



# 4<sup>th</sup> SGA-SEG-UNESCO-IUGS Short Course on African Metallogeny

*“Mineral Resources-Based Sustainable Development in Africa”*

*23<sup>rd</sup> to 31<sup>st</sup> March 2015*

Africa is well endowed with mineral resources and yet much of Africa’s mineral riches remain to be discovered. Mining has played a pivotal role in the economy of many African countries with contributions to foreign exchange earnings exceeding 50% in many instances. There is no doubt that the exploitation of mineral deposits could form a substantial, if not the strongest, platform on which to base the future uplifting of the African economy. The discovery of new deposits as well as the economic and sustainable exploitation of known deposits requires skills that are not as readily available in many areas of Africa as they might be in other parts of the world. The aims of the recently founded Short Courses on African Metallogeny have been firstly to train African geoscientists in the specific field of metallogeny. So far, the original goal to conduct these short courses on an annual basis in different parts of the continent could be achieved. After three highly successful editions, beginning in 2012 in Burkina Faso, followed in 2013 in Zambia and in 2014 in Morocco, we are very pleased to announce the fourth of these courses, which is being organized by the Society for Geology Applied to Mineral Deposits (SGA), in collaboration with the School of Earth Sciences at Addis Ababa University, the Ethiopian Ministry of Mines in collaboration with the Ethiopian Geoscience and Mineral Engineering Association (EGMEA) and the Geological Society of Africa (GSAf), and supported by UNESCO, IUGS, and the Society of Economic Geologists (SEG).





This course will be held in

**Addis Ababa,**

**Ethiopia,**

from

**23<sup>rd</sup> to 31<sup>st</sup> March 2015**

## **Why Ethiopia?**

Late Proterozoic low-grade metamorphic belts crop out in western, southern and northern Ethiopia. Ethiopia has numerous primary gold and base metal occurrences that have been reported in several locations throughout these belts. However, only one primary gold deposit, Lega Dembi, exists in southern Ethiopia. Currently, some projects have reached an advanced exploration stage in western Ethiopia and are entering a pre-mining phase, possibly in a couple of years to become the next mines. Although Ethiopia is still underexplored for gold, and other metallic and industrial mineral deposits, notable exploration activities have been carried out both by the Geological Survey of Ethiopia and private companies. To date, most exploration activities have been unsuccessful in identifying subsurface extensions of surface mineralization, largely due to a poor understanding on the structural controls, genesis and occurrences of mineralization using recent techniques and state of the art methods. The planned short course aims at expanding the knowledge base of professionals engaged in the sector to assist the emerging mining industry in the wider region.

## **The course**

This training course will provide an introduction to the mode of occurrence, genesis and economic significance of selected precious and base metal mineral resources that can be expected to occur in Archaean to Palaeoproterozoic cratons and younger orogenic belts. Emphasis will be placed on exploration-specific aspects, such as metallogenetic models, geochemical dispersion haloes, mobility of pathfinder elements in the surficial environments, and geophysical methods in exploration.

The course will comprise five days of training with lectures and practical exercises to be conducted at the School of Earth Sciences of the Addis Ababa University, and two days of field work (plus two days of travelling) at one of the mines/prospects in the area, provisionally scheduled for the Lega Dembi Gold Mine and nearby artisanal mining sites. The course is aimed at geologists wishing to improve their skill base in modern integrated economic geology and geophysical exploration techniques. It will help them to (i) better understand the genesis of a number of deposit types, (ii) improve the integration of their geological and geophysical data, (iii) better evaluate given projects, and (iv) develop better strategies for future exploration. It is expected that participants come from the formal mining/exploration sector, academia (post-graduate and young staff members) as well as government institutions (Geological Surveys of the wider region, Ministry of Mines, Regional Mining Bureaus). Representatives of artisanal miners are most welcome. A reasonable command of English will be helpful as the language of the course will be English.



The following **lectures** are currently planned. Some of them will be supplemented, where appropriate, by practical exercises:

### 1. Introduction

- 1.1 An overview of the geology of Ethiopia
- 1.2 Introduction to the metallogeny of the Nubian Shield
- 1.3 A mineral systems approach to ore deposits

### 2. Orogenic gold deposits

- 2.1 Diagnostic and critical features
- 2.2 Geological setting (controls of mineralisation, deposit sizes, host rocks)
- 2.3 Ore and gangue minerals
- 2.4 Metal association
- 2.5 Alteration
- 2.6 Mineralizing fluid
- 2.7 Orogenic gold deposits with an anomalous metal association
- 2.8 Lithogeochemical haloes around orogenic gold deposits

### 3. Volcanogenic massive sulfide deposits

- 3.1 Introduction, classification, volcanology
- 3.2 Geochemistry, alteration, exhalites
- 3.3 Oxide gold deposits of the Arabian - Nubian shield
- 3.4 Heat and fluid flow and VMS systems

### 4. Conglomerate-hosted gold-uranium deposits

- 4.1 Tectonic and sedimentological setting
- 4.2 Syngenetic versus epigenetic models
- 4.3 The crustal gold cycle
- 4.4 Main factors controlling fertility

### 5. Geochemical dispersion in regolith-dominated terrains

- 5.1 The regolith factor in mineral exploration
- 5.2 Regolith material description, nomenclature and
- 5.3 Geochemical dispersion mechanisms in the regolith
- 5.4 Practical methods to aid exploration in regolith dominated terrains

## 6. Exploration geophysics

- 6.1 Getting geology from Geophysics
- 6.2 What is petrophysics (density, magnetisation etc.)
- 6.3 Different methods (magnetics and gravity: from ground to air, IP, EM, AEM, seismic methods)
- 6.4 Exploration geophysics for targeting at different scales with case studies

## 7. Evaluation of mining projects

- 7.1 Economic evaluation of mining projects
- 7.2 Using Real Options to value a Mining Project (Open Pit Gold ) : combining uncertainties from Spot Prices and Geostatistical Conditional Simulations of Grades.
- 7.3 Assessment of shares of "Stakeholders": from deterministic value to probabilities of revenues.
- 7.4 Setting up a Conditional Taxation tool: a new approach to Fiscal Regimes. Examples from (West) Africa.

## 8. Artisanal miners and exploration – How to do it better!

- 8.1 Gold in the regolith
- 8.2 Gold in the fresh rock
- 8.3 Different styles of gold mineralization
- 8.4 Styles of prospecting
- 8.5 Sampling of gold ores – basics
- 8.6 Basic mining methods with emphasis on safety
- 8.7 Recovering gold from the rock – safely!
- 8.8 Selling gold
- 8.9 Other important matters

**The local organizing committee** comprises the following experts:

Dr. Asfawossen Asrat, GSAf, SES (asfawossena@gmail.com)  
Dr. Girma Woldetinsae, MoM, EGMEA (gwt\_girma@yahoo.com)  
Prof. Gezahegn Yirgu, SES, EGMEA (gezahgneyirgu@yahoo.com)  
Dr. Worash Getaneh, SES  
Prof. Solomon Tadesse, SES (tadefanta@yahoo.com)  
Dr. Kebede Hailu, KEFI Minerals  
Representative from Unity University/or Midroc Gold



## The presenters

The presenters are all internationally recognized experts with many years of experience in the fields of economic geology and geophysics.



Abdoul Aziz NDIAYE is senior lecturer at the Earth Sciences Institute, a Geological Engineering School at the University CAD of Dakar (Senegal). Before that he worked in the mining industry as geologist engineer in phosphate and industrial clays operations and as consultant in the development of mining projects in Senegal. His research activities are on the modeling of stakeholders' shares (states, mining companies and communities) in mining incomes, the setting-up of conditional fiscal regimes for mining taxation policies, and the assessment of risks - geological and financial - using geostatistical tools in project evaluation methods.



Asfawossen Asrat is an associate professor of petrology and geochemistry at the School of Earth Sciences, Addis Ababa University. He has an expertise in Ethiopian geology, particularly granitoids, of the Precambrian basement rocks of the Arabian-Nubian Shield.



C. Tucker Barrie is a consulting economic geologist based in Ottawa (Canada). He has worked for the Ontario Geological Survey and the Geological Survey of Canada on base and precious metal deposits, with a specialty in volcanogenic Cu-Zn massive sulfide and magmatic Ni-Cu-PGE sulfide deposits. He has worked on projects in over 20 countries for junior and major mineral exploration mining companies, and has advised governments about mining policy and regulations through The World Bank. Recently he has been focusing on VMS - Oxide Gold deposits in the Arabian - Nubian Shield, and on porphyry copper-gold systems in the northern Andes of Colombia and in the Caribbean.



Simon Bolster is head of exploration of Gryphon Minerals and is highly experienced with exploring regolith dominated terrains thanks to over 25 years industry experience with field work completed in more than 30 countries, including 15 in Africa. He was one of the pioneers of regolith terrain mapping for mineral exploration in Australia and expanded this into West and East Africa. He has previously been employed by Anglo American and Newmont Mining where he held the role of consulting geochemist and later became Global Manager Remote Sensing and Terrain Mapping. He has extensive gold exploration experience, with lesser stints in base metal exploration including work on the Zambian Copper Belt.



Pasi Eilu is senior geoscientist at the Geological Survey of Finland and adjunct professor in economic geology at the University of Turku, Finland. He has worked on gold deposits in Australia, northern Europe and Greenland, with the main focus on alteration mineralogy and geochemistry of orogenic gold deposits and their uses in exploration. During the last 15 years he has also led an international project on mineral deposit and metallogenic maps and databases for the Fennoscandian Shield.



Hartwig Frimmel is full professor of geology at the University of Würzburg (Germany), where he holds the position of Chair in Geodynamics and Geomaterials Research. He is also an honorary research associate of the University of Cape Town, South Africa, where he spent many years as lecturer and eventually professor at the Department of Geological Sciences. He can look back at more than 25 years of metallogenic research on gold and other ore deposits worldwide. He serves as advisor in mineral resources matters to the European Commission and the Bavarian Government.



Solomon Tadesse is a professor of economic geology at the School of Earth Sciences, Addis Ababa University, and a former vice-president of the Geological Society of Africa. He has long experience in research on shear zone-hosted gold mineralization; epithermal gold; tantalum-bearing complex pegmatite deposits and platinum and nickel deposits in ultramafic rocks. Apart from numerous research papers he has authored a book on the geology and mineral resources potential of Ethiopia.



Peter Williams has lifelong experience in exploration geophysics. He worked for Western Mining Corporation, Australia, as Chief Geophysicist and Manager of Geoscience Technology. Since then he has been on the forefront of exploration and founded several companies that were directly responsible for major discoveries and asset identification, also in West Africa. As well as working in industry he also holds adjunct positions at the Western Australian School of Mines, Curtin University and is an Adjunct Professor at the Centre for Exploration Targeting, at the University of Western Australia.





## Venue

The 5-day workshop will be held at the School of Earth Sciences of the Addis Ababa University (<http://www.aau.edu.et/cns/academics/school-of-earth-science/>). For location go to <https://www.google.com.et/maps/place/Addis+Ababa+University+College+of+Natural+Science/@9.032017,38.7633503,923m/data=!3m1!1e3!4m2!3m1!1s0x164b8f6264633b27:0xef6136cf034dc59d>.

## Number of participants and economics

A maximum of 50 participants is set for logistic reasons and in order to ensure maximum benefit for each participant. It is expected that participants from industry (c. 20) cross-subsidize participants from economically disadvantaged institutions (c. 30) – see below. The maximum number of participants for the post-workshop field trip is 20.

## Costs

The course fees for participants from industry will be US\$ 1800 USD per person for the 5-day workshop. The course fee includes the 5-day workshop lectures and practicals, course materials as well as lunch and two refreshments per day during the course. Costs for travel to and from Addis Ababa, accommodation, breakfast and dinner are excluded. Subsidies will be made available to university staff and students according to available budget. Subsidies will be distributed on a first come - first served basis and based on merit. To apply for a subsidy please fill in the attached form.

The field trip costs will be US\$ 800.00 per person for both days (plus two days of travel). Transport to the field will be by a hired bus.

For those attendees who would like us to help with accommodation reservation in Addis Ababa, please contact Asfawossen Asrat ([asfawossena@gmail.com](mailto:asfawossena@gmail.com)) so that we can discuss your needs.



## The Proposed Programme

Day	Date	Time	Course Element	Lecturer
1	Mon, 23/03/2015	Morning I	Introduction, Overview: Nubian Shield geology Ethiopian Mineral Resources	AA ST
		Morning II	Mineral System approach to ore deposits	HF
		Afternoon I	Orogenic gold deposits I	PE
		Afternoon II	Orogenic gold deposits II	PE
2	Tue, 24/03/2015	Morning I	Geochemical exploration for orogenic gold deposits	PE
		Morning II	VMS deposits I	TB
		Afternoon I	VMS deposits II	TB
		Afternoon II	VMS - Oxide gold deposits of the Arabian-Nubian shield	TB
3	Wed, 25/03/2015	Morning I	Heat and fluid flow and VMS systems	TB
		Morning II	Conglomerate-hosted Au-U deposits and the crustal gold cycle	HF
		Afternoon I	Uranium deposits and fingerprinting	HF
		Afternoon II	Regolith geochemistry I	SB
4	Thu, 26/03/2015	Morning I	Regolith geochemistry II	SB
		Morning II	Regolith exploration	SB
		Afternoon I	Exploration geophysics - basics	PW
		Afternoon II	Exploration geophysics - methods	PW
5	Fri, 27/03/2015	Morning I	Evaluation of mining projects, risks,	AN
		Morning II	Mining investments, taxes, regulations	AN
		Afternoon I	Artisanal miners and exploration I	PW
		Afternoon II	Artisanal miners and exploration II	PW
6	Sat, 28/03/2015	Whole day	Trip to Legadembi	all
7	Sun, 29/03/2015	whole day	Field excursion	all
8	Mon, 30/03/2015	whole day	Field excursion	all
9	Tue, 31/03/2015	Whole day	Trip back to Addis	all
Presenters: AA - Asfawossen Asrat, AN – Abdoul Aziz Ndiaye, SB – Simon Bolster , TB – Tucker Barrie, PE - Pasi Eilu, HF - Hartwig Frimmel, ST: Solomon Tadesse, , PW - Peter Williams				



# Registration Form for Individuals

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Short Course  
on  
African Metallogeny**

***“Mineral Resources-Based Sustainable Development in Africa”***

For further information go to: ***www.e-sga.org***

Title:

First name:

Surname:

Company name

Company address:

Country:

Contact Tel.:

e-mail:

Registration fee for 5-days workshop ..... US\$ 1800.00  
Registration fee for 2-days field trip ..... US\$ 750.00  
Total ..... US\$ \_\_\_\_\_

I am an academic without sufficient funds or a student and apply for a subsidy ..... NO   
YES \*

If YES, you will be requested to fill in a separate application form to be sent to you by the course organizer.

E-mail this form to the course organizer: Hartwig Frimmel: [hartwig.frimmel@uni-wuerzburg.de](mailto:hartwig.frimmel@uni-wuerzburg.de)  
or fax to +49 (0)931 318 7344.

On confirmation of your place, we will ask you to transfer the registration fee to the following bank account:

Name of the bank: Credit Suisse

Address: Postfach 500, CH-8070 Zuerich, SWITZERLAND

Account holder: SGA

IBAN (International bank account number): CH4604835181963192000

BIC (Bank identification code): CRESCHZZ80A



**SEG**  
www.segweb.org





# Registration Form for Companies

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African Metallogeny**

***“Mineral Resources-Based Sustainable Development in Africa”***

For further information go to: ***www.e-sga.org***

Company name  
Company address:  
Country:  
Company Tel.:  
Administrative e-mail contact:

Attendee’s Name 1:  
Attendee’s Name 2:  
Attendee’s Name 3:  
Attendee’s Name 4:

Total registration fees for 5-days workshop (US\$ 1800.00 per person) ..... US\$ \_\_\_\_\_  
Registration fee for 2-days field trip (US\$ 750.00 per person)..... US\$ \_\_\_\_\_  
Grand Total ..... US\$ \_\_\_\_\_

E-mail this form to the course organizer Hartwig Frimmel: [hartwig.frimmel@uni-wuerzburg.de](mailto:hartwig.frimmel@uni-wuerzburg.de)  
or fax to +49 (0)931 318 7344.

On confirmation of your places, we will ask you to transfer the registration fee to the following bank account:

Name of the bank: Credit Suisse  
Address: Postfach 500, CH-8070 Zuerich, SWITZERLAND  
Account holder: SGA  
IBAN (International bank account number): CH4604835181963192000  
BIC (Bank identification code): CRESCHZZ80A

