INTRODUCTION

South Africa is highly dependent on coal to generate 70% of its electricity. The majority of this coal comes from the Witbank Coalfield, but this source will be exhausted in the near-century (Prevor 2007). The Waterberg Coalfield (Figure 1) in the Limpopo province contains vast resources of coal and is the next area that will supply South Africa with energy well into the future. The coalfield is in the Karoo- Ellisras Basin. Coal was discovered in the Basin in 1920, but little exploration was conducted since.

The area covered by the geophysical investigation constitutes mainly the following area and will also source its coal from Grootegeluk, which could cause delivery problems. To conduct a credible geophysical interpretation and modelling, it is always important to understand the genesis of the basin.

GEOLOGICAL SETTING

The coal-bearing rocks belonging to the Karoo Supergroup and were deposited between 260 and 170Ma ago. They formed as a large graben structure bounded by the following basin edge faults:

- In the north on older basin rocks (the Melinda Fault zone) that belong to the Limpopo mobile belt
- In the south with the Waterberg Group (Barronshand and Ellisras Faults)
- Post Karoo faults (Daarby Fault) that disrupt coal seams.

The formation of the basin was controlled by structures that were formed and reactivated over time (Daarby Fault) and is the basin for the block faulting that occurs through the basin. To avoid confusion, the term ‘Ellisras Basin’ will be used.

STRATIGRAPHY

The areas covered by the geophysical investigation contributes mainly the following geological terrains:

- The Limpopo Mobile Belt – highly metamorphosed greisens which is a 2700Ma (Kramer et al., 2006)
- The Karoo Supergroup - consists of Waterberg Group (Barker et al., 2006) and the Karoo Supergroup (Johnson et al., 2006) and contains the coal. Most of it is in the Groenekloof Formation (110m thick in the north)
- Recent cover is from the weathering of greisens of the Limpopo Mobile Belt and the Karoo rock in the north, but from Waterberg sandstones in the south
- Intrusive rocks – the most important of these rocks are those that cut through the coal-bearing rocks and disrupt the seams. They occur less frequently in the Ellisras Basin.

GEOPHYSICAL SURVEY

This survey was conducted in 2007 and covered eight 1:50 000 sheets. The survey was flown in a north-south direction at a 200m line-spacing. The flying height was 80m at a speed of 230km/h. The sampling frequency was 10Hz, implicating a measurement every 6.5m.

The survey was flown in blocks of 5km by 5km with a tie-line every 1km in an east-west direction. The purpose of the tie lines is to facilitate the levelling of the flight lines, which was collected with a cesium vapour magnetometer (resolution 100nT). The radiometric data was collected with an 80 lire Nal crystal and the elevation was measured using a laser altimeter.

The contact between the Limpopo Mobile belt and the Ellisras Basin can easily be seen on the magnetic data. It also shows the absence of strongly magnetised structures in the basin.

The total count radiometric data (Figure 2) shows the northern contact of the Ellisras Basin clearly. It also shows the large block faulting and radioactive material eroding from the source (Waterberg Sandstones) in the south into the sediment load of the north-flowing Molokwane River. These sandstones are mainly the feldspar-enriched kromslo sandstones, which indicate that the original source was granite in composition. The source in the north is the granites of the Limpopo Molokwane Belt.

The uranium count and the thorium count show a similar pattern. However, the concentrations are low. The higher thorium count suggests that the source of the radioactivity is much older, i.e. the current source is a second generation source.

The potassium count is the highest and maps the distribution of the radioactive suite of radionuclides. The potassium count is the highest and maps the distribution of the radioactive suite of radionuclides.

GEOPHYSICAL INTERPRETATION

A phase operator was calculated on the magnetic data (Figure 3). The enhanced data show all the smaller anomalies in the data. This confirms that the structure in the Ellisras Basin is either weakly magnetic or all structures are below the Karoo cover in the basement material (Waterberg).

PHYSICAL PROPERTIES

To conduct a credible geophysical interpretation and modelling, it is always necessary to sample the geology and measure the physical properties of the different lithologies. Samples were taken of the Karoo lavas (Sattaba Basalt), Karoo sandstones (Magalakwe Formation) and Waterberg sandstones (Kranskop, Nickslopi and Magalakwe formations).

A specimen was taken from what we first believed was a Hydrothermal or Falcic Dyke. Microscope studies showed that it is an iron rich pillow with growth rings around its meristic axis. This means that the origin was not hydrothermal, but hypabyssal.

The physical properties show that the basalt and shale are magnetic and conductive. The sandstones are mostly non-magnetic. Densities of the shale and sandstones vary.

CONCLUSIONS

The airborne geophysical survey was a major contribution towards gaining knowledge about the Ellisras Basin. The data and the first interpretation have shown that the basin has undergone much more structural disturbance than what was previously suspected. The survey also revealed a large amount of previously unknown structure in the basin.

This poses the question – How many of these structures remain undetected because they are non-magnetic in nature? The question can most likely be satisfactorily answered by airborne electromagnetic surveys. This would produce much more additional data and greatly enhance the structural understanding of the Ellisras Basin. This will also ensure better coal delineation and ultimately better mining practices with a better coal recovery.

REFERENCES


New airborne geophysical data from the Waterberg Coalfield – South Africa’s major future energy source

South Africa’s current coal source will be exhausted in the next century – new airborne geophysical data sheds new light on an alternative energy source.

The Coaltech Research Association commissioned an airborne geophysical survey of the area to enhance the structural understanding of the basin. The magnetic and radiometric methods were applied. The datasets collected were:

- Magnetic
- Total count radiometrics (Figure 2)
- Uranium count radiometrics
- Thorium count radiometrics
- Potassium count radiometrics
- Digital elevation model radiometrics

The magnetic susceptibility in the Ellisras Basin is low; however, the application of a phase operator on this data (Figure 2) reveals a large amount of weakly-magnetised anomalies that could be due to pre-Karoo features in the basin floor. The radiometric data complemented the magnetic data by delineating the basin boundaries and indicated large block faulting.

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