DRAFT
Mining 101 Course
Based on Mine Trainer Competency Framework

Tier 4: Industry-wide Technical Competency

401. Geological Concepts – Understand where and how economic deposits are formed based on fundamental geological concepts and processes that shape the earth.

Earth processes
- Understand the structure of the earth.
- Why economic deposits are where they are
- Earth's history

Basic Rocks and minerals - Understand the relationship between chemical elements, compounds, minerals and rocks.
- Elements, chemical compounds, minerals
- Common rock-forming minerals
- Types of rocks

Economic deposits - Understand the processes that form different types of deposits and how they interact with the environment (plus presentations for specific commodities such as gold, copper, sand/gravel, etc)
- Types of deposits and how they are formed
- How rocks are changed by environmental interactions and how these changes affect mining activities
  - What negative impacts (risks) are possible from different types of deposits

402. Exploration - Understand how economic deposits are found, identified and evaluated for their development potential.

Prospecting - Methodological, high risk hunt for economic deposits
- Decide on the commodity needed
- Level of acceptable risk in the following areas: political, environmental, infrastructure, transportation, geological, mineralogical that will determination where on earth to start looking
- Library search to gather available geological, mineralogical, and geographic data
- Look from the large course scale and decrease the scale and increase the resolution on the areas of interest found in the previous activity
- Ground confirmation
- After each round of data collection and interpretation a business decision is made as to either continue or to fund other more promising projects

Geo-positioning and Mapping
- Georeferencing - different coordinate systems used for maps
- Gridding and Contouring
- GPS

Remote large scale - Geophysics, space, airborne and land based

- Satellite data looking for indicator mineralogy and geologic structures
- Airborne surveys of geophysical properties, e.g., magnetic, density, electric and electromagnetic responses which provide clues about the minerals and rocks present below the ground as well as their depth of burial and areal extent
- Ground confirmation: collect dense geophysical data based on the airborne results

Sampling - Collection of geochemical samples

- Mapping of indicator mineralogy, faults, and folds using the previously collected data as a guide
- Survey of geochemical properties from rock, soil and plant material

Assaying (some content included in geochem modules but could be separated and expanded)

- Basics of sample preparation
- Types of analyses – AA, Mass Spec, ICP, XRD, XRF, etc.

Drilling - Drilling sampling of areas of interest

- Drilling samples of representative areas of the rock mass
- Different types of drill samples are collected for mineralogical, rock mechanic properties and chemical analysis
- All data collected to this point are placed into a three- dimensional block model of the property for mine planning purposes
- After every step map data correlation and a continue/non-continue decision is made

403. Mineral Economics

- Mineral deposits have different types of risks that impact whether the resource can be mined
- Development of a mineral resource depends on the financial calculations that determine profitability
- Price of the mineral is an important part of whether a resource is developed and prices are set different ways for different minerals
- Minerals have different markets
- Companies have different structures to develop resources at different stages - prospectors focus on exploration, junior companies prove the resource is profitable, small to medium companies have 1 or 2 mines, large diversified senior companies have multiple mines, often in many countries and may mine many different types of minerals
- Discuss global trends that impact the mining industry (supply and demand)

404. Business of Mining - is the deposit economic with everything considered

- Junior exploration companies conduct high risk exploration to identify and confirm significant economic deposits
- Junior exploration companies sell mineral rights to mining company (typically larger) with capital, skills and resources to mine and process the ore
- Define geometry of deposit - identify economically viable approaches to mining and processing methods (optimized mine design)
- Economic analysis of project - Social license, capital cost, operational cost, projected revenue, and the tax liability
- Mining of materials of monetary value - mineral products, by-products, and co-products costs from gangue minerals

- Processing of mined materials to commercial products of value (commodity)
- Permitting, time required, operations, closure, long term monitoring and maintenance costs

405. Mine Development –how do we plan and build a mine

- Mining terminology – surface and underground
- Geostatistics
- Block models
- Mining methods
  - Surface
  - Underground
- Mine design parameters – surface, underground
- Mine planning and scheduling considerations

406. Mining Methods, Operations, and Equipment – Understand a variety of methods and equipment used in both underground and surface mining operations.

Mining cycle

- Explain the typical stages in mining operations - drill, load, blast, muck, haul, dump

Underground mines

- Identify common underground mining equipment
- Identify unit operations

Surface mines

- Identify common surface mining equipment
- Identify unit operations

407. Processing and Refining - Understand the basic steps in processing and refining a variety of materials.

Blasting

- Most economical method to break rock to the correct size for the mining methods used

Crushing particle size reduction

- Know the typical crushing equipment - gyratory, jaw, and cone crusher, etc.
- Understand what happens to the material during this stage of the process

Grinding even smaller particles

- Know the typical grinding equipment - AG mills, SAG mills, ball mills, etc.
- Understand what happens to the material during this stage of the process

Specific processes retrieving the commodity of interest

- Leaching: Pads or in situ
- Commodity extraction from leaching fluids
- Floatation, for ore concentration or cleaning
- Smelting for metal extraction from concentrates

408. Health and Safety (taught by College of Law)

Module 1 – Overview: 5 most important things to know about mining safety and health

1. History of industrial safety and health and mining safety -
    - History of labor safety and health and mining safety
    - List of major global mining accidents
    - ILO and role of unions and civil society
    - OSHA, MSHA, BLS, other agencies in EU, Australia, Canada, S.Africa, Mexico, Chile, etc.
    - Types of laws - statute, administrative, common law
2. Mines are hazardous but not inherently dangerous; hazardous because we have high energy systems that humans interface with and the work environment is dynamic and the conditions are not always optimal. Mining is not dangerous because we understand mining and have systems in place to prevent accidents.
    - Definitions of injuries, and statistical analyses
    - Categories of accidents and preventive measures
    - Analysis of fatalities and relationship to changes in laws
3. Systems are implemented to help prevent errors. Systems are regulatory, control, and behavioral
    - Heinrich triangle,
    - Bow tie, tap root methods of analyses
    - Critical controls,
    - Behavioral, regulatory, competency frameworks,
4. Worker and community health are a priority for mining companies and systems are in place for health protection
    - PPE,
    - Exposure measurements
    - Regulatory framework for worker health
    - Community health programs and successes
5. The main exposures that impact health:
    - black lung
    - silicosis
    - DPM
    - mine gases
    - ergonomics
    - fatigue
    - thermal exposure
    - hearing loss

Module 2 - Risk and safety analysis
- Accident theories
- Safety management principles, responsibilities, cost model
- Safety analysis methods
- Hazard ID and control
- Human error analysis

Module 3 - Safety systems and technologies
- ICMM leading indicators and safety management
- ICMM emergency preparedness
- Critical controls
- Technologies

Module 4 - Regulations (compare countries)
- Structure of mine safety laws and how they are implemented

Module 5 – Human component
- NMA core safety and other programs, competencies
- Role of leadership
- Training requirements in key countries

Module 6- best practices
- ICMM guides - exposures
- ICMM - communicable diseases
- ICMM- risk assessment
- ICMM-impact assessment
- ICMM - community health
- slips/trips/falls
- fatigue
- thermal exposure
- hearing loss
- electrical shocks
- chemical exposures

Module 7 – community health
- UN Millennium goals relevant to community health
- Civil society's role in community health in mining communities
- Major community health issues in key mining areas
- Regulatory framework to protect community health
- Best practices in mining industry for community health

109. Environment

- Water – types of pollution controls, water quality, quantity, protection
- Air – dust and other emissions
- Land – ecosystems, indigenous uses, reclamation, conservation
- Biodiversity – plants, animals

110. Communities

- Corporate social responsibility
- Social license to operate
- Sustainable resource development
- Conflict Minerals
- Artisanal Mining
- Indigenous communities

Tier 5 Industry-Sector Technical Competencies

An examination of commodity-specific issues (**Work in Progress**)

501. Metal –

- Types of metallic resources and geographic distribution
- Major types of metallic mineral deposits
- Major producers and producing countries
- Prices of metals
- Types of mining methods - surface and underground - and implications for cost, maintenance, safety
- Types of mining equipment - surface and underground - implications for cost, maintenance, safety
- Types of processing methods
- Critical risks - analysis of safety data
- Mine life
- Environmental stewardship
- Social license to operate including federal, vs state vs private land and permitting processes
- Workforce - types of jobs, skills, education, demographics

502. Nonmetal –

- Industrial minerals - types and distribution
- Markets and transportation issues - including role of changing technologies (e.g. lithium)
- Types of mining methods
- Types of mining equipment
- Types of processing methods
- Critical risks
- Mine life
- Environmental stewardship
- Health and safety
- Social license to operate including federal vs state vs private land and permitting processes
- Workforce - types of jobs, skills, education, demographics

503. Stone, Sand, Gravel & Cement

- Uses of products and required standards for products
- How cement and concrete are made
- Types of mining methods
- Types of mining equipment
- Markets and transportation issues
- Permitting issues
- Environmental stewardship - working in urban areas
- Health and Safety
- Social license to operate - community engagement
- Workforce - types of jobs, skill, education, demographics

504. Coal, Uranium, Gas & Oil Sands

- Types of resources and classification (e.g. peat, lignite, bituminous, anthracite) and quality measures
- Locations of coal basins and relationship to natural gas and oil
- Market differences for steam coal, metallurgical coal, natural gas, oil and market trends
- Surface and underground mining methods and equipment
- Critical Risks - safety data and health issues
- Permitting issues
- Environmental stewardship - reclamation, "clean coal", natural gas
- Health and safety management
- Social license to operate
- Workforce

505. Coal –

o Surface versus underground operational considerations (i.e., mining and processing methods and technologies)
o Equipment and associated maintenance (present/future)
o Critical risk management
o Workforce - demographic (i.e., education/training/skillset needs present/future), attrition projections/planning, and in-house versus contracting
o Mining method and processing optimization, strategic innovation investments
o Coal pricing structures - producer prices, negotiated prices, independent prices, commodity exchange prices
o Reserves available, explorations/acquisitions for next project(s), cash availability versus needs