirs by hydraulic fracturing. The 14^{th} International Conference of the International Association for Computer Methods and Advances in Geomechanics, September 2014, Kyoto, Japan.

Invited communications:

1. **AbuAisha M.** (2024). An experimental-numerical approach to investigate the non-isothermal two-phase hydrogen transport in the saturated intact and damaged rock salt. Seminar at the Institute of Sciences of the Earth (ISTO), October 2024, Orléans, France.
2. **AbuAisha M.** (2019). Hydraulic fracturing for geothermal and petroleum applications: Continuum/ discontinuum approaches. Seminar at the Karlsruhe Institute of Technology - KIT, May 2019, Karlsruhe, Germany.
3. **AbuAisha M.** (2014). Enhanced Geothermal Systems (EGS): Permeability Stimulation Through Hydraulic Fracturing in a Thermo-Poroelastic Framework. Seminar at the University of Seoul, August 2014, Seoul, South Korea.

Books and book chapters:

1. **AbuAisha M.** (2024-2025). Energy features of underground exploitation by fluid circulation. *Book is written and in the process of publishing.*
2. **AbuAisha M.** (2017). Geothermal reservoir stimulation using the finite element method. Éditions Universitaires Européennes, 978-3330872134.
3. **AbuAisha M.**, Eaton D., Priest J., & Wong R. (2016). Finite discrete element framework for investigating the effect of temperature-dependent dynamic viscosity on hydraulic fracturing. Microseismic Industry Consortium: Annual Research Report, Volume 7.
4. **AbuAisha M.**, Eaton D., Priest J., & Wong R. (2016). Hydraulic fracture growth and migration of induced microseismicity: Application of a fully coupled hydromechanical FDEM approach. Microseismic Industry Consortium: Annual Research Report, Volume 7.
5. **AbuAisha M.**, Eaton D., Priest J., & Wong R. (2016). Simulating hydraulic fracturing using Finite-Discrete Element Method (FDEM): Effects of pre-existing joints and induced seismicity. Microseismic Industry Consortium: Annual Research Report, Volume 6.
6. Eaton D., Mason Mackay, Anton Biryukov, & **AbuAisha M.** (2016). Identifying critically stressed faults without triggering slip: A discussion. Microseismic Industry Consortium: Annual Research Report, Volume 6.
7. **AbuAisha M.**, Eaton D., Priest J., & Wong R. (2015). Finite/Discrete Element Method (FDEM) by Y-Geo: An overview. Microseismic Industry Consortium: Annual Research Report, Volume 5.
8. **AbuAisha M.**, Eaton D., Priest J., & Wong R. (2015). Hydraulic fracture simulation using the GEOS code. Microseismic Industry Consortium: Annual Research Report, Volume 5.