Establishment of the GEOLOOC Online Training Site for West Africa

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Key themes:	Governance and Regulation Operational Effectiveness
Key countries:	Africa
Completion:	March 2015

Research aims:
This research aimed to develop an online course in geology to serve the West African region. This was in response to current teaching limitations including:

- insufficiency of text books with African geology and case studies
- technological limitations
- linguistic barriers

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IM4DC
Action Research Report

International Mining for Development Centre

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The University of Western Australia

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Summary of Action Research Activity

Establishment of the GEOLOOC online training site for West Africa

The primary objective for this action was to enhance knowledge-sharing in Geosciences by building a regional training network with special emphasis on African geology and related topics. This is being achieved through the provision of materials for Earth Science teaching in West African Universities in the 'Geology Open On-line Courses – West Africa' (GEOLOOC-WA) online platform. To achieve this goal, a set of 12 digital Open Access undergraduate and graduate level training modules for use across West Africa will be developed. In the first phase, five modules are being developed in the areas detailed below:

- GIS
- Sedimentology
- Structural geology and rock mechanics
- Petrology and geochemistry
- Governance: international conventions, policy, administration, legal codes and acts

A start-up meeting for the project was held in partnership with the WAXI project in September 2014, in Toulouse, which was attended by representatives of seven African nations, as well as France, Australia and a UNESCO delegation. At this meeting (which involved 34 participants in total), group decisions were made on the composition of the steering committee as well as the choice of the initial courses to be offered.

The database and web platforms for the training (Moodle) and project (Drupal) information sites respectively have been installed. The first complete courses (Structural geology and rock mechanics, Microstructures in naturally deformed rocks, and Structural geophysics) have been uploaded and are currently being translated into French. Other courses will appear though 2015.

Establishment of the GEOLOOC Online Training Site for West Africa

Professor Mark Jessell, Dr Vaclav Metelka, Dr Stephen Micklethwaite and Dr Geoff Batt

Centre for Exploration Targeting, The University of Western Australia

26th March 2015

Executive Summary

The 'Geology Open On-line Courses – West Africa' (GEOLOOC-WA) action is contributing to the enhancement of knowledge-sharing in geosciences by building a regional training network with special emphasis on African geology and related topics, including water resources, best practices for exploration and extraction of natural resources and minerals, environmental issues and engineering geology. The GEOLOOC-WA action augments the capacity of West African academics to provide quality graduate level courses that reflect the latest state-of-the-art learning in science, applied to and drawn from the specific geological problems found in the sub-region. It emphasizes local content, based especially on Africa's geological and cultural legacy. The development of a web portal for GEOLOOC-WA facilitates the application of recent scientific advances to the local geological contexts, and hopefully will ensure students are aware of the rapidly evolving frontiers in geosciences.

The primary objective for this action was to raise the standard of teaching and learning of geology and the geosciences in general. This is being achieved through the provision of materials for Earth Science teaching in West African Universities in the GEOLOOC-WA online platform. To achieve this goal, a set of 12 digital Open Access undergraduate and graduate level training modules for use across West Africa will be developed. In the first phase, five modules are being developed in the areas detailed below:

1. Sedimentology
2. Structural geology and rock mechanics
3. GIS
4. Petrology and geochemistry
5. Governance: international conventions, policy, administration, legal codes and acts

A start-up meeting for the project was held in partnership with the WAXI project in September 2014, in Toulouse, which was attended by representatives of seven African nations, as well as France, Australia and a UNESCO delegation. At this meeting (which involved 34 participants), group decisions were made on the composition of the steering committee as well as the choice of the initial courses to be offered

Five working groups were established to cover the principal course clusters:

1. Working group 'Metallogeny and mineral resources'
   Chair: Ousmane Bamba (University of Ouagadougou)
2. Working group 'Sedimentology'
   Chairs: El Hadj Sow (UCAD), Mariette Miningou (University of Ouagadougou)
3. Working group 'Structural geology and rock mechanics'
   Chairs: Gbele Ouattara (ESMG), Papa Moussa Ndiaye (UCAD)
4. Working group 'Petrology and geochemistry'
   Chairs: Daniel Asiedu (LEGON), Ousmane Wane (USTTB)
5. Working group on 'Governance'
   The membership is yet to be identified, but Toro Gold with its network will support the identification of potentially qualified persons for membership

After some initial delays in finding a suitable Dakar-based service provider, we have installed the database and web platforms for the training (Moodle) and project (Drupal) information sites respectively. The first complete courses (Structural geology and rock mechanics, Microstructures in naturally deformed rocks, and Structural geophysics) have now been uploaded and are currently being translated into French. Other courses will appear though 2015.

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Introduction

Brief history and status of the implementation of the GEOLOOC-WA Initiative

In 2013, the Institut de Recherche pour le Développement (IRD) Dakar, UCAD with L'Institut Fondamental d'Afrique Noire (IFAN) Cheikh Anta Diop proposed the development of an online course in geology to serve the West African region, subsequently named 'Geology Open On-line Courses – West Africa' (GEOLOOC-WA; http://www.geolooc.net) . In November 2013, these partners approached UNESCO Dakar office to propose collaboration with them on this project and the proposal was accepted. Other partners, who are now on board, include the University of Western Australia, the University of Toulouse France and the International Mining for Development Centre in Australia (IM4DC). Additional partners, that joined the project after it started, include Toro Gold Ltd, Dakar, Senegal and the five initial participating Universities. Discussions are underway with the Economic Community of West African States (ECOWAS) Secretariat, UNESCO's Earth Sciences Education Initiative (ESEI) coordinators to partner in this initiative and the coordinators of the Projet d'Appui au Développement des Technologies de l'Information et de la Communication pour le renforcement des capacités de mise en œuvre de la reforme Licence-Master-Doctorat dans les universités de l'espace UEMOA (PADTICE).

A first consultation meeting with partners took place in Toulouse France from 21st to 25th September 2014, back to back with the WAXI-3 meeting of the West African Extractive Industries Group (WAXI) held at the same venue. This allowed the partners of the GEOLOOC-WA project to present the initiative to the leaders and members of the WAXI group. The initiative aims to work cooperatively with the WAXI Group, which supports education in the geosciences and has been backing several universities in West Africa (WA) in the training of PhD students, and enhancing knowledge and skills building through fieldwork in the geosciences.

The outcome of the meeting in Toulouse, France included the formation of a Steering Committee and working groups by themes. Membership of the working groups was drawn globally and not restricted to West Africa and is described in the Beneficiaries section later.

A fifth working group was subsequently created, following the interest of Toro Gold Ltd who proposed that governance (including international mining conventions, policy, administration, Legal Codes and Acts in member states in the mining sector in WA) was a strong issue that required attention in the training of administrators and students in the field.

Partner(s) institutions:

UNESCO

Institut de Recherche et Développement

University of Toulouse France

University of Western Australia, Centre for Exploration targeting

International Mining for Development Centre in Australia (IM4DC)

Toro Gold Ltd, Dakar, Senegal

University Cheikh Anta Diop, Dakar, Senegal

University of Ouagadougou, Burkina Faso

University of Ghana, LEGON, Accra, Ghana

University of Sciences, Techniques and Technology of Bamako, Mali

Ecole Supérieure des Mines et de la Géologie de Yamoussoukro (ESMG), Côte d'Ivoire.

Université Houphouët-Boigny (UFHB), Côte d'Ivoire

Teng Tuuma Geoservices (TTGeo), Ouagadougou, Burkina Faso

ECOWAS Secretariat Abuja, Nigeria

Rationale

The teaching of geology and other geoscience subjects is currently inadequate to serve the needs of the member states of ECOWAS as the contribution of mining and the extractive industries to national economic development continues to grow. University teachers in West Africa are generally subject to enormous constraints in teaching students at all levels. This is particularly true in all natural sciences subjects including the geosciences, which demand mobility for field training, analytical facilities and equipment. In addition, the scarcity of textbooks or standard sample sets available to describe the geological characteristics of the region engenders a substantial barrier for teaching in geosciences. Amongst other constraints, the general inadequacy of national and international support has also meant that it has not been possible for university professors to pool their resources at sub-region scale, even though they often work on similar problems. Finally, access to high-speed network infrastructures has progressed only very recently and most teachers are unfamiliar with the use of external resources, so their capacities need to be upgraded in order to access the wide range of potential online resources appropriate to their teaching practices.

The eLearning Africa report (2013) (http://www.elearning-africa.com/) highlighted the need for high quality open access teaching materials as a means of overcoming the scarcity of teaching resources of international standard. The limitations in teaching geosciences of the target countries include:

- the insufficiency of textbooks that systematically rely on African geology and samples for case studies;
- the technological limitations, despite improvements in IT infrastructure (e.g. unstable internet access, low-speed connection), preventing effective use of online digital materials by students and professors;
- the linguistic barriers within the West Africa sub-region which make the creation of regional training networks more challenging.

In response, the 'Geology Open On-line Courses – West Africa' (GEOLOOC-WA) action is contributing to the enhancement of knowledge-sharing in Geosciences by building a regional

training network with special emphasis on African geology and related topics including water resources, best practices for exploration and extraction of natural resources and minerals, environmental issues, engineering geology. The GEOLOOC-WA action will augment the capacity of West African academics to provide quality graduate level courses that reflect the state-of-the-art knowledge in earth science, applied to and drawn from the specific geological problems found in the sub-region. It will emphasize local content, based especially on Africa's geological and cultural legacy. The development of a web portal for the Geosciences in West Africa will also facilitate the application of recent scientific advances to the local geological contexts and ensure the students are aware of the rapidly evolving frontiers in geosciences.

Relevance

Economic relevance

A recent analysis of the minerals sector in Africa highlights the importance of the minerals sector to West African economies (Fig 1). The growing and important extractive industries in West Africa will benefit from the GEOLOOC-WA programme, as they will have better skilled graduates to work with. The GEOLOOC-WA primary relevance is therefore in the contribution of graduates trained through well-designed courses to participate in the evolving needs of the 21st century mining sector. Furthermore, GEOLOOC-WA will also be working on the harmonization of qualifications in the geosciences and geology in particular. In this way, the mining industry will be assured of adequate supply of skilled locals within the region who have the necessary scientific and technical skills as well as an up-to-date vision of the governance and administration of the extractive industry in West Africa to support their economic activities. With enhanced skills in geosciences in general, graduates will be prepared to get jobs, being better qualified and meeting the standards of the job market.

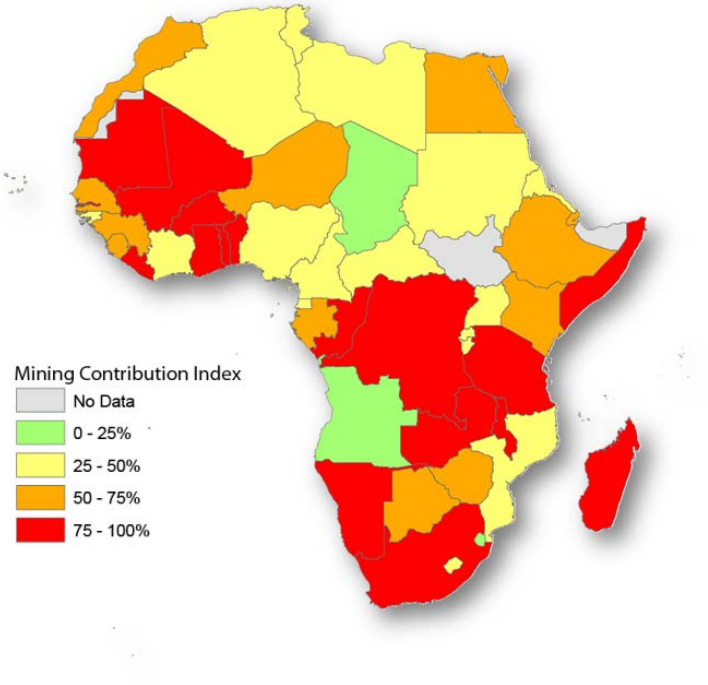

Figure 1. Mining Contribution Index based on each country's mineral export contribution; increase/decrease in mineral export contribution and mineral production value as a percentage of GDP. (After International Council on Mining and Metals).

Academic relevance

The GEOLOOC-WA action will directly address the academic needs of the West African sub-region by:

a) The establishment of the six West African academic Partners as international centres of excellence, via their skills in the creation and delivery of Open Access Digital Materials.

b) The improved capacity of the West African Partners to deliver high-level training study programs.

c) Creating better regional capacity for effective and autonomous networking and training.

d) Increasing inter-institutional networking.

e) Increasing West Africa-international networking.

Research and technology development

Through the partnership, the GEOLOOC-WA action will use the strong links they have within the framework of ongoing industry and government funded research and training programs such as WAXI and the T2GEM project (Geophysical and Geochemical Technologies for Mineral Exploration). These links provide important avenues for collaborative training via

research in areas of direct economic impact to the member states, which will feed back into the GEOLOOC-WA action as case studies to be used in the course materials.

Specific objective and expected outcomes

The primary objective for this action is to raise the standard of teaching and learning of geology and the geosciences in general in West Africa. This will be achieved through the provision of materials for Earth Science teaching in West African universities in the proposed GEOLOOC-WA online platform. To achieve this goal, a set of 12 digital Open Access undergraduate and graduate level training modules for use across West Africa will be developed. In the first phase, five modules will be prioritized in the areas detailed below:

1. Sedimentology
2. Structural geology and rock mechanics
3. GIS
4. Petrology and geochemistry
5. Governance: international conventions, policy, administration, legal codes and acts

Outcome 1 – Structured online course materials developed

Output 1 – Course outline and Training modules.

Activity 1.1: Develop template for the online courses in line with accepted formats and best practice.

Activity 1.2: Hold workshops for the preparation of course outlines and distribution of tasks.

Outcome 2 – Functioning platforms for online courses in place

Output 2 – Platforms for mounting the online courses active and functioning

Activity 2.1: Negotiate with online platforms such as UCAD's MOOC, PADTICE Platform etc. and establish MoUs and agreements with the hosts.

Outcome 3 – Strengthened capacities for the management and delivery of online course in selected Universities

Output 3 – 120 geology teachers trained in 10 workshops (1 workshop per country, 20 participants per five-day sessions) on the contents of the modules and on the utilization of the online platform. This corresponds to 66% of the teaching staff of all geosciences departments of the six academic partners that have expressed their interest into the project

during the kick-off meeting in Toulouse in September 2014. 500 students trained in six seminars (Dakar, Accra, Abidjan, Ouagadougou, Bamako, Yamoussoukro).

Activity 3.1: Organize training workshops.

Activity 3.2: Organize seminars for students in selected schools on the new online platforms for geology education.

Outcome 4 – Roadmap for a regional qualification framework for geology and the geosciences produced (Phase 1)

Output 4.1 – A roadmap for the development of a regional qualification framework and harmonization of certificates developed.

Activity 4.1: Hold an inception meeting with the Education, Culture, Science & Technology Directorate of ECOWAS, universities, mining industry representatives, and Ministries of Higher Education in selected countries.

Activity 4.2: Prepare a roadmap for the development of the regional qualification framework in ECOWAS by a Task Force.

Activity 4.3: Hold a validation meeting for the roadmap and submission to ECOWAS with a plan for sourcing funds for implementation of the identified actions.

Methodology

The GEOLOOC-WA action will support ECOWAS in its regional push for the harmonization of certificates in higher education. UNESCO, IRD, the University of Western Australia, the University of Toulouse France, Toro Gold, Teng Tuuma Geoservices (TTGEO), and other partners will provide advice and expertise on the development of an online course in geology, covering in the first phase five areas:

1. Sedimentology
2. Structural geology and rock mechanics
3. GIS
4. Petrology and geochemistry
5. Governance: international conventions, policy, administration, legal codes and acts

The partners will coordinate with the ECOWAS Secretariat and the relevant Ministries in member states to ensure alignment with existing legal frameworks and support the participative preparation of quality courses. These will be prepared for the online programme as well as defining the roadmap for the potential development of regional qualification frameworks and mutual recognition of qualification in geology and the geosciences in general.

Consultations with respective mining arms of the national Chambers of Commerce and Industries of each participating country will also be undertaken to ensure that their support is received, especially for understanding the issues relating to legal codes, acts and other governance issues in mining in these countries.

In support of the implementation of this activity, the ECOWAS Education, Culture, Science & Technology Directorate will work to ensure that it is aligned to the Secretariat's agreed

processes for harmonization of degrees in higher education in the region. The ECOWAS Secretariat shall also provide leadership for setting the direction for the preparation of the qualification frameworks and the harmonization of certificates and the advocacy for its implementation.

The GEOLOOC site has been implemented on a Server based in Dakar, Senegal and consists of two primary sites. The first site is the home page for the GEOLOOC network partners and other people interested in the project (http://geolooc.net/) and was built using the Drupal Open Source Content Management System (Fig. 2).

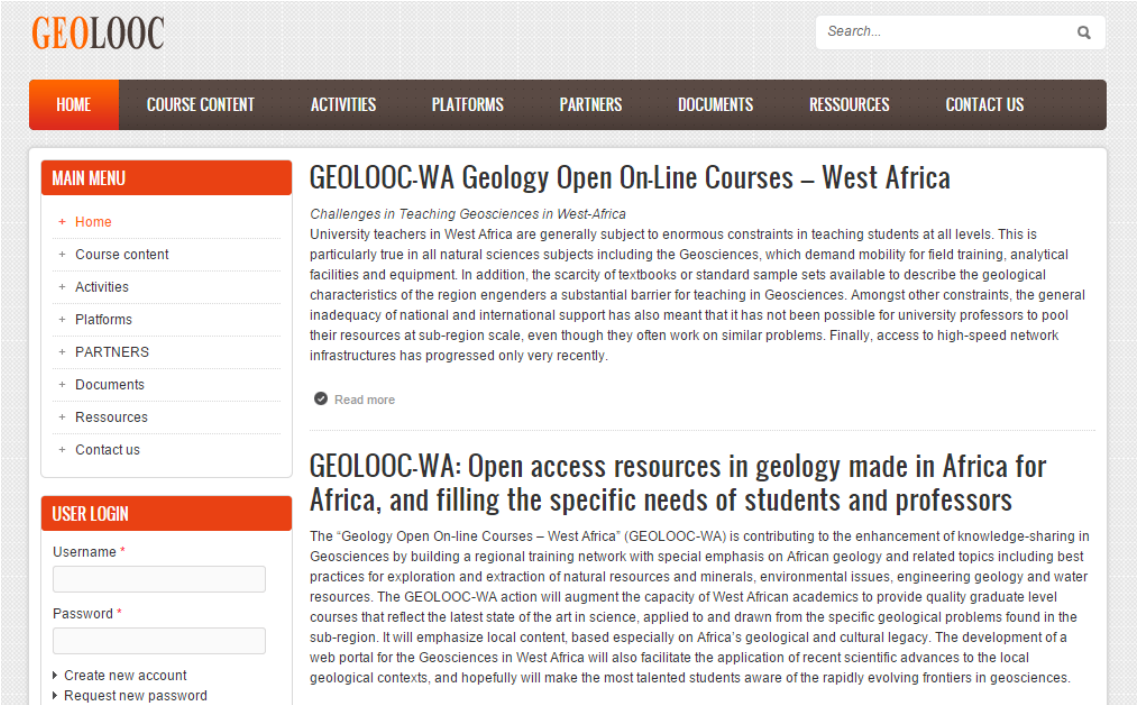

Figure 2. Home page of the GEOLOOC site

The second sub-domain of this site (http://fad.geolooc.net/) provides access to the course materials themselves (Fig. 3). The course content is stored online within a MYSQL database allowing real time updating of content.

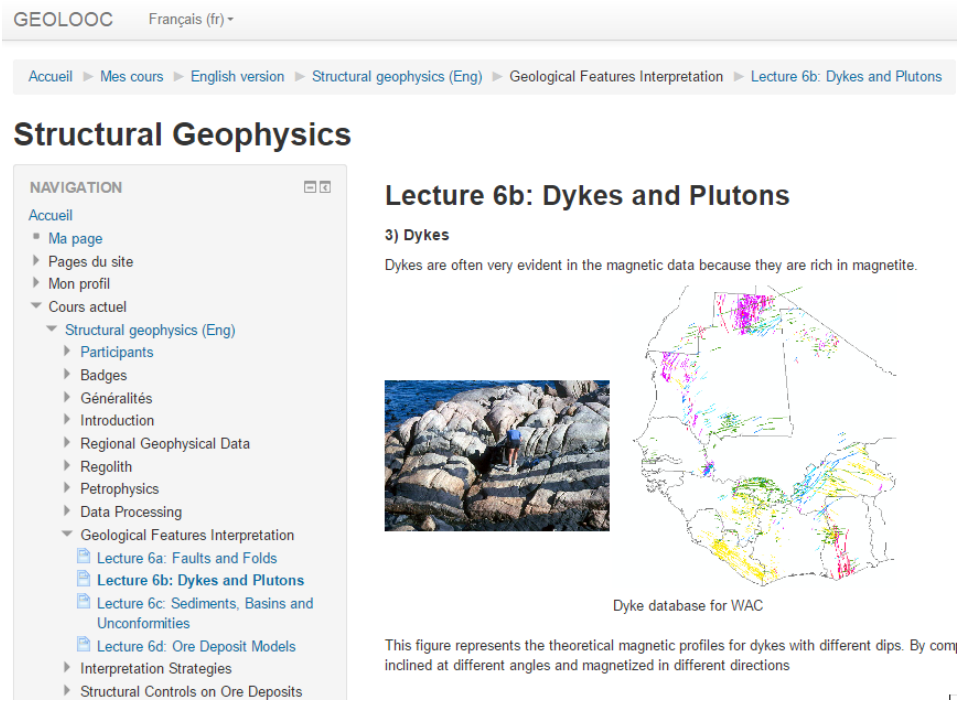

Figure 3. Example course content page from the GEOLOOC site

Implementation

Courses currently available as a result of IM4DC Support

IM4DC Support has enabled the provision of two courses, with a third additional course that will be finalised during the second quarter of 2015.

The first GEOLOOC-WA course brought online is the Microstructures course (original material sourced from a course taught by Mark Jessell and Paul Bons (now at Tubingen University, Germany)). This course allows students to get an overview of the underlying processes controlling microstructure evolution in rocks. The Microstructures course is in the process of being translated into French.

The second GEOLOOC-WA course is the Structural Geophysics course, which is already fully translated into French and is in the process of being uploaded.

The third GEOLOOC-WA course is the GIS course. Its content is being finalised and it will be uploaded in the coming months of 2015.

The Tables of Contents for the three courses supported by the IM4DC is in Appendix 1.

Further modules developed by our partners will appear progressively through 2015 and beyond.

Provisional composition of the steering committee

1. UNESCO - Anthony Maduekwe
2. Institut de Recherche pour le Développement (IRD) - Lenka Baratoux
3. Université des Sciences Techniques et Technologiques de Bamako (USTTB) - To be confirmed
4. Université de Ouagadougou - To be confirmed
5. University of Ghana, Legon-Accra - To be confirmed
6. Ecole Supérieure des Mines et de la Géologie de Yamoussoukro (ESMG) - To be confirmed
7. Université Houphouët-Boigny (UFHB), Côte d'Ivoire - To be confirmed
8. Institut des Sciences de la Terre, UCAD, Sénégal - To be confirmed
9. Département de Géologie, UCAD, Sénégal - To be confirmed
10. Institut Fondemantal d'Afrique Noire, Sénégal - To be confirmed
11. Université de Toulouse - David Baratoux (Coordinator)
12. Université de l'Australie Occidentale - Mark Jessell
13. TTGEO - François Morou Ouédraogo

Composition of working groups

1. Working group 'Metallogeny and mineral resources'

- Chair: Ousmane Bamba (Univ. Ouagadougou)
    - Juan Carlos (Univ. Barcelona)
    - Marieke van Lichtervelde (IRD)
    - Pieter Ndibewu (TUT)
    - Yolande Traoré (USTTB)

2. Working group 'Sedimentology'

- Chair: El Hadj Sow (UCAD)
    - Mariette Miningou (Univ. Ouagadougou)

3. Working group 'Structural geology and rock mechanics'

- Chair: Gbele Ouattara (ESMG)
    - Papa Moussa Ndiaye (UCAD)
    - Members: David Baratoux (IFAN/IRD)

- Seta Naba (Univ. Ouagadougou)
- Sylvain Block (Univ. Toulouse)
- Famara Diatta (UCAD)
- Mababa Diagne (IST)

4. Working group 'Petrology and geochemistry'

- Chair: Daniel Asiedu (LEGON)
  - Ousmane Wane (USTTB)

5. Working group on 'Governance'

- The membership is yet to be identified; however, Toro Gold with its network will support the identification of potentially qualified persons for membership.

Beneficiaries and other stakeholders

There are currently over 230 universities in West Africa (public and private), of which 63 have earth science departments and most of these award some form of post-graduate degree and offer courses to both their own students and those from universities that do not have graduate programs. The GEOLOOC-WA action should eventually be extended to all staff and students of the West African earth science and environmental departments. So far, six universities have been identified as the first beneficiaries of this action. The choice was based on several factors including, minimum infrastructure requirements, a well-established network of leaders in the major regional academic centres and current political stability.

The six universities are:

- University Cheikh Anta Diop, Dakar, Senegal
- University de Ouagadougou, Burkina Faso
- University of Legon, Ghana
- University of Sciences, Techniques and Technology of Bamako, Mali
- Ecole Supérieure des Mines et de la Géologie de Yamoussoukro (ESMG), Côte d'Ivoire
- Université Houphouët-Boigny (UFHB), Côte d'Ivoire

Future work

An indicative budget of $385,877 has been established that pertains only to the first phase of the activities relating to this project*.

The activities will last 24 months starting at the earliest in January 2015.

UNESCO has agreed to continue funding this project, with final confirmation of the budget levels to be decided by mid-2015. This funding will support training workshops in the host countries that will allow university staff to simultaneously learn the Moodle Course

Management System and convert their teaching materials into online content. The first of these courses will be held in Dakar in the third quarter of 2015.

* Note that this does not include the initial funding and money spent on the initial consultation meeting held in Toulouse France in September 2014 and in running the initiative so far.

Appendix 1: Implemented Online Course Tables of Contents

Microstructures Course Content

1 Deformation Mechanisms and Processes

Summary of the different deformation mechanisms and processes associated with deformation at the grain and sub-grain scale

Lecture 1: Deformation Mechanisms and Processes Page
Practical 1a: Numerical Simulations Page
Practical 1b: Analogue Experiments Page
Practical 1c: Naturally Deformed Rocks Page
Glossary 1 Page

2 Recovery, meta-dynamic recrystallisation & static grain growth

Inter- and intragranular processes that create and modify grain and sub-grain boundaries

Lecture 2: Recovery, meta-dynamic recrystallisation & static grain growth Page
Practical 2a: Numerical Simulations Page
Practical 2b: Analogue Experiments Page
Practical 2c: Evidence of recrystallisation in naturally deformed rocks Page
Glossary 2 Page

3 Grain Shape and Crystallographic preferred orientations

Geometric features in deformed rocks

Lecture 3: Grain shape and crystallographic preferred orientations Page
Practical 3a: Numerical Simulations Page
Practical 3b: Naturally Deformed Rocks Page
Glossary 3 Page

4 Metamorphism and deformation

The interaction of deformation and metamorphic processes

Lecture 4a: Metamorphism and deformation Page
Lecture 4b: Shear Zones Page
Practical 4a: Analogue and Numerical Experiments Page
Practical 4b: Naturally Deformed Rocks Page
Glossary 4 Page

5 Dissolution-Precipitation Creep, veins and pressure fringes

Deformation by transfer of dissolved material, veins and pressure fringes

Lecture 5a : Dissolution-Precipitation Creep Page
Lecture 5b : Veins Page
Practical 5a:Numerical Simulations Page
Practical 5b: Naturally Deformed Rocks Page
Glossary 5 Page

6 Additional Materials

Additional Materials

Table of Deformation Mechanisms Page
Open Access Papers Page

Structural Geophysics Course Content

1 Introduction

The aim of this course is to give an overview of the methods of producing geological interpretations based on geophysical data, in particular airborne data, which is in very common in the mining industry. This course will introduce the different systems of Earth observation, the data they generate and their resulting geological interpretations.

Lecture 1 Introduction to Structural Geophysics

2 Regional Geophysical Data

In this second lecture, we will discuss the means of acquiring geophysical data. Understanding of the acquisition process is essential when we interpret data. For example, the possible interpretations often depend on the spatial resolution of a series of measurements, which must be adapted to the problem. We will not be discussing ground-based techniques much in this section; instead, we will mainly focus on the regional-scale acquisition of magnetic, gravity data, radiometric, multi-spectral, elevation, electromagnetic, seismic and radar data.

Lecture 2a: Magnetometry Page
Lecture 2b: Gravimetry and Gamma-Ray Spectroscopy Page
Lecture 2c: Electromagnetics Page
Lecture 2d: Satellite Remote Sensing Page
Lecture 2e: Seismics, Digital Elevation Models, and Summary Page

3 Regolith

In this lecture, we will have a closer look at the regolith, its properties distribution and classifications. We will use geophysical data to map different regolith landforms and we will investigate how regolith affects the different data types.

Lecture 3a: Introduction to Regolith Page
Lecture 3b: Regolith in Geophysical Data Page

4 Petrophysics

In this section on the petrophysical analysis of rocks we consider four geophysical phenomena: Magnetism (magnetic susceptibility and remanence); Gravity (density); The gamma ray spectrometry (radiometrics) i.e. the proportions of radionuclides potassium, thorium and uranium; Electromagnetism (conductivity)

Lecture 4: Petrophysics Page

5 Data Processing

The section discusses the different stages of data processing, from the acquisition of data to the final image. We will go through the survey design, data acquisition and quality control, noise suppression, error corrections, identification and removal of anomalies due to anthropogenic effects, leveling, gridding, geophysical processing, and imaging processing. It is important to know the entire process and not limit onself to a single image. A knowledge of processing steps, which have been performed, is needed to correctly interpret the information.

Lecture 5a: Data Processing Page
Lecture 5b: Data Processing Page

6 Geological Features Interpretation

This section looks at how to interpret different types of structures and lithologies: faults, folds, dykes, plutons, unconformities, sediments & basins, ore deposits, non-geological Features.

Lecture 6a: Faults and Folds Page
Lecture 6b: Dykes and Plutons Page
Lecture 6c: Sediments, Basins and Unconformities Page
Lecture 6d: Ore Deposit Models Page
Lecture 6e: Non-geological signatures Page

7 Interpretation Strategies

This part of the course was borrowed from the course by Pete Betts and Laurent Aillères, Monash University and discusses in more detail the processes of gelogical interpretation of regional geophysical datasets.

Lecture 7: Interpretation Strategies Page

8 Structural Controls on Ore Deposits

This section focusses on the structural controls on ore deposit formation.

Lecture 8a: Scales of Mineral Systems and Controls on Orogenic Gold Deposits Page
Lecture 8b: Principles of Fluid Flow and Fluid Flow through Fractured Networks Page
Lecture 8c: Structural Traps for Mineral Systems Page

9 Summary

This chapter summarizes what we have learned.

Lecture 9: Summary Page

GIS Course Content

1. **GIS review and introduction**
   - 1.1. Vector and raster data
   - 1.2. Symbolizing data
   - 1.3. Map layout
   - 1.4. Working with tables
   - 1.5. Selecting and querying data
2. **Spatial coordinate systems**
3. **Geodatabases**
4. **Editing and data entry**
5. **Topology**
6. **Introduction to Remote Sensing for Geologists**
   - 6.1. RS principles
   - 6.2. Active Sensors
   - 6.3. Passive Sensors
   - 6.4. Geological features
   - 6.5. Image pre-processing
   - 6.6. Image processing and transformations
7. **Digital elevation models**
   - **7**.1. Sources
   - 7.2. Derived data and applications
8. **Analysing GIS data**
   - 8.1. Basic analyses
   - 8.2. Spatial analyses