PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA

MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH

HARMONISATION
MASTER'S OFFRING TRAINING
Professional

Institution	Faculty/Institut	Department
University of Djilali Bounaama – Khemis Miliana (UDBKM)	**NATURE, LIFE SCIENCES AND EARTH SCIENCES**	**Earth Sciences**

Domain: Earth and Universe Sciences

Field : GEOLOGY

Specialty : MINING GEOLOGY

Academic year : 2022/2023

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I – Technical data of Master

1 - Location of the training:

Faculty of Nature and Life Sciences and Earth Sciences

Department : Earth Sciences (Geology)

2- Training partners *:

- Other university institutions:
- Companies and other socio -economic partners

→ ENOF (National Non-ferrous Mining Company)

→ CETIM (Boumerdes) Center of studies and technological Services for the Construction Material Industry.

→ Private quarry

→ El Abed Mining School (Tlemcen)

- International parteners :

* = Present the agreements as an appendix to the training

3 – Context and objectives of training

A- Admission conditions

Licensees in :

- Licenses in Applied Geology , option : Minerals resources , geo-resources Mining Geology, mineral and environmental research.
- Licence in Geosciences (on file review).
- Licence Fudamental Geology (on file review).
- Acces on M2 for geological engineer (on file review).

B - Objectives of training *(*Targeted skills*, pedagogical knowledge acquired at the end of the training - max 20 lines).*

The training is adapted to the new concept of Earth sciences discipline in the company , with a very marked trend towards the fields of mineral and energy supply.
The aim of the courses is, on the one hand, to provide the fundamental knowledge essential for understanding the Earth and the phenomena that govern it, and, on the other hand, to introduce students to analytical methods commonly used in geosciences: specialized computing (GIS, etc.), geophysics and geochemistry. However, sufficient space is occupied by the fundamental aspects that constitute the framework common to geosciences: knowledge of materials (minerals and rocks), geological maps, mapping technics, mineral deposits, macroscopic and microscopic specifiation of mineral materials and resources.
Field courses are offered in semesters S2 (M1) and S3 (M2) to approve and develop the skills acquired previously. These are real field schools with observations and data acquisitions in the day, summary in the evening (directed work) and final synthesis at the end of the internship (final internship report).
In addition, know the techniques of evaluation and exploitation of resources in relation to the laws that manages the mining activities.

C – Targeted skills *(in the field of professional integration maximum 20 lines):*

Outlets

Preparation for professional integration leading to a wide variety of occupations related to the field of training typically in mining (geological services, design offices, mining and quarrying companies, cement plants, brickyards, management and preservation of geosites, etc.).

Impact:
Training of top-level masters in the field of mineral resources sciences and geomaterials, equipped with the scientific tools necessary to approach and solve the various problems related to mining research. The winners, after continuing their studies within the framework of doctoral research, will be ready to support the inevitable revival of the mining and develop the geo-materials and useful substances already very promising.
Training of future managers specialized in mining research, stakeholders in various fields inherent to natural resources (mines and quarries). This will make it possible to solve various problems related to the demand of the national and then international market for mineral raw materials and energy of the industrial sector.
To this is added the contribution to the development of the mining sector in particular and to the useful substances sector in a broader way.
Opening on the pursuit of doctoral studies preparing in particular for the careers of research and teaching in mining resources.
This training (learning) will also focus on the relationship between terrestrial geodynamics and the establishment of mineral raw material deposits.
At the end of this training, students will also have a solid knowledge on the various aspects of prospecting and assessment of reserves

D- Regional and National Employability Opportunities

The geologist's fields of activity are varied, since they concern many types of exploration and exploitation of the soil and subsoil throughout the national territory.

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the graduate from this training can operate in:

-The major groups and companies involved in the exploration and exploitation of Mineral Resources (ORGM, COMENA, FERPHOS, MANAL group , etc.).

- Public organisms and administrations in the mining sector (Ministry of Industry and Mines, Algerian Geological Service Agency, National Mining Agency, Mining survey, Wilayas Mining Service, etc.).
- Quarries that produce useful substances.
- Specialized mining studies offices.

In addition, this training can also be followed by a PhD in Geological Sciences.

E – Bridge to other specialization.

At the end of this training, the student has various scientific and technical skills in different fields to approach a professional life in a public or private company or to prepare a doctoral thesis in the field of mineral and energy georesources. Several subjects taught allow bridges to other paths:

Teaching on rock and mineral chemistry provides a recognized geochemical component for further studies.

The courses on mining and quarrying provide a gateway to mining studies and provide a recognized environmental component for continuing studies in this specialities.

The teaching of useful substances may lead to further studies in building materials technologies.

F – Program Monitoring Indicators

Continuous controls and presentation realized by students, EMD and Syntheses, Writing reports of field trips . Writing a Master's thesis on a well-defined subject related to the mining field.

G – Supervision Capacities

20 students per session

III - DETAILED PROGRAM BY COURSE

(1 sheet by course)

Master : MINING GEOLOGY Semestre *: 1*

UE : Fundamental Unit 1 **Code : UEF111**
Course title : Exogenous gitology
Credits : 6
Coefficients : 3

Objectives of teaching

Identify the concept of natural resources generally and mineral resources in particular.
To familiarize students with the geological parametres (gitology) and methods of formation (metallogeny) of the main types of mineral deposits in relationship with the host rocks.
Developing metallogenic ideas of global interest: mineralizing fluids, mechanisms of ore precipitation, in-depth vision of some type of deposits, methodological approaches.

Recommended prerequisite knowledge:
Petrography of sedimentary rocks, mineralogy.

Content :
Basic concepts and definitions (vocabulary of mineral resources, scales of metallogeny, typology of mineral deposits).
Classifications of mineral deposits of exogenous origin:
- Mineral resources in sedimentary basins:

Marine sedimentary gites:
• Banded Iron Formations (BIF)
• Oolithic iron and manganese
• Sedimentary phosphates
• Evaporites

Marine and continental diagenetic gites:
• copper and uranium sandstone
• Pb-Zn carbonates (MVT)
• coal

- Weathering mineral resources:

Pedogenetic ore:
• laterite and bauxite (Al, Ni, Mn).
• Iron hats and enriched ore.

Alluvial cottages: the placers
TP: macroscopic and microscopic study of minerals related to exogenous phenomena.

Assessment method: *Continuous Control TP EMD Exam*
References :
N. Arndt, C. Ganino. **Ressources minérales : cours et exercices corrigés.** Dunod, 2010, 192 pages.
G. Beaudoin. **Gîtologie et métallogénie- Manuel de cours.** UniversitéLaval, 2006. 116 pages.

Master : MINING GEOLOGY Semestre *: 1*

UE : Fundamental Unit 1 **Code : UEF112**
Course title :: **Useful substances**
Credits : 6
Coefficients : 3

Objectives of teaching:
The student will be able to recognize the different materials and useful substances used in industries or as building materials. He will be able to control the quality substances and offer solutions to economic and industrial operators if there is problems in the quality of the final products.

Recommended prerequisite knowledge:
Geology of Algeria, petrology of the three rock families, mineralogy, geochemistry and industrial standards.

Content :
1. Definition and characterization of useful substances (non-metallic substances)
2. Categorization and classification of useful substances:
- Carbonate rocks (used in aggregate, chemical industry and cement).
- Decorative stone (granite, marble, serpentine, travertine, etc.)
- Siliceous rocks (siliceous sand, sandstones, diatomites, radiolarites, etc.)
- Clays (red products, ceramics, cement, medical, etc.).
- Sulphates (Barite, Célestine).
- Evaporates (gypsum)
- Salts
3. Valuation and analytical methods

TP:
Standards and laboratory tests for different materials, Determination of physico-chemical properties of useful substances
Method of evaluation: *Continuous control, EMD TP examination*

References :
P.C. Aitcin, F. Généreux, G. Jolicoeur, Y. Maurice, Aggregate Technology. Modulo. 352 p.
Y. Berton, P. Le Berre. Career Materials Exploration Guide. BRGM. 1983. 160 p.
Barakat A. Quarry and construction materials. Course University Sultane Moulay Slimane, Morocco.. http://www.fstbm.ac.ma/newfstv08/support/cours_matx.pdf

Master : MINING GEOLOGY Semestre *: 1*

UE : Fondamental unit 2. **Code : UEF121**
Course title: Petrography and Geochemistry
Credits : 6
Coefficients: 3

Objectives of teaching:

Understanding the relationships between the structure and mineral chemistry , defining their importance as indicators of physico-chemical conditions crystallization of magmas genesis , transportation, crystallization and establishment of magmas. Familiarizing students with geochemical study methods (major, trace and isotopes) to the find a geochemical tracers and markers of deep materials.

Study of the behaviour and the laws of distribution and fractionation of elements during petrogenic processes (fractional crystallization, partial fusion, mixtures, etc.) Use of comparative and systematic geochemistry of elements in different geodynamic contexts for their characterization.

Discussion of petrogenic models and characterization of mantellic sources.

Recommended prerequisite knowledge:

Magmatic petrography-geochemistry of rocks.

Content :

- Structure and chemistry of minerals and their role.
- Physico-chemical conditions of magma crystallization.
- Methods of training, transport, crystallisation and magma's implementation.
- Geochemical study methods (major, trace and isotope).
- Fractionation of elements during petrogenic processes.
- Discussion of petrogenic models and characterization of mantellic sources.

TP :

-Study of different types of rocks.

-Sample's preparation techniques for different types of analyses

-Applied exercises. Absolute Dating, Temperature, Salinity Reconstruction, etc.

Assessment method : *Control continu Examen TP EMD*

References:

Barnes H.L. (1997)- Geochemistry of hydrothermal ore deposits, 3rd edition. John Wiley, New York, pp 972 Hoefs J. (1996)- Stable isotopes geochemistry, 4th edition, Springer, Berlin, 201 p. Roedder E. (1984)- Fluid inclusions. Mineralogical society of America, Review in Mineralogy 12, 644 p.

Master : MINING GEOLOGY Semestre *: 1*

UE : Methodological unit **Code : UEM21**

Course title: Geophysical prospection

Credits : 5

Coefficients : 3

Objectives of teaching;

Get more information on geophysical prospecting methods and focus on methods used in prospecting mineral resources and useful substances.

Recommended prerequisite knowledge:

Basic concept of Geophysics.

Content:

1. **INTRODUCTION:** Reminders on different geophysical methods.

1.1- Geophysical prospecting of high recognition (aeromagnetism and aeropectrometry),
1.2- Retail geophysical prospecting methods,
1.3- Overview of geophysical methods used in mineral exploration.

2. **ELECTRICAL METHODS**

2.1- Reminders on methods,
2.2- Applications of electrical methods to the exploration of mineral resources and useful substances.

3. **THE GRAVIMETRIC METHODS**

3.1- Reminders on the methods,
3.2- Applications of gravimetric methods to the exploration of mineral resources and useful substances.

4. MAGNETIC METHODS

4.1- Reminders on methods,
4.2- Applications of magnetic methods to the exploration of mineral resources and useful substances

5. SEISMIC METHODS

5.1- Method Reminders,
5.2- Applications of seismic methods to the exploration of mineral resources and useful substances

6. LOGGING

6.1- Reminders on methods,
6.2- Applications of Logging to Mineral Resource Exploration and Useful Substances

TD:

Exercises on each of the methods studied in progress Evaluation mode: Continuous control EMD, TD

References:

(Books and copies, websites, etc.).

Allard M. and Bois D. (1999)- Geophysics applied to mineral exploration. Publisher: Cégep de l'Abitibi-Témiscamingue. 330 pages. http://www.ccdmd.qc.ca/catalogue/geophysique-appliquee-lexploration-minerale-la

Master : Mining Geology Semestre *: 1*

UE : Methodological unit 1 **Code : UEM22**
Course title: *Geochemical prospection*
Credits : 4
Coefficients : 2

Objectives of teaching:
Perfection in a geochemical exploration's methods used in mining exploration.

Recommended prerequisite knowledge:
Basics of Geochemistry

Content :
1. GENERAL
History, role of geochemical exploration in the search of deposits.
Basic geochemical concepts: geochemical environment, dispersion, mobility, background content, significant content, geochemical anomaly.
2. LITHOGEOCHEMICAL METHODS
3. ALLUVIAL METHODS
4. SOIL GEOCHEMISTRY
For all methods it is necessary to treat: Principles of methods. Sampling: types and techniques of sampling, contamination hazards, geochemical survey planning, preservation, drying, screening and storage of samples. Analysis: type of analysis, analytical detection limits, histogram and distribution curves, basic statistics, computerized databases
5. MAPPING: types of geochemical maps, types of interpretive maps. Interpretation of results: background content, geochemical indicators, domains, location of anomalies.
TD: Statistical processing, mapping and interpretation of geochemical data (application to lithogeochemistry, stream-sediments and soil chemistry data).

Assessment method : *Continuous control- EMD, TD*

References:
Moon C.J. ; Whateley M.K.G. and Evans A.M. (2006)- Introduction to Mineral Exploration. Blackwell Publishing; 2nd ed ition. Rose A.W. Hankes H.E. and Web J.S. (1979) Geochemistry in Mineral Exploration. London: Academic Press. 657 pp Journals:
Journal of Geochemical Exploration (Elsevier), Handbook of Exploration Geochemistry (Elsevier)

Master : MINING GEOLOGY Semester *: 1*

UE : Discovery unit 1 **Code : UED11**
Course title: Study methods of mineral deposit
Crédits : 1
Coefficients : 1

Objectives of teaching:
The objective is to know the different types of morphologies of the ore bodies and textures.

Basic concepts of geometry and mineralogy (macroscopic and optical)

Content :

1. Morphology of ore-body
- Veins
- Strata bound ore
- Cluster
- Dessimination

2. Paragenises and Textures
- Structures and textures
- Mineralogy
- Geothermometers

3. Alterations

TD: exercises in relation to the geometric representation of mineralized bodies
Assessment Method: *Continuous Control, TD EMD Review*

References

Michel J et Marcoux E (2008) : Géologie des ressources minérales.
Moon C.J. ; Whateley M.K.G. and Evans A.M. (2006)- Introduction to Mineral Exploration.
G. Beaudoin. Gîtologie et métallogénie- Manuel de cours. Université Laval, 2006.
Ozer, A. (1989). Ressources minérales et ressources en eau: l'apport de la télédétection dans le monde francophone. *Télédétection en francophonie: bilans régionaux et thématique*s, 117-123.

BOUHLEL S. (1993) - Gîtologie, minéralogie et essai de modélisation des minéralisations à F-Ba-Sr-Pb-Zn-(Soufre) associées aux carbonates (jurassiques et crétacés) et aux diapirs triasiques: Gisements de Stah - Kohol, Zriba-Guebli, Bou Jaber et Fej Lahdoum (Tunisie septentrionale). Doctorat d'Etat ès-Sciences Géologiques. Faculté des Sciences de Tunis. 293 p., 53 fig., 32 pl.

D. Lagleze (1981). Cadre géologique et gitologie de la minéralisation sulfurée stratiforme à Zinc, plomb, cuivre de Menez Albot (France).These 3eme cycle, Toulouse '(France).

Guillou-Frottier, L., Augé, T., & Bertrand, G. (2010). Géodynamique et ressources minérales. Géosciences, BRGM, 2012, 15, pp.22-27. ffhal-00723228f.

Master : MINING GEOLOGY Semester *: 1*

UE : Transversal unit 1 **Code : UET11**
Course title : GIS and remote sensing
Credits : 1
Coefficients : 1

Objectives of teaching:
Enable the student to acquire basic techniques for the interpretation of aerial and satellite photographs and techniques for the management of geological information by geographical information systems
Recommended Prerequisite Knowledge
Basic notions of computer science and the manipulation of certain software**.**

Content :
1. Basic concepts of the Geographic Information System (GIS).
- Definition of geographical information.
- Characteristics of geographic information.
- The duties of an S.I.G.
- Map projections and georeferencing
- Modes of data representation:
- Vectors/Raster.
- Geoprocessing of geographic information.
- Multicriteria analysis;

2. Imaging and remote sensing
-Definitions
-Physical bases of remote sensing
- Remote sensing platforms and sensors
- Remote sensing image processing

3. Concept of Digital Mapping:
-Standard, Quality and Update
-Symbology and decoration of maps.

TD: exercises on remote sensing, GIS, manipulation and control of Arc gis software, Map info, etc.

Assesment method: *Continuous Control, TD EMD Review*

References:
Wilson J. P. and Gallant J. C. (2000). Terrain analysis: Principles and Applications. John Wiley and Sons.
Poudry G., 2005. Numérisation et amélioration d'image
Girard, M. C. and C. M. Girard (2010). Traitement des données de télédétection.
Campbell, J. B. and R. H. Wynne (2011). Introduction to Remote Sensing
Wilson J. P. and Gallant J. C. (2000). Terrain analysis: Principles and Applications. John Wiley and Sons.
Robin, M., & Gourmelon, F. (2005). La télédétection et les SIG dans les espaces côtiers. Eléments de synthèse à travers le parcours de François Cuq. Norois. Environnement, aménagement, société, (196), 11-21.
Mericskay, B., & Stéphane, R. (2010). Cartographie et SIG à l'ère du Web 2.0. In Conférence internationale de Géomatique et AnalyseSpatiale (SAGEO 2010) (pp. 228-242).

Master : MINING GEOLOGY Semester *: 1*

UE : Transversale Unit 1 **Code : UET12**
Course title : *scientifique English*
Credits : 1
Coefficients: 1

Objectives of teaching:

The objective is to familiarize the student with scientific English n geological and mining vocabulary in English language.

Recommended prerequisite knowledge:
Basics of English: grammar, spelling.

Content :
- Translations of articles related to earth science and in particular mining geology
- Scientific text processing in relation to mining geology.

Assessment Method: *Review*

References :
Jean-Pierre Michel, Michael S.N. Carpenter, Rhodes W. Fairbridge. Bilingual dictionary of earth sciences: English/French-French/English. Collection: Sciences Sup, Dunod, 2013 - 5th edition - 512 pages.
Philippe Laruelle. Better writing in English. PUF, 2012, 192 pages.
Jean-Michel Fournier. Manuel d'anglais Oral. OPHRYS, 2010, 251 pages Articles scientifiques

Master : Mining Geology Semester *: 2*

UE : Fondamentale Unit 2 UEF211

Course title : *endogenous Gîtology*

Credits : 6

Coefficients : 3

Objectives of teaching

Deepen knowledge of the main mineralization systems linked to endogenous processes by taking the example of large types of metalliferous deposits placed in their geodynamic contexts

Recommended prerequisite knowledge:

Basic knowledge of endogenous geological processes (hydrothermalism, magmatism, tectonics, etc.).

Content:

- Classifications of mineral deposits of endogenous origin:
- Mineral resources of plutonism.

Mafic and ultramafic plutonism deposit

• Platinum ultramafic intrusions
• Komatites to Nikel
• Chromium and Platinoid Ophiolites

Intermediate plutonism to felsic deposit

• Granitic Rare Metal Pegmatites
• Copper porphyry- molybdenum- gold
• Porphyries and cupolas with tin and tungsten
• Iron, copper oxides, gold and uranium (IOGC)

-Contact metamorphism deposit

• Tungsten, copper and gold skarns
• Wollastonite Skarns
• Gold replacement in carbonates (Carlin type)

Alkaline plutonism deposit

- Kimberlites and Diamond Lamproid.
- Rare earth carbonatites, niobium and tantalum
- Volcanic mineral resources

-Aerial volcanism deposit

• Gold, silver and uranium epithermals

Gites of underwater volcanism

• Mafic volcanism: copper-zinc sulphide clusters
• Bimodal and Felsic Volcanism: Zn,Cu,(Pb)
• **volcano Sedimentary context (SEDEX)**

- Hydrothermal mineral resources

Fluorite, barite, Pb-Zn, Antimony

TP: study of minerals related to endogenous phenomena.

Assessment Method: *Continuous Control TP EMD Exam*

References :

N. Arndt, C. Ganino. **Ressources minérales : cours et exercices corrigés.** Dunod, 2010, 192 pages. G. Beaudoin. **Gîtologie et métallogénie- Manuel de cours.** Université Laval, 2006. 116 pages.

Master : Mining Geology Semester *: 2*

UE : Fondamentale Unit 2 **Code : UEF212**
Course title : Algerian gîtology
Credits : 6
Coefficients : 3

Objectives of teaching:
Good knowledge of the main Algerian deposits and deposits as well as their setting up context.

Recommended prerequisite knowledge:

To have knowledge on the geology of Algeria and on the general gitology.

Content :

1. THE GITOLOGY OF NORTHERN ALGERIA
Reminders of the main geological and structural features of the Alpine orogen (paleogeogeographical characteristics of the different domains of the Alpine chain in Algeria).
Lead-zinc deposits
Polymetallic deposits
Iron deposits
Phosphate deposits
2. GEOLOGICAL FEATURES OF THE BASEMENT AND THE SAHARAN PLATFORM
3. GITOLOGY OF THE MAIN MINERALISATIONS OF HOGGAR AND EGLAB
Gold mineralization
Acid affinity mineralizations (skarns, greisen, albitite)
Mineralization related to basic and ultrabasic rocks
Mo d' Bled M'dena deposit - ext…
4. GITOLOGY OF THE MAIN MINERALISATIONS OF THE SAHARAN PLATFORM
The mineralization of Cu, Mn, Ba d'Ougarta-Iron mineralization of the Tindouf Area
The placers of the Reggane Area. Coal in the Kenads Basin.

TP : study of deposits in different geological contexts of Northern Algeria, the Saharan platform and the Hoggar and eglab.

Assesment Method: *Continuous Control, EMD TP Review*
References :
Kesraoui M (2006) Nature et évolutions comparées de granites à métaux rares dans le Hoggar Central (Algérie) à travers la pétrographie, la cristallochimie des micas et des minéraux à Ta, Nb, Sn, W. et la géochimie. Thèse Doctorat d'Etat, FSTGAT /USTHB, Alger. 237 p, Graine Kh (2010) Metallogénie et cadre géogynamique du massif de Boukais et des monts d'Ougarta (Béchar / SW, Algérie). Thèse de Doc d'Etat Alger 256. **KHALDI, A. (1987)**. Le gisement de Kherzet Youssef: une minéralisation Pb-Zn-Fe-(Ba) stratiformc dans ie membre médian marno-carbonaté du Barrémien de la région de Aïn Azel (Hodna, Algérie). Th. Doct; 3 Cycle, ENSG Nancy, 439p
TOUAHRI, B (1987) : Géochimie et métallogénie des minéralisations à Pb-Zn du Nord de l'Algérie. Th. Doct. Se. Univ. Paris VI, 380 p.
Hebib, R. (2010). Géologie et gisements de pierres de taille en Algérie du Nord, caractérisations géotechniques (Doctoral dissertation, Alger).

Master : Mining Geology Semester *: 2*

UE : Fondamental unit 2 . **Code : UEF221**

Course title : global Tectonic and mineral resources.

Credits : 6

Coefficients : 3

Objectives of teaching:

Deeper understanding of expression of plate tectonics, the mechanisms of deformation of the lithosphere, the dynamics of sedimentary basins, collision chains, subduction zones, rifting…

Recommended prerequisite knowledge:
Ideas on natural deformation of materials and its mechanical and geometric sides
Reading maps (structural), graphs, pictures …and their interpretation.

Content :

1. **Definition of structural geology and its applications**
2. **Study of natural deformations of materials and mineral resource deposits.**
3. **Different types of tectonics (fragile and ductile)**
4. **Role of tectonics in the formation of mineral resource pools**
5. **Wilson Cycle and Overall Mineral Resources Metallogeny**

- Breaking stage.
- Immature ocean stage.
- Advanced ocean stage.
- Convergence.
- Collision and hypercollision**.**

6. **Tectonic metallotectics in mineral resource exploration**
7. **Strain markers on mineral resource deposits**

TP: geological cross-sections, graphical representation of structural data (stereographic projections, rose windows, etc.) in relation to the different types of mineral resource deposits: MVT, porphyry cuprifere, VMS, etc**.**

Assessment Method: *Continuous Control TP EMD Exam*
References:
Twiss R J. and Moores E M. (1992). **Structural Geology,** 531 pp; *Freeman and cie,* New York Ramsay J G. and Hubert M I. (1987). **The techniques of modern structural geology,** Volume 1 strain analysis, 307 pp, 3th edition, Academic press INC (London) Ltd.

Master : Mining Geology Semester *: 2*

UE : Méthodological Unit 2 **Code : UEM211**
Course title : *Analytical technics*
Credits : 5
Coefficients : 3

Objectives of teaching:
The purpose of this teaching is to familiarize the student with the different analytical methods used in geology (geology, mineralogy and metallogeny) such as XRD and XRF, plasma torch, ATD neutron activation, SEM, micro thermometry etc.

Recommended prerequisite knowledge:
Basic knowledge of chemistry, mineral geochemistry, mineralogy and crystallography**.**

Content :

1. **Sample preparation methods for geochemical analysis**
2. **X-ray diffractometry analyses:**

Method principle, RX interaction – material,
Bragg's law, powder method.
Notions about equipment (site visit),
Description of diffractograms graph, ASTM plugs (applications).

3. **X-ray fluorescence spectrometry analyses:**

Principle of method, apparatus, sample preparation,
Applications and data example interpretations.

4. **ICP-ES spectrometry analyses:**

Principle of method, apparatus, sample preparation,
application and comuting data example interpretations.

5. **Atomic absorption spectrophotometry analyses:**

Principle of method, apparatus, sample preparation,
Applications and comuting data example interpretations.

6. **Microprobe analysis:**

Principle of method, apparatus, sample preparation,
Applications and comuting data example interpretations.

7. **SEM (Scanning Electron Microscope) analyses:**

Principle of method, apparatus, sample preparation,
Applications and data example interpretations**.**

TD: Reading, digital processing and graphical data obtained by different methods.

Assessment Method: *Continuous Control TD EMD Exam*
References :
Cantle J. E. (1982)- Atomic absorption spectrometry- Elsevier. Echlin P. (2009)- Handbook of Sample Preparation for Scanning Electron Microscopy and X-Ray Microanalysis. Springer **Revues**

Master : Mining Geology Semester *: 2*

UE : Méthodological Unit 2 **Code : UEM212**
Course title : *Internship*
Credits : 4
Coefficients : 2

Objectives of teaching
The aim is to teach the students the methods of collecting geological information in field and mine , description and sampling of the ore and useful substances, understanding of geometry and kinematics. Uses geological and mining map.

Recommended Prerequisite Knowledge:
Basic concepts of the general geology, stratigraphy, tectonics, geology and gitology of Algeria
Content:
Internship of 8 days:
- Geological Mapping
- Sampling
- Observation
- Conduct geological sections and stratigraphic logs
- Report writing

Assessment Method: Report of internship-field interrogation.

References
Larouci M. (1988) : Etude de la caractérisation et de la valorisation du minerai de phosphate de Djebel Onk – Algérie- thèse de doctorat ingénieur. Université orléans. 1 vol texte, 194p.
Sami, L. (2011). *Caractérisation géochimique des minéralisations à Pb-Zn, F, Ba, Cu, Fe et Hg des confins Algéro-tunisiens* (Doctoral dissertation, Alger).
Malembane, A. D. (2020). *Caractérisation des rejets miniers de la digue de la mine d'El Abed* (Doctoral dissertation, Université Mouloud Mammeri).
Marignac, C., & Zimmermann, J. L. (1983). Ages K-Ar de l'événement hydrothermal et des intrusions associées dans le district minéralisé miocène d'Aïn-Barbar (Est Constantinois, Algérie). *Mineralium Deposita*, *18*(3), 457-467.
MAHROUG, Dalila. *Etude géologique et gîtologique de la minéralisation de fer de Sidi Safi (Béni Saf, Algérie)*. 2014. Thèse de doctorat. Université Mouloud Mammeri.
BOUZENOUNE A et al : CHRONOLOGIE RELATIVE ET CONDITIONS DE MISE EN PLACE DES MINERALISATIONS DU MASSIF DE L OUENZA (ALGERIE NE). *Bulletin du Service Géologique de l'Algérie*, 2006, vol. 17, no 1, p. 3-27.
Benali, H. (2007). *Les minéralisation associées aux roches magmatiques tertiaires du Nord de l'Algérie* (Doctorat, Alger).

Master : Mining Geology Semester *: 2*

UE : Dicovery Unit 2 **Code : UED21**

Course title : *Geostatisitcs*

Credits : 2

Coefficients : 2

Objectives of teaching;

The objective is the student's familiarization with graphic tools and the analysis and interpretation of geostratistic data used in geology.

Recommended Prerequisite Knowledge:

Mathematics and statistics concepts and data processing software.

Content:

1. **Reminder on linear statistics (mono and bivariable)**
2. **Spatial Interpolation Methods**

- Barycentric Methods
- Triangulation methods
- Spacing interpolation methods
- Geostatistical estimation methods

3. **Regionalized variable**

- Defining Moments
- 2nd order stationarity
- The intrinsic hypothesis

4. **Variogram**

- Variogram Characteristic
- Variogram calculation
- Isotropy and Anisotropy
- Leg structure
- Schematics of the theoretical variogram
- Adjustment of experimental variogram

5. **Estimation variance**

- Development of an estimator
- Estimation of an average by another average
- Estimated average by weighted average

6. **Kriging**

- Regular kriging geostatistical procedure
- Properties of regular kriging
- Material writing of ordinary kriging
- Universal Kriging and Cokriging

7. **Statistical Data Processing and Graphic Representation**

- **Objectives**
- Data Management
- Descriptive statistical analyses and inferential statistical elements

TD: statistical treatment of geochemical data (software: Statistica), initiation to calculations and adjustments of experimental variograms (Calculation of variance of estimates and realization of a contour map (anomalies) using kriging (software: Surfer. Variowin, S-GEMS, etc.).

Assessment Method: Continuous Control, TD EMD Review

References : Chauvet P. (1999) : Aide-mémoire de géostatistique linéaire. Presses de l'Ecole de Mines de Paris, 367p. Denis Marcotte (2006) : Traitement statistique des données géologiques

Master : Mining Geology Semester *: 2*

UE : Transversal Unit 2 **Code : UET21**

Course title : *Numerical methods and applied computing*

Credits : 1

Coefficients : 1

Objectives of teaching

the student must master the computer software used in the mining field.

Recommended Prerequisite Knowledge:

Basic computer skills

Content :

- Introduction to software management in relation to mining: AutoCad, Covadis, Surfer, MapInfo, ArcGis, etc.
- Creation and management of a digital database**.**

TD:

Software application exercises on issues related to mining geology and creation of a database of deposits type:

- MVT (polymetals).
- VMS (polymetals).
- Vein type (barite, fluorite, etc.)
- Layers and strata of (oolithic iron, phosphat, manganese, clay, etc.)

Assessment Method: *Continuous Control TD EMD Exam*

References:

Davis J. C. **(2002).** Statistics and data analysis in geology. 3rd EdmJohnWiley and Sons, Inc.

Cardenas G., Perdrix E. (2005). Adaptation des méthodes géostatistiques à la cartographie automatique de NO2

Master : Mining Geology **Semester *: 3***

UE : Fondamental unit 3 **Code : UEF311**
Course title : *Mineral prospection and exploration*
Credits : 6
Coefficients : 3

Objectives of teaching:
The students must master the different techniques of research and mineral exploration and the different techniques and stages of tactical and strategic mineral exploration in order to prepare the deposit for the exploitation phase

Recommended Prerequisite Knowledge:
Basic knowledge of general geology, geochemistry of mineral resources

Content:

1. General
2. Preparing a prospecting/exploration campaign.
3. Mineral exploration construction
polls
Well Galleries
4. Prospecting/Exploration Techniques and Tools 5. Steps from mineral prospecting to exploration.
Stage of strategic exploration
Tactical Exploration Stage
6. Preparation of the deposit for exploitation

TP:
1. General
2. Preparing a prospecting/exploration campaign.
3. Mineral exploration works.
Polls
Well
Galleries
4. Prospecting/Exploration Techniques and Tools
5. Steps from mineral exploration to exploration.
Stage of strategic exploration
Tactical Exploration Stage
6. Preparation of the deposit for exploitation

Case study: preparation of a prospecting/exploration campaign on different types of mineral and geometrial resources:
- Useful substance deposit:
Clay.
Limestone and dolomite.
Diatomite
Sand
Decorative stones (granite, marble, basalt, etc.).
- Metallic and no-metallic deposit:
Sulphide clusters.
Placers (diamonds, gold, etc.). veins- Diaper.

Assessment Method: *Continuous Control TP EMD Exam*

References :

B. Landry. **Prospection minière,** Ed. Modulo, Canada, 1996, 240 pages. J.B. Chaussier. **Manuel du prospecteur minier.** BRGM, Manuels et méthodes, N°2 1981, 273 pages.

Master : Mining Geology **Semester *: 3***

UE : Méthodological Unit 3 **Code : UEM312**
Course title : *Mining exploitation*
Credits : 6
Coefficients : 3

Objectives of teaching:
The aim is to teach the student the different technics of mining and to provide him with the bases of statistical methods applied to mining

Recommended Prerequisite Knowledge:

The basis of geometry, geostatistics, topography and geological mapping
Content of the material:
Course:
1. Introduction
2. Open Pit Concept
- Mining Industry / - Equilibrium Break Grade
- Economic considerations / - Stripping rate
3. Geometry of the ore body
- Definition of the size of an ore deposit
- Power at the preparation facility
- Size the preparation works
4. Open Pit Mining
- Definition of the various waste rock/ore stripping ratios
- Identification of exploitable and inoperative angles of an open pit mine.
- Condition of open pit exploitation for an deposit.
- Analytical and geometric determination of the final depth of an open pit mine.
- Determination of open pit mining method parameters.
- Production planning
5. Underground Mining:
- Methods of opening underground deposits.
- Well Sinking: Traditional Sinking Mode, Special Sinking Mode.
- Shaft supports.
- Felling work: process projection methods; exploitation methods.
6. Classic Open Pit Mining
- Ultimate Pit and Floating Cone
7. Access to the Deposit
- Operating Methods / - Discovery (Strip Mining)
8. Loading Equipment
- Drill, Shovels, Dragline and Bucket Chain Excavators
9. Conveyances
- Transport by dump trucks and conveyor belt

TP:
Reserve calculation exercises and case study

Assessment Method: *Continuous Control TP EMD Exam*

References
V. Kovalenko. Quarrying. OPU, 1986. B. Boky. Quarrying

Master : Mining Geology **Semester *: 3***

UE : Fondamental Unit 3 **Code : UEF321**

Course title : *Impact of mining on the environment*

Credits : 6

Coefficients : 3

Objectives of teaching:

The aim of this teaching is to raise awareness of the activities associated with the extraction of mining materials and the aspect of environmental protection during mining and to master the tool of reclamation and after mines.

Recommended Prerequisite Knowledge:

Good knowledge of chemistry, geochemistry and the basics of hydrogeology.
Knowledge of activities associated with mining.

Content :

1- DEFINITION AND OVERALL.
2.ENVIRONMENTAL EFFECTS ANALYSIS OF OPERATIONS:
Impact on water: Change in water flow (diversion of streams and increase in solid load).→ Alteration of groundwater piezometry. Alteration of the productivity of catchments. Alteration of water quality.Soil impact: Erosion upstream and downstream of the farm (quarry Impact on crops and forests: Evaluation of agricultural areas stripped and deforested.→ Vulnerability and sensitivity of crops and forests to dust emissions.
Impact on the natural environment: Destruction of the flora on the site.→ Movement of fauna.
Modification of the diversity of fauna and/or flora in the periphery.
Upset of the soil structure.
Impact on the landscape: Form of excavation.→ Clearing. Position of treatment facility. Positions and dimensions of stocks of extracted and discovered materials.
Impact by noise: The origin of the effects: drilling of mine holes;→ blasting; breakers; internal transport; processing plant; transport of finished products.
The consequences: neighbourhood disturbance and deterioration of the quality of life.
Impact by vibrations: The origin of the effects: mine shots.→ The consequences: risk of damage to neighbouring buildings; interference with neighbours; modification of the deep geological structure.

References :

MAHFOUD Z (2016)**.** *L'impact de l'exploitation minière du gisement de Pb-Zn-Cu de Boudoukha (Skikda) sur l'environnement immédiat* (Doctoral dissertation, Université des Sciences et de la Technologie d'Alger, Houari Boumediène)./ **Deshaies, M (2016)** Mines et environnement dans les Amériques: les paradoxes de l'exploitation minière. *IdeAs. Idées d'Amériques*, **MUTSHIMA,et al (2016).** L'exploitation miniere artisanaleet son impact environnemental dans la ville de kolwezi. *kas african law study library***/ Deshaies, M. (2011).** Grands projets d'exploitation minière et stratégie des firmes pour se rendre environnementalement acceptables. *L'Espace politique. Revue en ligne de géographie politique et de géopolitique*. **Aubertin, M et al (2002) :** La gestion des rejets miniers dans un contexte de développement durable et de protection de l'environnement. *Congrès annuel de la Société canadienne de génie civil*, 5-8.

Master : Mining Geology **Semester *: 3***

UE : Methodological Unit 3 **Code : UEM31**

Course title : *Entrepreneurship and Mining Project Management*

Credits : 5

Coefficients : 3

Objectives of teaching :

Mining activities is an specific environment , it brings together both service companies, research-oriented exploration companies and production companies (exploitation), this course aims to: acquire knowledge about entrepreneurship with a view of all the stages constituting a mining project, have a common language to describe the life stages of a mining project.

Recommended Prerequisite Knowledge :

Basics of Management-mining economics, economic feasibility.

Content :

Definition of entrepreneurship

- Company and its environment and the Contractor.
- Market prospection.
- Acquisition, Processing, Dissemination and Identification
- Exploration of the deposit

Field methods (Mapping, Sampling,);

Laboratory (Analyses appropriate to each type of mineral resource to be studied);

Data management and exploitation;

- Technical and economic study:

Preparation of geological reports

Technical feasibility study

- Development of the mining project.
- Exploitation and production
- Closure, reconversion and after-mine management

TD Case Study:

- Open Pit Mining Project:

Useful substances: decorative stones, limestone for aggregates, sand for construction or glassware, ceramic clay or cement

- Underground Mining Project:

Metallic or non-metallic deposits: polymetals, barite, gold, iron

Evaluation Mode: Continuous Control, EMD, TD

References :

Champy-Remoussenard, P. (2012). L'éducation à l'entreprenariat: enjeux, statut, perspectives…. *Spirale-Revue de recherches en éducation*, *50*(1), 39-51.

Lazuech, G. (2006). Les cadres de l'économie sociale et solidaire: un nouvel entreprenariat?. *Formationemploi. Revue française de sciences sociales*, (95), 59-74.

Bergeron, K. M., Jébrak, M., Yates, S., Séguin, C., Lehmann, V., Le Meur, P. Y., ... & Gendron, C. (2015).Mesurer l'acceptabilité sociale d'un projet minier: essai de modélisation du risque social en contexte québécois. *VertigO-la revue électronique en sciences de l'environnement*, *15*(3).

Goria, S. (2004). *Evaluation d'un projet minier: approche bayésienne et options réelles* (Doctoral dissertation, Paris, ENMP).

Rey, P., & Mazalto, M. (2020). QUELLE COLLABORATION PUBLIC-PRIVE POUR L'INTEGRATION D'UN PROJET MINIER A SON TERRITOIRE? ETUDES DE CAS EN

AFRIQUE DE L'OUEST. *Revista Opera*, (26),
55-76. Nobert, P. (2014). La flexibilité managériale dans la gestion de projets miniers: une analyse qualitative par l'approche des options réelles.
OWEN J., R., KEMP D., 2013 – Social licence and mining: A critical perspective, Resources Policy 38: 29-35. FILER C., 2002 – Implications of the “Mining, Minerals and Sustainable Development” Project. Port Moresby: PNG Department of Mining (Sustainable Development Policy and Sustainability Planning Framework, Working Paper 1).

Master : Mining Geology Semester *: 3*

Intitulé de l'UE : Methodological Unit 3 Code : UEM32
Intitulé de la matière : *Internship 2*
Credits : 4
Coefficients : 2

Objectives of teaching ;

The aim is to teach the students the methods of collecting geological information on the ground at the level of mine sites, description and sampling of the ore and useful substances, understanding of geometry and kinematics.

Recommended Prerequisite Knowledge:

Basic concepts of the general geology, stratigraphy, tectonics, geology and gitology of Algeria

Content of the material :

Field Internship:

- Mapping
- Sampling
- Observation
- Conduct geological sections and stratigraphic logs

Assessment method : *Report writing-field interrogation.*

References

Scientific researchs (thèses de doctorat ; magisters, rapports d'entreprises minières…) :Kesraoui, M., & Verkaeren, J. (1998). Minéralisation à W–Sn du Hoggar central. Exemple du gisement de Tin-Amzi. *Mém Serv Géol Alg*, *9*, 187-198.
Augé, T., Joubert, M., & Bailly, L. (2012). Typology of mafic–ultramafic complexes in Hoggar, Algeria: Implications for PGE, chromite and base-metal sulphide mineralisation. *Journal of African Earth Sciences*, *63*, 32-47.
Benramdane, H., Belial, M., & Kolli, O. (2001). Gold mineralisation in the Yetti-Eglab Zone (NE Reguibat Shield, SW Algeria). In *Mineral Deposits at the Beginning of the 21st Century* (pp. 695-698). CRC Press.
Lagraa, K., Salvi, S., Béziat, D., Debat, P., & Kolli, O. (2017). First insights on the molybdenum-copper Bled M'Dena complex (Eglab massif, Algeria). *Journal of African Earth Sciences*, *127*, 159-174.
Hamoud, A., Chakiri, S., El Hadi, H., Baghdad, B., & Zahidi, K. (2014). Etude géochimique de la minéralisation polymétallique de la zone d'Amsaga (dorsale de Rgueïbat, Mauritanie). *European Scientific Journal*, *10*(21).
Semchaoui, A. A. (2017). *Contribution à l'étude gitologique du champ filonien de barytine de Draïssa (Ougarta-SW Algérie)* (Doctoral dissertation, Faculté des Sciences de la Terre, de la Géographie et de l'Aménagement du Territoire).
Bouima, T. (1986). *Le gîte de Rahmani (Monts d'Ougarta, Algérie), sédimentologie du Cambrien inférieur et étude des minéralisations s-tratiformes cuprifères associées: mise en évidence d'un processus de remobilisation de type Roll* (Doctoral dissertation, Paris 11).
GRAÏNE, Khadidja. *Métallogénie et cadre géodynamique du massif de Boukaïs et des monts d'Ougarta (Bechar/sud-ouest, Algérie)*. 2010. Thèse de doctorat. Alger.
Dressen-Hammouda, D. (1998). Le «cadre géologique» dans l'article de géologie en français et en anglais: crédibilité et retenue sur le terrain. *ASp. la revue du GERAS*, (19-22), 51-66.
Hoover, H.C., 1909, "Principles of Mining", McGraw-Hill Book Co., New York, 199p.

Master : Mining Geology **Semester *: 3***

UE : Discovery unit 3 **Code :UED31**
Intitulé de la matière : Mining Economy
Crédits : 2
Coefficients : 2

- **Objectives of teaching**
- The aim is to teach students the basics of mining economics and the economic management of mining operations. It is also necessary to read the Algerian mining law (part dedicated to taxation tax, extraction fees, superficies taxes, etc.).
-
- **Recommended Prerequisite Knowledge :**
- Basic notions of the economy (breakeven point, cash flow, etc.) and vocabulary related to legislation.
- **Content :**

  - Contemporary macroeconomic problems: economic growth and fluctuations, inflation, Algerian monetary policy.
  - Description of the economic costs of a mining project.
  - Economic feasibility study of a mining project.
  - Farm profitability analyses
  - Economic analysis of political and economic conditions.
  - Mining legislation and law.

Assessment method : *E*xam.

References

- Donald W. Gentry, Thomas J. O'Neil, Thomas J. O'Neill, Mine Investment Analysis – 1984.
- SME's Mining Engineering Handbook, Hartmann, H.L., 1992.
- Open Pit Mine Planning and Design, 3rd Edition, W. Hastrulid, M. Kuchta and R. Martin, CRC Press 2013. 3
- Marchand, J. (1996). *L'économie minière en Afrique australe*. KARTHALA Editions.
- Gentry D.W., O'Nell T.J., (1984). Mine Investment Analysis, AIME, Society of Mining Engineers, USA, pp 502.
- William A. Vogely, (1985). Economics of mineral industries, AIME, USA, pp 660.
- SME Mining Engineering Handbook, (2011), 3rd edition, Society for Mining Metallurgy and Exploration, USA, pp 1846.

Master : Mining Geology **Semester *: 3***

UE : Transversal Unit 3 **UET31**

Course title : *Introduction to documentary research*

Credits : 1

Coefficients : 1

Objectives of teaching :

This course introduces students to control a documentary information also to familiarize them with the instrumented attendance of university productions through library resources and training in documentary methodology.

Recommended Prerequisite Knowledge:

Good knowledge of the principles of the French language, English and the notion of computer basics.

Content :

1- Literature Search Methodology.

- General Presentation (from the popular to highly scientific article).
- Documentary ethics (plagiarism, referencing, etc.).
- The tools (library, web, journals, etc.).

2. Literature Search Methodology.

- Web of Science and Science Direct.

3. Literature Search Methodology.

Bibliographic Standards, End Web Note and Practice.

4. Methodology for drafting a briefing note.

Assessment method: *E*xam

References

1. Annie Piolat. **La recherche documentaire : Manuel à l'usage des étudiants, doctorants et jeunes chercheurs.** Solal Editeurs, 2003, 150 pages.

2. Bernard Pochet, Sylvie Chevillote et Elisabeth Noël. **Méthodologie documentaire : Rechercher, consulter, rédiger à l'heure d'Internet.** De Boeck; Édition : 2e édition, 2005, 200 pages.