Queen’s Geological Engineering

GEOE

www.queensu.ca/geol
Queen’s Engineering Class of ‘23

Welcome to
GEOLOGICAL ENGINEERING

Dr. Vicki Remenda, PEng
Department Head
Geological Engineering

Combines the concepts and techniques of the geological sciences with the tools of engineering to create designs to satisfy human needs.

“The Earth is Our Classroom and Our Responsibility”
GEOE: Geological Engineering

Housed within:

Queen's University
DEPARTMENT OF GEOLOGICAL SCIENCES AND GEOLOGICAL ENGINEERING

Dr. D’s Car

“The Earth is our Classroom and our Responsibility”
"The Earth is our Classroom and our Responsibility"
Dr. Mark Diederichs, PEng
Geological Engineering

“The Earth is our Classroom and our Responsibility”
Believe it or not....
Geological Engineering is so much more than just TUNNELS!

“The Earth is our Classroom and our Responsibility”
GEO-Hazard Engineering

Identifying and Engineering Solutions for Threats to Our Infrastructure, Safety and Economy

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GEO-Hazard Engineering

Building 4D Virtual Worlds of Hazards to Analyze Stability of Terrain We Can’t Safely Reach

Applications Developed at Queen’s GEOE and Now Industry Standard

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GEO-Environmental Engineering

Remediation and Sustainability

Protecting and Managing Groundwater and the Environment

Subsurface Contamination Remediation

Mine Waste Management

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GEO-Environmental Engineering

Environmental Remediation and Monitoring

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GEO-Exploration and Design in Minex and Mining

Applying Modern Tools and Geological Concepts to the Search and Sustainable Extraction of the Minerals We Need
GEO-Expertise for Energy Resources

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GEO-Technical Rock & Soil Engineering

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GEO-Physics
Our “Eyes and Ears”

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Corner Office? Sure but only if you want one!

GEOEs at Work
Why GEOlogical Engineering at Queens?

Well rounded education and skill set and confidence to go beyond ...... Here’s a sample....
Geological Engineering, GEOE

Dr. Jenn Day, PEng, PGeo
“On the Job Training”

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Fall 2nd Year: Field Training Begins

GEOE 221 – Field Methods

Learn field skills to observe and analyze rocks in their natural habitat
Weekly field trips in Kingston area
Integration with GEOE and GEOL students

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August before 3rd Year: Field Training Continues

GEOE 300 – Field School
Residential 10 day field school in our backyard with wicked geology
Geological field mapping follows through with office analysis
Team work focus and integration with GEOE and GEOL students

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August before 3rd Year: Field Training Continues

GEOE 300 – Field School

FINISHED GEOLOGICAL MAP: TOP SECRET

“The Earth is our Classroom and our Responsibility”
Mt Cook, New Zealand

Hollinger Mine, Timmins

Rob Harrap
Mineral & Energy Resources

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Mineral Exploration

Where are recoverable resources for metals that society needs?
How do we locate them efficiently, even at great depth?
How do we plan and carry out Exploration?
  Extraction?
  Remediation?

How does economics, politics, law all change how we approach this?

Canadian Wolastonite, a mine partly within Kingston City Limits

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Mineral Exploration

Mineral Resources Development Cycle

- Geophysics
- Field mapping
- Drilling
- Assaying
- Environmental assessment & approval
- Ongoing stakeholder consultation
- Feasibility
- Permits
- Community involvement
- Physical construction
- Mining operation
- Extraction & processing
- Transition from operations to reclamation
- Environmental management
- Reclamation
- Monitoring
- Exploration
- Construction
- Operation
- Closure
- Mining

Mineral Resource Development Cycle

Value of Geological Resources to 2002

Total Geological Resources ($Billions)
- >50
- 20-50
- 10-20
- 1-10
- <0.1

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Energy Resources

Where are the energy resources for the near future? The farther future?

How do we discover, access, recover, and distribute these?

How can this be made more sustainable?

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410 Field Course – Getting Real!

4th year GeoEngineering Field Trip to Sudbury and Timmins

Minerals Life Cycle – Exploration to Extraction To Remediation

Interact with industry professionals to see roles, career paths, opportunities

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410 Field Course

Interacting with Industry Experts in Geology, Mining, Geotech and Environmental Engineering

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A Few Summer Work Experiences …..

Sasha Schouten, GEOE ‘21
Geological Exploration

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Bedrock Mapping of Precambrian Rocks

Ontario Geological Survey (OGS)
Provide geological info to the public
Promote sustainable investment

Queen’s Geological Engineering
Queen’s GEOE is well regarded among employers, providing you with the skills to quickly jump into this work

Field Methods (GEOE 221)
Weekly field work (on the job training), including a professional report and map

Field School (GEOE 300)
Apply 2nd year experience to a large project

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My Work

Daily Duties
Planning logistics
Field Mapping
Rock and Structure Analysis
Field Photography
Sampling

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Geological Engineering, GEOE

Nicole Julien, Sci ’22
MINEX/Geochem

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Alamos Gold

- Canadian-based intermediate gold producer with four operating mines in North America

Lynn Lake Project, Manitoba

- Ongoing gold exploration project
- Operational from 60s to 80s
- Exploration involved a combination of geochemical surveys, geophysics, field mapping, and drilling.

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What my job actually was

Soil Survey (soil is cooler than you might think)
- Got paid to be in the field
- Excavated test pits to sample soil/till
- Classified and described soil in the field
- Learned note taking...This is really important!
- My daily commute was in a helicopter!
- Focus on Field Safety!!

In office
- Entered field data into database
- Prepared samples for shipping to lab
- Analyzed rock samples
- Training talks by geologists, managers, geophysicists and ministry reps

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Ashlyn Secord GEOE’20
GeoEnvironmental/Risk Assessment

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USGO Pipe Integrity, TC Energy Calgary

Assessed Geohazard/Geotechnical Threats and Risk to Gas Pipeline System:

**Geotechnical and Hydrotechnical:**
- Slope Instability, Earthquakes, Crossings, Pipe Exposures, Erosion, etc.

**Manufacturing & Construction**
- Defects and Installation

**Multiple Interacting Threats:**
- Development of visualization tools for interacting pipe threats
- Implemented into threat management procedures.

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Tailings Dam Monitoring, CNRL/Shell Calgary

Albian Sands Project
- Oil sands mining project located in northern Alberta
- System to safely retain waste products (tailings)
- Infrastructure consists of storage pits and external tailings dams

What I did
- Assessed geotechnical and hydrological performance
- Instrumentation monitoring, modelling and data processing.
- Used data to revise the design of mine earth structures and construction plans.

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Madeline Agnew, GEOE'21
Energy and Mining

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Suncor Energy Base Plant

Suncor

Based north of Fort McMurray, Alberta. Vision is to be Canada’s leading integrated energy company.

- Oil sands, renewable energy investments
- Safety above all else
- Environment and Sustainability

Field Services Co-op Student

Pitwall monitor working in open pit mine from a geotechnical perspective

- Shovel pit faces
- Monitor failures and instabilities
- Instrumentation

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My Experience

Geology and Engineering
   A new understanding and a different perspective

Opportunity
   • Field work and office work
   • Mine tours, plant tours
   • Used lots of Tech:
     (Drones, Autonomous Haulage System, etc)
   • Environmental

Community and Connections
   • Professional Connections
   • Personal Connections

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From Classroom to Workplace (and back again)

Geological Engineering
Program does an amazing job of preparing you for on-the-job tasks you may face in the future.

- Field experience (GEOL 221, GEOL 300)
- Design courses (APSC 100, APSC 200)
- Technical Courses (GEOE 281, GEOL 238, etc)

Invaluable Experience
On-the-job experience translates back to your Queen’s GEOE education

- More prepared for upper year courses
- Hands-on experience and perspective
- Creative thinking

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Rob Harrap and Jenn Day
Technology in a GEOE World
Analytical GEO-Labs: Labwork, Summer Jobs, Careers

2nd Year

Optical and Electron Microscopes

3rd and 4th Year

Geochemistry and More

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Design Project Work....

Wet Lab

Inductively coupled plasma mass spectrometry

Scanning Electron Microscope

Energy-dispersive X-ray Spectroscopy

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Computing Lab: GIS, 3d Visualisation, LiDAR, ...

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Computing Lab: GIS, 3d Visualisation, LiDAR, ...

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LiDAR and Photogrammetry

Capturing the world in 3D using lasers or multiple camera views

3D models, change detection, hazard analysis

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“The Earth is our Classroom and our Responsibility”
Geomechanics Testing Lab

Collecting Samples!

Rock Joint Shear Testing

Apply the Weight of Two Blue Whales

Rock Compression Testing

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Geomechanics Testing Lab

Studying how rocks blow up to make tunnels safe!

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Geomechanics Numerical Modelling Software

Underground Excavation Stability

• Tunnels, Mines and Caverns
• Nuclear Waste Repositories

Slope Stability & Landslide Prediction

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Rachel Bourassa, McKenzie Douglas
Engineering Geophysics
Engineering Geophysics

Using physics and non-destructive techniques to understand the subsurface for engineering input and monitoring
Geophysical Surveys at Queen’s

- Seismic
- Resistivity
- GPR
- Magnetic
- Gravity
- Electromagnetic

You learned a little about these in APSC 151
Now you can use them yourself!
Geophysics Applications

- Mineral Exploration
- Oil/Gas Exploration
- Hydrological Studies
- Environmental Assessments
- Infrastructure detection
- Archeological Studies
- Hazard Analysis
- Earth History
Geophysics Research

• Surface Water Pollutants
• Satellite Earth Observation Analysis
• Magnetic and Bathymetric Surveying with Autonomous Watercraft
• Natural Hazard Assessment
• Mineral Exploration
Geophysics Careers

- Specialty Surveys from Ground, Air, Water, Space
- Software Development
- Geophysical Interpretation and Modeling
- Technological Development
- Exploration

www.thewest.com.au
Rachel Bourassa Sci ‘20

Lamontagne Geophysics
• Web Application Development
• Geophysical Processing
• Field Work

Ontario Geological Survey
• Lots of Field work!

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McKenzie Douglas Sci ‘20

- TRUE Consulting
- Field or Office, YOUR CHOICE

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Other Opportunities

• Are you interested in more than one subject?  
  Dual Degrees are the answer!

• Want to see the World?  
  Foreign Study Exchange is an option!!

• Want to have an extended “summer” placement?  
  Internships!!
Geotechnical Engineering

Engineering “with” and “in” soil and rock
Field and Laboratory Testing
State of the Art Simulations
Design Decisions based on Geology:
The Past Impacts Future Behaviour

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Geotechnical Engineering

Engineering Projects

**Surface:**
Landslides / surface stability
Dam stability
Building foundations

**Underground:**
Tunnels, of course!
Large underground excavations
  subway stations,
  power generation caverns,
  urban expansion
  recreation

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Geological Engineering, GEOE

Caitlin Fischer, GEOE’20
Geotechnical Engineering

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Mine Stability Team, Golder Vancouver

Golder
Consulting and design services in the earth and environmental science industry
Prides themselves on technical excellence and innovative solutions

Caitlin Fischer: Rock Mechanics Student
Worked in office on Grasberg Underground Mine (Indonesia) and Bingham Canyon Pit Mine (USA)

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Mine Stability Analyses

Bingham Canyon Mine
Largest open pit mine in the world
Salt Lake City, Utah
Conducted stability analyses on open pit mine slope walls using numerical modeling software

Grasberg Mine
Underground mine
Largest gold mine and second largest copper mine in the world
Conducted critical infrastructure reviews including:
• geology model,
• structural geology,
• groundwater,
• ground support conditions,
• overall stability

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Graham Swarbrick, GEOE’20
Tunnel Engineering

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Tunnels Team, Hatch Ltd.

Hatch Ltd.
- Top consulting & project implementation firm
- Infrastructure and mining
- Top 100 Canadian employers 3 years in a row

My Experience
- Completed Summer Internships in Toronto and Vancouver
- Worked on 7 major tunnel projects with total value of over $9 Billion (CAD)

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A Career in Tunneling & Geotech

Key Tasks

• Design work for TBMs
• Shaft design
• Tunnel support design
• Reviewing contracts
• Construction management

Opportunity/Environment

• Travel and office work
• Working in urban centre
• Transferable skills
• Booming industry
• Abundance of job opportunity

• Queens GEOE faculty are world renowned and heavily connected to industry leaders

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Dr. Bas Vriens, EIT
GeoEnvironmental Engineering

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GeoEnvironmental Engineering

Engineering the environmental impacts of human activity

Problems:
- Industrial and societal contaminants
- Ground- and surface water, soils, sediments

Tools:
- Site investigations,
- Field and lab experiments,
- Numerical and geospatial modeling

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Large-scale fluxes of emerging contaminants

Collaborative, drainage basin-scale screening:
Field sampling, interaction with legislators, utilities, engineers

Earth system analyses: budgets and loads
Geospatial analyses to identify natural or human sources

Scientists find gold worth $2 million in Swiss sewage

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Environmental impacts of mine wastes

Water, air, energy transport in waste rock

Contaminant mobilization into the environment?

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Opportunities and career paths

**Common:**

- Industry: Teck, Goldcorp, etc.
- Government: federal, provincial, regional
- Consulting: BGC, Arcadis, Golder, etc.
- Other: academia, NGO’s, etc.

→ Technical expertise

**Not-so-common:**

- Wastewater hydrologist; now in private equity
- Biogeochemist; now in logistics for grocery chain

→ transferable skills
→ practical, conceptual and quantitative engineering mindset
→ creativity!

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ENIRONMENTAL ENGINEERING AT DILLON CONSULTING

The Work they Do

Manage environmental projects, hydrological investigations, and contaminated site remediation projects

My Work as a Summer Student

Completed the environmental monitoring for the City of Ottawa’s landfill, collecting and analyzing groundwater, surface water, and soil

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FIELD WORK

• Environmental sampling for contaminated/potentially contaminated sites

OFFICE WORK

• Reporting – Phase I and II Environmental Site Assessments
• Designing remediation plans
• Analytical work analysing the sites geochemistry
Queen’s GEOE Program: Geological Engineering Design

Dr. Mark Diederichs, GEOE Curriculum Chair

Site Investigation

Final Design

Geological Model Design
(Virtual Reality)

Analysis Program Design
(A New Challenge Every Time!)
GEOE SECOND YEAR
FUNDAMENTAL KNOWLEDGE
LAB AND FIELD SKILLS
INTRO TO GEOE

Mathematics

MTHE 225  Ordinary Differential Equations (The Math of Change)
CHEE209  Analysis of Process Data (The Math of Variability)
CIVL230  Solid Mechanics (The Math of Stability)
APSC221  Economics (The Math of Sustainability)

Science

GEOE 207 History of Life (Deep Time)
GEOE 232 Mineralogy (Basic GEO Building Blocks)
GEOE235 Solid Earth Materials (Rocks—Nature’s Primary Composite Materials)
GEOE 238 Sedimentation (Recycled Earth Materials)
GEOE 249 Earth Physics (The Dynamic Earth)

Engineering

GEOE281 INTRO TO GEOLOGICAL ENGINEERING
GEOE221 GEOLOGICAL ENGINEERING FIELD METHODS (Site Investigation)
APSC200 ENGINEERING DESIGN (GEOE) (First chance to do a GEOE Design Project)
APSC293 ENGINEERING COMMUNICATION (Reports, Memo, Presentations)

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GEOE THIRD YEAR
ENGINEERING INVESTIGATION & ANALYSIS

GEOE Analysis
- GEOE359 Numerical Analysis for GEOE
- GEOE333 Terrain & Spatial Analysis

GEOE300 GEOE Field School
- GEOE319 Applied Geophysics
- GEOE345 Site Investigation & Engineering Design

GEOE321 Rock Structures
- GEOE313 Geomechanics & Rock Engineering

CIVL340 Geotechnical Engineering
- GEOE343 Groundwater Engineering

GEOE365 Geochemistry
- GEOE362 Ore Deposits & Mineral Resource Engineering

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GEOE FOURTH YEAR
APPLICATION, DESIGN, SPECIALIZATION

Advanced Field Schools

- GEOE410
Geomechanics and Geoenvironmental Engineering

OR

- GEOE419
Advanced Engineering Geophysics

GEOE DESIGN

Fall

- GEOE446
DESIGN PROJECT (Initial Design)

Winter

- GEOE447
DESIGN PROJECT (Final Design)

+ 5 Technical Electives

- Advanced Geophysics
- Advanced Rock Engineering (Slopes, Tunnelling & Mining)
- Geo-Environmental & Water Resource Engineering
- Advanced Mineral Resource Engineering
- Advanced Geoscience & Geochemistry
- Energy/Mining Engineering
- Geotechnical Engineering
- Advanced Geo-statistics & Big Data Analysis
- Geographic Information Systems (GIS)
- Sustainability
- Physics

+ many more streams
70+ Tech Electives to choose from

+ 3 Complimentary Studies Electives (to keep you human!)
Knowledge and Skillset to take on the Earth’s Challenges

INVESTIGATION & MEASUREMENT
- Pure and Applied Geology
- Composition & Properties of Geo-Materials
- Field Skills/Investigation/Testing/Imaging
- Applied Geophysics
- Applied Geochemistry

DESIGN of Geological Models
- Genetic
  - Stratigraphy
  - Structural Geology
  - Tectonics
  - Surface Processes
  - Mineral Paragenesis
- Spatial (3D) and Temporal (4D)
  - Geochronology
  - Geomechanics
  - Hazards
  - Hydrogeology
- Behavioural
  - Geochemistry
  - Geophysics

ANALYSIS
- Mechanical Analysis
- Numerical Analysis
- Geo-chemical Analysis
- Data Visualization
- Inversion Analysis
- Geostatistics

DESIGN of Analysis Protocols
- Design Concepts/Approaches
- Economics & Sustainability
- Design Option Ranking & Selection
- Permits/Regulations/Contracts
- Stakeholder Issues & Codes
- Risk & Acceptability

DESIGN of Engineered Solutions
- Site Investigation Programs
- Site Monitoring Systems

Communication

Professionalism

Judgement

Teamwork

Breadth

Calibration and Verification

Industry Approved Program!!
Geological Engineering, GEOE

Billy Hoyle

2nd Year Experience

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Why did I choose Geo?

- The profs,
- The small class size,
- The job opportunities,
- The hands on learning approach
- The field trips

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2nd Geological Engineering Year Courses

Geology Courses
- GEOL/E 207 History of Life
- GEOL/E 221 Field Methods
- GEOL/E 232 Mineralogy
- GEOE 281 Earth Systems Engineering
- GEOL/E 235 Petrology
- GEOL/E 238 Sedimentology
- GEOL/E 249 Geophysics

Engineering Courses
- APSC 200 Engineering Design
- APSC 221 Economics
- CHEE 209 Statistics
- MTHE 225 Differential Equations
- CIVL 230 Solid Mechanics

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Why Should You Choose Geo?

Course Diversity
- Take civil, math, environmental science and geology courses
- Flexible Degree

Job Opportunities
- The Professors are top rated globally
- Geological engineers are in very high demand

The Cool Stuff
- You understand the memes
- You get a rock hammer

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Benjamin Saadiah
Undergrad Research and Design
Introduction

Who am I:  
4th Year undergrad student, class of 2020  
Likes computational problems in GEOE

What I did this summer  
Worked for Dr. Diederichs in Geomechanics Lab on VIRTUAL TUNNELS !!

Why I love GEOE:  
Tight knit community of high quality people  
Great department, lots of support for students  
Broad field trip and job opportunities  
Impactful field, lots of problems to solve

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Undergraduate Research (Queens Geomechanics Group)

What
Research Assistant in World Class Rock Mechanics and Rock Engineering Group

How
Creating 3D models of tunnels to be analyzed
Script Code Development (Python and FISH)
Simulating how tunnels respond to stress

Why
Significantly enhanced grad student progress
Computers and coding VERY useful in GEOE

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Best Experience: GEOE 410 Field Course

What

Travel north to Timmins, Elliot Lake and Sudbury
Visit mines, mills, and tailings (waste) ponds
Speak with very important and friendly people

Why

First hand exposure to complex technical, social and environmental issues affecting resource engineering

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4th YEAR DESIGN PROJECT
IBM Machine Learning applied to Core Scanning

What

Apply machine learning to interpret rock core
(Most intensive component of exploration)
Clients are two GEOE grads at IBM
Great computational problem: Big data in GEOE!

3D Virtual Model of Rock Core

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Geological Engineering, GEOE

Caitlyn MacPhee GEOE ‘20
Miller Club

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What is Miller Club?

- Department of Geological Sciences and Engineering undergraduate student club
- Plans fun social, academic and networking events throughout the year
- Liaison between staff and students

Miller Club is a chance to showcase your leadership skills, Queen’s spirit and get involved with the Geological and Geological Engineering community!

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Extracurriculars and Events

- Back to School Barbecue
- Intermural Sports & BEWICS
- Gronch: Holiday Semi-Formal
- Fur Cup: Geo vs. Mining Hockey Game
- Department Geo Swag
- Miller Memoirs

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Academic Activities and Networking Events

- Prospectors and Development Association of Canada (PDAC) Conference
- Peer Tutoring
- Curriculum Committee Representation
- The opportunity to work with the Department on many projects
- Much More!!

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Geological Engineering, GEOE

Vicki Remenda
GEOE Alumni and Career Potential

Just a Sample of the Possibilities......

“The Earth is our Classroom and our Responsibility”
Victoria Sterritt
GEOE 2004

Lead, Technology and Innovation - Teck

Masters of Economic Geology, UBC, 2006
MBA, Queen’s 2015

Resource Engineering
Matt Lato
GEOE 2006
PhD 2010
Senior Geotechnical Engineer – BGC Engineering
Laser (Lidar) Surveying and Terrain Analysis for Geotechnical Engineering
Virtual Reality and GeoEnvironmental Engineering
Shelby Yee
GEOE 2016
Co-Founder & CEO at RockMass Technologies

Won the Queen’s Innovation Connector Summer Initiative (QICSI) Venture Pitch Competition in 2016

Remote Scanning and Mapping tools for surface and underground
Max Howarth
GEOE 2014
Managing Consultant

Alex Harvey
GEOE 2014
MSc 2016
Consultant

Queen’s Engineering Excellence Award Winner
Shawna Munn
GEOE 2010

Project Manager/Engineer
Design of:
Subway Stations
Retaining Walls
Deep Foundations
Shafts
Andrew Gagnon-Nandram
GEOE 2014
MSc 2016
Field Manager – Pioneer Aerial Surveys Ltd
DRONE SURVEYING
Stephanie Robillard
GEOE 2009
MSc 2010

Tunneling Engineer
McMillen Jacobs Associates
Director Tunnelling Association of Canada
Gabe Walton
GEOE 2011
PhD 2014
Geophysics and Rock Mechanics
Professor
Colorado School of Mines

Construction, Tunnel and Mine Stability

Nuclear Safety

Geophysical Surveying

Experts to Advise WIPP on Worker Safety, Regulatory Compliance
Drew Feustel
PhD 1995
Commander of the International Space Station
June – October 2018

Michelle Thompson
GEOE 2011
Planetary Scientist and Post-Doctoral fellow at the Johnson Space Center in Houston, Texas
GARNET
Geo-Alumni Resource Network

Bringing current Queen’s GEOE students together with GEOE Alumni

- Career Mentoring
- Resume Review
- Cover Letter Help
- Speaker Series

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garnet@queensu.ca
Interested in GEOE?
See if we can help now
GEOLOGICAL ENGINEERING
It’s not just an ADVENTURE. It’s a JOB!
IT’S YOUR CAREER....Come be part of Team GEO !!

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