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The High Resolution Airborne Geophysical Survey Programme of Namibia: A Success Story in Promoting Mineral Exploration

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ABSTRACT

In the current Global Market Economy, nations compete for investment and this is particularly important in the mining industry. Many governments have adopted modern mining legislation and provide favourable fiscal regimes to attract mineral exploration investment, but what is often lacking is high-quality geoscientific data, the provision of which can only be achieved by considerable government support and investment. The decision of the Namibian government to support the generation and distribution of modern high-quality geoscientific data, especially the High Resolution Airborne Geophysical Survey Programme, has been rewarded with increased mineral exploration activity.

INTRODUCTION

In Namibia mining has long been the cornerstone of the economy, since the early 1900's, when a considerable amount of superficial prospecting resulted in the discovery of many outcropping mineral occurrences. The economic mineral deposits include diamonds, uranium, tin, base and precious metals, industrial minerals and semi-precious stones. Several prospective mineral environments have been recognised. These include beach diamond placers, volcano-exhalative base metals, sedex lead-zinc, extensive carbonate-hosted base metals, uraniferous granites, tin (and tantalum) pegmatites and skarn-hosted tungsten and gold.

It is against this background that the Namibian government has entrusted the Ministry of Mines and Energy and in particular the Directorate of Geological Survey with the generation and distribution of high-quality geoscientific data to assist mineral exploration. One of government's major initiatives is the High Resolution Airborne Geophysical Survey Programme, which commenced in 1994. Initial results of this programme were presented at the 4th decennial International Conference on Mineral Exploration (Hutchins et al. 1997).

THE HIGH RESOLUTION AIRBORNE GEOPHYSICAL SURVEY PROGRAMME

The High Resolution Airborne Geophysical Survey Programme is designed primarily to assist and promote mineral exploration and aims at virtual complete national coverage with high-resolution airborne magnetic and radiometric data.

Prior to this High Resolution Airborne Geophysical Survey campaign a programme of regional surveys was funded by government from 1968 and achieved almost complete coverage in the early 1990's. These surveys were typically flown with 1 km line spacing, 10 km ties and 100 m ground clearance, but some surveys undertaken in sedimentary basins for petroleum exploration adopted a wider line spacing of up to 10 km. All magnetic data of the regional programme were subsequently compiled into one consistent data set and some radiometric data were back-calibrated and also merged (Eberle and Hutchins 1996, Eberle et al. 1997).

Although the resultant regional magnetic and radiometric compilations provided a new insight into the crustal evolution of Namibia and provided a fresh impetus to mineral exploration, further advances in airborne geophysical data acquisition, made the data archaic when compared to a new generation of high resolution airborne geophysical surveys. These surveys using the latest technological developments, including increased instrument sampling rate, improved computer processing and satellite navigation, enabled surveys to be flown along closely spaced survey lines. The parameters adopted for Namibia's high resolution magnetic and radiometric surveys are 200 m line spacing with 2500 m ties and a nominal terrain clearance of 80 metres.

The first surveys flown under the High Resolution Airborne Geophysical Survey Programme were funded by the SYSMIN programme of the European Union. The quality and detail of these surveys generated renewed interest of the mineral exploration community towards Namibia and encouraged the Namibian government to commit annual resources to a programme of high-resolution surveys. The first survey funded and supervised entirely by the Namibian government was a small 34.000 line-km survey flown in 1997. Subsequent annual

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budget allocations have increased over the years and to date more than 3.5 million line-kilometres of data are available to the exploration industry representing a national coverage approaching 80 %. The cost of these surveys amount to approximately N$ 120 Million (US$ 16 Million) and the estimated cost for completion of this programme is N$ 150 Million (US$ 20 Million).

Although the annual magnetic and radiometric surveys form the main thrust of the programme, other airborne techniques such as EM, Gravity and Hyperspectral imaging have also been employed to address specific exploration challenges. The location of all these surveys is shown in Figure 1a whilst the NW shaded TMI image in Figure 1b gives an impression of the complexity of Namibian geology. The data displayed is a compilation of all existing high resolution and regional magnetic data and is overlain by the outlines of the high-resolution airborne magnetic/radiometric surveys. The image is dominated by the magnetic response from three proterozoic fold belts surrounding the Congo Craton in the north and the Kalahari Craton in the east. These fold belts are the Kaoko Belt in the northwest, the multi-zoned Damara Belt, that crosscuts northern-central Namibia from the central coast towards northern Botswana, and the southeasterly striking Namaqua Belt in the south of the country.

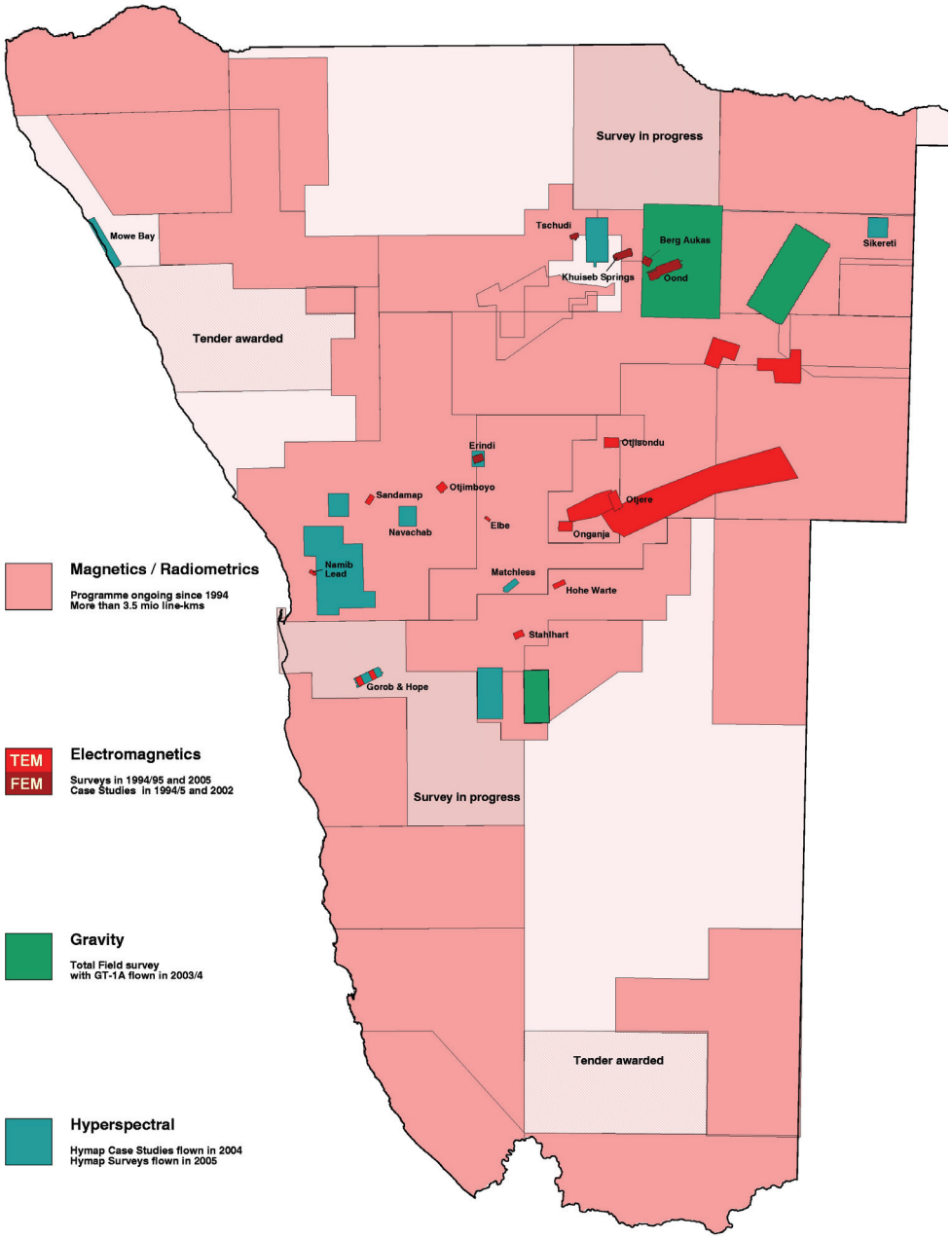

Figure 1a: High Resolution Airborne Geophysical Surveys, Index Map

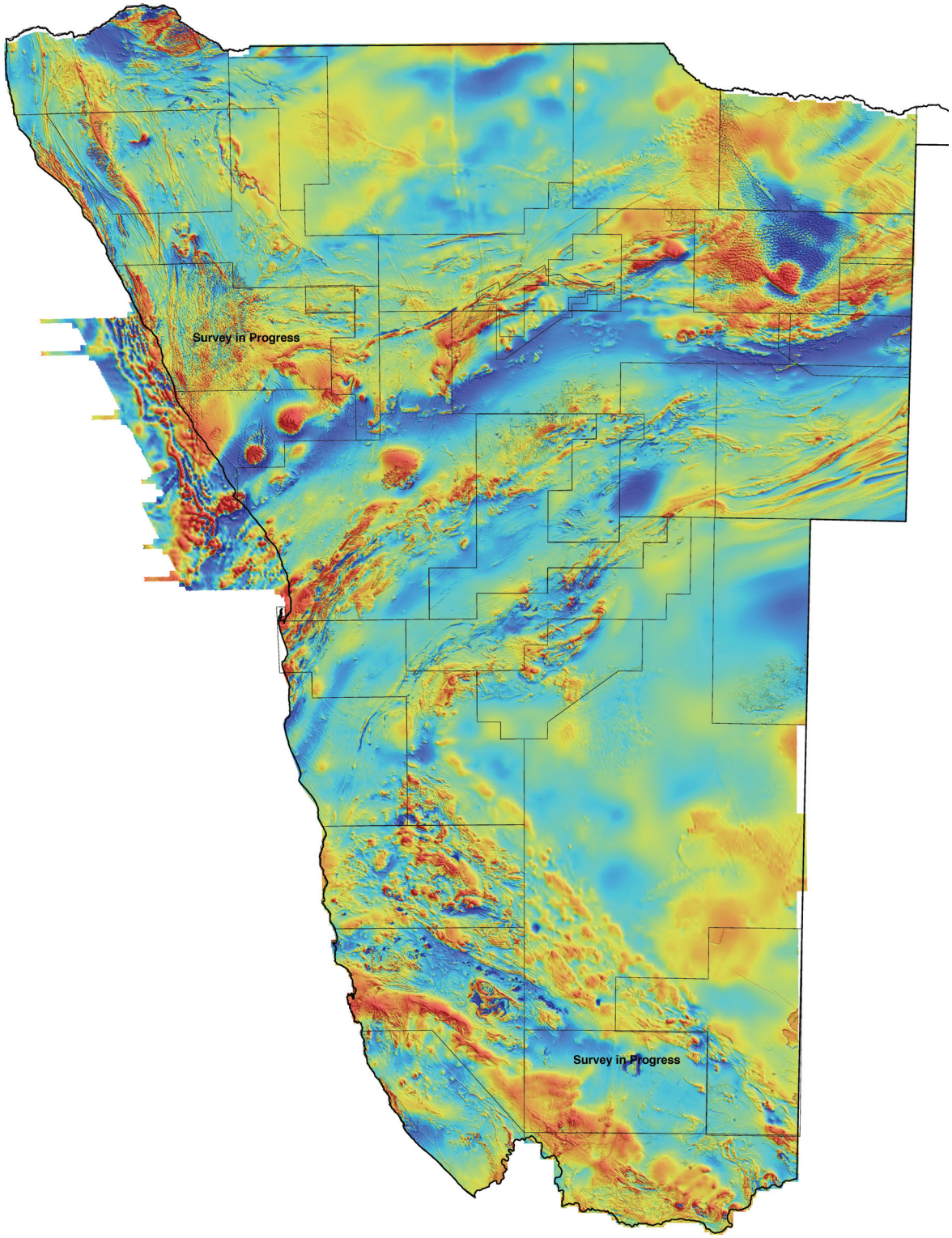

Figure 1b: NW shaded TMI image of the merged high-resolution and regional magnetic data of Namibia

DATA SALES

During the first stages of the programme data were sold based on 10% of acquisition costs with the idea to create a revolving fund, from which further surveys could be financed. However, data sales never did generate sufficient money to finance future surveys, and the idea of a revolving fund was abandoned in 1996. Since that time data have been sold for a nominal price of N$ 1 per line-kilometer (approximately 2% of acquisition cost) with the funds accruing to the Mineral Development Fund established by the Namibian government to support the mining industry.

The shear volume of data and the increasing number of requests by customers for data windowed to their area of interest necessitated the development of a dedicated online data storage and management system. Consequently the Geological Survey of Namibia entered into a co-operation contract with DFA, Australia, to develop and customize a viewing, handling and archiving system. The system stores all grid and line archives in a consistent format, which guarantees data integrity and facilitates data distribution. In case a clients area of interest encompasses more than one survey, grid data are supplied as individual survey grids and also as windowed supergrids. Supergrids are compilations from all available high-resolution and regional data and are upgraded annually as new survey data become available.

The success of the *High Resolution Airborne Geophysical Survey Programme* in assisting and promoting mineral exploration in Namibia is demonstrated in Figure 2, where survey kilometres and data sales are compared to the number of active exploration licenses. The increase in survey coverage is mirrored by a corresponding increase in exploration activity, which provided impetus to exploration investment in Namibia at acceptable levels even during the years of low commodity prices prior to 2002. Following the recent upturn in the commodity market, Namibia, with high-quality airborne geophysical data available for nearly the entire country, has attracted considerable further exploration interest. It is also interesting to note that exploration activity has, at least partially, followed the expanding coverage of new high-resolution airborne surveys and has attracted the exploration community into previously under-explored areas covered by young sediments.

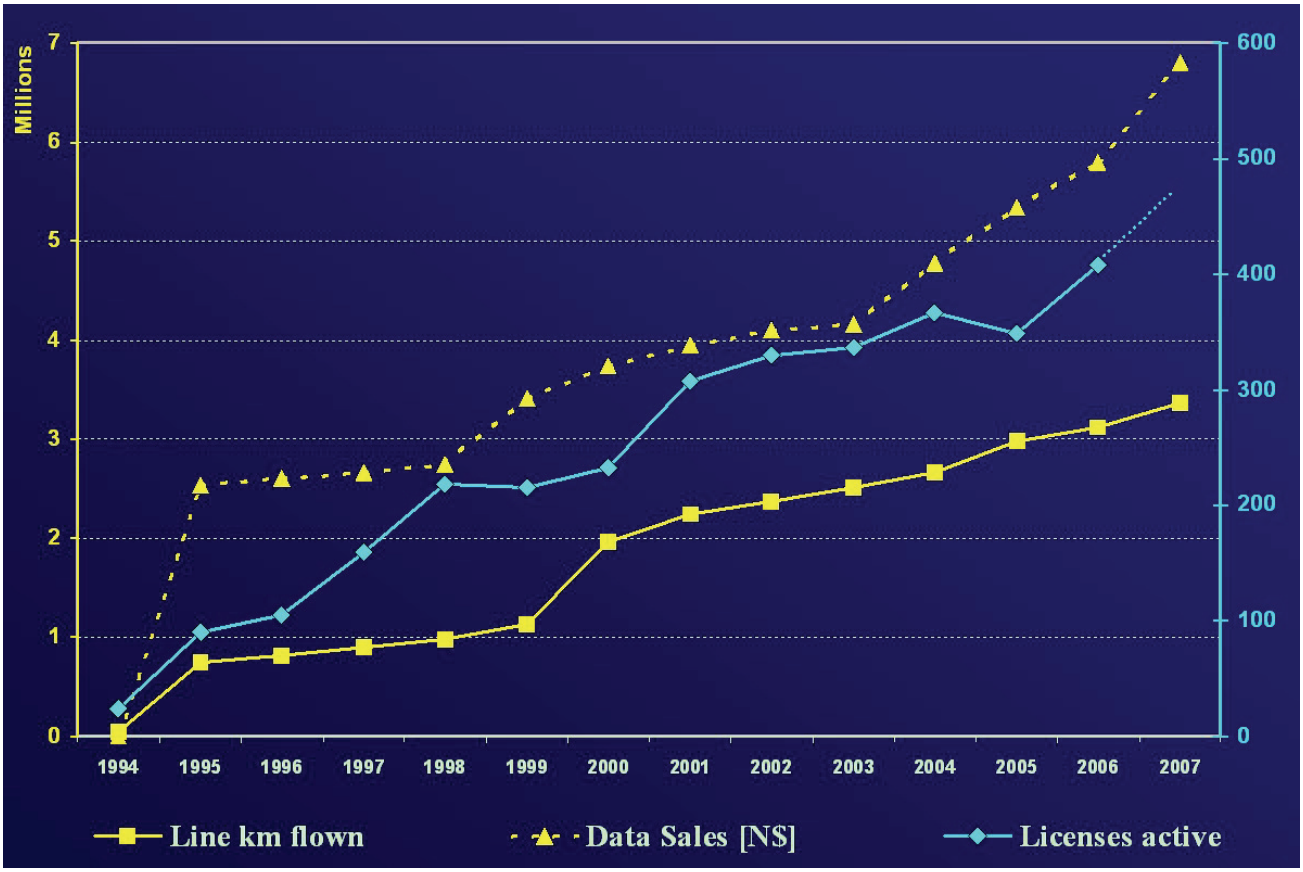

Figure 2: Airborne Geophysics Data Production and Sales compared to Active Exploration Licenses

GEOPHYSICAL TECHNIQUES

Although the main thrust of the programme lies with magnetics and radiometrics and virtually complete coverage is envisaged by the year 2009, other geophysical techniques have also been employed to address specific exploration challenges:

Electromagnetics

- In 1994/95 an Electromagnetic survey focused on the extension of the copper rich Matchless Amphibolite Belt under young Kalahari sediments and supported an intensive exploration programme by an international mining house.
- In 2005 two surveys were located in northeastern Namibia, an area covered entirely by Kalahari sediments, where airborne magnetic data indicated a possible triple junction of the Damara Orogen with mineral potential. The results of the surveys indicate that Kalahari sediments can be penetrated by modern EM systems and that the sediments are not too thick to discourage mineral exploration.
- In addition to these larger surveys, 15 case studies have been flown over known mineralisation to provide reference EM signatures of these occurrences.

Airborne Gravity

- In early 2004 the Geological Survey conducted two Airborne Gravity surveys to test the performance of the new GT-1A total field gravimeter. One survey was flown using a drape flying approach to test whether airborne gravity could economically be combined with magnetic and radiometric data acquisition.
- The second survey was flown conventionally at constant barometric altitude over an interesting magnetic target (Hat Anomaly) in the Kavango region of northeastern Namibia, an area also covered by young sediments. Results from the gravity data resolved the complex magnetic anomaly into a broad single linear, possibly intrusive, structure which may have mineral potential.

Hyperspectral Imaging

In 2004 some airborne Hyperspectral test surveys were conducted over known mineralisation to test the applicability of the method in the Namibian environment. Encouraged by the positive results several surveys were flown in 2005/06 and close to 20.000 sq-km of hyperspectral data are now available (Hausknecht et al, 2006):

- The **Otavi Mountainland Survey** was flown to enhance the knowledge about the mineralisation processes of Namibia's most prominent mineral district. This has interested at least one major international mining company. In addition, the data are currently being used to investigate environmental problems caused by over 100 years of mining activity in the Tsumeb area.
- The **HSU Survey** located over the Central Damara Belt was flown to assist exploration in this area, which is highly prospective for Uranium, and many companies have purchased data.
- The **Haib Survey** in southern Namibia revealed further insight into the mineral potential of this region but has, as yet, failed to attract interest.
- Two extended case studies were flown to assist diamond exploration: The **Mowe Bay Survey** along the northern Namibian coast has shown that hyperspectral mapping can assist in the identification of palaeo beach terraces. The **Sikereti Survey** in the Kavango region of northern Namibia was aimed at identifying indicator minerals of Kimberlites covered by thin Kalahari sediments.

CONCLUSION

The decision of the Namibian government to support the acquisition and distribution of modern high-quality geoscientific data, especially the High Resolution Airborne Geophysical Survey Programme, has been rewarded with increased mineral exploration activity. The current programme is due to be completed in 2009, and once complete national coverage is achieved, the acquisition of more target-orientated geophysical data is envisaged.

Initial exploration targets will be identified through a coordinated interpretation of the existing magnetic and radiometric data. This will be followed by appropriate detailed airborne geophysical surveys over areas of interest and further interpretation, which will be supported by stratigraphic drilling.

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