Reliable Geological and Minerals Management Systems – A Precondition for Mining Sector Development

Case Studies from Selected African Geological Surveys

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Data is Money?

- **Billions of Dollars** were spent for mineral resources and geological exploration
- **Data** is stored as paper files & different data formats
- **Data** is the key issue for:
  - mining investment attraction
  - national development
  - land use and infrastructure planning
  - environmental protection
  - geo-hazard prevention
  - forestry, water management

Data is money!
Investor’s Expectations Regarding Data

Minerals ?
Geological framework ?
Political framework ?
Decision making processes, licensing procedures ?
Taxation?
Infrastructure ?
Working forces ?
Opportunities / prospects ?

- What data is available ?
- How to get it ?
- How much does it cost ?
- How long does it take ?
- What format is it ?

Data availability is the key factor
How to Make Data Available?

• Have data „on stock“
• Centralise data management
• Standardize data structures and coding
• Have instruments for data distribution
• Regulations for data release/ usage
• Guarantee data security
• Prevent loss of data

Information management systems (IMS) are the key instrument to make data available
**Case Study Locations**

**Ghana:**
2005 – 2007
EU funded

**Namibia:**
2001 – 2017
National MDF funded

**Uganda:**
2007 – 2012
WB funded

**Tanzania:**
2013 – 2016
WB funded
Case History 1: IMS Ghana - Facts

• Task:
  • Interconnect five Mining Sector institutions
  • Implement central database and GIS: deposits, mining reports, mining cadastre, geophysical, geochemical data, reports, documents, maps,...
  • Provide training and support

• Starting point 2005:
  • separated ACCESS databases and ArcView 3.2 applications

• Situation in 2012:
  • IMS is running at GSD and MC
  • Maintenance of hard and software required

(the level of the system is 2006)
Case History 1: IMS Ghana – Benefits & Lessons

- **Mining sector data centralised**
  - all mineral licenses
  - 900 mineral occurrences
  - 4200 documents (incl. bulletins, reports,...)
  - 1000 samples
  - Airborne geophysical data
  - All 126 geological maps

- **User friendly interfaces implemented**

- **Bad infrastructure damages the system**
  - power shortages, climate (hot, humid)
  - no reliable Internet (in 2006-2009)
  - low quality communication masts

- **Very high expectations**
  - interconnect all branches... to a centralised system...
  - create a unified system for five institutions:
    - geo-scientific data, mining data, cadastral data, mineral trade data
Case History 2: Earth Data Namibia – Facts

• **Starting point in 2000:**
  • separated ACCESS and GIS applications (ArcView 3.2)

• **2003:**
  • centralised system implemented (ORACLE, ArcView 3.3)

• **2012:**
  • Database and GIS upgraded (SQL 2010, ArcMap 10.0)
  • System is maintained continuously
  • Interactive web site implemented
  • Data capture is ongoing

• **2016-2017:**
  • Field data capture module implemented
Case History 2: Earth Data Namibia – Benefits & Lessons

• Geological sector data centralised, cadastral data taken from the mining cadastre

• User friendly database & GIS

• Stakeholder involvement from the beginning → broad support

• Continuous maintenance very helpful
  • Infrastructure: server & workstations
  • system software, application software
  • ongoing data capture

• Problems
  • qualified IT staff
  • personnel for data capture
Case History 3: DGSM Uganda - Facts

- **Starting point:** no database, paper files, AUTOCAD data

- **Task:**
  - create local IT infrastructure
  - create the documents IMS
  - implement the GIS
  - implement the Mining Cadastre

- **Final situation in 2012:**
  - Archive upgraded
  - IT infrastructure upgraded
  - Several databases and GIS created
  - Hardware, infrastructure, training provided
Case History 3: IMS Uganda – Benefits and Lessons

• Geological archive/maps digitised completely
  Metadata of books/Journals: 24,000 (MARC Standard)
  Scanned documents: 8,700
  Geological maps data
  Geophysical data
  Cadastral data

• System centralised

• Data available: LAN, Internet

• System at a high technical level

• Problems:
  • Too long implementation time
  • Fluctuation of personnel
Case History 4: Tanzania - Background

Provision of Consulting Services for Preparation of Geoscientific Data Information Management System

- IT Infrastructure
- **GMIS Design and Implementation**
- 60 QDS Map Sheets
- Minerogenic Map
- Data Dissemination Policy
- Library and Archive
- Museum, Rock Store and Core Depot
- Investment Promotion
- Remote Sensing Unit
- Training

Beneficiary:
Ministry of Energy and Minerals
Geological Survey of Tanzania

Project Team
Case History 4: Tanzania – Previous Existing Situation

- Information on paper: reports, books, maps,…
- Stand alone databases: minerals, library metadata
- Start of Geological Map digitisation
Case History 4: Tanzania – Database Interface

The GMIS - Portal to:
- 20 technical modules
- System administration
- GIS module
Data freely accessible for the public:

- All metadata (library, archive, spatial data)
- Low resolution data, i.e. maps and data 1:1M (deposits/occurrences, geology, geophysics)

Data accessible for the public for a fee:

- High resolution data (geology, geophysics)

Confidential data:

- Ongoing private projects
Case History 4: Tanzania – Public Web Site

- Developed with open source (no license costs)
- Hosted by Beak
- Including topographic background information, e.g.
  - Topographic map 1:1 M
  - Open source background images (Google Earth, OpenStreetMap…)
  - Vector data from Ministry of Lands
- Low-resolution thematic data:
  - Geology
  - Geophysics
  - Minerals

www.gmis-tanzania.com
Case History 4: Tanzania – Web GIS & Database

The Geological Survey of Tanzania (GST) is the government agency responsible for the acquisition and storage of geoscientific data and information used in the mineral resources sector and other sectors of the economy. GST is active in promoting mineral exploration and mining in Tanzania. GST core activities range from geological mapping, mineral exploration, evaluation, and processing, and research work on geological processes and mineral systems and geohazards. GST’s vision is to evolve as a centre of excellence providing national geoscientific data and information for use in the evaluation and sustainable utilization of natural resources. GST maintains a balance between its primary responsibility for geological mapping and data management, data collection, conceptual research and development, and services to both public and private sectors.
Case History 4: Tanzania – Web Store

www.gst-datashop.com
Case History 4: Tanzania – Publication & Advertisement

Explanation Booklet
Minerogenic Map

Brochures & Flyers
Summary: Main IMS Components

IT Infrastructure: hardware, network, system software

Data content

Database and GIS engines

User interfaces

Frame conditions: communication, electricity, security, climate, .....
**Recommendations:** IT Infrastructure - Hardware & Network

- **Hardware & network**
  - Server with n TB, work stations, backup system
  - Printers, plotters, scanner

![Diagram of IT infrastructure]

- Access to the public web portal
- Internet
- Full access via VPN or terminal server
- Remote (internal) user 1
- Remote (internal) user 2
- Remote (internal) user n
Recommendations: GIS / Database Software / Engines

- **System software**
  - No real alternative to Microsoft Windows Server
  - LINUX as an option ...

- **Database and GIS software engine**
  - MS SQL Server (or ORACLE)
  - Esri ArcGIS Server
  - PostGre SQL, PostGIS, ...
  - Other options ...

- **Application software – always customised solutions**
  - Windows-based database and GIS interfaces
  - Web-based database and GIS interfaces
Recommendations: GIS / Database Software / Engines

- **Commercial software**
  - Service & support always available
  - Broad range of experts
  - Provides much functionality ready to use
  - Lower dependency from individual experts
  - Expensive

- **Free software products**
  - Service & support not always available
  - Limited amount of experts
  - Provide less ready to use functionality
  - High dependency from individual experts
  - Free or very cheap
Recommendations: Data Content

- **Structured data**
  - Licenses and related data
  - Mineral deposits & occurrences data
  - Mine data
  - Production data
  - Exploration data
  - Bore hole data
  - Geochemical data
  - Geophysical data
  - Hydrogeological data
  - Environmental data
  - Company data

- **Non-structured data**
  - Documents/ reports
  - Scanned maps
  - Images

- **Spatial background data**
  - Topographic maps
  - Images
  - Elevation model
Recommendations: Staff / Personnel

• Most important component of the system

• Make them owners of the system

• Required are trained:
  • IT system administrator
  • Database administrator
  • GIS administrator
  • Geo-scientists
  • GIS experts, cartographers
Challenges

- Environmental conditions
- IT infrastructure (internal & external)
- Missing / incorrect & incomplete data
- Data harmonization
- Costs
- Human resources
- Lack of support from above
- Working process integration
IMS implementation is a **strategic issue**

**Small but reliable system** is better than a big system with bad data, software bugs, slow infrastructure ...

**Expectations and funds** must be adjusted to each other

**System life time** is short: 5 – 8 years

Correct & standardised data is a must: users expect **correct data**

**Stakeholder involvement** from the beginning will support the system acceptance

**Human resources** require much attention
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