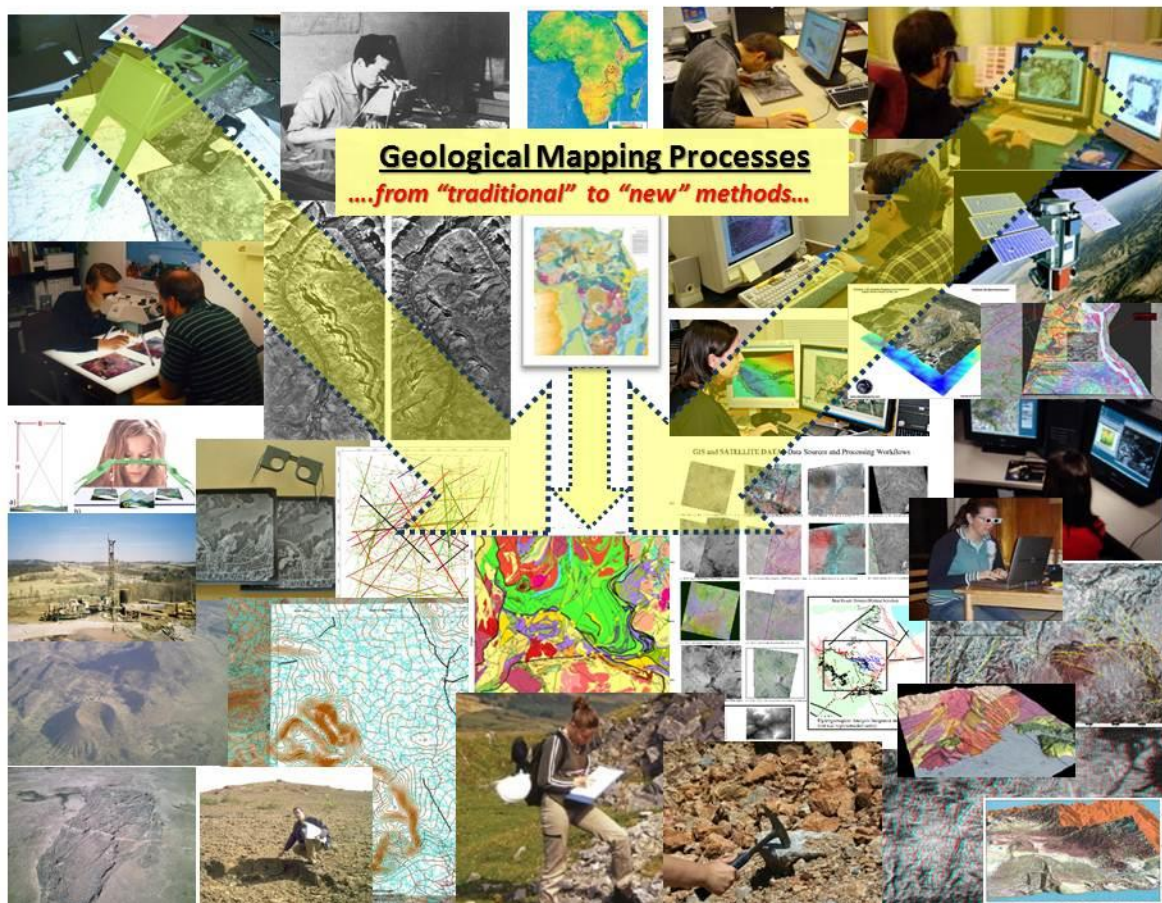


The African Minerals Geoscience Initiative (AMGI)

The “Billion Dollar Map” Technical Report



July 2014

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Executive Summary

The **African Minerals Geoscience Initiative (AMGI)** is a pan-African initiative under the leadership of the **Africa Union Commission** for the collection, consolidation, interpretation and effective dissemination of national and regional geodata through a geo-portal, thereby increasing accurate and updated geo-scientific data available in public domain. This would be done with the ultimate goal of seeking to facilitate broad-based governance changes in the mineral and other downstream and side-stream sectors, including: (i) improved licensing processes and procedures that efficiently leverage the natural resource wealth of countries; (ii) improved spatial planning, infrastructure development, forest and wildlife conservation through the use of regional resource corridors; and (iii) sustainable development policies for natural resources management.

AMGI corresponds to one of 9 clusters (Geological and Mining Information Systems) of the **African Mining Vision (AMV)** Action Plan. The African Mining Vision (AMV) was developed by Africa's Ministers responsible for Mineral Resources at their conference in Addis Ababa in October 2008, with the ultimate objective that Africa's mineral resources must be used to meet the Millennium Development Goals (MDGs), eradicate poverty, and achieve rapid and broad-based socio-economic development. The African Union Heads of State and government, at their assembly in Addis in February 2009, welcomed the AMV and requested the "AU Ministers in charge of Mineral Resources Development to develop a concrete action plan for its realization". The AMV Action Plan therefore responds to this directive. It comprises several program clusters of activities constructed around the key pillars of the vision.

The World Bank seeks to assist the AMV to build upon, interact and partner with existing regional and international initiatives aimed at improving Geological mapping and Mineral Inventory in Africa for the ultimate benefit of Africa Member States. This Report is aimed to further leverage the stakeholder interest generated during the Bank's Pre-ADF VIII event, titled "*Geological Mapping and Mineral Inventory in Africa*" (Addis Ababa, October 22, 2012).

A primary function of a national geological survey organisation is to collect, maintain and disseminate public geodata in the interests of the state's economic development and quality of life. While large sums have been spent on programmes to map and acquire new public geodata, in many examples these data are not easily found or delivered to end users, thereby inhibiting investment, planning and other forms of decision making.

A primary objective of AMGI is to strengthen national geological survey organisations and other purveyors of geoscience information (academia, research institutions) in order to better allow them to fulfil their functions. Data owners will receive support in digitizing and hosting their data, and in disseminating their geodata through a central portal using OGC standards, equipped with a central data catalogue to help dissemination. The AMGI is not just a *portal* but a "complete mapping process" assisting countries in adding value to their geodata and identifying and funding priorities for the acquisition of new datasets. The AMGI will also incorporate detailed information on environmental, social, infrastructural, and logistical considerations, ideally as a set of complementary GIS layers. All those information layers together with other socio economic datasets

can be used for regional and sector environmental assessments to plan infrastructure and to assist in national planning.

AMGI attempts, in a first phase, to identify, recover, host and disseminate such geodata. It recognises that the data are disparate and distributed, in a wide variety of formats, and not edge matched or consistently geo-referenced and not in the right geographic data format. The AMGI is proposed as a significant practical application of existing, proven technology to deliver tangible, measurable results, and thereafter to be self-sustaining. It differs from other initiatives in that it will carry out conditioning and re-interpreting of the geodata to make them compatible with geospatial systems (GIS), ready for analysis, searchable and available, ultimately leading to a selection of priorities to re-mapping certain areas of Africa featuring key geological formations.

This Report builds on previous work, comments and meetings on different approaches identifying the need to improve and disseminate public geodata by proposing a two workflow process for geodata enhancement within a technical system, a management structure and a financial plan that allows the AMGI to move forward quickly and with a consistent view of the user needs. The Report addresses the complex areas of copyright and intellectual property. It assumes symbiotic relationships with other organisations and initiatives and allows for interfaces with organisations who will add value to public geodata as well as to the skills needed for enhancing it. An innovative aspect of this will be to create better conditions for exploration investment based on outlined target areas using relevant geodata and associated processing steps as well as to provide a trading floor for data markets, commonplace in the oil and gas sector but rare in other extractives.

The Report recognises the sensitivities around data ownership and custodianship, in particular that GSOs may be reluctant to release public geodata without assurances of data ownership, control of reciprocity of financial benefit, and solutions are proposed. However, geodata improvement processes may strongly contribute to ease such perception since the original geodata will be enhanced in terms of features, detail and format compatibility overcoming sensitivities and building an important level of trust as the GSO's will eventually "own" the processes and workflows through consistent capacity building and sustained skill development.

Technologies will change during the service life time of the project, but the AMGI is not a technology-led initiative. For sound technical reasons, it is proposed that the AMGI will compile, collate, process, store and disseminate geodata from a technical facility to be located in the African continent with a back-up in a cloud system. The geodata will be gathered and improved along two parallel "Tracks" or work-flows:

- Track-1, focusses to Fast Delivery (FD) of geo-data; gathering all available mapping datasets in a repository, performing basic processing and served through a web-mapping interface whereas,
- Track-2, is concerned with Value-Added (VA) geo-data and entails a rather more complex workflow ranging from geo-data schema definition, use of pre-processed satellite imagery and performing 3D geological re-interpretation by adding value through a well-defined process.

In order to test the complex workflows and inter-actions between both Tracks, highlight technical issues and geodata limitations, a "Pilot Study" will be undertaken.

Total funding for the first 3 years of operation is estimated at US\$ 380 million.

Activities	Budget / Finance	Timeframe
MDTF -----→ 280 Million \$US		
Track-1 (FD) - <i>Fast Delivery</i> Pilot Study Repatriation of geodata hosted in Donor countries (FD) - <i>Fast Delivery</i>	60 M \$US 20 M \$US 200 M \$US	3 years
World Bank Regional Integration Loan ---→ 100 Million \$US		
Track-2 (VA) – <i>Value Added</i>	100 M \$US <u>Loan</u> (Regional Integration) 5 countries	3 years

A multi-donor trust fund (MDTF) is envisaged as the most effective solution for financing Track -1 and the Pilot Study. Track-2 is proposed to be financed through a World Bank Regional Integration Project including five African countries, initially from Southern and Eastern Africa. The work program could then later be extended to other parts of the Continent. Country programs under Track-2 will involve a lot of capacity building and will be mostly executed by country Geological Survey Organizations, research centres and academia. With a key requirement to ensure long term financial sustainability, the AMGI will generate an income stream to cover its operating costs.

The Report assumes that the AMGI will be managed through a Secretariat hosted by the **African Minerals Development Centre (AMDC)** reporting to a multi-stakeholder Board chaired by the **Africa Union Commission (AUC)**. A number of governance structures will be created such as:

- a *Management Board* primarily responsible for the strategic guidance of the project; the board would be chaired by the AUC and comprise members from a range of stakeholders representing, for example, i) participating countries ii) geological survey organisations, academia and research centres, iii) donor countries, and iv) end users such as extractive companies;
- a *Technical Advisory Committee* reporting to the Management Board and responsible for overseeing the technical quality of the project thus ensuring data consistency and compatibility of the many and varied workflows involved;
- a *Secretariat* that would be housed in the African Minerals Development Center (AMDC), a center of excellence being established under the African Union, created to steer the implementation of the African Mining Vision (AMV). It will provide project management and technical support during implementation including in-country liaison with data-providers and allocation of operating funds; subsequently to support and coordinate on behalf of the Management Board and Technical Advisory Committee;
- a *Multi-Donor Trust Fund (MDTF)* hosted by the World Bank which would be created for the purpose of pooling together resources and financing for AMGI. The MDTF would manage the allocation of funds and the issuance of contracts for the creation and maintenance of the facility, servers, geo-portal, support AMGI’s organizational structure, as well as the implementation of country-specific programs, within the broad procedures set by the World Bank and in consultation with the AMGI Management Board and the Secretariat. The logistic

arrangements related to the implementation of specific projects could be subcontracted to specialized institutions.

All activities will have a considerable amount of technical capacity building and knowledge transfer to the participating African countries, creating a conduit between AMGI and their national Geological Survey Organizations, academia and research centres.

The project has been called “**The Billion Dollar Map**” to convey the sense that the wider benefits to Africa potentially derived from stakeholders having better access to better data should be measured in the billions. The benefits include, but are not limited to, inward investments, economic growth, better EI negotiation stand point, enhanced asset valuation, sustainable planning, especially through trans-national development corridors, environmental protection and avoidance of asymmetrical negotiating advantages. For this purpose, AMGI will incorporate detailed information on environmental, social, infrastructural, and logistical considerations, ideally as a set of complementary GIS layers. The basic assumption is that by providing such data development by extension transformation of the economies can be facilitated and promoted.

Regarding the economics of AMGI public information provider, the value is not the information (geodata costs by themselves) but the investments AMGI is likely to generate with suitable geological maps. AMGI’s Benefit/Cost ratio, measured as the amount of investment that the initiative expects to generate from dissemination of geological datasets is estimated at 10 to 15 times the initial investment.

Introduction

Case for the “Billion Dollar Map”

The opportunity for countries to transform natural resources into economic development can be significantly enhanced if there is an understanding of the scale and endowment of such resources, in particular mineral and energy resourcesⁱ. An understanding of the geology and mineral-resource potential of a national territory is an essential pre-requisite for the sustainable development of its resources and an important factor in the economic development of the country. As known resource producing areas deplete, the search for alternative areas is strongly dependent on access to modern fit-for-purpose geoscience data and its interpretation. The availability of such data generally leads to increased interest from potential exploiters of resources and places the host country in a stronger negotiating position when allocating resource exploration and exploitation rights.

The status of Africa’s public geodata is generally in a suboptimal state. Despite some excellent and well-funded work by organizations within and beyond Africa, collections of good quality, digital, fully geo-referenced and homogenous geodata are rare and where they exist at all, tend to cover small areas only or act as demonstrators of what could be done; or are at scales and resolutions little required by commercial users. For most of Africa, the data are dispersed, disparate, of variable quality, mainly analogue, poorly maintained and inhomogeneous.

Previous studiesⁱⁱ have shown that Africa’s economic development through the extractive industries (EI) sector is inhibited by the lack of, as well as difficulties of access to, publicly available geoscience data (particularly geodata). These problems act as disincentives to investment, planning and social interaction, and raise the cost barriers for both the public and private sectors intending to develop the EI sector. Despite significant investments from aid agencies and development banks, there remain serious gaps in the availability of modern, high quality “fit-for-purpose” geodata¹, whilst what exists is often difficult to obtainⁱⁱⁱ or outdated.

Facilitating the resources and governance mechanisms for geodata collection as public good is a World Bank’s approach in relation to public geoscience institutions, geodata generation, management and dissemination. Making geodata available is one of the key steps that countries can take to obtain the maximum benefit from mining for poverty reduction and multi-sector planning. The lack of geoscience data may limit the appropriate use of existing resources for economic development because private sector firms, in an investment-intensive sector, are not adequately attracted as there is not basic suitable geodata infrastructure to adequately assess potential mineral resources. The World Bank has undergone a number of geodata mapping and geoscience acquisition projects in several African countries with diverse results but all have substantially contributed to developing the mineral sector assisting countries in their contract negotiation process by using reliable information. However, homogeneous quality data with efficient economies of scale and geodata accessibility has not been achieved at suitable scales for efficiently boosting mineral exploration investment. Geodata consistency across countries and jurisdictions in terms for compatible formats for exchange (inter-operability) and from a geological interpretation perspective also constitutes a key success factor considered by the project outcome.

¹ See <http://www.eisourcebook.org/africa-mapping/>

The mandate of a national geological survey organization is to collect, maintain and disseminate public geodata in the interests of the state's economic development and quality of life. Different countries consider the transfer point from public to private investment differently but this divide should always bear the concept of geodata effectiveness and usefulness driving the demand side. Such a high geodata demand is not marked by geological survey's role alone but is driven by investors willing to transform basic geodata into a more elaborated and detailed product to be used for mineral prospectivity analysis in order to discover and exploit any mineral asset bringing economic development to countries. The geological surveys need to ensure a minimum data quality however, and the higher the geodata quality, the more attractive a country will become. This direct correlation has been fully demonstrated in many developed mining countries that have further invested in enhanced geo-science information. Studies carried out in several countries show that for each dollar spent in exploration (mapping is 80% of exploration work), 7 to 10 dollars can be generated in investments in mining exploitation alone. This return does not take into consideration other benefits such as better soil survey, geotechnical maps for planning infrastructures and supporting agricultural practices, as well as the identification of hydrogeological or groundwater resources^{iv}.

Building on recent initiatives put forward by the World Bank and others, there is now a considerable momentum behind the concept of improving the quality, re-interpreting features, making available, and providing better access to, existing public geodata for Africa, and to making sure that future programmes of geodata production also create sustainable maintenance and access beyond the end of the programme itself. The so-called "Billion Dollar Map"² is not intended to compete with the current functions of Africa's geological survey organisations (GSOs) nor with projects such as One Geology and AEGOS, which have different purposes³. Rather, the mission of the Billion Dollar Map project is to enable those who wish to access Africa's geodata to do so efficiently, effectively and sustainably using technologies that help to lower the investment barriers and in so doing, allow the GSOs, academia and research centres to fulfil their roles more effectively.

Purpose of the AMGI

The need for new initiatives to enhance mineral geo-sciences in Africa is recognized in the Africa Mining Vision (AMV) and forms one of the nine clusters of the Action Plan for implementing it. AMV is an Africa-grown approach to the sustainable development of mining in the region, developed by member states under the auspices of the Africa Union. The principal purpose of the African Mining Geoscience Initiative (AMGI) is to deliver cost-effective access, processing and dissemination of high quality African geodata, relevant to stakeholders and end users, for the purpose of benefitting the national and local economies, environment and quality of life of African countries. The motivation for AMGI is to employ new institutional arrangements to generate, manage and give public access to

² The term "Billion Dollar Map" was coined to illustrate the potential value to the economies of Africa over a period of time from investments positively influenced by the availability of high quality geodata – it should not be taken that the geodata themselves (the "Map" or geo-database) will cost, or be valued at, a billion Dollars. Many observers think that the economic gains for Africa will vastly exceed one billion Dollars.

³ In the case of AEGOS the attempt is to produce a seamless integration of all geodata in Africa using a common and agreed upon geodata language so that there is interoperability between datasets. In contrast, One Geology attempts to serve small scale national data (million-scale coverage) that gives a very broad overview of the geology but not of other data sets such as geochemistry and geophysics.

geodata at a regional level. Innovative governance, data sharing agreements and institutional arrangements will be developed. They have been made possible due to: a) the existence of proven technologies that were not available a decade ago; and b) the development of stronger alignment among stakeholders on the need for and potential value of such a solution, including importantly, a more favorable political economy. At this point, it is necessary to refer to positive developments in the governance environment for managing mineral resources which has given confidence that the political economy today is more supportive than in the past.

It is very important that this message is clearly understood because of the risk that the Initiative could otherwise be misinterpreted as some sort of take-over of African data by, and for the benefit of, investors; or an attempt at political centralisation. Many geological survey organisations (GSOs) are highly sensitive to retain and control the release of geodata, and some are dependent on a revenue stream from their sale. Others who hold African geodata, such as European GSOs and related organisations, feel proprietorship over those data for historical reasons. The AMGI is designed not to confront these positions but to provide in one hand, added-value for “new data” and on the other, the GSO may directly benefit from more streamlined dissemination processes. In this context, mineral exploration investors can be attracted, thus creating sustainable wealth whenever new resources are identified and exploited.

However, in developing the AMGI, it may be necessary to persuade at the highest political level that a tendency of a GSO to retain its geodata is not necessarily in the national interest if it risks inhibiting stakeholders and other end users, such as those involved in planning, and, importantly, investment. There will in some countries be a case to be made for the open and transparent release of geodata as an adjunct, and not a challenge, to national planning and socio-economic self-interest.

An organised system where geodata can be hosted may also act as a “catalyser”, at concessions level, for structuring the generation and subsequent storage of detailed geological information which otherwise, could be lost or not handed over by private firms to respective governments and/or jurisdictions. This element of facilitation also links with a number of well-known information transparency initiatives supported by the World Bank Group and African Member Countries in recent times.

The situation in the Oil & Gas (O&G) sector with respect to geodata is different and eventually the AMGI will tend to get inspiration from data sharing agreements and geological datasets already in use by Governments and Oil & Gas operators in their complex exploration work. The marked difference between the oil and gas (O&G) and mining sub-sectors may be explained, in part, by the service offerings of national geological surveys. Historically, these focused on mining, originating in the days before oil was a significant global commodity. The model left behind in Africa by the BGS, BRGM and others is of geological surveys that focused on regional scale geological mapping aimed at mineral reconnaissance. Most African geological surveys are little changed today from that original model, and are ill adapted to the needs of oil and gas development, which often is left to the companies themselves, and sometimes have responsibility of a different government ministry.

It is important to note that the O&G exploration is often offshore, for which there is rarely much publicly available data. Thus O&G companies, or those providing subsurface information management and servicing them, have developed proprietary exploration capacity and capabilities

that they can re-use onshore, with less dependence on publicly available data. In parallel, there is a developed business sector that acquires and sells specialist and high-value, confidential geodata commercially (“spec-data”) into the O&G market with little coordination with publicly available geodata.

On the other hand, the mining sector is generally more fragmented than the O&G sector, involving a greater dependence on a “food chain” of junior exploration companies (with limited staff in operations) trading their concessions upwards to larger exploration companies that in turn sell to junior and later to major mining houses. The exploration baseline therefore depends more heavily on the availability of public geodata – which can be seen as the base layer of the mining food chain, without which the larger players would not easily exist.

Ownership and custodianship of African geodata

One of the most difficult issues is the legal and ownership rights to the data. This is a highly complex area, notwithstanding various laws of copyright and intellectual property rights. But it is fundamental that these matters are explored and addressed in the setting up and operation of the AMGI.

At this stage, there is a risk that the owners of the geodata will not agree to allow data replication or copies to be used in the AMGI for financial and other reasons. In the case of African geological surveys and their parent ministries, many of them derive a small but important part of their revenue from the sale, officially or otherwise, of maps and reports. The potential loss of this income may be a disincentive to cooperation even though the benefits of participation in the AMGI, in terms of macro-economic development, far exceed the relatively trivial incomes from map sales. This risk will be mitigated both by explaining the relative benefits at Ministerial level, thereby securing top cover for the initiative, and by returning a part of the AMGI’s sales revenue to the geological survey that has supplied the raw geodata. Moreover, another decisive incentivizing factor will be the provision “on return” of re-interpreted and adequately structured geodata that the AMGI will also develop. This re-interpreted and enhanced geodata will be shared with CSOs bringing upfront stronger skills and capacity building.

In a general sense, the entity that sponsored the creation of the data will own its rights, but this simplistic approach has many complex caveats, including:

- Many copyright laws exercise protection for defined periods that range from 25 to over 70 years from first publication.
- In a situation increasingly commonplace with digital data, where significant value is added or the original data are altered through a re-interpretation process, the rights to the changed product may pass to a new owner, but this is an extremely grey area in law. Often geodata is modified and will obviously be enhanced; therefore ownership will be shared by the original country as well as the AMGI. When dealing with geospatial data or geodata which is in a digital format and the data can be exchanged all the rights become access rights to use or query a geo-database. This fact is clearly different from a traditional paper map which is subjected to printing and physical reproduction rights. It is particularly pertinent as it challenges the amount of value-add and hence the conditions for transfer rights.

- In most recent cases where new geodata are created as part of a donor-funded programme, in particular those funded by the World Bank, Africa Development Bank, Islamic Development Bank, European Union SYSMIN and similar organisations, the ownership of those data belongs to the beneficiary Government. There are exceptions in the case of, mainly, pre-1990s bilateral aid programmes where the rights may be retained by the donating governments.
- In some limited cases, ownership and other rights relating to geodata may have been traded as commodities increasing, proportionally, the actual value of the asset and placing it in a good situation for optioning. This is common in the oil and gas sector but less so in the mining area, with the important and complex situation pertaining to exploration and production company data submitted to GSOs or mines departments as part of the licence conditions.

It is important to clarify that the AMGI will not seek to alter any ownership rights or protections of geodata, but will operate on the basis of “entitlements” agreed with the data owner and will consider those output products resulting from geodata enhancements with a particular perspective within the AMGI. In other words, **data will be owned by the respective governments and the AMGI will be the custodian and distributor but will not become the owner of original geodata**⁴. The AMGI will add value to the data by re-interpreting and rendering it fully usable by GIS systems which is the accepted way to store and analyse basic geodata with computer science technology.

Not a technology solution

There may be a view that an ambitious and far-reaching initiative such as this will require from the beginning the development and utilisation of new and complicated technologies. However, a purely technology-led project risks adding considerably to the costs of the project and delaying its fulfilment. The initial purpose is to recover, make improvements, produce data re-interpretation, store and disseminate as much public geodata as quickly and smoothly as possible in the interests of economic development. Thus, the AMGI will start by using and adapting as far as possible existing proven technologies and initiatives and be commercially operated to a high and reliable standard. The AMGI is not intending to lag behind and develop a project with outdated and/or low level geospatial technology, but to keep pace of reasonable accepted practices and internationally recognised geodata standards. In this way GSOs will benefit from technical capacity building, improved education skills and up to date mapping methods. More importantly, the geodata will have homogeneity and future continuity avoiding obsolescence and back dated practices. Geodata is a valuable asset that needs to be kept “data alive” using proper systems, for the current and future benefit of African countries.

AMGI’s goals will be achieved not only through a compilation of existing geological maps and other relevant information but also through a geo-database design for those areas where large-scale geological map coverage is a pre-requisite for development and mineral investment. This will require the development of a sound geological geo-database which in most cases will involve the re-interpretation of existing geological maps producing geodata fully compliant with international standards. This will be undertaken by either using or generating a common foundation layer and/or topographic geo-database (1:50k to 1:100k) upon which vector data having geographical, geodetical, internal data homogeneity (compatible with GIS) could be built. Thus, ensuring geodata

⁴ This will be a key differentiator between the AMGI and various data release and added value companies that may, with the owners’ permission and appropriate commercial arrangements, extract geodata from the AMGI for value add processing (see figure 2).

interoperability through easing exchange mechanisms among different systems will be a major step forward for Africa.

Certain improvements will need to be made to the data before they can be loaded into the AMGI, in particular, metadata capturing and geo-referencing to a consistent geographic baseline compatible with emerging initiatives such as the US-NGA chaired MGCP (*Multinational Geospatial Co-Production Program*). The MGCP is aimed at a homogeneous topographic base-map (TLM *topographic line maps*) using satellite data, to which the U.N. is fully collaborating in a co-production and bi-lateral geodata exchange mode. However, it is an unrealistic goal to attempt to produce seamless, edge matched, 1:50k or 1:100k geological maps for the whole of Africa in less than a decade, bearing in mind that a geological map is, at least 3 times more complex, than any topographical line map of the same scale using GIS-collected datasets. However, concentrating scattered mapping efforts in a common set of homogeneous procedures will surely create important synergies and large economies of scale -driven by extractive industries demand- towards achieving a shorter and more reasonable completion horizon.

This report is organized around five core tasks defined in the Terms of Reference featured in annex and the development of those Tasks have configured the structure of the Report:

- TASK 1: Developing a phased work-plan for project implementation.
- TASK 2: Determining the initial technical and business terms required to be incorporated in a Charter of Rights and Obligations of stakeholders.
- TASK 3: Identifying the role of the proposed 'Secretariat', 'Technical Advisory Committee' and other institutions in creating the Billion Dollar Map.
- TASK 4: Identifying the technical and legal issues involved in establishing a 'Cloud Server' for storage and dissemination of the geo-data.
- TASK 5: Initial evaluation of the financial sustainability of the proposed arrangements

TASK 1: Developing a phased work-plan for project implementation

Context

An important primary step in the development of the AMGI is the design of a work-plan to list and define the incremental phases for project implementation. Such a plan needs to address the major problems identified to date with respect to public geodata of Africa and listed below:

- **Inability to deliver**: a recent industry survey¹ revealed widespread dissatisfaction with the process of obtaining geodata from most national geological survey organisations (GSO) reflecting underfunding, inadequate facilities and poorly trained staff that often lack motivation, resulting in a weak institutional base.
- **Applicability of geodata**: much of the data are unreliable, inaccurate and poorly archived; often not in a digital format (GIS raster and/or vector) and characteristically not at a scale or level of detail that is required for performing exploration work (50k to 100k scale) by the industry.
- **The type of data** that is or can be made available over the internet is not appropriate being mainly national small scale geological maps rather than raw, but processed, airborne geophysical and geochemical data in a compatible format. Data is not GIS-ready to use with a geodatabase. Consequently, rendering the data useful for direct use by industry would imply an important additional upfront cost.
- **Ownership issues**: the majority of data are archived either with the national GSO or externally with other surveys or contractors, which raises issues of copyright that need to be overcome prior to distribution. Looking forward, it would be appropriate to also pass minerals legislation that gives ownership of all raw data produced by mining companies to the government. There should also be more detail with respect to clauses regarding confidentiality of data from specific periods of time, ensuring that periods of confidentiality are aligned with exploration rights.
- **Resistance to distribution**: many of the African GSOs resist the release of geoscience data on a national or regional basis as they see that process as undermining their position and status. Making data freely available through the internet is viewed by some as against national interests.

Work Plan

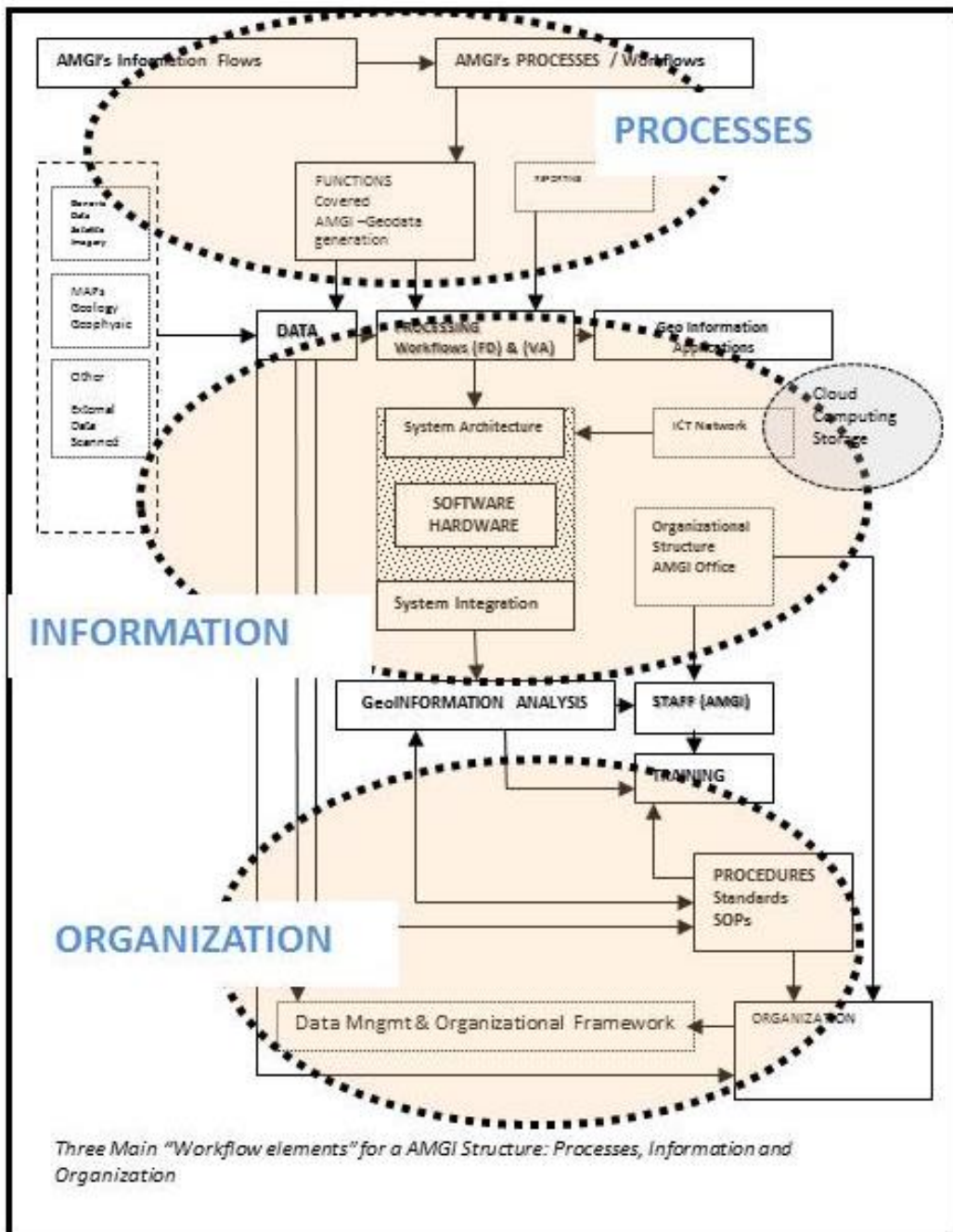
In view of the long gestation period in creating the final product, a structured work plan is required to establish and prioritise the main steps involved. This will necessarily involve both the over-arching organisational structure as well as the more technical aspect of the projects. However, the plan must also take in account that it is the stated intention that the AMGI will be a sustainable entity under the mandate of the African Union Commission and reporting to the Conference of Ministers. Although the AMGI will benefit from donor funds income and support during its first years of operation, it must be self-sustaining in the medium-term, including generating profits to finance sustaining operations.

The work plan is defined taking into account a typical 3-tier *system approach* starting with a number of outputs and deliverables or products.

Firstly, this approach requires a number of “processes” and workflows to generate end-products. Two types of processes leading to **Track-1 FD (Fast Delivery)** and **Track-2 VA (Value Added)** are considered as main workflows for this technical report.

Secondly, these processes will require “information” systems to handle and manage them. The AMGI will need to set up a localised information system (physical facility) where the processing will take place. This facility will be located in the African Continent (selected through competitive bidding) and could eventually, at a later stage, be relocated to the Secretariat at the **African Minerals Development Centre (AMDC)** in order to continue with the remaining operational work.

Figure 1: Three Main Workflow Elements for the AMGI Structure



Thirdly, an “organisation” will need to be operating the managed information systems undertaking technical processes. The organisation will monitor and manage the processes according the AMGI

mandate to implement key activities and workflows linked to the two tracks, FD and VA or internal operational activities.

The main components of the organisational structure are as follows:

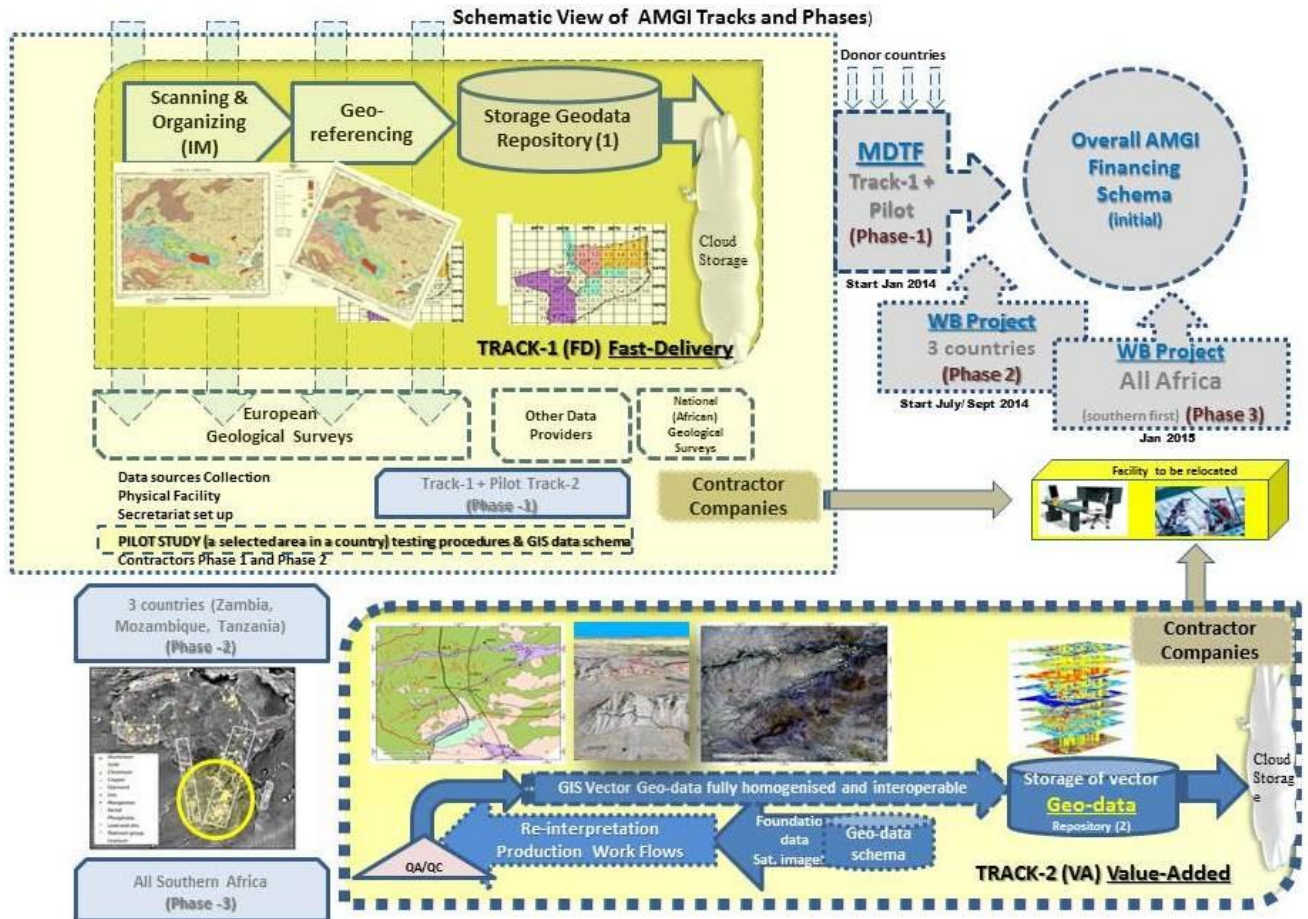
- AMGI main stakeholders consultation/review. The following steps will be undertaken:
- Establish an agreement between stakeholders for participation in the process;
- Identify detailed “*processes*” and **workflows for FD and VA tracks**:
 - Develop an implementation plan for Pilot Study;
 - Operational implementation of 1 Pilot Study (covering 3 areas);
 - Operational extension (5 countries);
 - Develop a *work deployment* plan.
- Outline and define the “*information*” systems needed to handle those processes:
 - Define site and system requirements to develop FD and VA;
 - Implement a “preliminary system” to undertake the Pilot Study;
 - Analyse and verify Pilot Study Geodata;
 - Propose a system for a “work deployment plan” (extension to 5 countries).
- Define an “*organisational*” structure to manage the resources required for operating the systems.
- Implement an *organisational mandate* focussed on the delivery of geodata following AMV’s principles.
- Create Governance structures:
 - Establish a **Management Board** primarily responsible for the strategic guidance of the project; the board would be chaired by the AUC and comprise members from a range of stakeholders representing, for example, i) participating countries, ii) geological survey organisations, academia and research centres, iii) donor countries, and iv) end users such as extractive companies;
 - Create a **Technical Advisory Committee** reporting to the Management Board, responsible for overseeing the technical quality of the project thus ensuring data consistency and compatibility of the many workflows involved;
 - Appoint a **Secretariat** to provide project management and administrative support during implementation, including in-country liaison with data-providers, preparation of work programs, and support to the Management Board and Technical Advisory Committee;
 - Select a localised physical facility for hosting the information system and an “organisation” to undertake technical processes, and define data backup arrangements;
 - Establish a **Multi-Donor Trust Fund**;
 - Create a conduit between the AMGI and participating countries through their national Geological Survey Organisations.

In terms of the technical aspects of the project, namely dealing with the geodata to be hosted in the AMGI, two interlinked but independent approaches are required (see Figure 1): **Track-1 or Fast Delivery (FD)**, and **Track-2 or Value Added (VA)**.

In order to be able to test the complex workflows and inter-actions between both tracks, highlight technical issues and geodata limitations, a “Pilot Study” will be undertaken. Part of the Study will focus on defining a preliminary geodata or GIS-type of database in an organised schema (skeleton).

This work will need to be defined and implemented in conjunction with international standards (ISO, OGC, etc...).

Figure 2: Two-tracks for the Development of AMGI



Work-plan: Track-1 (Fast Delivery) the following implementation steps needed to roll out would include:

- Identify the data-types to be included in the AMGI, prioritise the data-types to be included; create an index for scanning and archiving;
- Source the location and ownership of that geodata, including any existing licensing arrangements;
- Establish the major points of contact at an organisational level within participating countries for data access and geodata replication;
- Enter into dialogue with the data-owners to replicate the geodata and establish agreements on reprocessing and integration of the various multi-disciplinary data-sets as part of a future value-add process;
- Catalogue the sourced geodata in terms of its format, quality, collection scale, reliability and integrity; identify the mismatches and incompatibilities in the various datasets, establishing and quantifying the need for translation into English. Possibly include a preliminary ranking system to identify high value data layers;

- Identify a facility from where to start the operational or preliminary system work. This work will entail a competitive selection of an African institution and a “commercial contract” for a fixed term (tentatively 3 years) including system implementation and IT administration functions;
- Design of a suitable geodata structure for archive and secure storage of the data based on current international best practice, making use of open-source software whenever possible;
- Harmonize nomenclatures, metadata profiles, access arrangements, accuracy standards, data models, feedback mechanisms, etc.;
- Collate and validate geodata for subsequent entry into the (AMGI) system as GIS data layers; undertake first pass scanning and geo-referencing, attempt to rectify data degradation of hard copy datasets and proceed with vectorization (basic GIS compatible format) according to specifications.

AMGI has important technologies and capacity building components. An essential step is to design a work plan to provide capacity building for participating Geological Survey Organisations, academia and relevant research centres. In the case of CSOs, such required capacity will be in line with the skills needed to develop a geodatabase schema for geology and operate both Track-1 (FD) and Track-2 (VA). This will, serve to enhance the technical level of geological and mining institutions and to increase the skills of the current and future technical personnel. This point will impact, at institutional levels, the success of the AMGI initiative, in addition to the operational outputs and deliverables expected from the AMGI workflows.

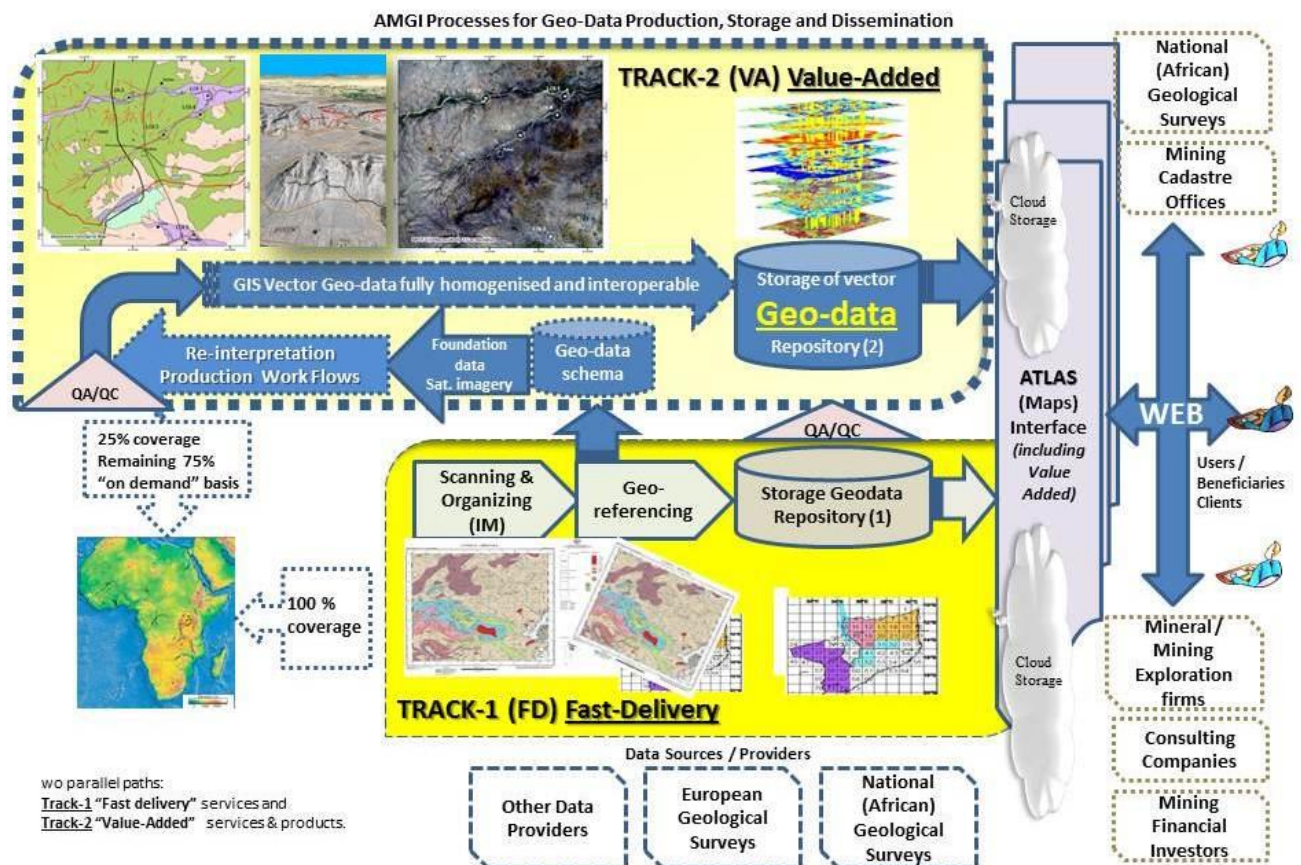
Track-1 (FD) will also be used to support the "Geo-database Schema Definition", i.e. the definition of the existing geological formations and the necessary data dictionary that will be used for creating vector geo-data schema (mapping scales ranging from 250k to 100k, and in a few instances 50k scale) within the “Pilot Study” foreseen. This geodata schema activity will constitute the framework to collect GIS features in the geological context using pre-existing maps (scanned & vectorized), in addition to high resolution satellite imagery (to be developed under Track-2). Existing geological work from SADC and other sources will be the basis for geo-database definition at 1:50k or 100k scale. The geodata schema definition to be developed under Track-1 (through a Pilot Study) will ensure full interoperability with Track-2 (VA). The schema will have to be fully scalable, covering the entire Africa Continent, starting from the priority region of southern Africa. In order to operationalize the "Geo-database Schema Definition", a pilot study will be developed as immediate outcome.

Work-plan: Track-2 (Value-Added) a complete workflow for the implementation of Track-2 (Value Added) is beyond the current scope of this Report. However, a schematic view (Figure 3) of the different steps involved is important to adequately dimension the scope and technical implications of this work. The following points presented) will add further detailed specifications as the work progresses:

- **Generation of "foundation" geo-data or image-like-map:** This will be made by using satellite ortho-imagery (at 2.5m resolution) plus other datasets (probably using stereo medium resolution multispectral). This layer ensures a seamless layer with homogeneous geometry, no relieve distortion and a common geographical/geodetical projection for the whole continent which could be re-projected on demand according to region needs.

- **Development of topographic line maps (TLMs) and its corresponding geo-database:** This will be carried out through feature extraction procedures using satellite imagery, interpretation and QA/QC following the available MGCP standard (or Vmap2) geo-database schema definition. Additionally, technical reference documentation (TRD) and vector feature extraction manual (FEM) will be used to homogenize the way imagery interpretation will be performed. Finally, a QA/QC workflow of the type similar to MGCP-type or GAIT will be used.

Figure 3: AMGI Processes for Geo-Data Production, Storage and Dissemination



- **Development of geological (geo-database) schema:** This is will be defined under Track-1, as a sub-Pilot-project (from the Pilot Study) that has to be fully OGC standard compliant, for which three potential pilot areas are being outlined already stretching across boundaries in three countries. This phase will provide the framework where all GIS layers or features, attributes, and relationships will be located, organized among themselves and stored as a homogeneous geographical database. This will also serve to test feature extraction procedures and verify cross-border feature matching and interpretation models. In addition, and due to the specialized work envisaged collaboration with those organizations that have developed or created similar data schemas for managing and storing geological maps in GIS-acceptable formats will need to be contacted.
- **Generate Geological Data through feature extraction and re-interpretation.** Under this phase the actual work to “add extra value” will be developed using several types of satellite data plus

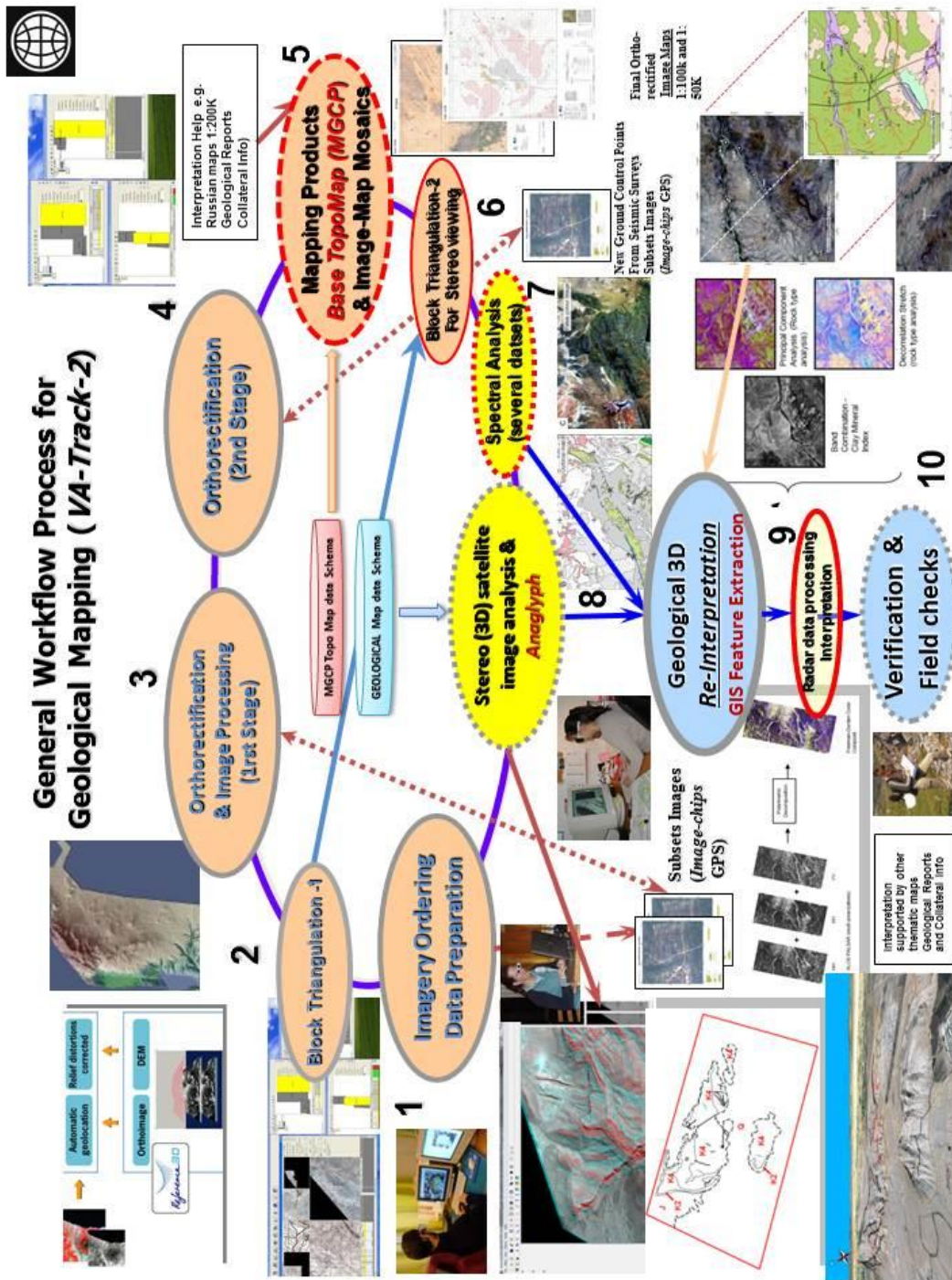
ancillary maps and geological reports. A certain amount of revision and re-interpretation from available geological maps will be required. This work is essential for reshaping lithological and interpretative boundaries within the geological formations. This task will be based on visual identification using high resolution imagery (2D and 3D-stereo) of outcropping features. Issues such as edge matching in complex adjacent map sheets will not be resolved but there will be a *record kept on the discrepancies identified* which will form part of the metadata. Key steps of the work plan would include:

- **i) Use of existing vector datasets or vectorizing** the scanned maps according to their own (or predefined) geo-data structure. These maps in raster format will be checked for geo-referencing quality. If quality is found to be not acceptable, then a new geo-referencing process will be performed using the satellite ortho-imagery (or *foundation data*) as the “master” or geographical reference. This way image-generated control points will be identified and correlated with the map. The coordinate system will be agreed to be homogeneous for the whole Africa. Whenever necessary, there will be an option to re-project into a different coordinate system at the local level.
 - **ii) Creation of pseudo-stereoscopy with ortho-imagery**, geo-reference imagery and 30 m grid resolution DEM (if not fully available, a 90m grid will be used instead). This is essential since traditional geological mapping has been carried using stereoscopy or 3D view of the terrain either using or overlaying conventional aerial stereo photography as in the 70’s or 80’s or, with modern techniques using satellite imagery products from the 90’s which are generated to be used in the computer screen; doing screen digitizing in 3D or interpretation of the data through GIS vectorization also referred as *feature extraction*.
 - **iii) Creation of multi spectral middle-resolution satellite stereo coverage** whenever available at low cost (e.g. Aster or other sensor). Proper lithological interpretation will require the use of different spectral band combinations and different types of dedicated processing algorithms from either optical or radar sensors. The amount of processing and co-interpretative products (to assist in *re-interpreting* existing maps) will be limited due to time and budget constraints. This will be specified in the “Technical Reference Manual” to be created to carry out the geological re-interpretation process workflow.
 - **iv) Re-interpretation** of 2.5m resolution satellite datasets (possibly using direct image to image triangulation of raw satellite data viewing a 3D product) through overlaying “existing geological data” of that country and extracting *vector-GIS features* by a geologist. These features will be output according to the geodatabase structure which will be defined during the Pilot Study mentioned earlier. For re-interpretation purposes any satellite sensor (from optical, multispectral, hyperspectral or radar) can be used as long as it can be considered as adding geological value to the analysis process.
- **Warehouse or Data archiving mechanism** through a Google Earth Enterprise (GEE) server, requiring data preparation/ingestion to feed all assets both in raster & vector format creating a new GEE “globe”. This “globe” is similar to the open-to-the-public-GE “globe” but, it will only contain the data created for AMGI and it will clearly be restricted to a number of accredited users.
 - **Open data dissemination through a conventional web-mapping interface**. This option is the one currently considered and it will, perhaps, be the most operational in the initial three years of project existence.

Both **Track-1** and **Track-2** must be run “in parallel”. It is anticipated that, at least in the beginning, there will be three times more generation of **Fast Delivery (Track-1)** geodata as compared to the generation of **Value Added (Track-2)** geodata. This is because the VA methodology is more complex

and needs to be rolled out involving higher technical skills that in some instances they will have to be built. Once this is done the process will be smooth and productivity will be increased. In later stages Track-2 will represent most of AMGI’s workflow. Country programs under Track-2 will involve a lot of capacity building and will be mostly executed by country Geological Survey Organizations, research centres and academia

Figure 4: General Workflow Process for Geological Mapping



Work Plan

Including Governance, Pilot Studies, track-1 and Track-2 (3 years plan)

ID	Task Name	2014		2015		2016		2017		20
		H1	H2	H1	H2	H1	H2	H1	H2	H1
1	AMGI- 3 years									
2	Review main AMGI stakeholders									
3	Establish Stakeholder's Agreement for participation									
5	Develop and Implement plan (Pilot Studies)									
6	Operational development of 3 Pilot Areas									
7	Operational extension (3 countries)									
8	Develop a work deployment plan									
10	Define site and system req. for FD & VA									
11	Implment a "preliminary System" for Pilot Study									
12	Analyze and verify Pilot Study Geodata									
13	Propose a System for a "work deployment plan" (3 countries)									
14	Define and "Organizational Structure", res mgmt & operate the syste									
15	Implement "Organizational Mandate" focussed to Geodata delivery									
17	EstablishAMGI Management board									
18	Creation of Scientific and Technical Advisory Committee									
19	Identification and Appointment of AMGI Secretariat									
20	Set up and activateof the AMGI Donor Trust Fund									
22	Establish working dialogue with participating country (GSO)									
23	Identification of main data types and formats									
24	Source ownership & Geodata location (initial participating country)									
25	Establish main PoC for data retrieval (countries signed wt. AMGI)									
26	Process of data retrived& repatriation process (from countries)									
27	Collate & validate Geodata for entry in AMGI									
28	Undertake first-pass scanning& geo-referencing of Geodata									
29	Populate AMGI for selected countries									
31	Completion of PHASE-1 (in 3 countries)									
32	Review: General Assesment in 3-years time frame									
33										
34	Re-location to AMGI and Data Migration takes place (resources transferred & Qa/QC)									

TASK 2: Determining the initial technical and business terms required to be incorporated in a Charter of Rights and Obligations of stakeholders - Funding Report

AMGI requires an agreed institutional governance structure with procedures that will ensure accountability in the management and oversight of the initiative and in the alignment of deliverables to AMV priorities. The AUC represents the highest collective political decision making body and is expected to provide leadership over the initiative on behalf of the AU. The Regional Economic Communities (RECs) represent avenues for establishing a favorable environment for cross border implementation, skills enhancement, capital mobilization and investment. In addition, they enable the sharing of capacities in a broad range of areas of the AMV, such as capacity building and technology development. Thus it is important that the framework arrangements also include sub regional plans for harmonizing policies and procedures. The institutional governance structure provides linkages between the AUC, AMDC, the RECs, the technical and financial arrangements for AMGI, as well as guidance for implementing countries at the technical working level. Further, the institutional governance clarifies relationships between them and partner organizations and donors.

The purpose of this Report is to set out a framework defining the stakeholders, their various roles and relationships in the AMGI and the technical and business conditions of operation, which can be encapsulated in the Draft **Charter of Rights and Obligations** presented in the Annex. This enables a business model to be defined and sets out the products and services to be offered through the AMGI.

Stakeholders

There are many stakeholders of the AMGI each of whom will have different requirements and contributions. This will inevitably result in internal tensions and even conflicts which must be managed carefully.

Table 1: List of Stakeholders

Group	Category	Principal function	Secondary function	Relationship to others
Africa Union Commission	Policy & regulatory	AMGI will be established under the AUC who will chair the Management Board. The AMDC will host AMGI's Secretariat	Management coordination and oversight	High level support for national interest of members
Regional union or economic cooperation zones (eg EAC, SADC, ECOWAS, etc.)	Harmonization, Regional Coordination & Implementation	Policy agreement at regional level Harmonization	Regional coordination and oversight	High level support for national interest of members
National government s/ Ministries	Policy Demand side	Policy agreement at national level Information regarding the definition of blocks for	Management representation; social and economic planning	Member of Regional economic cooperation zone

		auctioning, environmentally sensitive areas, ecosystems, waterways, nearby infrastructure, social information, and economic information.		
African National GSOs, research centres and academia	Supply side	<p>Custodianship of national geodata</p> <p>Data sharing agreements with AMGI</p> <p>Develop capacity and skills for reinterpretation of existing data and production of new data</p>	<p>Upgrading of national geodata</p> <p>Revenue receipt from AMGI</p>	Takes policy steer from and reports to Ministry
Non-African GSOs and other research centres	Supply side	<p>Facilitate repatriation of relevant data to African countries</p> <p>Data sharing agreements regarding geodata for which they are custodian (owner)</p> <p>Provide technical assistance and services</p>	Scientific cooperation with African GSOs (eg One-Geology; AEGOS, MGCP)	Informal links with African GSOs (eg OAGS, IUGS)
Commercial geodata service contractors / spec survey companies (eg airborne geophysics and seismic operators)	Supply side	Data sharing agreements with regards to commercially paid for geodata for which they are custodian (occasionally owner) – fee earning	Data release and value-added agents	Customer-contractor relationships with both Government Ministries and EI companies
Satellite image agencies / companies (eg NASA, ASTER, EU, Astrium-EADS, QB, Ikonos RapidEye...)	Supply side	Shares copies of remotely sensed data – usually fee earning	Potentially data release and value add agents	Generally taxpayer funded suppliers of public good but increasingly customer-contractor relationships with GSO & EI firms
EI Companies	Demand and Supply side	<p>Users of geodata in support of investment decisions and their de-risking and exploration / mining activities</p> <p>Produce large amounts of geodata as part of their exploration and mining activities that ultimately</p>	(limited) suppliers and traders of company owned geodata	Operate under licence conditions of national government but principal responsibility is to shareholders

		reverts to Governments		
Investors / brokers / market analysts	Demand side	Users of geodata for investment decisions, mineral property asset/valuation and fund raising / due diligence		Usually work for EI companies and capital markets
Donor agencies and development banks	Facilitators / donors; Technical Assistance	Maximise sustainable economic and social benefit of aid / donor funds	Support for regional development (corridors)	Funders to national governments
Service providers to AMGI	Operator	Build and operate the AMGI effectively		Service contractor to AMGI management
Management Board	Operator	Provides overall guidance and control in the best interests of stakeholders	Exerts influence at government levels	Responsible to stakeholders
Secretariat	Operator	Translate the policy directives and performance targets of the Management Boards into service provision	Advise and service the management Board. Liaise with other stakeholders. Effect marketing and publicity for AMGI	Reports to the Management Board
Technical Advisory Committee	Operator	Provides key technical oversight, ensures that AMGI technical development is compatible with AMGI objectives and achieves the necessary QA/QC requirements	The Committee is expected to receive advisory services from the Geological Society of Africa (GSA) network of educational institutions to support in capacity building and sustainable skill development.	EI companies representation

Mission and Vision

The high level mission^v of the AMGI is to:

- Provision of public geodata to a global audience and hence to accelerate and cost reduce the exploration process.
- De-risk investments
- Improve competitiveness and transparency
- Improve benefits to States (by avoiding asymmetrical disadvantage)
- Facilitate regional infrastructure planning and maximize economic development impacts
- Use the geodata-derived products for other economic and land-related development purposes

This will be achieved by:

- Recover, repatriate, re-condition and carry out re-interpretation of existing relevant public geodata
- Ensure data integrity and geodatabase homogeneity at a working level
- Ensure safe repository for new and existing geodata
- Enable data trading, where appropriate
- Deliver data cost effectively to owners and end-users
- Promote data release for investment attraction and value added services
- Develop new datasets according to agreed priorities

Giving a **vision statement** of:

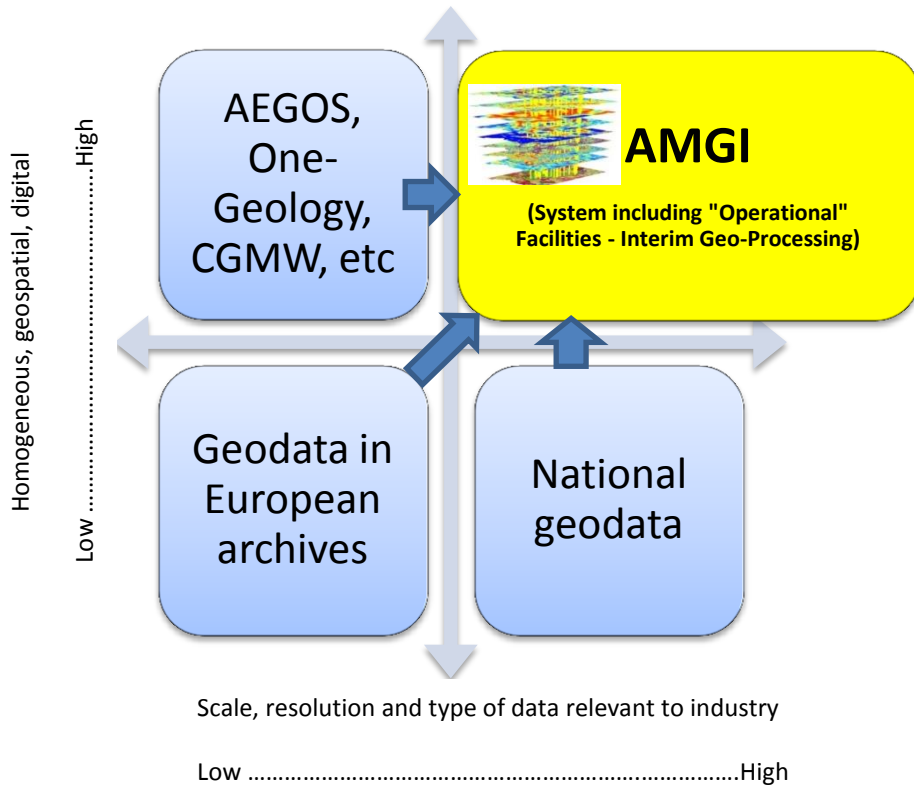
“AMGI aims to be a single, secure, complete on-line repository of digital geodata with access controlled by entitlement”. The Mission and Vision statements describe the long term aspirations of the AMGI. Task 1 of this Report details an approach to achieve this goal that reflects the practicality of setting up such a complex system and the realities of data holdings based on the experience of other projects in this sector.

Current state of the data

Africa’s public geodata are generally in a suboptimal state. Despite some excellent and well-funded work by organisations within and beyond Africa, collections of good quality, digital, fully geo-referenced and homogenous geodata are rare and where they exist at all, tend to cover small areas only or act as demonstrators of what could be done; or are at scales and resolutions little required by commercial users. For most of Africa, the data are dispersed, disparate, of variable quality, mainly analogue, poorly maintained and inhomogeneous. Nevertheless, these are the data which currently exist, and are the data with which AMGI must work. Unlike other initiatives, AMGI aims to deliver a full range of useable public geodata for the whole of Africa. This is shown schematically in figure 2, with the implied data migration routes to be followed, through time, from their current positions to the (top right) AMGI end-point.

It is not intended that the AMGI will become operational until all the data have been sourced, digitised, homogenised and quality assured. At any given time, the geodata in AMGI will be in a state of flux; there will be a continuous flow-line process of data improvement and growth, with new data arriving and existing data being upgraded or re-interpreted (pending, in some instances, field verification work). This will require sophisticated version controls, but will keep the system alive and dynamic at all times, with priorities set by the Management Board.

Figure 5: Schematic Migration Paths of Geodata Conditioning



Sourcing the geodata

Africa’s geodata currently reside in numerous locations around the World governed by a variety of conditions of ownership and copyright. There is no desire for any ownership rights to be transferred to the AMGI, however for participants there will be an acceptance through the Charter for the AMGI to act as secondary custodian and disseminator of the data and, as necessary, to catalogue, provide quality control and facilitate the improvement of the geodata.

Thus, an early stage activity will be to liaise with supply-side stakeholders on the conditions and methods for transferring copies, or occasionally originals, of the geodata to the AMGI.

There are four potential categories of suppliers of data:

African Geological Surveys

African Geological Surveys, and their parent Ministries, are the custodians of the country’s national geodata owned by governments. In practice however, few such surveys are in a position to process pre-existing digital data and a significant effort will be required, for which the AMGI must provide funding, expertise and equipment, to digitally capture and organise the geodata already held within the surveys of Africa. Thus a great benefit for an African geological survey of becoming a stakeholder in the AMGI will be that they become the recipient of modern data management facilities to bring their existing geodata to modern standards and to create a digital framework for the collection and storage of future new geodata. For practical purposes, there will be a selection and prioritisation of the types and quality of nationally held geodata, which can be decided on a case-by-case basis by mutual agreement between the implementing countries and the AMGI Secretariat.

European Public Sector Archives

Very large volumes of mainly historical Africa geodata reside in the library archives of several European geological surveys and other organisations, with the largest collections by volume in the BRGM (France), BGS(UK) and MRAC (Belgium). With over 200,000 maps from Africa in the BGS collection alone, it is a non-trivial task to identify, index, scan and subsequently database all such items, in order to make it available to African GSOs and other relevant interested stakeholders. This constitutes a big challenge even without taking into account the complex questions of ownership and copyright.

Most of the European geological surveys have, through their partnership organisation, EuroGeoSurveys, agreed in principle to allow their African archives to be copied for the purpose of repatriation, subject to the availability of suitable resources. It is unlikely that the AMGI will have the resources or the requirement to carry out a massive transfer of all these geodata; not least because much of the archives contain very old data of limited value, a lot of which has been superseded by newer and higher quality information. Nevertheless, for some parts of Africa, the data held in these European archives represents the only, or the best, coverage available and every effort should be made to repatriate these items to their relevant country, with a copy held in the AMGI.

The proposed way forwards is therefore:

- To acquire from these European organisations a detailed index of their Africa relevant geodata holdings (this may require a formal request at a senior level to the European organisations coming from the AUC or governments of the relevant African countries);
- To use expert teams to prioritise the requirements for repatriation and copies, based in part on demand side needs; these may be based on countries, regions, themes or historical importance of the data;
- To use AMGI resources as a catalyst, in cooperation with the European organisations and relevant African countries, to generate digital copies of the geodata for both African repatriation and AMGI custodianship (mainly by raster scanning the originals and ensuring the appropriate permissions are in place from the legal data owner which will normally be the relevant African country);
- In some cases, where the European organisation was the consultant (contractor) of a donor aid funded project in an African country, and where that country has not retained the original data, it should be relatively straightforward for the European organisation to duplicate and repatriate the project information.

Extractive Industry sourced geodata

Mining and exploration companies generate considerable volumes of data. These include detailed geological maps of their licence areas, high-density geochemical analyses of soil and stream sediments, core and borehole logs and area specific high-resolution airborne geophysics. Most of these data are considered to be company confidential, although a subset of the data are usually required to be lodged with the mining authorities of the host country as part of the licence maintenance condition. Procedures need to be developed to systematize and enhance the collection and use of the data contained in the legal reporting requirements mandated under the countries' mining laws. In addition, it is often the case that a mining or exploration company will not develop a licence area for a variety of reasons, including the inability to raise funds at the appropriate time,

and so many of these useful datasets can be lost. Companies have little incentive to carry the additional costs of good data management without the realistic possibility of being able to derive some revenue from the data if they are sold. However, it is likely that many such companies would be prepared to transfer otherwise redundant data to the AMGI on the basis that they will remain confidential but available for sale or release. This procedure is commonplace in the oil and gas industry but is so far rarely apparent in the mining sector. The situation now is that such data is “lost” and, even if available in paper or as part of mining concessions progress reports, is not usable for specific database storage.

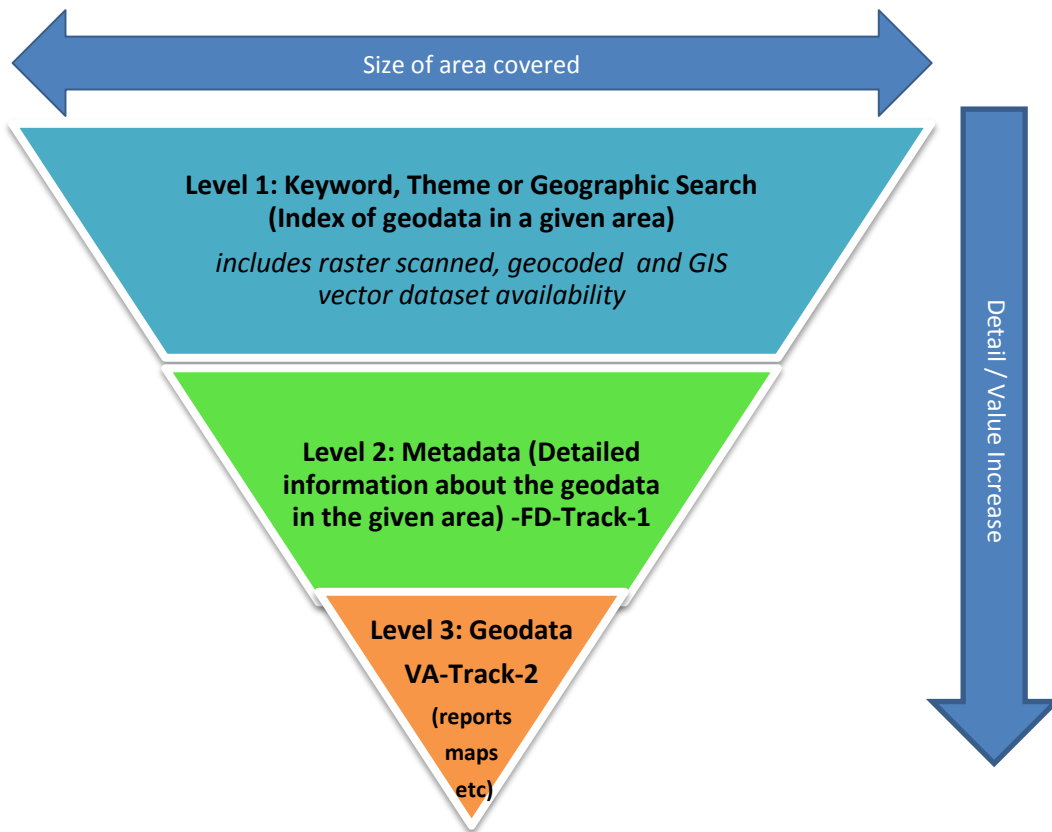
Other sources of geodata

Relevant geodata may be held in other organisations worldwide for which the same approach as described above will be adopted. These may include geological institutes and universities that have operated scientific cooperation projects in Africa, and private sector contractors in donor funded geoscience programmes. Significant amongst the latter are airborne geophysical companies which may hold copies of airborne data, and specialist commercial data suppliers which may have acquired or recovered important historical geodata. Financial compensation from AMGI may be necessary to secure these types of data.

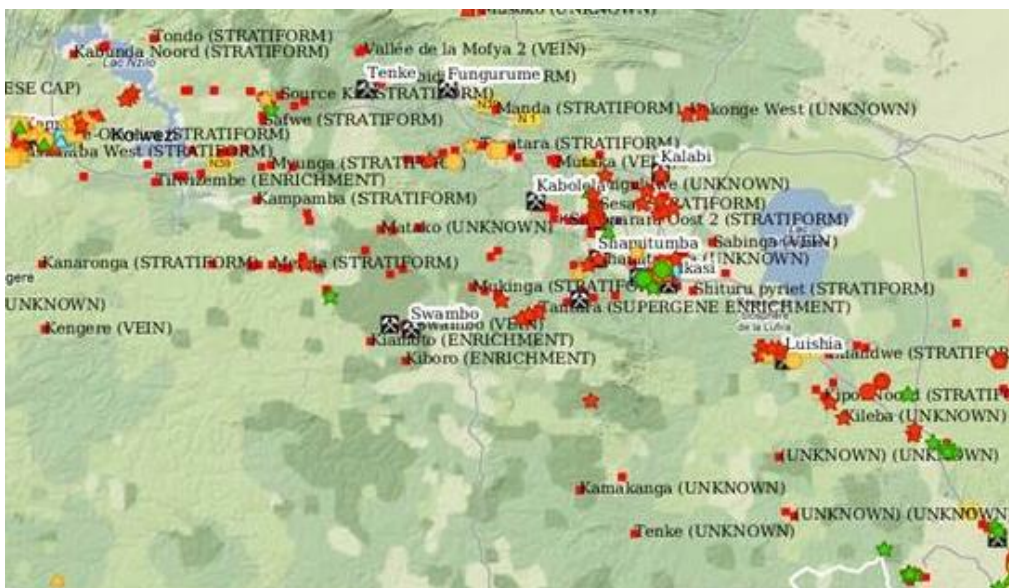
Products Offered

AMGI will be, essentially, a repository for Africa’s geodata. However, two types of geodata will be offered through the AMGI named: A) basic raw raster datasets from existing sources and post geocoding and served through the web (FA –**Fast Delivery- Track-1** and B) Re-interpreted fully GIS compatible geodata using raw sources plus an improvement process using satellite imagery (**VA- Value Added- Track-2**). Track-2 will involve a lot of capacity building and will be mostly executed by country Geological Survey Organizations, research centres and academia.

Some of the principal products offered will be copies of these geodata according to entitlement. In practical terms, the primary interface between users and the AMGI will be a web-enabled geographically searchable index to metadata, which enables access to the selected geodata, shown conceptually below:



The **Level 1** interface (portal) is essentially a publicly access, web enabled keyword, theme and clickable map (of Africa) using established and proven technologies⁵ with a look-and-feel similar to GoogleEarth™ (GEE) that indicates, using polygons and / or symbols on the map, for any chosen area, the current availability of geodata within the AMGI, for example⁶:



⁵ For example, see <http://mapapps2.bgs.ac.uk/geoindex/home.html> or <http://www.eisourcebook.org/africa-mapping/>

⁶ Taken from the AfricaMuseum.be/Geco website

The Level 1 portal will offer a selection by data type (through a check box window) and individual symbol clickability in order to take the user to **Level 2**, which will present detailed metadata for those geodata units, including: type of geodata, owner, scale, resolution, author, publication date, parameters (raster, vector GIS), usage restrictions, quality metrics, entitlements, price, version number and, in some cases, non-downloadable “thumbnail” images.

Access to **Level 2** is intended to be free of charge but will require pre-registration and login, mainly for purposes of monitoring use and marketing, but also to limit access to certain users for any sensitive metadata.

The Level 2 metadata interface will include a simple “shopping basket” and “checkout” facility. The geodata themselves (Level 3) that are purchased at checkout (through user accounts and/or credit cards), will be delivered expeditiously and depending on the geodata unit and the user’s requirements.

Hence the product delivery will be either:

- a physical copy of the geodata, dispatched by courier;
- a digital copy of the geodata, either dispatched by courier or sent on-line through a secure web delivery service
- an improved version of the vector dataset enhanced by using satellite imagery and a full process of 3D or stereoscopic interpretation as has always been traditionally done in the past with aerial photographic interpretation but, instead, adding high resolution imagery to the pipeline.

The **Level 3** AMGI interface dispatch function will be adopting a “just-in-time” approach to scanning and product preparation, according to orders received independently of the level of processing or re-interpretation.

Note that in a second stage, once the AMGI has proven effective for VA-Track -2 geodata, this datasets will also be created (re-interpreted) on demand but always ensuring at least 25% of the area coverage produced beforehand by the AMGI facility itself.

The importance of Standards is an essential factor for the whole process. It is clear that without GIS standards from which OGC (*open GIS consortium & ISO*) are key players, the AMGI cannot be certified in terms of data integrity or in terms of the quality of its internal processes (TQM –total quality management). Therefore the interoperability component has to be stressed and be adequately considered.

It is important to insist on issues mentioned earlier related to “*versioning*” and data back-ups. The versioning is a very complex matter especially dealing with GIS vector data and database replication. Work or basic geo-processing tasks (geo referencing, balancing, vectorizing etc...) will be performed at a specified facility (selected through AMGI) that will have the necessary computer systems and communication infrastructure to be operational. Therefore, it is not sure how database replication and new versions as work progresses - both in vector and raster domains - will be tackled. These issues will be tested during the Pilot Study covering three areas.

Market Drivers and Demands

Whilst the supply-side will largely come from public institutions such as geological surveys and European archives, the demand side for the AMGI will include end users such as policy makers, planners, researchers and the mining and exploration industry. Other users of the system will include those working for the mining investment community, and government / regional decision makers. Previous work (EI Source Book, *op cit*) has shown that the industry is frequently frustrated by the difficulties in obtaining relevant geodata in the early phases of decision-making. This is particularly the case when a company or an investor is developing an interest in a frontier area or across a trans-boundary corridor.

An assessment of African mineral endowment, ***what is known and could remain to be undiscovered***, would be a valuable tool for mineral users, mineral explorers, land planners, international governments, and environmental protectors alike. Without proper geodata this “*key development goal*” cannot be achieved. The mineral industry does not use mineral assessments “directly to discover new ore deposits”, but an assessment can be a tool that, in concert with other measures of Earth’s resources, might provide a logic-based forum for long-term land use planning, coordinating environmental issues and assisting in related legal issues.

There is frequently a need to establish quickly the availability, quality and resolution of existing public geodata, when considering applying for licences or raising funds in the market. Therefore the immediate online access to the meta-database component of the AMGI is essential, together with a high level of confidence that if the public geodata are shown to exist, they can be obtained without undue delay and at a known price. Another key issue in this respect is the ability that will be provided by AMGI of re-interpreting and generating new geodata from previous sources in a fully compatible GIS format. Such a geodata format, whenever the information analysis has the right scale (around 100k), can be used for improving prospectivity targeting allowing investors and explorers to pick up those areas that appeared to have a high probability rate for hosting a typical type of ore deposit model (just through inference and GIS-based analysis).

It should be noted that the meta-database in particular will be a frequently changing dynamic system, as new geodata are added and existing geodata are improved through re-interpretation, homogenisation and quality enhancements and/or external value-addition as contemplated in Track-2 (VA- Value Added). The meta-database must also act as an advertising medium for those data release and value added companies which are producing significant new value, symbiotically with the AMGI.

In some cases, the suppliers of public geodata will be content to regard the AMGI as the primary repository for national holdings, thereby relieving themselves of the costs and infrastructure required to hold the geodata in-house. This is perfectly acceptable, but will not suit the political sensitivities in every case. However the public geodata held within the AMGI can at all times be regarded as a secure backup facility in case of loss or damage to geodata held nationally, from where the data can be recovered. This has resonance with the repatriation of historical geodata from European and other archives.

Modes of financing

What a user would pay (the offer side)

In discussion with mining and exploration companies it is clear that there is a willingness to pay for good quality data delivered effectively. End users are less willing to indicate the amount they would pay for an individual map, report or other type of dataset. However a suitable price list can be set against the amounts companies currently spend in order to obtain equivalent data. Thus for example, in order to obtain a printed copy of the geological map from a geological survey in Africa, at a cover price of \$10, the end user may well spend several thousand dollars in travel costs and staff time visiting the geological survey, and in addition will spend several hundred more dollars to digitise the map back in their offices. It has been estimated⁷ that up to one third of the time of a company geologist may be spent simply in tracking down suitable data. It is therefore reasonable to suppose that companies would be willing to pay an amount considerably more than the current cover price of the map but less than they spend obtaining the data through their own resources for direct access.

Parallels in the oil and gas industries show that companies are prepared to structure their financial contributions through a combination of subscription and per item use. It is intended in the case of the AMGI to set a subscription charge based on the size of the company and the amount of data in the system of potential interest to them, and a lower unit price for data downloaded. Occasional users who do not have a subscription arrangement would be required to pay a higher unit price to reflect the additional costs of servicing that business. The advantage of a subscription arrangement is that it creates a "club" of customers at an early stage and provides some front loaded income to the business.

There is a risk that a large well-resourced company could simply download all of the geodata for a given territory and then leave the membership club. Even worse, having obtained all the relevant geodata, the company could set up a rival system to the AMGI. The latter threat can be dealt with quite simply through an appropriate clause in the subscription agreement limiting the use of the data to bona fide company exploration and production purposes only. The risk of a bulk download and exit can be mitigated because of the dynamic nature of the data, in that through time old data are improved and new data are added to the system, thereby restricting the effectiveness of a one-time bulk download.

It is extremely difficult to give an estimate of the total potential revenue as this is a totally new product offering. However based on a very conservative view that 5-15% of companies exploration budget may be spent on data acquisition and that half of this may be spent purchasing data hosted by AMGI, published data for exploration in Africa leads to the view that the revenue could exceed \$10 million per year once it is established and properly marketed. However, a relevant economic analysis from existing social and economic evaluation (conducted in 2002 and 2003) of the MAGNA Plan (Geological Map of Spain, 1:50k scale) has produced very favourable results. The authors of the analysis paper (iv), using a very similar methodology to the one applied by the Illinois Geological Survey (USA) in 2000 for the evaluation of the detailed geological maps of the State of Kentucky, found that a *Benefit/Cost ratio* ranging from 10.35 to 27.54 for the 1035 map sheets at 1:50k scale

⁷ Informal discussions

totalling 121 Million Euros. Whereas for the Geologic Mapping of Kentucky, the *Benefit/Cost ratio* ranged 12.1 to 18.5 having 707 map sheets at 1:24k totalling 90 Million\$. Therefore, from the dissemination of datasets alone the AMGI expects to recover and multiply its investment from at least 10 to 15 times.

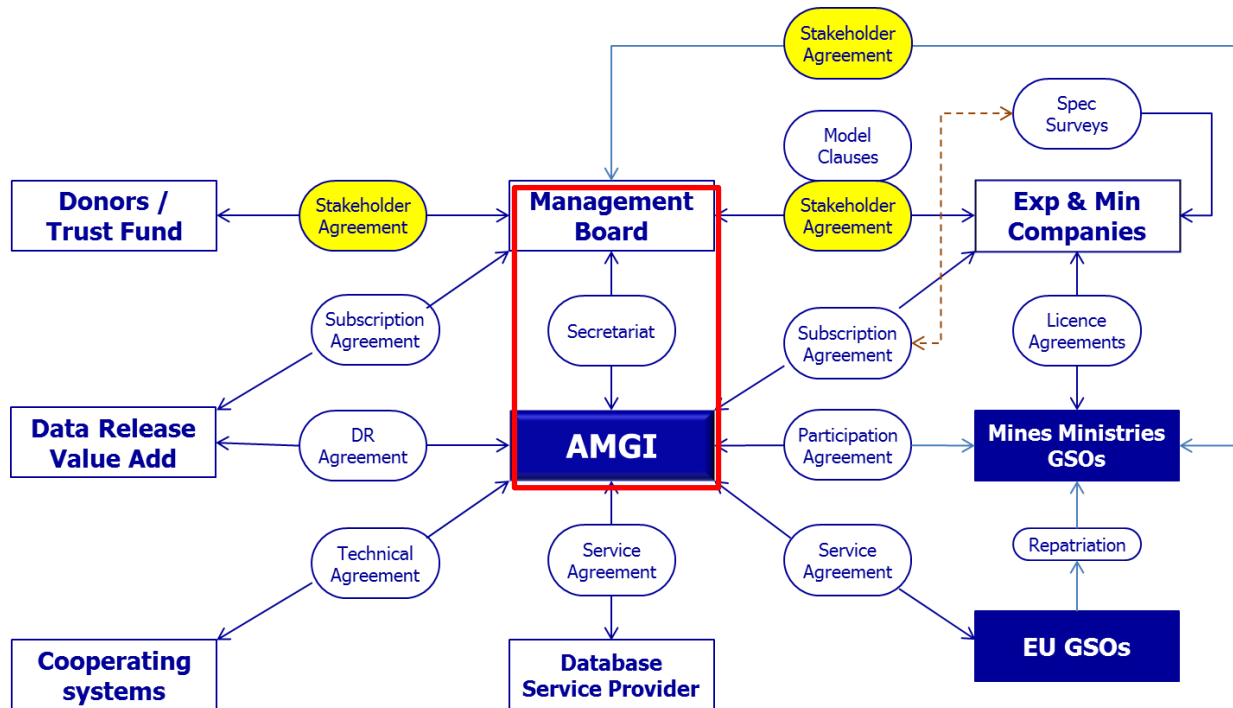
Institutional structures

The AMGI will embrace a number of different institutions and organisations as shown on Figure 3. The role and responsibility of each element of the diagram is described below:

Management Board and Secretariat to manage and operate the AMGI and its associated functions and agreements. The structure of this is described in more detail in Task 3.

Database service provider- it is intended that the AMGI is operated by a specialist organisation or company through a service level agreement, on a commercial basis. The agreement (contract) needs to be awarded following a competitive international tender, and for a fixed period of time. Preference will be given to an African with experience of building and operating complex geospatial databases and networks for other organisations, such as, natural resources organisations dealing with advanced geographic information systems & satellite remote sensing, geographical, topographical/ photogrammetric or engineering companies, financial institutions. It is suggested that the contract be awarded for initial period of three to five years, renewable through market testing. The physical location of the databases in the first years is very important as non-automatic work has to be performed upon which (its quality and operationalization) further AMGI phases will be founded. **Mines Ministries and GSOs of African states** will be primary participants both through management representation and directly involvement in the enhancement of public geodata. Accordingly a series of bilateral participation agreements will be required between these institutions and the AMGI, to be administered by the Secretariat and based on the Charter of rights and obligations, which will define the public geodata made available to the AMGI and the commercial returns from them.

Figure 6: Proposed Structures and Relationships



European archives- principally those of European geological surveys and other institutions such as the Royal Africa Museum, which will relate to the AMGI through a series of bilateral service agreements negotiated and administered by the Secretariat, that will enable appropriate public geodata to be shared with the AMGI, either directly or preferably through a process of repatriation to the African ministries and geological surveys for whom the data refers.

Exploration and mining companies- principally as one of the end users of the AMGI through a series of bilateral subscription agreements negotiated and administered by the secretariat that may relate to license agreements between the companies and the mining ministries. As part of a complex series of relationships these companies will also be represented in the AMGI management as described in Task 3 of this Report, and may include spec survey company data and proprietary company data that are not publicly available but which may be managed in the AMGI and traded commercially through and entitlements index, with the AMGI acting as a broker and receiving commission.

Cooperating systems - which may include OneGeology, CGMW, AEGOS, MGCP, IUGS, research organisations and other initiatives, will be invited to discuss cooperation agreements with the AMGI in which technology, data and expertise may be exchanged. It is entirely possible that cooperation agreements might be established in the future with major commercial organisations such as Amazon and Google, who may wish to link public geodata into their offerings. The Geological Society of Africa (GSA) will be an Advisory body that will be consulted since as the GSA has a strong Earth sciences scientific and educational network liaising with national geological surveys, the EuroGeoSurveys (EGS) as well as the most relevant educational institutions, initiatives and professional network in Africa.

Data release and value added organisations- the AMGI though its secretariat will seek to establish agreements with a number of companies whose role will be to release public geodata with added

value beyond those geodata improvements and enhancements which are intended to take place within the AMGI itself. For example, the AMGI will support CSO work to geo-rectify and standardise a series of geological maps, including re-interpretation or value added according to track-2, of the area, and may also retain processed airborne geophysical data for the same region, but it would be for the value added organisations to undertake advanced data integration, interpretation and report writing based on the public geodata.

Donors - the business case for the AMGI, described in more detail in Task 5 of the Report, requires a substantial amount of set up funding from donors. As a principal stakeholder in the system, these institutions will also have management board representation.

Expectations and limitations

Given the complex and multidimensional structure of interested parties and institutions, there is a risk that expectations of the AMGI may seriously exceed what it is reasonable and practical to deliver, as each stakeholder will understandably bring their own set of requirements.

The AMGI will seek to build as quickly as possible those public geodata sets relating to Africa which are readily available. It must of necessity go for the "low hanging fruit" and avoid being diverted and bogged down in complex data recovery and conditioning activities. It is very likely that they will start with five African states for which to concentrate the initial effort. Similarly, those geodata initially acquired from a number of sources will be of variable quality. Whilst there is an obvious need to have a level of quality control and filtering out of inappropriate data, it is important to offer existing data immediately rather than hold back until the data are conditioned and put into new formats with edge matching, full geo-referencing and consistent indexes and legends. The AMGI must guard against the failure of other projects never to release data because they are deemed to be not of good enough quality.

The main custodians of public geodata, principally the African geological surveys and the European archives, can expect from the AMGI technical, financial and expertise assistance to gather the data in suitable digital formats, to reinterpret the data, and to develop programs to carry out the production of new data. In the case of African geological surveys, those participating in this process will gain a double benefit through the receipt of data management facilities and resources into the survey and from the subsequent revenue streams from the use of such data through the AMGI. Whilst it is envisaged that the managers and custodians of the European archives will be willing to cooperate with the AMGI, they are resource limited and it is likely that they will require funding and the temporary input of other resources to effect the copying, release, and repatriation of African public geodata.

The table below is intended to give an illustration of what is likely to be included and excluded from the AMGI, through various examples. The full details will be a matter for the secretariat in consultation with the management board.

Table 2 – Suggested AMGI Limitations

Feature	Part of AMGI?	Comments
Raster scan maps	Yes	
Vector digitised maps	Yes	
GIS feature extraction & re-interpretation or attribution processes	Yes	On a "just-in-time" basis but ensuring at least 25% coverage in the plan for AMGI support
Edge matching	Yes/No	This requires major geological rethinking, could be done by the supplying geological survey, in which case the updated data would be loaded.
Geo-referencing	Yes	This could involve the development of a common georeferencing system based on the foundation layer concept (using ortho-rectified imagery)
Standardised indexes and codes	Yes/No	Could be done by the supplying geological survey, in which case the updated data would be loaded
Scanned reports, logs and other documents	Yes	Probably as PDF
Hypertext referencing of reports and digitised logs	No	Could be added later subject to demand and database functionalities
Processed airborne geophysics	Yes	Probably as maps, supplemented by digital data and by-products if possible
Interpreted airborne geophysics	Yes	Qualitative subsurface bodies linked to likely features of outcropping geology
Geochemical survey data	Yes	As maps and data values if possible
Land-use, geomorphology or any terrain-related data such as DTM, infrastructure networks etc	Yes/No	Will depend on Management Board and Technical Advisory Committee on the role of terrain-related datasets as well as generation of multi-thematic by-products for various applications and uses.

NOTE: Following the proposed structures and relationships among stakeholders an **Annex (Draft Charter on Rights & Obligations)** is presented below, showing the different rights and obligations of those involved parties in order to better clarify their functions within the AMGI structure.

Annex - Charter of Rights and Obligations (draft)

Preamble

The African member states of the **African Union**, parties to the present initiative entitled "**African Geoscience Mining Initiative**"

Acknowledging that the African Union Commission (AUC) represents the highest collective political decision making body and will provide leadership over the AMGI on behalf of the AU.

Recalling the decisions taken at the Meeting in Addis Ababa October 2012

Recognising the importance of geodata in the development of Africa's extractive industries and quality-of-life

It is hereby agreed as follows:

Schedule 1 – Obligations on African States

Article 1 that the African states will give their full support and cooperation to the AMGI.

Article 2 that the geodata belonging to each African state shall remain the property of the state in perpetuity and the primary benefits of those geodata shall accrue to the African state.

Article 3 except where considerations of national and international security deem otherwise, that each African state shall enter in a data sharing agreement with the AMGI stipulating conditions of access, dissemination and use of the geodata, confidentiality clauses, remuneration for the sale of geodata products, as well as an action plan for the enhancement of the existing geodata and the production of new datasets, including capacity building and funding for the national Geological Survey Organization, academia and research centres.

Article 4 that each African state shall cooperate with the AMGI to seek to obtain from other locations including but not limited to European archives such public geodata as referred to the African states and are reasonably assumed to be the property of those states.

Schedule 2 – Rights of African States

Article 5 that AMGI will contribute funding, expertise and / or equipment to the appropriate authority in the African state, according to agreements reached between the African state and the AMGI Secretariat.

Article 6 the African state has a right to receive a proportion of the revenue generated by the AMGI through the sale or licensing of public geodata derived from the African state, according to agreements reached between the African state and the AMGI Secretariat.

Article 7 that the African state has a right to receive from the AMGI management information such as may be released without breaching confidentiality relating to the volume, type and customer of that states public geodata.

Article 8 that African state has a right to participate and be represented in the management process of the AMGI according to its constitution.

Schedule 3- Obligations on the holders of European archives of African geodata.

Article 9 that organisations which hold archives of public geodata relating to Africa will give their full support and cooperation to the AMGI.

Article 10 that such organisations will cooperate fully in making available their archives for copying and repatriation of copied geodata to the appropriate organisations of the countries to which the data refer and to the AMGI.

Schedule 4-Rights of the holders of European archives of African geodata.

Article 11 that organisations which hold archives of public geodata relating to Africa will retain the originals of such data in their current form.

Article 12 that such organisations can expect the AMGI to contribute to obtaining resources to make copies of these data the purposes of repatriation and copying to the AMGI.

Article 13 that in making such copies no damage or harm will be done to the geodata and the holders of the archives will be absolved of any responsibility for any breaches of copyright or other obligations that may occur.

Schedule 5-Obligations of commercial companies which participate in the AMGI

Article 14 That commercial companies participating in the AMGI will do so strictly in accordance with the participation agreements they have entered into and in the spirit of full cooperation with the broader objectives of the AMGI, in particular with the ownership and copyright of the geodata and the terms under which they may be used.

Article 15 that commercial companies which obtain data from the AMGI or deposit data within the AMGI will do so strictly within the commercial terms agreed.

Schedule 6-Rights of commercial companies which participate in the AMGI

Article 16 that commercial companies which deposit data within the AMGI all through their own intellectual efforts add value to data will at all times unless agreed otherwise retain ownership of their intellectual property, the entitlement to which will be controlled at all times by its owner who may withdraw the data from the AMGI at any time for whatever reason.

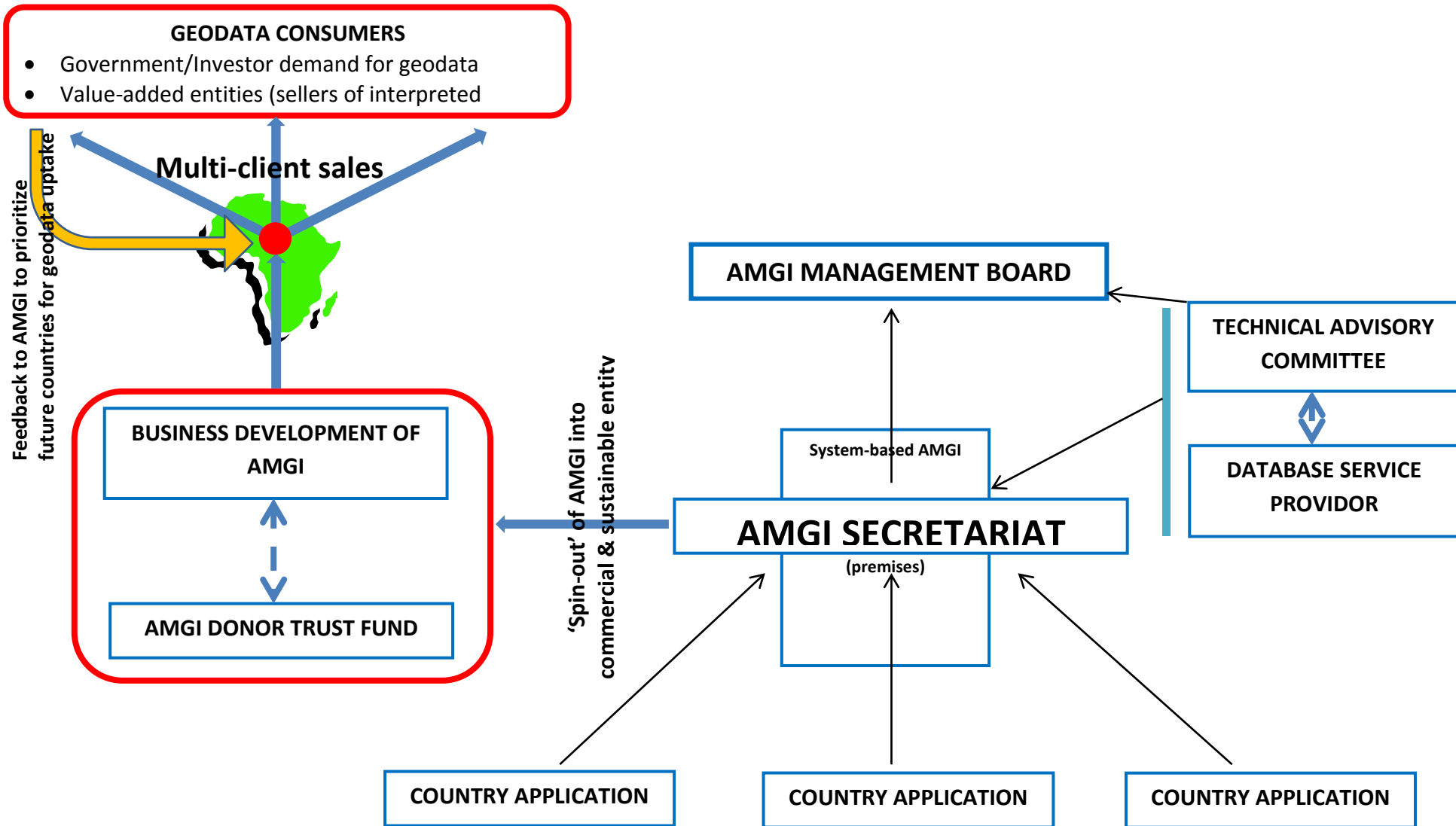
TASK 3 - IDENTIFYING THE ROLE OF THE PROPOSED SECRETARIAT, TECHNICAL ADVISORY COMMITTEE AND OTHER INSTITUTIONS

This report deals with a review of the organisational elements of the proposed 'Organizational structure of the AMGI presented below (Figure 4). The principle features of this proposed structure are listed:

- The AMGI organizational structure shows an important focus on the 'spinning out' of the AMGI as a self-sustaining initiative that produces, compiles, collates and disseminates geodata.
- The geodata consumer base is expected to include multi-end users from land use planners through to the mineral exploration sector and commercial entities that will draw on the AMGI geodata to reinterpret and add value and in so doing, develop a niche market offering for African geodata. A similar network of value-add service providers exist in the oil and gas sector, which is expected to be replicated in the minerals sector with AMGI representing a fundamental geodata platform that will initiate a greater degree of geodata exchanges.
- The AMGI is conceived under the mandate and leadership of the African Union Commission.
- Feedback from stakeholders will assist AMGI in identifying the priority regions and/or countries for which geodata is required. This, together with country applications will keep AMGI responsive to stakeholder demands.
- The composition, roles and function and governance of the AMGI Management Board is presented below.
- Taking into account the value of geodata in general terrain analysis and land-use planning, it is recommended a representation by a land-use role to ensure that the delivery of geodata has impact on land-use issues be they local, regional or or multi-sector as well as multi-country in scope.
- The composition, roles and function and governance of the AMGI Technical Advisory Committee is presented below. A key role of the Committee is to set the overall technical requirements and scope of the AMGI geodata model, including its limitations and technical design constrains. It is recommended that representation on the Committee should have participation by the EI sector to ensure that AMGI in its technical scope is compatible with EI requirements. The Technical Advisory Committee would provide input to the Secretariat and report directly to the Management Board.
- A strong link between the Technical Advisory Committee and the database service provider is envisaged to ensure overall technical compliance by the database provider. This link will also enable important technical developments and suggestions being passed onto the Committee for consideration and possible amendment of the AMGI technical specifications by the Committee.
- The composition, roles and function and governance of the AMGI Secretariat is presented below. The fundamental role of the Secretariat is to implement via its support services the country specific programmes.
- It is recommended that the Secretariat comprises a 'Business Development of AMGI and Marketing & Communications Services' functionality. The role of this unit will be to develop and implement a sustainable business model and to raise the level of awareness for large-scale mapping products.

- The Secretariat will be responsible for providing sound financial management of the activities it implements.
- The Secretariat would have full executive oversight of country applications for AMGI funding, their program management, liaison with GSOs/Mining Ministries, liaison with country regarding allocation of shared income of AMGI, liaison with Technical Advisory Committee to ensure each country program is within the AMGI vision and operational mandate. Particular attention would be given to understanding the country requirements from AMGI in respect of coverage, scale, types of data, assessment of value of data where it would be made digitally available, constraints on the data, levels of entitlement requested by the data owner and implications for AMGI system, setting of user-fee structure and liaison with the relevant GSO and Ministry. Members of the Secretariat are expected to have skills and experience in managing and applying geodata.
- With regard to enhancing geoscience skills and building the necessary capacity to adequately assist in the different AMGI steps, the Geological Society of Africa (GSA) will be an Advisory body that will be consulted and their views duly considered as they have a strong Earth sciences scientific and educational backing by liaising with national geological survey, the EuroGeoSurveys (EGS) as well as the most relevant educational institutions and network of professionals in Africa.

Figure 4 – Proposed organizational structure of the AMGI and its spin out as a commercial and sustainable entity



COMPOSITION

Chairperson: AUC appointee

RECs Representatives: One appointee per participating REC

Participating Countries: One representative per country

- .
- The number of representatives on the Board will depend on the number of participation agreements entered into between AMGI and the country.
- The validity of a participating country is based on the duration of the agreement between AMGI and the country. Board representation of participating countries will therefore change as new countries are signed on to replace the expiry of existing participating country agreements.

Organisation of African Geological Surveys (OAGS) and African Geological Society (AGS): 1 representative each

- Representative will provide Board with input on GSO functionality and civil society participation both general and specific.
- OAGS will be an important communications conduit between AMGI and non-participating countries through the respective Ministries and/or GSOs in promoting the AMGI.
- A representative of the African Geological Society (AGS) as having an NGO-role within the Advisory committee

Extractive Industries: 1 representatives of the extractive sector (TBC)

- It is useful that the AMGI Board is informed by the demands of the mineral exploration sector in respect of geodata
- Representative will provide important guidance on geodata in terms of its availability, coverage, scale, precision and format in the short, medium and long term. He/she should hold high-level executive management position in mineral exploration rather than technical abilities in GIS and related informatics.
- Representative will provide strategic input regarding mineral economic trends for the sector as important input to AMGI’s prioritization strategy.
- No pan-African extractive industries body currently exists from which to request membership of the above representatives to represent the body as a whole. Accordingly, the selection of the representative could be based on proven industry representation i.e. group(s) of companies that have together proposed a suitable representative.

Donor Countries: One representative of the MDTF

- One representative per donor country could result in many representatives ‘sitting’ on the AMGI Board irrespective of their level of respective contributions. Consideration could therefore be given to limiting representation to one MDTF member.

Land-use: One representative

- There is an acknowledgement that making geodata available will play a significant role in broader land-use issues and particularly in developing regional resource corridors. Furthermore, AMGI’s strategic direction and prioritization may be influenced by such an approach and accordingly, it is recommended that an informed representative be appointed to guide the Board on this matter.

ROLES AND FUNCTIONS

- Provides overall strategic direction, prioritization, vision and clear articulation of AMGI’s primary objective.
- Approves AMGI’s business plan to ensure sustainability of its objectives
- Define the policy space into which the AMGI initiative fits in terms of the pan-Africa notion and resolutions regarding mineral sector development along with policy clarity in respect of national imperatives for the continent.
- Ensure that developed work programmes are adhered to in terms of specification, budget and timing.
- Oversight of AMGI’s budget
- Hold an Annual General Meetings and other fora to ensure sufficient communication and/or marketing of AMGI’s vision to all relevant stakeholders, and non-participating countries in Africa.
- Oversight for efficient functioning and approval of staffing plans envisaged for the AMGI Technical Advisory Committee and Secretariat
- Provide high-level enabling assistance to countries in the repatriation of foreign-controlled geodata
- Ability to appoint ad-hoc members to the Board to assist in its operations
- Provide high-level communication and possible linkages to related initiatives such as EITI and others

GOVERNANCE

- The AMGI Board will establish its own charter
- A financial committee to oversee the expenditure of all AMGI activities through the Secretariat, and to maintain strategic oversight on AMGI’s implementation of its sustainable business proposal

COMPOSITION

- Committee members to be approved by the Management Board
- All Committee Members will have proven technical experience and ability in managing large ideally multi-disciplinary geodatasets
- Committee would have extractive industries sector representation to ensure business and commercial sustainability

Technical Director:

- Appointment of Director is not done by Committee and instead directly by the Management Board
- Person must have proven experience of large geodata information management systems..

Additional Technical Representatives:

- Additional technical representatives would include the following:
 - Donor GSO representative to ensure the release and incorporation of geodata held in non AMGI GSOs such as BGS, BRGM, MRAC, EuroGeosurveys etc. onto the AMGI system.
 - Representatives of regional initiatives such as AEGOS and OneGeology to serve on an ad-hoc basis to share experiences of these initiatives. There is a concern that the influence of these representatives by sitting on the Committee will attempt to steer the technical development of AMGI along pre-established models (European GSO-led initiatives).
 - 2 Extractive industries representatives. No pan-African extractive industries body currently exists from which to request membership of the above representatives to represent the body as a whole. Accordingly, the selection of representatives would be based on proven industry representivity i.e. group(s) of companies that have together proposed a suitable representative.
 - Land-use representative
 - GIS/Informatics/database expert with e-commerce experience

Database Service Provider

ROLES AND FUNCTIONS

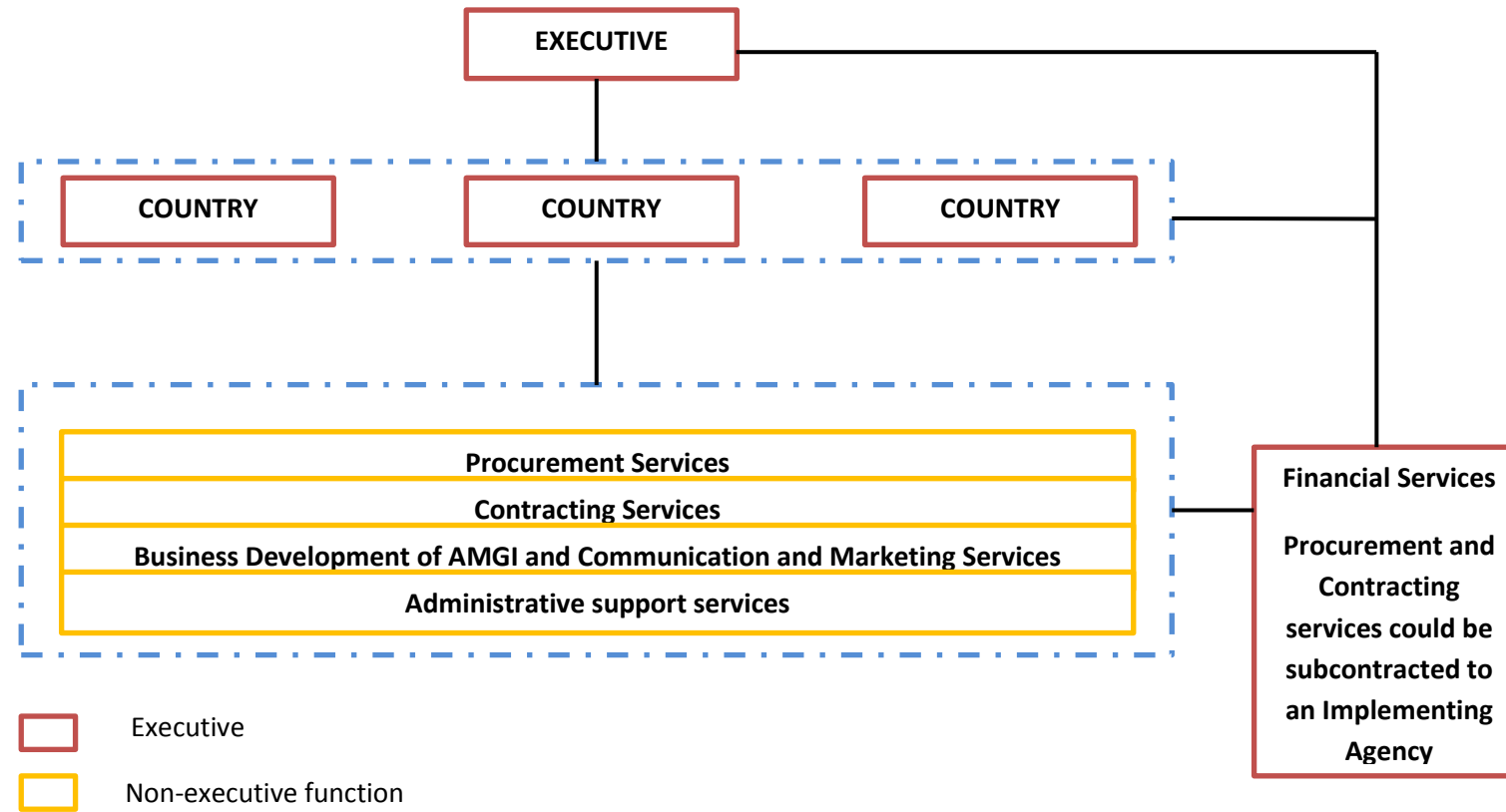
- Develop the technical specifications of the AMGI system and accordingly to the Secretariat for sourcing consulting/contractor services
- Develop an overall technical and phased work plan for the Secretariat that maps the development, implementation and testing of the AMGI system.
- Steer the technical development of the AMGI in accordance with the Management Board’s principle vision of AMGI and ensuring that AMGI vision is not absorbed or unduly influenced by existing regional initiatives.
- Assist in the harmonization of data schemas and name conventions
- Maintain vital link between itself and the Database Service Provider in terms of progress, quality and adherence to AMGI technical model. This link becomes increasingly important as progress is made on the AMGI system.
- Develop quality assurance, quality control and quality management procedures to ensure that co-production partners will adhere to the agreed geodata management standards with especial emphasis on feature extraction workflows that must be homogeneous regardless the region or producing entity.
- Enlist on an ad-hoc basis specialist expertise when required.
- Provide essential technical e-commerce understanding so that commercial functionality of the AMGI system is developed and implemented
- Reporting to the Secretariat and the Management Board
- A strong link between the Committee and the database service provider is envisaged to ensure overall technical compliance by the database provider. This link will also enable important technical developments and suggestions being passed onto the Committee for consideration and possible amendment of the AMGI technical specifications by the Committee.

GOVERNANCE

- Technical Board would meet on a quarterly basis especially initially
- It would draw up its own charter
- Reporting to the Secretariat and the Management Board

COMPOSITION

- The Secretariat would comprise the following functional elements:



- The number of country managers would depend on the country take up to the AMGI system
- business development & marketing and administrative support services represent support services to the entire Secretariat
- Financial services interacts with support services in providing financial services such as monitoring, forecasting and reporting to the country managers and the executive director.
- The Business development of AMGI and marketing services plays a key role in assisting the Financial Services in supporting the development of a commercial and sustainable AMGI.
- Procurement and contracting services would follow World Bank procedures and policies in this regard. They could be subcontracted to an Implementing agency (i.e. UNOPS, etc.)

ROLES AND FUNCTIONS

- The Secretariat would have full executive oversight of country applications for AMGI funding, their programme management, liaison with GSOs/Mining Ministries, liaison with country regarding allocation of shared income of AMGI, liaison with technical advisory committee to ensure country programme is within the AMGI vision and operational mandate. Particular attention would be given to understanding the country requirements from AMGI in respect of coverage, scale, types of data, assessment of value of data where it would be made digitally available, constraints on the data, levels of entitlement requested by the data owner and implications for AMGI system, setting of user-fee structure and liaison with the relevant GSO and Ministry.
- Secretariat would:
 - Support and coordinate the management Board and Technical Advisory Board in setting up their meetings. This would include ensuring also the avoidance of conflicts of interest in the selection of service providers.
 - Provide program management and support in implementing a country's AMG Initiative
 - Administer the financial operations of AMGI programmes through the Financial Services Unit
 - Source and identify through WB procurement the selection of the contractor to serve the geodata co-producers from either track-1 and/or track-2.
- A key responsibility of the Secretariat will be to implement a sustainable commercial model as well as to assess, whenever data becomes available, any enhanced or streamlined cost-efficiency schema applicable.

GOVERNANCE

- Strong links between the Secretariat and the Technical Advisory Committee should be developed to ensure that the AMGI programme selection and implementation is serving the vision of the AMGI as an accessible repository of data. Close links would therefore need to be kept between the Secretariat and the technical advisory committee to the extent of sign offs being required by the latter body.
- The location of the Secretariat within the AUC does not imply that the eventual hardware and software to serve the geodata would be located at the same institution (see report for Task 4)

TASK 4: Identifying the technical and legal issues involved in establishing a Server for geodata storage and dissemination

AMGI Storage Server Location

It is important to make a clear distinction between **a)** the location where the system related work for both approaches **Track-1 (Fast Delivery)** products and **Track-2 (Value-added)** products will be performed and **b)** the physical location where the geodata products will be stored and accessible for end users. This is straightforward as the level of complexity is such that re-interpretation (**VA**) and pre-processing steps (**FD**) cannot be automatized. Other matter is the actual storage of the geodata as ultimate product. Bearing this in mind, one of the more sensitive issues surrounding the AMGI is that of the physical location of the final storage system as well as the location of the AMGI initial facility where operational work is carried out by specialised resources.

The traditional view of data is that its physical location should be observable, controllable and secure by those who claim ownership. This view applies as much to digital data on computer disks as it does to physical files of paper. There will therefore be a completely understandable fear and reluctance by many of the African institutions involved to allow their valuable public geodata to be stored in a remote location over which they have no direct control. There would be particular sensitivity if they felt that the remote location was in a country which could therefore derive benefit from inappropriate access to the geodata. Even keeping the digital databases within Africa could raise political issues as to which African state would have this vital responsibility and technical issues because of the limited network bandwidth in most cases.

In practice all of these concerns are unnecessary given that the organisation or company with the responsibility for managing the AMGI would be contractually committed to do so under terms of the strictest confidentiality and neutrality which will be regularly audited by a data systems quality compliant organisation. It is very likely that such an organization will already have a distinguished track record in managing very large databases in the mining or petroleum sector. In most cases, such organizations locate their physical storage facilities, computers, servers, network equipment and disk farms in a number of geographical locations around the world (original storage servers and back-up facilities for system hazard and business continuity), the exact details of which they do not reveal for security purposes. It is no more relevant to the supplier of data to the AMGI, or the user of such data, where the physical server/disks is located as it would be when that same person makes an enquiry online to his bank or insurance company. This is entirely familiar to users of household name systems such as Google, Amazon, eBay, Facebook and the many other sites which allow photo storage and sharing.

Technical Requirements

For AMGI to be effective, there is a clear need for a system “*on the ground*” (physically) that processes and stores such geo-data in an initial production stage following track-1 and track-2 respectively. This system is the “Primary platform or system infrastructure” that could be later transferred to the “*cloud computing*” for storage (better called cloud storage). Such system need to be in place to be able to generate the actual AMGI final products but what cannot be hosted in the

cloud is a complex geo-processing system that relies on complete human intervention and the work of analysts and technicians to generate both the VA and FD products.

In other words, the AMGI will require a sound hardware infrastructure with systems, processing skills, “storage capacity” and the ability to restoring data quickly and without inherent damages (business continuity and back-up). Eventually, there is a need to talk about *image servers* and GIS-servers like the ones used for storing large volumes of satellite data since the AMGI (whatever its organizational structure will be) will generate 25% of the VA geo-data using complex but fully operational data processes, as well as 100% FD geodata according to both tracks. An image server of the type Apollo (like NGA, USGA UNLB etc... organizations) or any other will be a requirement for a computer-processing infrastructure that as been designated as the “system” earlier in this Report. Such an infrastructure will have to be hosted in a specific place with staff skillful for system administration, software maintenance & development and for basic data and information management. This is a question that the cloud computing solution only meets partially as it is limited to only -storage and accessing- pre-prepared or processed geo-datasets.

It is intended that the AMGI “system” will be operated under contract (service level agreement) by a African organisation or a company but controlled by the Management Board through its Secretariat. The operating organization will be responsible for, and take care of, most of the technical issues required by the AMGI. The principal requirements for such a system that will need to be incorporated in the terms of reference to select such a company will include:

- Sufficient disk storage capacity to hold the very large volumes of geodata that will come into the AMGI, with the potential for expansion;
- Security of access according to entitlements tables which will be maintained dynamically on instructions from the Management Board through the Secretariat;
- Adequate network access to enable downloads of geodata to end users at high speeds, and appropriate network capacity for uploading new data;
- 24/7 availability under normal circumstances and less than 24-hour recovery in the event of major disaster (disaster recovery and back up provisions);
- Firewalls and other measures to prevent hacking and illegal access;
- Full transaction, versioning management (for raster & vector this later result from various possible re-interpretation versions) as well as management recording;
- User-friendly software interface allowing meta data searching according to geographical coordinates, type of data, owner, data protection, keywords and other factors specified by the secretariat. Ability to develop the interface menus and formats through time according to user needs;
- Capability to use software application packages that were used for the FD and VA processes;
- Transaction payment management by credit card based on a selectable area from a data browser and for subscription account, with automatic invoicing and financial management / accounting;
- Full capability and tested back-up and business continuity requirements ensuring regular data audits and quality compliance.
- The organization is to carry all the necessary insurance and legal liability in the event of damage or claims against the AMGI and/or the owners of the geodata

Key features of the technology will be performance (near-instant delivery of maps and documents internationally over the internet), reliability and expandability. The technology needs to be, as far as possible, “future-proofed”. This point should be applied not only to this end of the product chain (storage & dissemination) but to any geo-processing steps as well as to the data sources to avoid obsolescence and losing sight of IT basic developments from the AMGI perspective as well. These requirements further point to the need to adopt proven, reliable, commercial technology operated under contract (service level agreement) by a professional organization specialised in this field and with a good track record of transaction processing as well as backup/ system continuity would be advantageous.

It is difficult to give estimates of initial sizes and future upgrades – the following table should be taken only as containing indicative order-of-magnitude values.

Track-1 (FD)	On start-up	After 2 years	After 5 years	After 10 years
ONLY				
Disk space ⁸ (Terabytes)	10	100	400	1000
Number of simultaneous users ⁹	50	100	200	500

It is important to highlight again that AMGI will require “on the ground” (physically) sound hardware infrastructure with a system that processes to store such geodata in an initial production stage and is able to restore & backup data quick and without inherent damages ensuring system continuity in crises. This system is the “Primary platform or system infrastructure” that will be later transferred to the “cloud computing” for storage. In very simple terms is unavoidable the fact that, in the first three years of AMGI, a facility needs to be selected and operationally used as the “technical house for preliminary AMGI work performed” ensuring very high levels of geo-processing, interpretation, storage and dissemination. Thus, this “**Preliminary AMGI or Interim Geo-processing Facility (IGF)**” needs to be located near the technical management of the project allowing constant oversight and quality control to be performed by a specialised team as work develops and issues or drawbacks are identified.

Legal Issues

Nothing in the AMGI can or is intended to supplant existing legal issues relating to ownership, intellectual property and copyright. These will be respected throughout. The basic issues are:

⁸ Based on the expected number of items loaded and the average size of each item (an “item” being a digital map, GIS layer or raster layers).

⁹ Based on expected searching and downloading from companies, public sector and academic stakeholders, taking into account time-zone differential loads

Ownership

Each item in the AMGI will have some ownership. In general, a map, report, dataset etc is owned by the person, organisation or institution producing or commissioning it. This may be a government, company, institution, person or donor aid agency, although in the case of donors and aid agencies it is normal practice for ownership to be conferred to the government of the beneficiary state.

Typically, a map or report produced by, say, a consultancy but funded by bilateral or multilateral aid to a government, will be owned by that government, even though the consultancy may retain copies of the data, or even retain the only existing version of the data if the data deposited in the beneficiary country have become lost or corrupted. Work done and funded by a university or other research group or as part of a PhD thesis in an African country will usually belong to the university or research centre carrying out the work, although there may be agreements that the university will donate copies of the data to the country concerned. Data generated by commercial companies at their own expense, even if lodged in a Ministry as a condition of licence, will normally remain the property of that company during the life of the license after which the geodata can be uploaded onto AMGI.

Intellectual Property

Generally ownership infers intellectual property rights (IPR), however it is frequently the case that data are improved or interpreted by a third party. In such situations, the background IPR, which is the data taken into the process, remains with the original owner, whilst foreground IPR, that is the value added information or interpretation element, belongs to the person or organisation carrying out the value-add or interpretation. Frequently, there will be an agreement in place between the parties on how to share any revenue derived from an inseparable combination of background and foreground IPR. An intellectual property right also includes other rights such as patents and trademarks.

Copyright

Copyright is subject to the legal system of the ownership, most of which apply time limits which vary according to type. Copyright is a particular type of IPR that protects the physical expression of ideas, e.g. a piece of writing, a photograph, or a web page.

Mapping these rights into cloud computing

There is nothing fundamentally different between storing an item on a locally held disk drive or a disk drive “in the clouds” except that greater attention to detail is required in the latter case. When all the data belonging to an organisation, such as a geological survey, are held on a disk server physically within that survey, there is little need to “tag” each element of data to that effect. However, when data items owned by many entities are stored side-by-side on a cloud server, each item must carry with it, within the metadata, full details of ownership and entitlement to access.

It is suggested that this “tag” on each data item should contain at least the following information:

- Metadata descriptions of the data compliant with ISO standard 19115:2003¹⁰ or equivalent (with conversion tables) – much of the early work carried out within the OneGeology and

¹⁰ See http://www.iso.org/iso/catalogue_detail.htm?csnumber=26020

AEGOS projects can usefully be re-used here through cooperation agreements. Also see Downey, 2007^{vi};

- Ownership, IPR and copyright;
- Entitlements to access (who can see which part of the data under what conditions and during/over which time periods);
- Prices and conditions of sale / licence;
- Transaction records of sales and licences and payments made to data owners.

Liabilities

Consideration should be given to liabilities and how these are managed through appropriate disclaimer clauses in the various agreements and insurances. In general, the owner of a data item will retain full responsibility for any errors or damages caused through its use, as if the data item had been distributed directly from its owner. Normally these risks are mitigated through a *caveat emptor* condition imposed in the transaction, but the owner may in addition carry professional liability insurance or legal exemptions.

Because national level legal exemptions may not carry into the trans-national world of cloud computing, professional advice and specialist insurance will be required in setting up the terms of use prevailing in the various agreements with the AMGI.

TASK 5: Initial evaluation of the financial sustainability of the proposed arrangements

Financial planning and Forecasts

This section contains a summary of the financial planning and forecasts, based on anticipated annual cash flows for Track-1 (FD) only. It sets out the investment requirements, assumptions and revenue forecasts for the set-up and implementation of that phase. Moreover, Track-1 will include a Pilot Study that will set the “GIS geo-database schema”, methodologies, datasets, procedures and resources required to extent Track-2 or Value Added approach to a larger region migrating from five countries towards the whole southern part of the continent.

A reasonable estimate for the Pilot Study in 3 selected areas in Africa could be put at US\$ 20 million covering 3 cells (one degree by one degree *Lat/Long* each cell, see below) including cost of creating the “Preliminary Geo-processing Facility” (PGF) for the first three years.

General Assumptions for Track-1

1. The financial forecast assumes that it will take the first year from launch of project to early operational position, which includes the parallel processes of setting up the management structures, putting in place the various agreements, tendering and contracting the service provider and loading sufficient data to proof of concept stage.
2. During the second year, the data for the lead countries (or regions) will grow incrementally towards full coverage, including selected replicated data from European archives for those countries (or regions), marketing and business development of a customer base, and large scale, high volume data collection for other countries / regions of Africa, including securing new data as they are made available from active geo-thematic projects.
3. Year three will aim at near-full coverage of existing relevant public geodata, limited data conditioning, fully developed input and output channels and establishing a trading floor for commercial geodata.
4. The principal costs of the project during the first three years will be:
 - a. Data collection and conditioning (from African geological surveys, European archives etc.)
 - b. Building and operating the data management system (design, hardware, software, communications, transaction processing)
 - c. Designing, developing and implementing the work program for Pilot Study on Track-2 (VA)
 - d. Management and secretariat
 - e. Payments of fees / royalties to data owners
 - f. Marketing and dissemination
5. The main sources of income (revenue) will be
 - a. Donor / trust fund income – first 3 years only
 - b. Transaction income from clients
 - c. Fees from data release / value added agents
6. AMGI will benefit from donor funds during its first three years but must attempt to be self-sustaining over the medium term, including the generation of retained profits for sustaining costs and system replacements.

Risks

1. There is a risk that the owners of the geodata will not agree to allow copies to be used in the AMGI for financial reasons. In the case of African geological surveys and their parent ministries, many of them derive a small but important to them revenue from the sale, officially or otherwise, of maps and reports. The potential loss of this income may be a disincentive to cooperation even though the benefits of participation in the AMGI, in terms of macro-economic development, far exceed the relatively trivial incomes from map sales. This risk will be mitigated both by explaining the relative benefits at Ministerial level, thereby securing top cover for the initiative, and by returning a part of the sales revenue into the AMGI to the geological survey or ministry that has supplied the geodata. The final agreement between AMGI and the participating country should demonstrate an increased level of income from data sales through AMGI to incentivise the country and mitigate this risk.
2. There is a risk that the African owners of the geodata will not agree to allow copies to be used in the AMGI for policy reasons. In the case of some African states, there is a view that geodata, even if they are theoretically a public good, should not be released openly except through the ministry control. The risk will be mitigated through discussion and agreement involving the AUC representatives of the AMGI Management Board. Getting early 'lead' countries to sign up to the AMGI will set the bar for other countries in their consideration to be involved with AMGI.
3. Separately, most of the organisations who are the custodians of European archives have already stated openly their willingness to allow public geodata referring to Africa to be copied and repatriated, subject to the provision of resources, but in practice there may be operational or organisational barriers to such work. The risk will be mitigated through discussion with those organisations, with their regional representative associations (eg EuroGeoSurveys) or at a political level between the AU and the Embassies of those countries, as appropriate.
4. There is a risk of not fully identifying the technical issues across countries during the implementation of the Pilot Study. Thus, further work in defining procedures and geo-data schema applicable to the full Track-2 will need to be revised to ensure the re-interpretation of the available geo-data is consistent with its actual value.
5. There is a risk that the AMGI data management system may fail to deliver as expected, or deliver late, incur cost over-runs or experience other problems. The risk will be mitigated through careful selection of the supply company, good project management incorporating appropriate gateways and well written service level agreements that include penalty clauses for delivery shortfalls (see "Government IT projects", 2003^{vii}).
6. There is a risk of litigation and damage claims. This risk will be mitigated through professional legal advice and insurances.
7. There is a risk that the management structure may, in order to be necessarily inclusive, become too unwieldy. This risk will be mitigated by giving appropriate authority to the Secretariat to act against certain pre-defined performance objectives and principles.
8. There is the risk of the AMGI vision being changed from the ultimate goal of developing a GIS / technology-driven programme that attempts to produce a seamless database for the continent while continuing to meet the needs of government authorities and industry.

Budgetary Estimates

Overall Estimate

A Summary of **Resource Implications** is presented to better comprehend the dimension of the AMGI undertaking.

Activities	Budget / Finance	Timeframe
MDTF -----→ 280 Million \$US		
Track-1 (FD) - <i>Fast Delivery</i>	60 M \$US	3 years
Pilot Study	20 M \$US	
Repatriation of geodata hosted in Donor countries (FD) - <i>Fast Delivery</i>	200 M \$US	
World Bank Regional Integration Loan ---→ 100 Million \$US		
Track-2 (VA) – <i>Value Added</i>	100 M \$US <u>Loan</u> (Regional Integration) 5 countries	3 years

A bidding process will be set up that will include: a) the contractual work of the different Tracks and b) the location to house the preliminary AMGI or Interim Geo-processing Facility (IGF).

For the initial period the geo-data will be housed in a “Data Warehouse” physically located within the contractor premises allowing technical project management quality control and constant oversight of workflows.

Data collection and conditioning (from African geological surveys, European archives etc.). This includes an average cost per institution for computers, scanners, consumables, training, staff and management to identify, catalogue, metadata base and digitally capture existing public geodata, for up to 40 such institutions (including European archives).

The collection of data in Track-1 implies a considerable amount of funding which is estimated at around \$200m spread disproportionately over years 1 to 3 inclusive; thereafter costs would be reduced to \$100k / year / institution for new data.

Building and operating the data management system (design, hardware, software, communications, transaction processing) This Facility will constitute the **Preliminary AMGI or Interim Geo-processing Facility (IGF)**. It will be subject to competitive tendering, but based on similar sized public sector procurements, including operating costs and maintenance during years 1 to 3 inclusive.

Management and Secretariat functions: including capacity building, training, legal and insurance costs. This activity will include Marketing & Dissemination roles

Payments made to geodata owners: As compensation for otherwise lost income locally, at 10% of transaction and release revenues.

In summary and considering the 3-years horizon the resource requirements are:

- **\$280m for Track-1** (Track-1 plus Pilot Study) setting up and operational facility (or through a contractor). To be financed through a **Multi-Donor Trust Fund (MDTF)**.

- **\$100m for Track-2** for Data Collection and Development. To be financed through a **World Bank Lending project** covering 3-5 countries.

References

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- ⁱ Understanding geology is also a pre-requisite for the sustainable exploitation of mineral resources. Geodata can help improve the sustainable environmental and social management of mineral resources as an economic activity, contributing to mitigate the negative impacts due to issues of externalities such as environmental damage but also social disruption and the loss of ecosystem services.
- ⁱⁱ “Geodata for Development – a Practical Approach” 2012, EI Source Book, GOXI, at <http://www.eisourcebook.org/cms/files/Geodata%20for%20Development,%20A%20Practical%20Approach.pdf>
- ⁱⁱⁱ See The African Minerals Development Centre, Business Plan, 2012, at <http://www.au.int/ar/sites/default/files/AMDC%20Business%20Plan%20EDITED%20Final%2017%20Sep%202012.pdf>
- ^{iv} García-Cortés, Á. *et al.* 2005. Evaluación económica y social del Plan MAGNA. *Boletín Geológico y Minero*, 116 (4): 291-305 ISSN: 0366-0176.
- ^v Taken from the World Bank sponsored public forum held during Mining Indaba, Cape Town, February 2013
- ^{vi} Downey, D.W., 2007 “What Do Geologists Need to Know about Metadata?” ESRI Petroleum User’s Group, Metadata Working Group Wiki, at <http://www.searchanddiscovery.com/documents/2007/07030downey/index.htm>
- ^{vii} Parliamentary Office of Science and Technology, Report 200, 2003 “Government IT projects” 38pp, at <http://www.parliament.uk/documents/post/pr200.pdf>