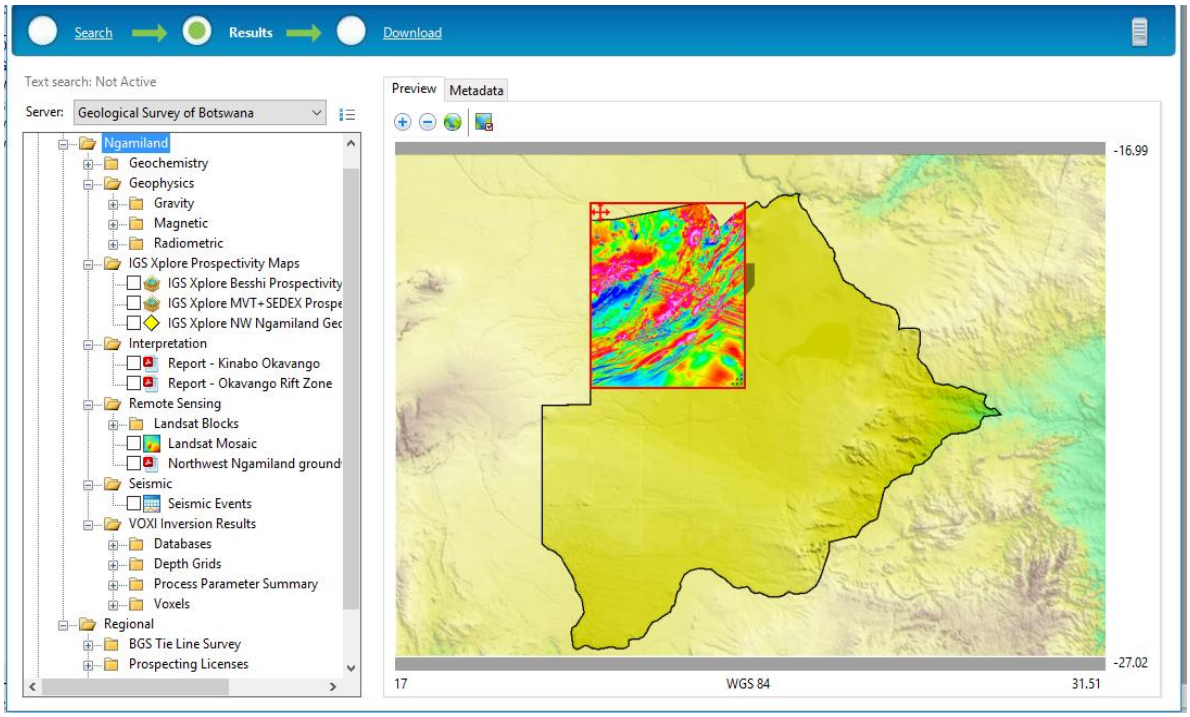
A Summary of the Ngamiland data in the Geoscience Portal



Introduction:

The Ngamiland data can be viewed online using the Geosoft seeker under the ***Geological Survey of Botswana*** server as shown above OR through the web address: https://geoscienceportal.geosoft.com/. It contains about 107 files or multi-disciplinary geophysical data of the Ngamiland area in the North West district as well as value-add products. These records/data are placed in their respective folders and sub-folders that are discussed below.

1. **Geochemistry:**

   The folder contains regional geochemistry dataset acquired on 500m soil sampling grid covering the NW part of the Ngamiland area. The regional soil chemical mapping extends over 30, 400sqkm, done from May 1997 to Dec 1999. Three main physiographic units are covered including the Okavango Swamps and alluvial floodplains (35.1%), the sandveld (64.1%) and some rock outcrops in the south and southeastern parts of the region (incl. Aha Hills, Ipopeng, Tsodilo Hills etc.

2. **Geophysics:**

   The Geophysics folder contains mainly high-resolution aeromagnetic data acquired and flown over the years by both Government and the private sector plus radiometric survey in some areas as well as regional gravity surveys archived under the following sub-folders:

a) Gravity

The gravity sub-folder contains merged regional gravity point data ranging from 1 to 7.5km spacing and grid data in the Ngamiland area.

b) Magnetic

The magnetic sub-folder contains all high resolution aeromagnetic data acquired over the area as far back as 1989 to 2003. The survey specifications are summarized in the table below. Some of the details about the surveys are captured on the logistics reports.

Survey Name	Year Flown	Flight Height	Line Spacing	Line Direction	Total line-kilometer
1. Block A	1989	80m	250m	0◦	92707
2. Boteti	2001	80m	250m	0◦	23260
3. Deception Pan	2003	80m	250m	0◦	43396
4. Ghanzi Chobe	1994	80m	250m	155◦	166211
5. Mopipi	1988	80m	250m	70◦	81681
6. Western Ngamiland	1997	80m	250m	345◦	281,494.6
7. Okavango	2003	80m	250m	345◦	101,067

c) Radiometric

Radiometric folder includes Maun radiometric data comprising Total count, Potassium, Thorium and Uranium. The data was acquired together with aeromagnetic data in in 1995 at 250m Line spacing and 165◦ Line direction.

3. IGS Prospectivity Maps

a) The Besshi Prospectivity Map

The data includes IGS Xplore prospectivity maps that contains a base metal prospectivity analysis for **Besshi-type copper deposits for the Ngamiland region of North West Botswana.** The analysis has been generated using the new semantically driven mineral prospectivity software service, IGS Xplore. The package contains a map in both geotiff and shape / layer formats and a mineral prospectivity report in PDF format, which provides details of the analyses completed as well as discussion of the prospectivity results. The IGS Xplore Besshi prospectivity map has been generated solely from geodata downloaded from the Botswana Geoscience Portal, namely (1) a vectorised bedrock geological map at a nominal map scale of 1:1,000,000 (ESRI shapefile); (2) geochemical dataset of 65,642 samples (XYZ file); (3) geophysical datasets: gravity, radiometric and aeromagnetic (GRD file); and (4) remote Sensing Landsat data (raster). The prospectivity map covers the very northwest of Botswana only as this is currently the only area where geochemistry data is available, and also where the geodata is the most overlapping. For further information, please refer to the full report, IGS Xplore Botswana Report.pdf.

b) The IGS Explore MVT and Sedex Prospectivity Map

Contains a base metal prospectivity analysis for carbonate-hosted Pb-Zn ± Cu deposits (MVT + SEDEX) for the Ngamiland region of Northwest Botswana. The analysis has been generated using the new semantically driven mineral prospectivity software service, IGS Xplore. The package contains a map in both geotiff and shape / layer formats and a mineral prospectivity report in PDF format, which provides details of the analyses completed as well as discussion of the prospectivity results. The IGS Xplore MVT + SEDEX prospectivity map has been generated solely from geodata downloaded from the Botswana Geoscience Portal, namely (1) a vectorized bedrock geological map at a nominal map scale of 1:1,000,000 (ESRI shapefile); (2) geochemical dataset of 65,642 samples (XYZ file); (3) geophysical datasets: gravity, radiometric and aeromagnetic (GRD file); and (4) remote Sensing Landsat data (raster). The prospectivity map covers the very northwest of Botswana only as this is currently the only area where geochemistry data is available, and also where the geodata is the most overlapping. For further information, please refer to the full report, IGS Xplore Botswana Report.pdf.

c) Also included is the Xplore NW Ngamiland Geology.

4. Interpretation

a) Report – Kinabo, Okavango (PDF)

Aeromagnetic and gravity data collected across the Okavango rift zone, northwest Botswana are used to map the distribution of faults, provide insights into the two-dimensional shallow subsurface geometry of the rift, and evaluate models for basin formation as well as the role of pre-existing basement fabric on the development of this nascent continental rift. The structural fabric (fold axes and foliation) of the Proterozoic basement terrane is clearly imaged on both gravity and magnetic maps. The strike of rift-related faults (030–050 in the north and 060–070 in the south) parallels fold axes and the prominent foliation directions of the basement rocks. These pre-existing fabrics and structures represent a significant strength anisotropy that controlled the orientation of younger brittle faults within the stress regime present during initiation of this rift. Northwest dipping faults consistently exhibit greater displacements than southeast dipping faults, suggesting a developing half-graben geometry for this rift zone. However, the absence of fully developed half-grabens along this rift zone suggests that the border fault system is not fully developed consistent with the infancy of rifting. Three en-echelon northeast trending depocenters coincide with structural grabens that define the Okavango rift zone. Along the southeastern boundary of the rift, developing border faults define a 50 km wide zone of subsidence within a larger 150 km wide zone of extension forming a rift-in-rift structure. It is inferred from this observation that the localization of strain resulting from extension is occurring mostly along the southeastern boundary where the border fault system is being initiated, underscoring the important role of border faults in accommodating strain even during this early stage of rift development. The report concludes that incipient rift

zones may provide critical insights into the development of rift basins during the earliest stages of continental rifting.

b) Report - Okavango Rift Zone (PDF)

The study used aeromagnetic and gravity data to investigate the thermal structure beneath the incipient Okavango Rift Zone (ORZ) in northwestern Botswana to understand its role in strain localization during rift initiation. The study used three-dimensional(3-D) inversion of aeromagnetic data to estimate the Curie Point Depth (CPD) and heat flow under the rift and surrounding basement. It also used two-dimensional (2-D) power-density spectrum analysis of gravity data to estimate the Moho depth. Our results reveal shallow CPD values (8–15 km) and high heat flow (60–90 mWm2) beneath a ~60 km wide NE-trending zone coincident with major rift-related border faults and the boundary between Proterozoic orogenic belts. This is accompanied by thin crust (<30 km) in the northeastern and southwestern parts of the ORZ. Within the Precambrian basement areas, the CPD values are deeper (16–30 km) and the heat flow estimates are lower (30–50 mWm2), corresponding to thicker crust (~40–50 km). The interpretation is that the thermal structure under the ORZ as due to upward migration of hot mantle fluids through the lithospheric column that utilized the presence of Precambrian lithospheric shear zones as conduits. These fluids weaken the crust, enhancing rift nucleation. The interpretation is supported by 2-D forward modeling of gravity data suggesting the presence of a wedge of altered lithospheric mantle centered beneath the ORZ. If the interpretation is correct, it may result in a potential paradigm shift in which strain localization at continental rift initiation could be achieved through fluid-assisted lithospheric weakening without asthenospheric involvement.

5. Remote Sensing

This folder contains the remote sensing data and Mosaic covering the Ngamiland area as well as

the Northwest Ngamiland Groundwater Remote Sensing Report that was part of the Northwest Ngamiland TGLP Groundwater Potential Study.

6. Seismic

Contains data on seismic events in the region that were recorded by local seismic monitoring network.

7. The VOXI inversion results

Contains Ngamiland VOXI Earth Modelling results and the following data bases:

a) MVI Measured and Predicted Magnetic Field

This database contains the measured magnetic field data used as input in the Magnetization Vector Inversion, as well as the predicted response from the inversion result at the observation points.

b) MVI Result Saved as Database

The Magnetic Vector Inversion (MVI) vector voxel result was converted to this database. For each cell in the vector voxel result, the location, component, amplitude, and orientation data are saved to this database.

c) Susceptibility Measured and Predicted Magnetic Field

This database contains the measured magnetic field data used as input in the susceptibility inversion, as well as the predicted response from the inversion result at the observation points. Project details can be found in the Ngamiland VOXI Earth Modelling Processing Report.

d) Susceptibility Result Saved as Database

The susceptibility result voxel was converted to this database. For each cell in the voxel, the location and susceptibility value are stored in this database.

e) Depth Grids

The folder contains MVI Amplitude Depth Grids and Susceptibility Depth Grids

This grid is the amplitude of the MVI result sliced at 0m depth to 6000m below the surface.

Also includes the grids for the susceptibility inversion result sliced at 0m to 6000 depth below the surface. Ngamiland VOXI Earth Modelling Processing Report

Magnetic field data over the Ngamiland, Botswana region was selected to model, in 3D, the magnetization distribution of crustal rocks beneath the Okavango delta and surrounding areas. This in turn can provide insight into structural processes that shape the Okavango Rift Zone. The 3D models were created with voxel-based inversion using the VOXI Earth Modelling Service from Geosoft Inc. To model the long and short wavelength anomalies in the regional data, the study used a combination of a large areal extent and a relatively small cell size to create the inversion mesh. This presented a significant computational challenge as the inversion mesh exceeded 35 million cells in volume. The solution was to utilize the High-Performance Computing capability in the Microsoft Azure, cloud based VOXI Earth Modelling Service. Two 3D models were created: the first using Magnetization Vector Inversion (MVI), which solves for the magnetization amplitude and direction without restricting magnetization to be along the Earth's inducing field direction; the second was a conventional susceptibility inversion, which solves for the magnetization amplitude assuming all sources are magnetized by induction only. In both models, use was made of Iterative Reweighting Inversion (IRI) Focusing to counter the smoothing effects of an unconstrained Tikhonov regularized 3D inversion. The result was a distribution of magnetized source bodies with well-defined edges.

8. Voxels

This folder contains 3D **VOXI inversion modelling results:**

a) 3D MVI Amplitude Voxel

This voxel is the scalar amplitude of the MVI result.

b) 3D MVI Vector Voxel
This voxel contains the 3D vectors of the MVI result.

c) 3D Susceptibility Voxel
This voxel is the susceptibility result from the inversion.

Project details can be found in the Ngamiland VOXI Earth Modelling Processing Report.

9. Tie Line Survey

The folder contains aeromagnetic country-wide tie-line survey that was flown in 2010-12 to facilitate seamless merging of all existing high resolution aeromagnetic survey data in Botswana. The survey was flown ate 80m height, 10 km line spacing in the North-South direction and 50km tie line spacing.

10. Prospecting License Reports

Contains Prospecting License shapefiles for various commodities such as coal, energy, industrial minerals, metals, petroleum, precious stones and radioactive minerals for the year 2015 and 2016 only