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 aim of the newly founded Short Courses on African Metallogeny is to train young African geoscientists in the specific field of metallogeny, i.e. practical aspects of the genesis of ore deposits that can be applied in the formulation of future exploration strategies. These Short Courses on African Metallogeny are planned to be conducted on an annual basis in different parts of the continent.
It is with great pleasure that we herewith announce the first of these courses, which is being organized by the Society for Geology Applied to Mineral Deposits (SGA), in collaboration with the Institut de recherche pour le développement (IRD) and Teng Tuuma Geoservices (TTG), and supported by UNESCO, IUGS, the Society of Economic Geologists (SEG), IRD, and the Geological Society of Africa (GSA).

In the light of a particularly strong interest in exploration of the West African Craton, as evidenced for example by the West African Exploration Initiative (WAXI), this course will be held in

**Ouagadougou,**

**Burkina Faso,**

**from**

**12 to 18 March 2012.**

This training course will provide an introduction to the mode of occurrence, genesis and economic significance of selected precious, ferrous and base metal mineral resources that can be expected to occur in Archaean to Palaeoproterozoic cratons. Specific commodities that will be dealt with in greater detail are gold, copper, iron, manganese and rare earth elements. A further component of the course will aim at the use of geophysical methods in exploration within old continental crust as in the West African Craton.

The course will comprise five days of training with lectures and practical exercises to be conducted in Ouagadougou, followed by two days of field work at one of the mines/prospects in the area. 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 mining/exploration sector, academia as well as government institutions. A reasonable command of English will be helpful as the language of the course will be English.
The presenters are all internationally recognized experts with many years of experience in the fields of economic geology and geophysics.

Roberto Perez Xavier is Professor of Economic Geology in the Geology and Natural Resources Department of the Geoscience Institute, University of Campinas, Brazil. He served as associate director of that institute and is currently coordinator of the research group on Crustal Evolution and Metallogeny at his home institution.

Nic Beukes is full professor at the University of Johannesburg, South Africa. He is essentially a field geologist, specializing in sedimentology and stratigraphy, with emphasis on understanding the origin of iron and manganese ore deposits and the nature of surface environments on early earth, which includes the history of atmospheric oxygen and climatic change in the middle Archaean to early Palaeoproterozoic. He has worked extensively on iron and manganese formations all over the world and also studied the genetic and sequence stratigraphy of Archaean siliciclastic strata in the Kaapvaal Craton as well as early Precambrian laterite profiles and paleosols. He is recipient of the Draper Medal, the highest award from the Geological Society of South Africa.

Pasi Eilu is Senior Geoscientist at the Geological Survey of Finland and lecturer in economic geology at the University of Turku, Finland. He has worked on gold deposits and 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 ten 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) and an honorary research associate of the University of Cape Town, South Africa, where he spent many years as lecturer and eventually professor. He is a former president of SGA and fellow of SEG who has worked extensively on gold and base metal deposits.

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 lectures at ENAG (Ecole nationale d'applications des geosciences) in France.

Morou Francois Ouedraogo is a local expert on Birimian geology and metallogeny with long experience in gold and base metal exploration. He worked as geologist in the Bureau of Mines and Geology of Burkina Faso and UNDP Project and also as lecturer at the University of Ouagadougou before serving as chief geologist and then VP exploration for a number of exploration companies, some of which were co-founded by him. He is currently Managing Director of Teng Tuuma Geoservices.

Lenka Baratoux is a postdoctoral research fellow at Institute de Recherche pour le Développement (IRD) in Toulouse. She is a field geologist with a specialization in structural geology and petrology. She is particularly interested in geodynamics of Precambrian terrains and timing of the gold and base metal mineralization within the global tectonic scenario. Since 2006, she has been working in West Africa (Burkina Faso, Ghana, Niger) in the framework of the WAXI project.

Marieke Van Lichtervelde is a researcher at the Laboratory Geoscience Environment Toulouse, working for the (IRD). She is specialized in tantalum mineralization in rare-element granites and pegmatites and she currently works on the distribution of rare metals (Nb-Ta, Sn, Li, U) associated with granites and pegmatites in the West-African craton.
**Course Contents**

All hydrothermal ore deposits are the end products of large-scale fluid circulation through porous and permeable rocks and structures, fluid-rock interaction and focusing of hydrothermal fluids at the site of ore deposition. Ore-forming processes in the crust involve a wide range of sources of heat, fluids and metals which may eventually lead to the formation of several types of world-class deposits. In this context, this short course intends to focus on an introduction to the basic aspects of how fluids are generated in the crust, interact with the rocks and form ore-bearing hydrothermal systems. Case studies to illustrate ore-forming hydrothermal systems that will be presented include iron oxide-copper-gold (IOCG) and intrusion-centered gold deposits (gold-rich porphyry-type), using examples from the Archean Carajás Mineral Province and the Paleoproterozoic Alta Floresta Gold Province, respectively, in the Amazon Craton, Brazil, as well as several Archaean to Palaeoproterozoic orogenic gold deposits.

The first part on ore-forming processes in hydrothermal systems will deal specifically with the formation and evolution of hydrothermal fluids in the Earth’s crust, the transport and deposition of metals by hydrothermal fluids, hydrothermal alteration (main types and implications on ore-forming processes), as well as some basics on stable isotope systematics (O, C, H, S) and how such isotope ratios can help in setting constraints on fluid sources. This will be complemented with a discussion of the structural control on mineralization.

Orogenic gold deposits in old cratons play a pivotal role in the global gold production. In the course, the diagnostic and critical features of this deposit type will be addressed, as well as its geological setting, typical ore and gangue minerals, metal association, alteration patterns, and the nature of the mineralizing fluid. This will be complemented by discussions of lithogeochemical haloes around orogenic gold deposits and orogenic gold deposits with an anomalous metal association.

With the advancement of high-tech industries over the last few years, especially rare metals have moved into the spotlight of the markets. This will be taken into consideration by a course component dealing with the distribution of rare metals in West African granites and pegmatite.

Archaean palaeoplacer deposits are by far the most important known hosts of economic concentrations of gold and to a lesser extent of uranium. The Witwatersrand gold-uranium deposits will be presented in greater detail and the question of what we can learn from these deposits about the likelihood of finding similar giant deposits elsewhere will be discussed.

Palaeoproterozoic strata are well known for hosting the world’s by far most important iron and manganese deposits and future resources. The course will address the sedimentology, genesis and palaeoenvironmental significance of iron formations through time as well as BIF-hosted high grade iron ores of supergene, hydrothermal and supergene-modified hydrothermal origin. Furthermore, the nature, origin and palaeoenvironmental significance of Precambrian manganese deposits and supergene enrichment of some will be addressed. This will include discussions of BIF-hosted, black shale-hosted, oolitic and karst-hosted deposits with emphasis on the first two. A part of the lectures will specifically look at the environmental significance of Mn deposits that preceded the Great Oxygenation Event.
Especially in poorly exposed regions, modern exploration would be unthinkable without a strong geophysical component. Therefore, an introduction to exploration geophysics will be given. This will entail the basics of how to obtain geological information from geophysical data, presentation of the different methods and application thereof to examples from West Africa.

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

1. **Introduction**
   1.1 An overview of Birimian geology
   1.2 Geological prerequisites for ore deposits

2. **Ore-forming processes in hydrothermal systems**
   2.1 Hydrothermal fluids: how they form and evolve in the Earth’s crust.
   2.2 Transport and deposition of metals by hydrothermal fluids.
   2.3 Hydrothermal alteration: main types and implications on ore-forming processes.

3. **Structural control on mineralization**
   3.1 Fluid flow in source rocks
   3.2 Fracture networks, fault zones and fluid flow
   3.3 Structural and other types of traps
   3.4 Vein Arrays

4. **Case studies**
   4.1 Iron oxide-Copper-gold (IOCG) systems: the Carajás Mineral Province, Amazon Craton, northern Brazil.
   4.2 Intrusion-centered gold ± copper deposits in the Alta Floresta Province, Amazon Craton, Brazil: examples of Paleoproterozoic gold-rich porphyry-type systems?

5. **Orogenic gold deposits**
   5.1 Diagnostic and critical features
   5.2 Geological setting (controls of mineralisation, deposit sizes, host rocks)
   5.3 Ore and gangue minerals
   5.4 Metal association
   5.5 Alteration
   5.6 Mineralizing fluid
   5.7 Orogenic gold deposits with an anomalous metal association
   5.8 Lithogeochemical haloes around orogenic gold deposits

6. **Rare metal deposits**
   6.1 Rare metal distribution in West African granites and pegmatite

7. **Precambrian palaeplacer deposits**
   7.1 Witwatersrand-type Au-U deposits
   7.2 Tectonic and sedimentological setting
   7.3 Syngenetic versus epigenetic models
   7.4 Main factors controlling fertility
   7.5 Potential of finding new deposits

8. **Precambrian iron and manganese deposits**
   8.1 Sedimentology, genesis and paleoenvironmental significance of iron formations through time.
   8.2 BIF-hosted high grade iron ores of supergene, hydrothermal and supergene-modified hydrothermal origin
   8.3 Nature, origin and palaeoenvironmental significance of Precambrian manganese deposits
9. Exploration geophysics
   9.1 Getting geology from Geophysics
   9.2 What is petrophysics (density, magnetisation etc.)
   9.3 Different methods (Magnetics and gravity: from ground to air, IP, EM, AEM, seismic methods)
   9.4 Exploration geophysics for targeting at different scales with case studies from West Africa

10. Metal availability prognosis
   10.1 Resource versus Reserve
   10.2 Modeling of future availabilities

Venue

The 5-day workshop will be held at the conference centre of Teng-Tuuma Geoservices (see http://www.ttgeo.com/), located in Ouaga 2000 in Ouagadougou.

Number of participants

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$ 1800.00 per person for the 5-day workshop. The course fee includes the 5-day workshop lectures and practicals, course materials and light meals during the course. Costs for travel to and from Ouagadougou, 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.

The field trip costs will be US$ 750.00 per person for both days. To keep costs as low as possible, participating company staff is asked to bring their own vehicles to the field trip.

For those attendees who would like us to help with accommodation in Ouagadougou, please contact Morou Francois Ouedraogo (feliteo@yahoo.fr) so that we can discuss your needs.
The Proposed Programme

<table>
<thead>
<tr>
<th>Day</th>
<th>Date</th>
<th>Time</th>
<th>Course Element</th>
<th>Lecturer</th>
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<tbody>
<tr>
<td>1</td>
<td>Mo, 12/03/2012</td>
<td>Morning I</td>
<td>Introduction, Overview: Birimian geology</td>
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<td>Morning II</td>
<td>Ore-forming processes in hydrothermal systems</td>
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<td>Afternoon I</td>
<td>Structural Control on Mineralization</td>
<td>LB</td>
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<tr>
<td></td>
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<td>Afternoon II</td>
<td>Structural Control on Mineralization</td>
<td>LB</td>
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<td>Tu, 13/03/2012</td>
<td>Morning I</td>
<td>Orogenic gold deposits</td>
<td>PE</td>
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<td>Morning II</td>
<td>Orogenic gold deposits</td>
<td>PE</td>
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<td>Afternoon I</td>
<td>Archean IOCG deposits</td>
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<td>Paleoproterozoic Au deposits associated with granitic systems</td>
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<td>Morning I</td>
<td>Geochemical exploration for orogenic gold deposits</td>
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<td>Morning II</td>
<td>Rare metal distribution in West African granites and pegmatite</td>
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<td>Afternoon I</td>
<td>Archaean palaeplacer deposits</td>
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<td>Afternoon II</td>
<td>Proterozoic BIF deposits</td>
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<td>Morning II</td>
<td>Proterozoic Mn deposits</td>
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<td>Afternoon I</td>
<td>Exploration geophysics - basics</td>
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<td></td>
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<td>Afternoon II</td>
<td>Exploration geophysics - methods</td>
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<td>Fr, 16/03/2012</td>
<td>Morning I</td>
<td>Exploration in West Africa</td>
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<td>Morning II</td>
<td>Exploration in West Africa</td>
<td>PW</td>
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<td>Afternoon I</td>
<td>Examples from the West African craton</td>
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<td>Metal availability prognosis</td>
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<td>6</td>
<td>Sat, 17/03/2012</td>
<td>whole day</td>
<td>Field excursion</td>
<td>all</td>
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<td>Sun, 18/03/2012</td>
<td>whole day</td>
<td>Field excursion</td>
<td>all</td>
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</table>

Presenters: RX - Roberto Xavier, PE - Pasi Eilu, HF - Hartwig Frimmel, NB - Nic Beukes, PW - Peter Williams, MFO - Morou Francois Ouedraogo, MvL - Marieke Van Lichtervelde, LB - Lenka Baratoux
Registration Form for Individuals

1st SGA-SEG-UNESCO-IUGS
Short Course
on
African Metallogeny

“Precious and Not-so-precious Metals in Old Cratons”

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 ...........  YES ____
                                                                                           NO ____

E-mail this form to Hartwig Frimmel: 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
Registration Form for Companies

1st SGA-SEG-UNESCO-IUGS
Short Course
on
African Metallogeny

“Precious and Not-so-precious Metals in Old Cratons”

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 Hartwig Frimmel: hartwig.frimmel@uni-wuerzburg.de
Or fax to +49 (0)931 318 7344.

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Name of the bank: Credit Suisse
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IBAN (International bank account number): CH4604835181963192000
BIC (Bank identification code): CRESCHZZ80A