

General Geology and Geological Investigations (Domain A)

[Note: Examples given below are descriptive only and are not all-inclusive lists of items]

A-1. Earth systems and processes

A-1.1 Earth history

A-1.2 Earth systems (e.g., geosphere, hydrosphere, atmosphere, biosphere)

A-1.3 Geological cycle and processes (e.g., rock types, plate tectonics)

A-1.4 Hydrologic cycle and processes (e.g., evaporation, precipitation, ocean currents)

A-1.6 Energy sources and cycles (e.g., solar vs. geothermal, global energy balance)

A-1.7 Carbon cycle

A-2. Sources of geological information

A-2.1 Government agencies (e.g., USGS, USDA, NRCS, state geological surveys)

A-2.2 Scientific literature (e.g., peer-reviewed publications, geological field trip publications, graduate theses)

A-3. Geological and geophysical tools, techniques, and interpretation

A-3.1 Subsurface investigation (e.g., drilling, rock coring, soil sampling)

A-3.2 Rock and soil logging and description

A-3.3 Surface and borehole geophysics (e.g., seismic refraction/reflection, resistivity, GPR, televiwer)

A-4. Field notes, documentation, and record-keeping

A-5. Global positioning, coordinate systems, and datums

A-5.1 Coordinate systems and datums (e.g., types and applications)

A-5.2 Global Positioning Systems (GPS)

A-5.3 Measurement accuracy and precision

A-6. Scale and scale analysis

A-6.1 Scale types, applications, and analysis

A-6.2 Horizontal and vertical scales and relationships (e.g., vertical exaggeration)

A-7. Surface and subsurface mapping and map applications

A-7.1 Topographic maps, slopes, and profiles

A-7.2 Geologic maps, symbols, and applications

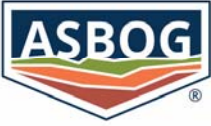
A-7.3 Strike and dip, apparent dip, thickness and depth

A-7.4 Isopach and isoconcentration maps

A-8. Remote sensing, image analysis, and Geographic Information Systems

A-8.1 Aerial imagery and photogrammetry

A-8.2 Remote sensing (e.g., infrared, radar imagery, satellite imagery, and Light Detection and Ranging (LiDAR))



A-8.3 Geographic Information Systems (GIS) and applications

A-9. Analysis and interpretation of geological sections and sequences

A-9.1 Geologic cross sections, boring logs, and geologic maps

A-9.2 Sequence of geological events (e.g., relative geologic time)

A-10. Project planning and development (***PG Only***):

D-10.1 Work scoping and cost estimating

D-10.2 Literature and regulatory review

D-10.3 Site-specific data, maps, and health & safety plans

D-10.4 Hazard identification and analysis



Mineralogy, Petrology, Geochemistry (Domain B)

[Note: Examples given below are descriptive only and are not all-inclusive lists of items]

B-1. Mineralogy

- B-1.1 Mineral groups (e.g., silicates, oxides, carbonates, sulfides)
- B-1.2 Mineral chemical and physical properties (e.g., composition, density, hardness, magnetism, luminescence, anisotropy related to crystal structure)
- B-1.3 Hazardous minerals and processes (e.g., asbestiform minerals, Pb-bearing minerals, silicosis)
- B-1.4 Material characterization methods (e.g., X-Ray Diffraction, X-Ray Fluorescence, ICP-MS, Scanning Electron Microscope)

B-2. Igneous petrology

- B-2.1 Igneous rock classification (e.g., intrusive and extrusive, mineral- and chemistry-based classification schemes)
- B-2.2 Magma evolution and phase diagrams (e.g., fractionation, nucleation, exsolution)
- B-2.3 Igneous petrogenesis and tectonic settings (e.g., mid-ocean ridge spreading centers, subduction zone volcanism, hotspots)
- B-2.4 Volcano types, eruption styles and volcanic deposits (e.g., stratovolcanoes, fire fountains, volcanic explosivity index)

B-3. Sedimentary petrology

- B-3.1 Sedimentary rock classification (e.g., siliciclastic, carbonates, evaporites, biochemical)
- B-3.2 Mineralogy of sediment & sedimentary rocks (e.g., common mineral occurrences in different environmental settings)
- B-3.3 Diagenesis (e.g., common clay minerals, oxides and oxyhydroxides, alteration of silicate minerals, redoximorphic features)

B-4. Metamorphic petrology

- B-4.1 Metamorphic rock classification (e.g., foliated and non-foliated)
- B-4.2 Metamorphic facies and tectonic regimes (e.g., greenschist, blueschist, granulite)
- B-4.3 Mineral/metamorphic rock associations (e.g., index minerals and associations)

B-5. Geochemistry

- B-5.1 Chemical composition of the Earth's layers (e.g., most common elements in Earth's crust, mantle, and core)
- B-5.2 Element classification and associations (e.g., halides, transition elements, noble elements)
- B-5.3 Chemical weathering (e.g., Reduction-Oxidation reactions, dissolution and reprecipitation reactions, hydrothermal alteration)
- B-5.4 Stability diagrams (e.g., pH/Eh diagrams, P-T diagrams, T-X_i-diagrams)



B-5.5 Isotope geochemistry and geochronological techniques (e.g., U-Pb, K-Ar, Rb-Sr, ¹⁴C methods, and optically stimulated luminescence)

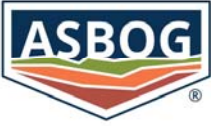
B-6. Project planning and development (***PG Only***):

B-6.1 Scope of work and cost estimate

B-6.2 Literature and regulatory review

B-6.3 Site-specific maps (GIS) and health & safety

B-6.4 Site-specific data



Sedimentology, Stratigraphy, and Paleontology (Domain C)

[Note: Examples given below are descriptive only and are not all-inclusive lists of items]

C-1. Stratigraphic principles

- C-1.1 Naming conventions (e.g., bed, units, members, formations, contacts)
- C-1.2 Rules (e.g., superposition, original horizontality, cross-cutting relationships)
- C-1.3 Unconformities (e.g., non-conformities, disconformities, paraconformities, angular unconformities)
- C-1.4 Using and interpreting stratigraphic columns, cross sections, fence diagrams
- C-1.5 Geochronology (e.g., geologic timescale, geochronologic methods)
- C-1.6 Correlation (e.g., geomagnetic polarity reversals, rock types, index fossils)

C-2. Sedimentary structures

- C-2.1 Primary (e.g., cross-bedding, ripples, flute and tool marks)
- C-2.2 Secondary (e.g., concretions, stylolites, Liesegang banding)
- C-2.2 Biogenic (e.g., burrows, trails, stromatolites)

C-3. Diagenesis

- C-3.1 Post depositional changes (e.g., compaction, recrystallization, dissolution, replacement, cementation, lithification, reduction-oxidation reactions)

C-4. Facies analysis

- C-4.1 Fabric (e.g., porosity, permeability, packing, isotropic vs. anisotropic)
- C-4.2 Facies changes (e.g., movements of shorelines, shallowing or deepening upwards successions)
- C-4.3 Facies-depositional environment relationships
- C-4.4 Relative sea level change (e.g., transgression, regression)

C-5. Depositional environments

- C-5.1 Clastic environments
 - C-5.1.1 Textural indicators (e.g., grain size, shape, angularity)
 - C-5.1.2 Non-Marine (e.g., glacial, eolian, alluvial, fluvial, lacustrine)
 - C-5.1.3 Transitional (e.g., deltaic, tidal, beach, lagoon, barrier island)
 - C-5.1.4 Marine (e.g., shelf, slope, rise, abyssal plain)
- C-5.2 Carbonate environments
 - C-5.2.1 Platform and bank
 - C-5.2.2 Ramp
 - C-5.2.3 Pelagic
- C-5.3 Evaporite environments

C-6. Fossil record and evolution

- C-6.1 Connections to structure of geologic time scale
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C-6.2 Index fossils

C-6.3 Biostratigraphy

C-7. Basin analysis

C-7.1 Sequence stratigraphy

C-7.2 Seismic stratigraphy

C-7.3 Depositional systems

C-7.4 Global cycles (e.g., Milankovitch cycles of eccentricity, obliquity, precession)

C-7.5 Facies architecture

C-7.6 Provenance

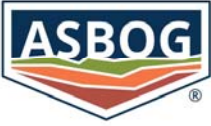
C-8. Project planning and development (**PG Only**):

E-8.1 Scope of work and cost estimate

E-8.2 Literature and regulatory review

E-8.3 Site-specific maps (GIS) and health & safety plan

E-8.4 Site-specific data



Geomorphology and Surficial Processes (Domain D)

[Note: Examples given below are descriptive only and are not all-inclusive lists of items]

D-1. Basic processes

- D-1.1 Driving forces (e.g., climate, gravity, tectonics)
- D-1.2 Resisting forces (e.g., lithology, structure, friction)

D-2. Weathering and soil development

- D-2.1 Chemical weathering processes (e.g., oxidation, dissolution, hydrolysis) and products (e.g., clay minerals, laterite)
- D-2.2 Physical weathering processes (e.g., frost wedging, sheeting) and products (e.g., talus, grus)
- D-2.3 Soil development (e.g., profile/horizon development, residual [in-situ] vs transported)

D-3. Analysis of surficial materials

- D-3.1 Grain size analysis (e.g., sieve, hydrometer)
- D-3.2 Soil classification systems (e.g. USDA, USCS)
- D-3.3 Age dating techniques (e.g., relative vs. absolute; optical stimulated luminescence [OSL], radiocarbon)

D-4. Fluvial processes and landforms

- D-4.1 Erosional processes and landforms (e.g., cut bank, point bar)
- D-4.2 Depositional processes and landforms (e.g., delta, alluvial fan)
- D-4.3 Hydraulic gradient and equilibrium
- D-4.4 Channel morphology, patterns, and profiles (e.g., meandering, braided, dendritic, trellis)
- D-4.5 Sediment grain size and distribution
- D-4.6 Effects of external influences (e.g., climate, urbanization, changes in base level)

D-5. Mass movements and slopes

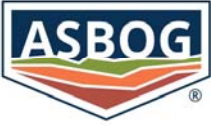
- D-5.1 Factors initiating movement (e.g., angle of repose, role of water)
- D-5.2 Classification of movement type (e.g., slump, slide, earthflow, debris flows, lahars)

D-6. Aeolian processes and landforms

- D-6.1 Erosional processes (e.g., deflation) and landforms (e.g., blowouts, desert pavement)
- D-6.2 Depositional processes and deposits (e.g., loess, dunes)

D-7. Glacial processes and landforms

- D-7.1 Formation, movement, and mass balance



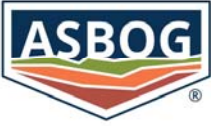
- D-7.2 Erosional processes (e.g., plucking, abrasion) and landforms (e.g., arete, cirque, horn)
- D-7.3 Depositional processes and landforms/deposits (e.g., lateral moraines, kettles, till)
- D-7.4 Sediment grain size and distribution
- D-7.5 Isostatic effects
- D-7.6 Effects of changing variables (e.g., climate, ice temperature, albedo)

- D-8. Karst processes and landforms
 - D-8.1 Erosional processes and landforms (e.g., sinkhole, sinking stream, cave)
 - D-8.2 Hydrology and drainage
 - D-8.3 Cave development

- D-9. Coastal processes and landforms
 - D-9.1 Erosional processes and landforms (e.g. wave-cut platforms)
 - D-9.2 Depositional processes and landforms (e.g. spits, barrier islands, tombolo)
 - D-9.3 Waves, tides, and currents
 - D-9.4 Drivers and effects of sea level change (relative and absolute, past and future)
 - D-9.5 Beaches and shorelines

- D-10. Volcanic processes and landforms
 - D-10.1 General features (e.g. vent, crater, caldera)
 - D-10.2 Intrusive (e.g., dike, sill, batholith) and extrusive landforms (e.g. cinder, composite, shield)
 - D-10.2 Types of volcanic eruptions (e.g. plinian, strombolian) and associated deposits

- D-11. Project planning and hazard analysis (**PG Only**):
 - D-11.1 Work scoping and cost estimating
 - D-11.2 Literature and regulatory review
 - D-11.3 Site-specific data, maps, and health & safety plans
 - D-11.4 Hazard identification and analysis



Structure, Tectonics, Seismology (Domain E)

[Note: Examples given below are descriptive only and are not all-inclusive lists of items]

E-1. Structural interpretation

- E-1.1 Three-point problems and structure contours
- E-1.2 Predicting depth and thickness of strata/faults
- E-1.3 Outcrop patterns and structural rule of “Vs”
- E-1.4 Interpretation of geologic maps and cross-sections

E-2. Deformation styles

- E-2.1 Brittle deformation (e.g., faults, fractures, joints)
- E-2.2 Ductile deformation (e.g., folds)

E-3. Structural fabrics

- E-3.1 Fabric development (e.g., linear, planar, shear)
- E-3.2 Fabric analysis (e.g., stereonet, rose diagram)

E-4. Classifications

- E-4.1 Fault classification (e.g., dip-slip, strike-slip, oblique-slip)
- E-4.2 Fold classification (e.g., anticline, syncline, monocline)

E-5. Mechanical properties of rock

- E-5.1 Stress, strain and strain rate
- E-5.2 Mohr circle (e.g., determination of shear strength, friction angle, cohesion)
- E-5.3 Conditions of brittle, brittle-ductile, and ductile deformation

E-6. Seismic/paleoseismic history

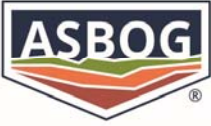
- E-6.1 Exploration methods
- E-6.2 Age determination
 - E-6.2.1 Absolute age determination (e.g., OSL, ¹⁴C)
 - E-6.2.2 Relative age determination (e.g., cross cutting relations)

E-7. Plate tectonics/tectonic regimes/earthquake processes

- E-7.1 General characteristics of earth layers (e.g., density, seismic velocity)
- E-7.2 Earthquakes at plate boundaries (e.g., depth and magnitude)
- E-7.3 Tectonics and volcanic activity

E-8. Project planning and development (**PG Only**):

- E-8.1 Scope of work and cost estimate
- E-8.2 Literature and regulatory review
- E-8.3 Site-specific maps (GIS) and health & safety plan
- E-8.4 Site-specific data



Hydrogeology (Domain F)

[Note: Examples given below are descriptive only and are not all-inclusive lists of items]

F-1. Hydrologic cycle and hydrostratigraphy

- F-1.1 The hydrologic cycle
- F-1.2 Aquifers, aquitards, and hydrostratigraphy
- F-1.3 Saturated and unsaturated systems (e.g., vadose zone, water table, and phreatic zone)
- F-1.4 Watershed mass balance and processes (e.g., evaporation, transpiration, precipitation, infiltration, sublimation, and recharge)
- F-1.5 Stream discharge and hydrographs
- F-1.6 Groundwater/surface water interaction (e.g., streams, lakes, springs, and wetlands)
- F-1.7 Water resources management and protection (PG)

F-2. Hydrogeologic properties and principles

- F-2.1 Hydraulic head and hydraulic gradient
- F-2.2 Hydraulic parameters (e.g., porosity, hydraulic conductivity, permeability, and transmissivity)
- F-2.3 Groundwater flow concepts (e.g., Darcy's Law, specific discharge, and average linear velocity equation)
- F-2.4 Groundwater storage (e.g., specific yield, specific retention, storativity, and specific storage)

F-3. Groundwater flow systems

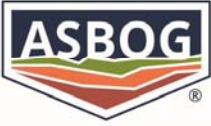
- F-3.1 Groundwater flow systems and flow nets
- F-3.2 Groundwater flow models
- F-3.3 Zones of Influence and well interference
- F-3.4 Karst and fractured rock flow systems

F-4. Hydrogeologic methods of investigation

- F-4.1 Types of wells, well drilling methods, and construction (PG)
- F-4.2 Laboratory hydraulic tests (e.g., permeameter tests)
- F-4.3 Single-well tests (e.g., slug tests and specific capacity tests)
- F-4.4 Multiple-well tests (e.g., confined, leaky, unconfined, time-drawdown, and distance-drawdown pumping and recovery tests)
- F-4.5 Pumping test boundary conditions
- F-4.6 Investigating the unsaturated zone (e.g., tensiometers, lysimeters, gypsum blocks, and time domain reflectometry)
- F-4.7 Hydrogeophysical methods (e.g., borehole geophysics, surface resistivity, seismic, and ground penetrating radar)

F-5. Aqueous geochemistry and contaminant hydrogeology

- F-5.1 Groundwater geochemical parameters



- F-5.2 Groundwater contaminants
 - F-5.3 Contaminant fate and transport (e.g., advection, sorption, dispersion, diffusion, degradation) and breakthrough curves
 - F-5.4 Groundwater remediation (PG)
 - F-5.5 Isotopic and tracer studies
- F-6. Project planning and development (PG only)
- F-6.1 Scope of work and cost estimation
 - F-6.2 Literature and regulatory review
 - F-6.3 Site-specific maps and health and safety plans





Engineering Geology (Domain G)

[Note: Examples given below are descriptive only and are not all-inclusive lists of items]

G-1. Geologic properties, soil origins (in-situ and transported), and groundwater

G-2. Soil mechanics

- G-2.1 Soil properties: physical and index (e.g., grain size, soil gradation, density/unit weight, water content, void ratio, porosity, cohesive, non-cohesive)
- G-2.2 Soil classification (e.g., sieve analysis, specific gravity, Atterberg limits)
- G-2.3 Classification systems (e.g., USCS, AASHTO)
- G-2.4 Compaction and consolidation
- G-2.5 Shear strength (e.g., cohesive v. non-cohesive soils)
- G-2.6 Stability of soil slopes

G-3. Rock mechanics

- G-3.1 Classification and index properties (e.g., rock type, weathering, deformation)
- G-3.2 Rock mass classifications (e.g., rock fabric orientation, joint spacing, joint/planar surface features, joint filling materials, rock quality designation [RQD])
- G-3.3 Rock strength failure criteria (e.g., uniaxial compressive strength, shear strength of discontinuities, tensile strength, Hoek-Brown geological strength index, Mohr-Coulomb)
- G-3.4 Failure modes (e.g., wedge, topple, planar)
- G-3.5 Planes of weakness and testing planes (e.g., friction angle, cohesion of failure planes, water content of fractures)
- G-3.6 Deformability of rock (e.g., direct shear test, ripability)
- G-3.7 Kinematic analysis (e.g., stereonet)

G-4. Geologic hazards

- G-4.1 Hazard and risk analysis (e.g., floods, landslides, earthquakes, subsidence, erosion)

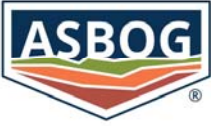
G-5. Engineering geology methods of investigation

- G-5.1 Well drilling methods (e.g., direct push technologies, sonic, hollow stem, rotary)
- G-5.2 Geophysical methods (e.g., borehole geophysics, seismic refraction, surface resistivity, ground penetrating radar)
- G-5.3 Image analysis and interpretation

G-6. In-situ and laboratory testing

- G-6.1 In-situ testing (e.g., standard penetration testing, cone penetration testing, infiltration, slug/pumping test)
- G-6.2 Laboratory testing (e.g., triaxial, uniaxial, point load, drained, undrained)

G-7 Project planning and development (*PG only*)



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- G-7.1 Scope of work and cost estimation
 - G-7.2 Literature and regulatory review
 - G-7.3 Site-specific maps and health and safety plans





Mineral and Energy Resources (Domain H)

[Note: Examples given below are descriptive only and are not all-inclusive lists of items]

H-1. Ore/mineral systems and principles

H-1.1 Ore minerals and their economic use(s)

H-1.2 Mineral system/ore formation processes

H-1.2.1 Magmatic (e.g., disseminated deposits, vein/lode deposits, sulfide deposits, pegmatites, kimberlites, carbonatites)

H-1.2.2 Hydrothermal deposits (e.g., porphyry, volcanogenic massive sulfide, epigenic, geothermal brines)

H-1.2.3 Sedimentary ore deposits (e.g., placer, banded iron formations [BIF], evaporites, laterites, phosphorites)

H-1.2.4 Metamorphic deposits (e.g., skarn)

H-1.2.5 Meteoric/Groundwater (e.g., U-V roll front deposits)

H-2. Geologic energy resources

H-2.1 Coal deposits

H-2.2 Oil and natural gas reservoirs

H-2.2.1 Traditional systems

H-2.2.2 Unconventional systems

H-2.3 Geothermal energy

H-2.4 Nuclear energy (e.g., uranium mineral systems)

H-3. Prospecting/exploration techniques

H-3.1 Geophysical (e.g., resistivity, gravity, seismic refraction/reflection, magnetic susceptibility, aeromagnetic surveys)

H-3.2 Geochemical (e.g., soil, rock, groundwater/surface water sampling)

H-3.3 Drilling techniques (e.g., air/mud rotary, reverse circulation, diamond core)

H-3.4 Remote sensing and GIS (e.g., geologic maps, aerial imagery/photography, lidar, hyperspectral/multispectral imaging)

H-3.5 Petrophysical (e.g., bulk, grain, texture)

H-3.6 Analytical methods (e.g., fire assay, atomic absorption spectroscopy, inductively coupled plasma, x-ray fluorescence, microprobe)

H-3.7 Geostatistical analysis approaches – spatial modeling (PG)

H-4. Development techniques

H-4.1 Resource and reserve assessments

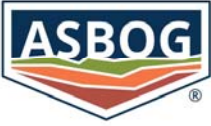
H-4.2 Quality and quantity evaluation

H-4.3 Economic evaluation (e.g., cutoff grade)

H-4.4. Mining methods

H-4.4.1 Surface methods

H-4.4.2 Underground methods



H-5. Environmental, health, safety, and security

H-5.1 Geological aspects that affect human health and environment

H-5.2 Extraction techniques

H-5.3 Waste management

H-6. Reclamation and restoration

H-7. Project planning (**PG Only**):

E-7.1 Scope of work and cost estimate

E-7.2 Literature and regulatory review

E-7.3 Site-specific maps and health & safety plan

E-7.4 Site-specific data