Development of GIS database related to West African Geoscience

Mark Jessell

Map of sandstone quarry, gold mine and settlement at Bir Umm Fawakhir, Egypt

Scribe-of-the-Tomb Amennakhte, son of Ipuy, 1160 BC
CET Activities in Africa

- GEOLOOC
  - Online Geoscience Training
- WAXI
  - Research and Training
- Field Studies
  - in Côte d’Ivoire
- Tax Regimes
- Karoo Basin and LIP
- NachingweaNi
- IM4DC
  - Prospectivity Training
- IM4DC GIS Training
...where a mineral deposit might occur at depth, although in no way evident at the surface...

...strategic minerals...

Geomorphology...of increasing importance...

...taxation...vs investment

...security of tenure of mining leases...

...primary geological mapping is essential...

...modern techniques...little or no value...in the absence of geological control...
## Exploration Spend & performance by Region: 2003-2012

*How does Africa compare to the Rest of the World?*

Note: Analysis excludes Bulk Minerals, and excludes satellite deposits found within existing camps
Discoveries refer to Moderate-, Major- and Giant-sized deposits.
The Estimated Value is approximate only, and ignores the value of unreported discoveries

<table>
<thead>
<tr>
<th>Region</th>
<th>Exploration Spend (2012 $b)</th>
<th>No of Discoveries #</th>
<th>Tier 1+2 Discoveries</th>
<th>Estimated Value (2012 $b)</th>
<th>Value / Spend</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australia</td>
<td>$12</td>
<td>10%</td>
<td>84</td>
<td>15%</td>
<td>14%</td>
</tr>
<tr>
<td>Canada</td>
<td>$21</td>
<td>18%</td>
<td>74</td>
<td>13%</td>
<td>15%</td>
</tr>
<tr>
<td>USA</td>
<td>$9</td>
<td>8%</td>
<td>19</td>
<td>3%</td>
<td>6</td>
</tr>
<tr>
<td>Latin America</td>
<td>$27</td>
<td>23%</td>
<td>133</td>
<td>24%</td>
<td>15%</td>
</tr>
<tr>
<td>Pacific/SE Asia</td>
<td>$6</td>
<td>5%</td>
<td>23</td>
<td>4%</td>
<td>2</td>
</tr>
<tr>
<td><strong>Africa</strong></td>
<td>$16</td>
<td>14%</td>
<td>124</td>
<td>22%</td>
<td>20%</td>
</tr>
<tr>
<td>W Europe</td>
<td>$3</td>
<td>3%</td>
<td>24</td>
<td>4%</td>
<td>1</td>
</tr>
<tr>
<td>Rest of World</td>
<td>$22</td>
<td>19%</td>
<td>78</td>
<td>14%</td>
<td>11%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>$116</td>
<td>100%</td>
<td>559</td>
<td>100%</td>
<td>86</td>
</tr>
</tbody>
</table>

Note: Analysis excludes Bulk Minerals, and excludes satellite deposits found within existing camps. Discoveries refer to Moderate-, Major- and Giant-sized deposits. The Estimated Value is approximate only, and ignores the value of unreported discoveries.

Source: MinEx Consulting © November 2013

MinEx Consulting
Whole Rock Geochemistry
>4000 georeferenced analyses
WAXI
Geochronology Database:

~1200 Georeferenced ages
~500 Georeferenced Zircon Ages
100 new Zircon Ages
22 Terranechron
65 Lu/Hf, 22 Oxygen Isotope

Publication date of Geochron Data
Data

3D Models

SIGAFRIQUE Digital Geology

536 SRTM Grids

BGS Mineral composite maps
More data

Regolith Maps

Metamorphic Studies

BF grav/mag inversions

Geology map metadata

metadata
Yet more data

- 25 Landsat mosaics
- 245 Landsat 7 scenes
- 880 Global gravity grids
- 25 mineral deposit databases
- 2300 metadata entries on African geology maps
Global data

Sedimentary Basins

LIP

Ore Deposits & Tectonics
250,000km² of new geophysically-constrained mapping:

- NW Ghana (Bole-Nangondo Belt and Wa-Lawra Belts)
- SW Ghana (Ashanti Belt)
- SW Burkina Faso (Boromo, Houndé and Banfora Belts)
- NE Burkina Faso (Oudalan-Gorouol & Markoye regions)
- SW Mali (Bougouni region)
Regolith and landform analysis
Projets en Afrique

Kiniéro, Guinea
(>7 million ounce)

Mana > 2 million ounces
Burkina Faso

Morila, Mali
(7 million ounce)

Syama, Mali
(5 million ounce)

Sadiola, Mali
(5 million ounce - Oxides)

Komana, Mali

Bogoso, Ghana
(5 million ounces)

Obuasi, Ghana
(>50 million ounces)
Deposit Scale Studies

Laser Ablation ICPMS analysis of sulphides

Petrographic analysis
Lithosphere to laterite interpretation of geophysical datasets

Magnetotelluric line 2013

Dublin Institute for Advanced Studies
Burkina Faso
Ivory Coast
Ghana

Sample of MT data quality

3D models
Petrophysical summary tables

<table>
<thead>
<tr>
<th>Lithology</th>
<th>Birimian</th>
<th>Late Dykes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Micaschists</td>
<td>0.24 - 0.32</td>
<td>0.35 - 24.70</td>
</tr>
<tr>
<td>Volcanoclastic metasediments</td>
<td>0.24 - 0.56</td>
<td>25.13 - 30.90 (+ Remanence)</td>
</tr>
<tr>
<td>Phyllites</td>
<td>0.06 - 0.60</td>
<td></td>
</tr>
<tr>
<td>Metabasalts Metaandesites</td>
<td>0.09 - 4.22</td>
<td></td>
</tr>
<tr>
<td>Metagabbros</td>
<td>0.35</td>
<td></td>
</tr>
<tr>
<td>Dolerite (dykes)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MagSus Data**

- **Map of Mag Sus Data**
  - Log mag sus: 
    - 0
    - 0.5
    - 1
    - 1.5
    - 2
    - 2.5
    - 3
    - 3.5
  - Response
    - Moderate intensity domains
    - Strong magnetic fabric (parallel to bt. alignment)

- **Airborne Radiometric Response**
  - Medium U
    - High Th
    - Medium K (dark green)
  - Low U
    - Medium Th
    - Low K (green)
  - Low U
    - Medium to high K (red-violet)
  - Low U, Th, K
    - Often covered by high U, Th regolith (blue-green)
  - Low U, Th, K
    - Often covered by high U, Th regolith (blue-green)
  - Low U
    - High Th
    - Low K (green)

**Perrouty et al., (2012)**
Mineral Systems
Data Delivery: WAXI GIS

Scope:
- Country
- West Africa
- Africa
- Global
- Marine

Themes:
- Geography
- Geology
- Geophysics
- Mineralisation
- (Tectonics)

Format:
- On-disk and on-line
- 280 layers
- 80 layers unique to WAXI
- 300 Gb

ArcMap and MapInfo
Knowledge Delivery: Research Training Courses

**Exploration Geochemistry**, Jan 2012, Ouagadougou, Presented by Yann ITARD, Consultant 20 participants. 3 days

**Structural Geophysics**, April, 2012, Dakar, Presented by Mark Jessell, Laurent Ailleres, 25 participants. 5 days

**Knowledge Delivery: Applied Structural Geology in Mineral Exploration and Mining** (SW Ghana), 4th Quarter, 2012, Presented by John Miller. 25 participants. 4 days

**Field Structural Mapping**, Jan 2012, Kaya. Presented by Kim Hein, 27 participants. 6 days.

**Structural Geophysics**, April, 2012, Dakar, Presented by Mark Jessell, Laurent Ailleres, 25 participants. 5 days.

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Annually
5 WAXI Courses
20 total days training
100 total participants

Plus 1-2 IM4DC Courses
6 WAXI-funded and 30 additional Masters, PhD and Postdoctoral projects, half of them African, has created a new pool of qualified researchers applied to mineral exploration in West Africa.
Upcoming WAXI special issues (2015)

Monograph of West African Ore Deposits
Project Broker & Coordinator

Industry Sponsors

Funds, Logistical Support, Access to deposits (& Data)

Ideas, Data, Training

Research and Capacity Building Partners

Country Data and Logistical Support

Sponsors in kind (Geological Surveys)

Training and new data

Access to equipment, funds, training
Montreal Statement on Research Integrity in Cross-Boundary Research Collaborations

Preamble. Research collaborations that cross national, institutional, disciplinary and sector boundaries are important to the advancement of knowledge worldwide. Such collaborations present special challenges for the responsible conduct of research, because they may involve substantial differences in regulatory and legal systems, organizational and funding structures, research cultures, and approaches to training. It is critically important, therefore, that researchers be aware of and able to address such differences, as well as issues related to integrity that might arise in cross-boundary research collaborations. Researchers should adhere to the professional responsibilities set forth in the Singapore Statement on Research Integrity. In addition, the following responsibilities are particularly relevant to collaborating partners at the individual and institutional levels and fundamental to the integrity of collaborative research. Fostering the integrity of collaborative research is the responsibility of all individual and institutional partners.

Responsibilities of Individual and Institutional Partners in Cross-Boundary Research Collaborations

General Collaborative Responsibilities

1. **Integrity.** Collaborating partners should take collective responsibility for the trustworthiness of the overall collaborative research and individual responsibility for the trustworthiness of their own contributions.

2. **Trust.** The behavior of each collaborating partner should be worthy of the trust of all other partners and the institutions they represent.

3. **Purpose.** Collaborative research should be conducted for purposes that benefit humankind.

4. **Goals.** Collaborating partners should agree on the goals of the research and the criteria should be negotiated and agreed to by all partners.

Responsibilities in Managing the Collaboration

5. **Communication.** Collaborating partners should communicate with each other as frequently and openly as necessary to foster full, mutual understanding of the research.

6. **Agreements.** Agreements that govern collaborative research should be understood and ratified by all partners.

Responsibilities in Collaborative Relationships

12. **Roles and Responsibilities.** Collaborating partners should come to mutual understandings about their roles and responsibilities. Those understandings should be documented and change as responsibilities change.

13. **Assumptions.** Collaborating partners should discuss their assumptions related to the research, including expertise and methods, and the practices, standards and processes that could compromise the integrity of the research should be addressed openly.

14. **Conflict.** Collaborating partners should seek prompt resolution of conflicts, disagreements and misunderstandings at the individual or institutional level.

15. **Authority of Representation.** Collaborating partners should come to agreement on who has authority to speak on behalf of the collaboration.

Responsibilities for Outcomes of Research

16. **Data, Intellectual Property and Research Records.** Collaborating partners should come to agreement, at the beginning of the collaboration, on who owns what data and intellectual property and on the management of records. Final disposition of these assets should be managed in a manner that ensures compliance with laws and regulations and protects the integrity of the research.
**Theme 1** - The spatial and temporal mapping of the multiple depth-proxies that are preserved in ancient terranes

**Theme 2** - Application of new 3D and multidimensional methodologies to study integrated mineral prospectivity at the camp and craton-scales

**Theme 3** - Study of the conversion of industry-focussed scientific research into industry and government behaviour that leads to regional development.

>$10M budget over 5 years, with opportunities for companies to leverage ARC funds to support work in Africa and Australia
In about the 25th year of the reign of Ramses III (c. 1170 BCE) the laborers were so exasperated by delays in supplies they threw down their tools and walked off the job in what may have been the first sit-down strike in recorded history.