

## AIRBORNE GEOPHYSICS AS A TOOL TO PROMOTE MINERAL INVESTMENT IN AFRICA

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### INTRODUCTION

Airborne geophysics, particularly aeromagnetic and gamma-ray spectrometer (radiometric) surveys, forms a critical component of geological mapping and mineral resource inventory programs in many African countries. In the 60's and 70's, regional aeromagnetic surveys were fairly widespread over much of the continent, in both sedimentary and hard rock terrains (Barritt, 1993). In the 80's and 90's, higher resolution surveys, incorporating radiometrics, were carried out in certain countries, particularly in southern Africa. In the last decade, a number of national initiatives (e.g. Madagascar, Mozambique, Namibia, Morocco, Mauritania, Nigeria, Ghana, etc.) have seen the high-resolution geophysical coverage greatly improve. The surveys form part of larger initiatives to improve the geological knowledge of a country or region, with the ultimate objective of increasing mineral investment and developing a sustainable mining industry. These geoscience programs are typically accompanied by reforms in the mining law to promote such investment. They contribute to tectonic reconstruction, groundwater and environmental applications, and petroleum exploration, all of which ultimately assist societal development (Reeves, 2005). International funding agencies such as the World Bank, European Community and African Development Bank have seen the value in such programs, and ensure that airborne geophysics receive a large share of project budgets. In jurisdictions throughout the world, it has been demonstrated that high-quality geophysical coverage leads directly to increased and more focused exploration. A trend in the last few years has been the inclusion of an airborne electromagnetic follow-up component to the airborne program.

This paper provides current examples from two countries. In Uganda, more than 600,000 line-km of magnetic and radiometric data are being acquired over most of the country. In addition, eight blocks with high mineral potential are being flown with electromagnetic systems (Tempest and heliGeotem). In Senegal, the entire hard rock region has been covered by 130,000 line-km of magnetic and radiometric data, followed by a Tempest survey over three large blocks.

### NEW AIRBORNE SURVEYS IN UGANDA

#### Sustainable Management of Mineral Resources Project

In 2004, the Ministry of Energy and Mineral Development of the Republic of Uganda embarked on the five-year Sustainable Management of Mineral Resources Project (SMMRP). The project covers the following aspects:

- Strengthening of governance in mineral sector management;

- Community development and mineral resources;
- Establishment of environmental/social systems;
- Geo-information and development; and
- Project management and coordination.

Financial support for the project is supplied by the World Bank and the African Development Fund, in addition to the Government of Uganda. This endeavour is modeled after similar projects carried out in Africa in recent years (e.g. Mozambique, Madagascar, Nigeria).

The Department of Geological Survey and Mines (DGSM) in Uganda is tasked with the collection, analysis and dissemination of geoscientific data and, as such, is playing a critical role in the SMMRP. One of the main objectives of the program is to promote Uganda as a destination for mineral exploration by domestic and international companies. An important contribution of a geological survey is to make high-quality geoscientific data accessible, for companies to assess the mineral potential of a country or area and, ultimately, to attract mineral investment.

A new geological mapping program will be one of the legacies of the SMMRP. Airborne geophysical data provide the framework for such a program, by mapping lithology, structure, metamorphism, alteration and tectonics, which provides a focus for the geological fieldwork. The geophysical data themselves are extremely useful in characterization of ore environments and exploration targets, and are in high demand by the exploration community.

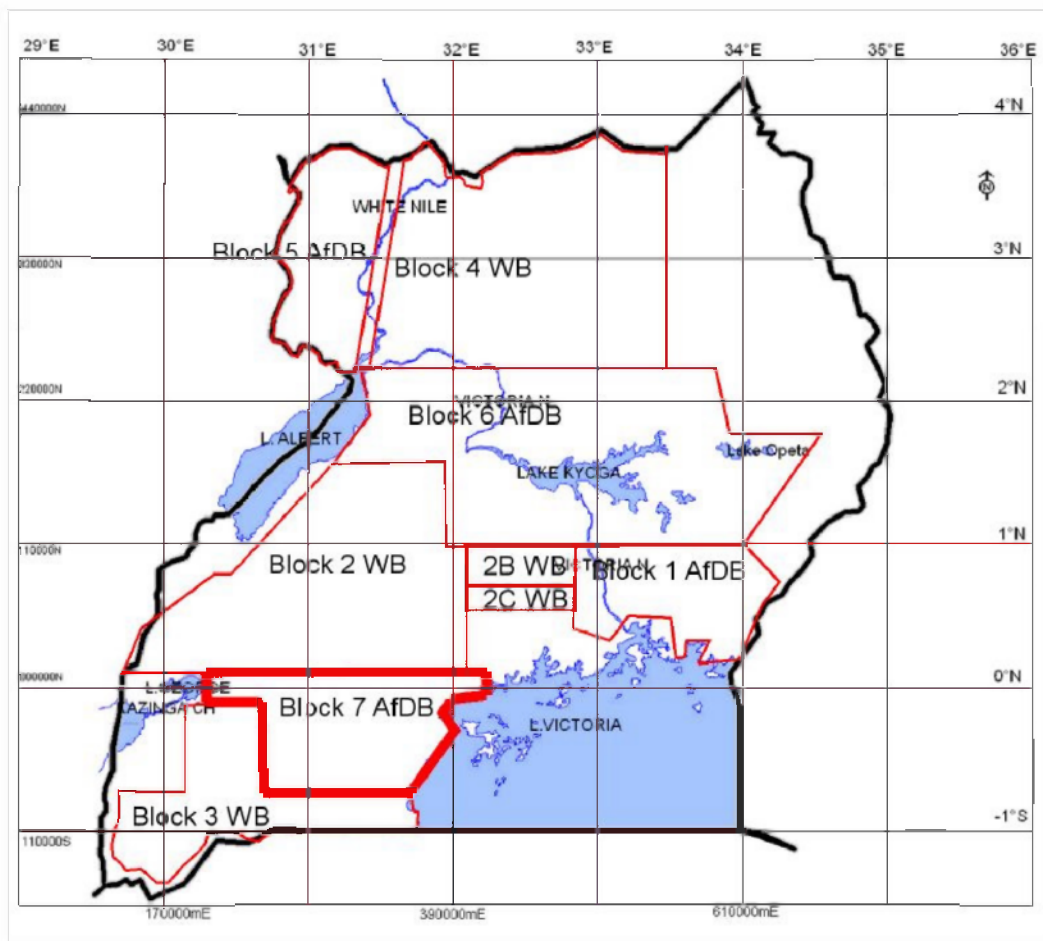


Figure 1: Location map of Uganda magnetic and radiometric survey blocks, 2006-08 (AfDB – African Development Bank, WB – World Bank).

## Airborne Geophysical Survey Program

Airborne magnetic and radiometric surveys covering most of Uganda commenced in late 2006, and will be completed early in 2009 (Figure 1). The airborne surveys are being flown by Fugro Airborne Surveys Ltd., with one to four fixed wing aircraft deployed at any given time. The basic survey specifications are 200 m traverse line spacing, 2000 m control line spacing and 80 m nominal terrain clearance. Block 6 is the exception, with a 500 m traverse line spacing and 100 m terrain clearance. All are being flown with fixed wing magnetic horizontal gradiometer and gamma-ray spectrometer systems. The surveys total approximately 623,600 line-km.

Eight smaller blocks, totalling approximately 23,200 line-km, are being flown with a time-domain electromagnetic system (TDEM). They were selected based on their potential for hosting mineral deposits that may be characterized by TDEM. These will have a 200 m line spacing and system-dependent terrain clearance. Two blocks were flown early in the project using the fixed-wing Tempest system. The remaining six blocks will be completed early in 2009 using the heliGeotem system, in areas of rougher terrain.

The magnetic and radiometric data products for blocks 1 and 6 have been released to the public (Figures 2 and 3). The products for blocks 2, 2b and 5 are scheduled for release in late 2008, and the remainder in 2009, along with the TDEM survey products. These products will not only assist the follow-up geological mapping, but have also proven their worth to Ugandan and international mining companies exploring for the extension of the Tanzanian goldfields and other mineral commodities. The data in the north will assist in petroleum exploration after Uganda's first commercial oil discovery near Lake Albert in 2006.

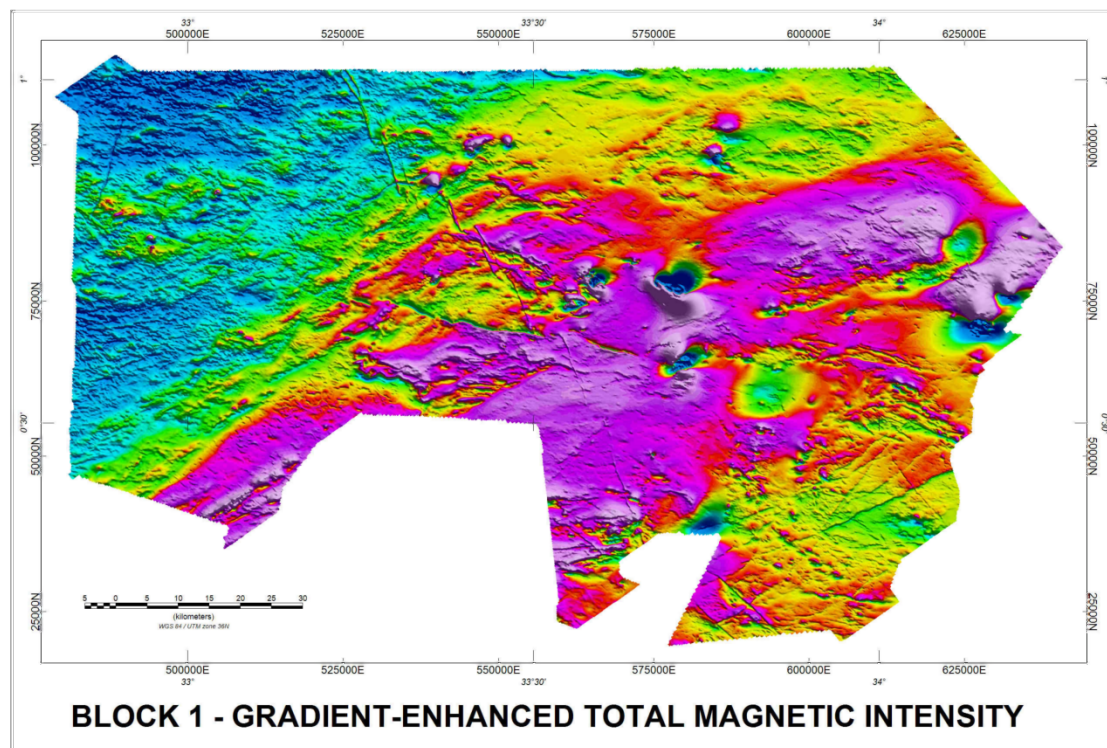


Figure 2: Total magnetic intensity, Uganda block 1.

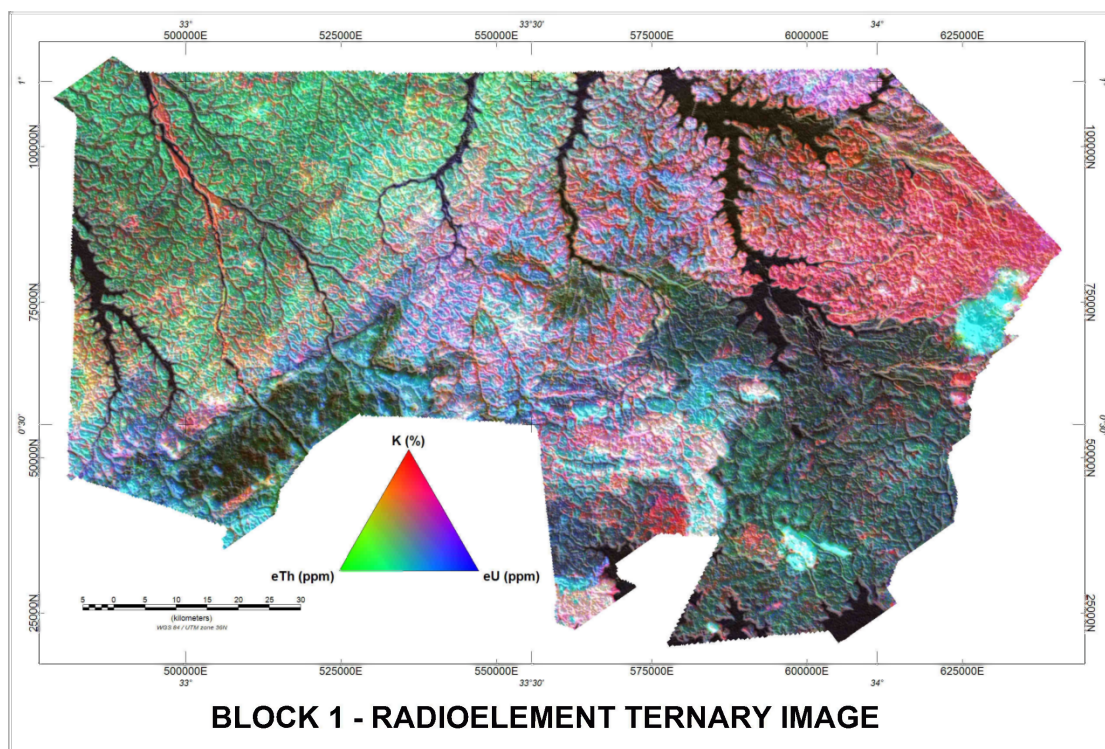


Figure 3: Radiometric ternary image, Uganda block 1.

## NEW AIRBORNE SURVEYS IN SENEGAL

The Department of Mines and Geology in Senegal embarked on a similar project to that described for Uganda. It is under the auspices of the Government of Senegal, with the assistance of the European Community. The field work is focused on the eastern part of the country (Figure 4), where igneous and metamorphic basement rocks outcrop or are buried under relatively thin cover. The remainder of the country hosts thick successions of sediments. The eastern basement incorporates Birimian volcano-sedimentary belts which host important gold deposits through much of West Africa, including those across the border in Mali.

The airborne magnetic (horizontal gradiometer) and radiometric survey (Figures 5 and 6) was flown by Fugro Airborne Surveys Ltd. in 2007, using two aircraft concurrently. The basic survey specifications were 250 m traverse line spacing, 3000 m control line spacing and 80 m nominal terrain clearance. The survey totaled approximately 133,800 line-km. The data products from the survey were released in 2008.

Subsequently, three blocks were chosen for TDEM surveys over prospective but underexplored areas (Figure 5). These were flown in 2008 with Tempest system. The basic survey specifications were 400 m traverse line spacing and 120 m nominal terrain clearance (TDEM receiver at 67 m above ground). Since high-resolution magnetic data were acquired on the previous survey, the magnetometer was dispensed with for the TDEM survey and as a result, control lines were unnecessary. Consequently, the 21,000 line-km of acquisition covered a larger area than a typical TDEM survey. The TDEM data products are due for release in late 2008. At that time, an interpretation incorporating the magnetic/radiometric and TDEM surveys will be released as well.



Figure 4: Location map of eastern Senegal magnetic and radiometric survey 2007.

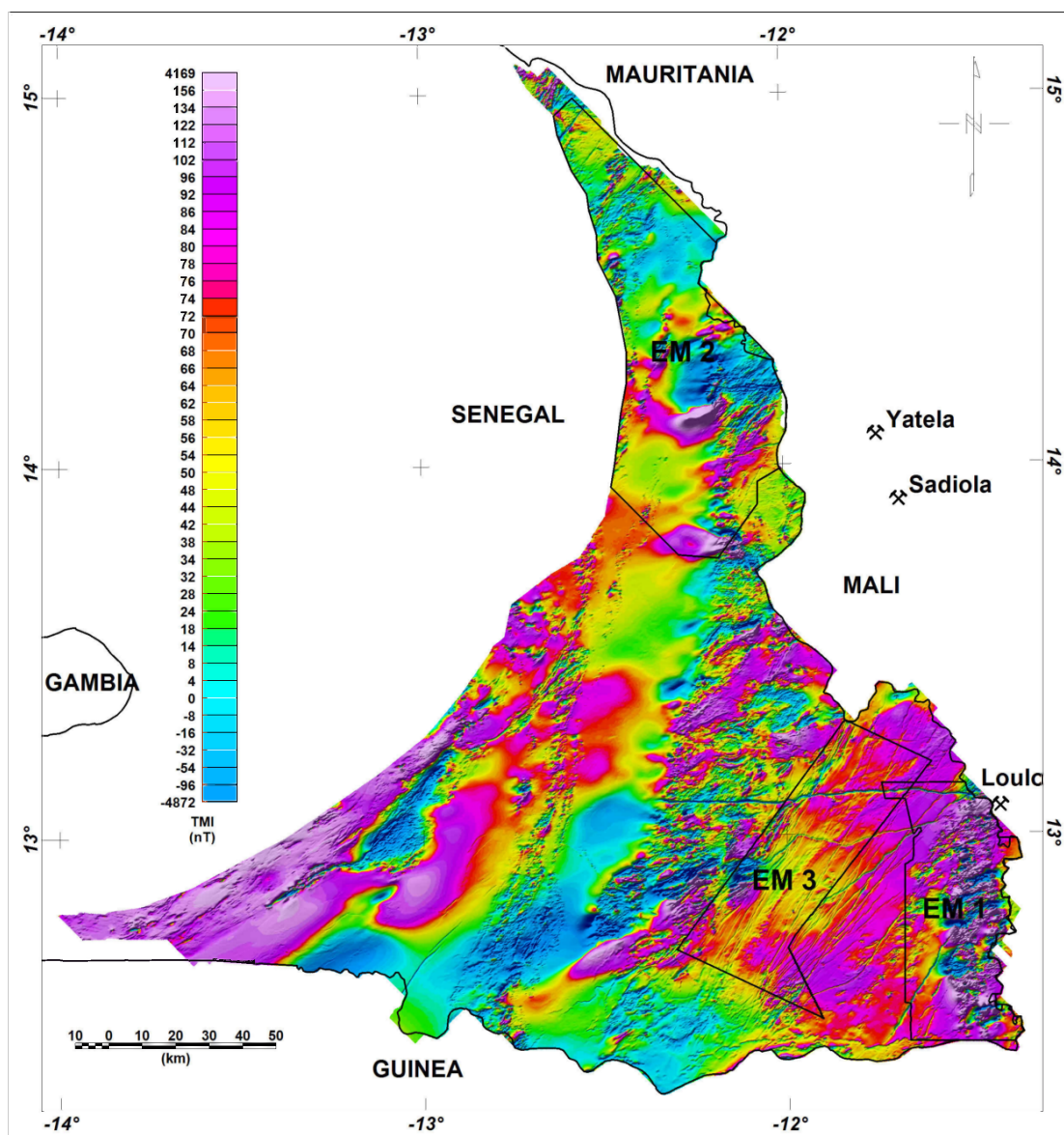


Figure 5: Total magnetic intensity, eastern Senegal with TDEM survey blocks and Malian gold mines.

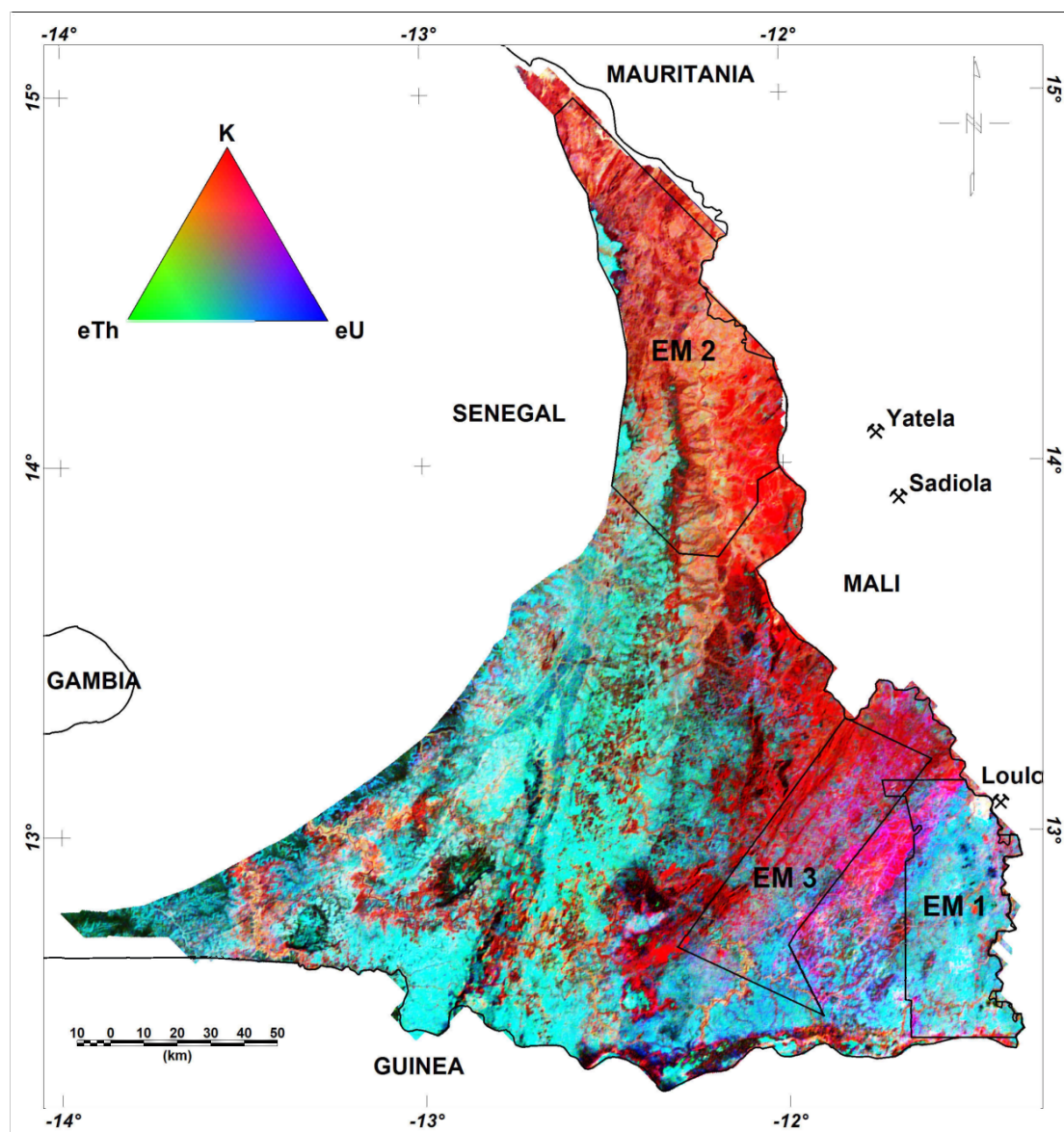


Figure 6: Radiometric ternary image, eastern Senegal with TDEM survey blocks and Malian gold mines.

## CONCLUSIONS

The new airborne geophysical surveys flown in Uganda and Senegal have already led to an increase in mineral investment in these countries, which are fundamentally underexplored compared to some of their neighbours, who are more mature from a mining perspective. These data provide a lasting legacy for mineral exploration and geological knowledge. Both survey programs have benefited from the addition of time-domain electromagnetic surveys in specific areas, to provide direct detection of mineralized systems, as well as better characterization of the regolith, cover sediments and basement.

## **IN MEMORIAM**

Our co-author, Julius Nyakaana, passed away suddenly in September 2008 at the age of 44. He was the Principal Geophysicist at the Department of Geological Survey and Mines in Uganda, and served as the Project Coordinator for the ambitious Sustainable Management of Mineral Resources Project during the last three years. He is dearly missed by his family, friends, co-workers and colleagues.

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