THE UNIVERSITY OF BRITISH COLUMBIA Experiential Learning Hub Faculty of Applied Science

UBC

# GEOLOGICAL ENGINEERING Industry Guide

## Introduction

The Geological Engineering department at the University of British Columbia (UBC) provides a comprehensive undergraduate education, offering students the opportunity to engage in world-class research and hands-on experience. UBC's Geological Engineering program equips students with a strong academic foundation in geotechnical, environmental, and geological sciences. Graduates are well-prepared to address the complex challenges facing industries such as natural resources, environmental protection, infrastructure development, and natural hazard mitigation.

Geological engineers from UBC work across a wide array of sectors, including mining, water resources, oil and gas, environmental consulting, and geotechnical design. They leverage their expertise in assessing geological conditions, designing and optimizing structural solutions, and ensuring sustainable practices in both natural and built environments. UBC's program also emphasizes interdisciplinary collaboration, preparing students for roles in diverse fields like environmental impact assessment, remote sensing, and resource management. This document outlines the various industries where geological engineers from UBC may find rewarding careers, highlighting the broad scope of opportunities and their critical role in shaping a sustainable future.

Key Areas of Study

 Geology and Geophysics, Soil and Rock Mechanics, Environmental Engineering, Hydrology and Water Resources, Mining Engineering, Geotechnical Engineering, Natural Hazard Assessment and Mitigation, Structural Foundations and Earthquake Engineering, Remote Sensing and GIS, Environmental Impact Assessment.

## Industries

Geological Engineering plays a critical role in addressing societal challenges related to the Earth's natural resources and built environment. From natural resource extraction and environmental protection to infrastructure development and hazard mitigation, geological engineers are at the forefront of ensuring the sustainable use of the Earth's resources. This field applies expertise in geology, geotechnical engineering, hydrology, and environmental science to solve problems in mining, civil engineering, water management, and more. Below are the key industries where geological engineers typically find employment.

# Industries

## MINING AND MINERAL EXPLORATION

Geological engineers in the mining and mineral exploration industry focus on the discovery, extraction, and processing of natural resources. They use advanced techniques to identify mineral deposits, assess their economic viability, and ensure safe and environmentally responsible extraction processes. They also play a crucial role in risk management and resource estimation, making them indispensable to the mining industry.

## ESSENTIAL SKILLS:

- Resource Estimation and Modeling
- Exploration Techniques
- Risk Assessment and Mitigation
- Environmental and Sustainability Practices
- Project Management

#### POSITIONS:

- Entry Level: Junior Geologist, Exploration Geologist
- Mid-level: Geotechnical Engineer, Mining Engineer
- Senior: Senior Mining Engineer, Resource Manager, Chief Geologist

## ENVIRONMENTAL ENGINEERING

Environmental geological engineers work to minimize the impact of human activities on the Earth's ecosystems. This includes assessing and remediating contamination in soil, groundwater, and air. They play an essential role in designing and implementing systems for waste management, land reclamation, and environmental restoration. Their work ensures that industrial operations comply with environmental regulations and contribute to sustainability.

#### ESSENTIAL SKILLS:

- Environmental Impact Assessment
- Site Remediation and Restoration
- · Water and Soil Contamination Management
- Regulatory Compliance
- GIS and Remote Sensing

#### POSITIONS:

- Entry Level: Environmental Consultant, Environmental Technician
- Mid-level: Environmental Engineer, Environmental Compliance Officer
- Senior: Senior Environmental Engineer, Environmental Project Manager

## OIL AND GAS

Geological engineers working in the oil and gas industry play a critical role in ensuring the safe and efficient exploration, extraction, and transportation of petroleum products. They are responsible for assessing subsurface conditions, which requires a deep understanding of geology and geophysics, to determine the most effective locations for drilling operations. These professionals design detailed drilling programs that include selecting optimal drilling techniques and ensuring the stability of underground reservoirs to prevent blowouts or collapses.

In addition to traditional extraction techniques, geological engineers in this field apply cutting-edge geological modeling, remote sensing, and data analytics to predict the behavior of oil reservoirs over time, thus maximizing resource recovery. They collaborate closely with other engineering disciplines, such as mechanical and civil engineers, to ensure that drilling operations are safe, sustainable, and cost-effective.

#### ESSENTIAL SKILLS:

- Reservoir Engineering
- Geological Modeling and Simulation
- Subsurface Mapping and Imaging
- Drilling and Extraction Techniques
- Safety and Environmental Regulations (e.g., spill containment, waste management)
- Risk Assessment and Management
- Remote Sensing and Geophysical Surveying

#### POSITIONS:

- Entry Level: Junior Petroleum Engineer, Geologist, Geotechnical Engineer
- Mid-level: Reservoir Engineer, Drilling Engineer, Production Engineer
- Senior: Senior Petroleum Engineer, Production Manager, Senior Reservoir Engineer, Drilling Operations Manager

# Industries

## GEOTECHNICAL ENGINEERING

Geotechnical engineers are crucial in ensuring the stability and safety of construction projects. They assess soil and rock conditions to design foundations for buildings, roads, dams, and bridges. Their role includes site investigations, soil testing, and recommending materials and techniques for optimal foundation design. They also mitigate risks like landslides, ground settlement, and seismic activity by designing retaining walls and slope stabilization systems.

These engineers are involved in both the design and construction phases, ensuring structures remain stable over time. Their work also extends to environmental concerns, such as soil contamination and remediation.

#### ESSENTIAL SKILLS:

• Soil and Rock Mechanics

- Foundation Design
- · Site Investigation and Testing
- Seismic Hazard Assessment
- Construction Monitoring

#### POSITIONS:

- Entry Level: Junior Geotechnical Engineer, Site Engineer
- Mid-level: Geotechnical Engineer, Design Engineer
- Senior: Senior Geotechnical Engineer, Project Manager

## WATER RESOURCES AND HYDROLOGY

Geological engineers specializing in water resources focus on the management and conservation of water systems, ensuring both sustainability and safety. They conduct hydrological studies to assess water flow and distribution, and design drainage and flood control systems to prevent water-related disasters. These engineers also work on managing groundwater resources, ensuring efficient usage, and monitoring water quality to safeguard ecosystems and human populations from contamination.

In addition to addressing issues such as water scarcity, they play a key role in designing irrigation systems and optimizing water supply for agricultural and urban areas. By combining geological knowledge with hydrological expertise, water resources engineers are essential in creating sustainable, resilient water management solutions.

#### ESSENTIAL SKILLS:

- Groundwater Modeling
- Hydrological Modeling and Analysis
- Water Quality Management
- Flood Risk Assessment

#### POSITIONS:

- Entry Level: Hydrologist, Junior Water Resources Engineer
- Mid-level: Water Resources Engineer
- Senior: Senior Hydrologist, Water Resources Manager

## NATURAL HAZARD MITIGATION

Geological engineers play a vital role in the study and mitigation of natural hazards such as earthquakes, landslides, floods, and volcanic eruptions. They use their expertise to assess potential risks and design strategies to reduce the impact of these disasters. This includes developing and implementing emergency response plans, as well as reinforcing infrastructure to withstand extreme events. Their work is crucial in safeguarding communities, infrastructure, and ecosystems from the potentially devastating effects of natural hazards. They also contribute to policy-making and regulations aimed at minimizing risk and promoting resilience in both urban and rural areas.

#### ESSENTIAL SKILLS:

- Seismology and Earthquake Engineering
- Landslide Risk Assessment and Mitigation
- Disaster Management and Emergency Planning
- Structural Resilience Design and Reinforcement
- GIS and Remote Sensing for Hazard Mapping and Monitoring

#### POSITIONS:

- Entry Level: Junior Hazard Mitigation Specialist, Geohazards Analyst, Junior Seismologist
- Mid-level: Earthquake Engineer, Landslide Mitigation Consultant, Risk Assessment Specialist
- Senior: Senior Geotechnical Consultant, Natural Hazard Expert, Disaster Risk Management Director

## **CONSTRUCTION & INFRASTRUCTURE**

Geological engineers involved in infrastructure development assess geological conditions for large-scale projects such as tunnels, dams, bridges, and highways. They ensure that foundations are stable, and the environmental impact is minimized during construction. Their role is crucial in designing sustainable and resilient infrastructure that can withstand natural and human-made stresses.

#### ESSENTIAL SKILLS:

- Infrastructure Design and Planning
- Site Investigation and Analysis
- Earthquake and Structural Engineering
- Environmental Impact Assessment
- Construction Project Management

#### POSITIONS:

- Entry Level: Junior Infrastructure Engineer, Site Investigation Technician
- Mid-level: Geotechnical Project Engineer, Infrastructure
  Design Engineer
- Senior: Senior Infrastructure Engineer, Project Manager

# **Technical Skills**

## CORE SKILLS

#### GEOTECHNICAL ENGINEERING

Proficiency in analyzing soil and rock mechanics, including the study of their behavior under load, and the design of foundations, slopes, and retaining structures.

#### HYDROGEOLOGY

Understanding of groundwater flow, aquifer testing, water quality analysis, and the management of water resources. Expertise in modeling groundwater systems, assessing groundwater contamination, and designing water supply and drainage systems.

## SEISMIC HAZARD ASSESSMENT

Knowledge of earthquake engineering, seismic hazard analysis, and site response analysis. This includes understanding the impact of seismic events on infrastructure, as well as the ability to develop mitigation strategies to reduce earthquake risks.

## LANDSLIDE RISK ASSESSMENT AND MITIGATION

Experience in assessing landslide risks and designing slope stabilization measures. Proficiency in conducting site investigations to evaluate soil and rock conditions for landslide potential, as well as designing retaining walls, drainage systems, and other mitigation strategies.

## ENVIRONMENTAL GEOTECHNICS

Expertise in assessing and mitigating environmental impacts related to land development and construction. Includes evaluating soil contamination, designing remediation plans, and ensuring compliance with environmental regulations.

## GEOPHYSICAL SURVEYING AND MAPPING

Familiarity with geophysical methods like seismic, magnetic, and electrical resistivity surveys to map subsurface conditions. Ability to interpret geophysical data for exploration, hazard assessment, and resource evaluation.

## GIS AND REMOTE SENSING

Skills in using Geographic Information Systems (GIS) and remote sensing tools for geological mapping, hazard assessments, and resource exploration.

## SOFTWARE AND TOOLS

## GEOTECHNICAL ENGINEERING TOOLS:

- PLAXIS: Software for geotechnical analysis and foundation design.
- GeoStudio: Suite for slope stability, seepage, and groundwater flow analysis.

## GEOLOGICAL MAPPING & GEOPHYSICAL TOOLS:

- ArcGIS: GIS platform for mapping and spatial analysis.
- Surfer: Tool for creating 3D geological models and contour maps.
- Geopsy: Software for seismic data analysis and inversion.

### HYDROGEOLOGY SOFTWARE:

- MODFLOW: Groundwater flow and solute transport modeling tool.
- HydroGeoAnalyst: Tool for groundwater modeling and water quality analysis.

## MINING ENGINEERING SOFTWARE:

- MICROMINE: Mining software for resource modeling and mine design.
- Vulcan: Geologic modeling and resource estimation for mining.

## SEISMIC & GROUND VIBRATION TOOLS:

- Seislmager: Seismic data processing.
- GeoSeis: Seismic hazard assessment.

## ENVIRONMENTAL MONITORING TOOLS:

- EnviroInsite: Environmental analysis.
- RockWorks: Geological data analysis and visualization.

## GIS & REMOTE SENSING TOOLS:

- QGIS: Open-source GIS for geological mapping and analysis.
- ERDAS Imagine: Remote sensing software for geological exploration.

## How to get Involved

- Engineering Design Teams
- <u>Georox</u>
- <u>EUS</u>
- UBC Clubs
- Personal Projects
- <u>UBC Work Learn Program</u>

## Other Resources

- <u>Canadian Institute of Mining, Metallurgy and Petroleum</u> (CIM):
- About your degree Geological