Mineral potential of Rwanda: Prospective target areas at depth as interpreted from airborne gravity and aeromagnetics

D. James Misener, Paterson, Grant & Watson Ltd., Michael Biryabarema**, Rwanda Geology and Mines Authority, Sally Barritt***, GeoWitch*

Paterson, Grant & Watson Limited
1710-155 University Avenue
Toronto, ON. M5H 3B7 Canada
jim.misener@pgw.on.ca

Rwanda Geology and Mines Authority (O.G.M.R.)
P.O. Box 2195
Kigali, Rwanda
mbiryabarema@yahoo.com

GeoWitch
Bolwerk 33
1411 LK Naarden, The Netherlands
geowitch@telfort.nl

Summary

The Rwanda Geology and Mines Authority has compiled one of the most comprehensive countrywide geoscientific databases in East Central Africa. Recent airborne gravity coverage has been commissioned by O.G.M.R. and complements the regional airborne magnetic and radiometric coverage. Interpretation of these datasets combined with results of geological mapping has lead to the production of a Mineral Prospectivity Map for Rwanda. A number of Prospective Target Areas have been selected that have potential for Sn, W-Nb-Ta and/or Au mineralization.

The geophysical interpretation results are a compilation of aspects that include **a)** the outline of voluminous granites and surficial granites based on a combination of 2D and 3D modelling of gravity data and analysis of the airborne radiometric results and **b)** the delineation of regional structures and surface Proterozoic lithologies using processed aeromagnetics.

Introduction

Rwanda hosts a large number of historical mineral occurrences and a few operating mines, the major commodities produced being Sn, W, Ta and Nb. All of these commodities are now in high demand worldwide and in short supply, thus Rwanda is a prime candidate for renewed greenfields exploration. Studies of two major Sn and W deposits in Rwanda (Pohl and Gunther, 1990 and DeClerq et. al., 2008) indicate that the metals are deposited in quartz veins resulting from metamorphism of granites at depth.

In order to discover new Sn/W deposits it will be necessary to find extended or unknown granites at depth that exhibit little or no surface geological or geochemical expression.

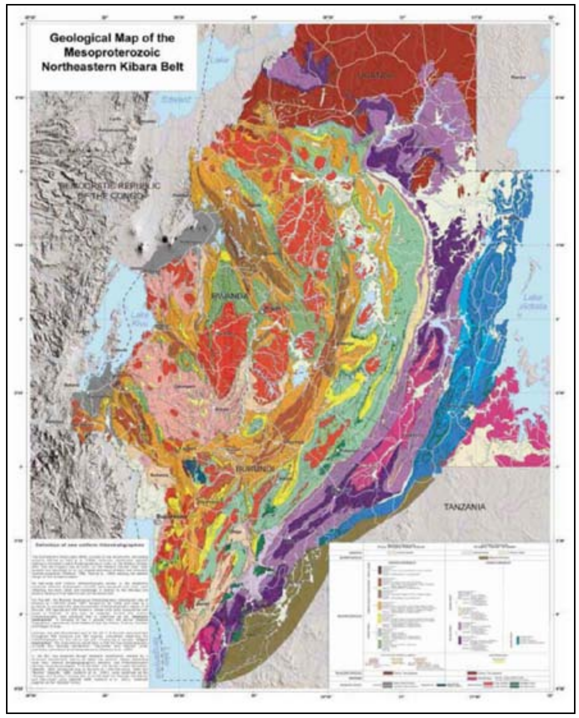

Figure 1: Geology of Rwanda.

The mineralogy and geochemistry of the favourable 1.38 Ma, S-type granites which intrude the Western Domain of the NE Kibaran belt (see Figure 1), indicate a limited compositional range. Dominated by syeno-monzogranites, with minor granodiorite and quartz diorite, these peraluminous, calc-alkaline intrusives are likely to possess a low density in comparison to the host Kibaran metasediments and pre-Kibaran granitic gneisses. The S-type granites are systematically associated with, and often enclose, subordinate mafic rocks consisting mainly of amphibole-bearing, coarse-grained dolerite or gabbro. Such mafic rocks would, typically, have a higher density than their granitic counterparts as well as the host metasedimentary and granitic gneiss terrains. However, field observations report only small bodies and pods of

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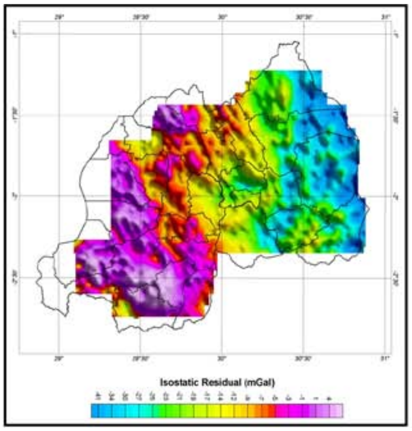

Figure 2: Isostatically Corrected Bouguer Anomaly.

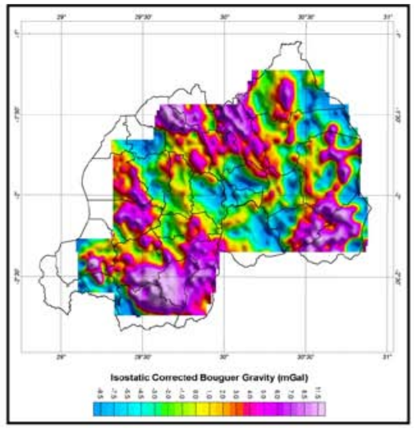

Figure 3: Isostatically Corrected Bouguer Anomaly with Regional Field removed.

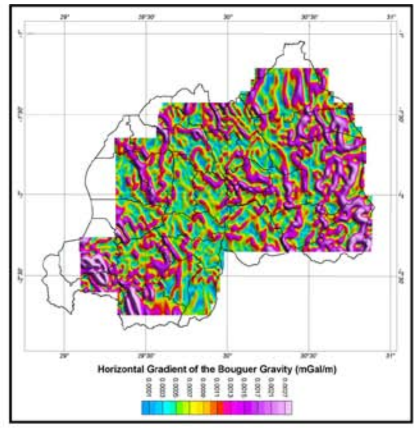

Figure 4: Total Horizontal Gradient of the Residual Bouguer Anomaly Field.

mafic rocks as subordinate components of the domes, elongate bodies and sheeted intrusions. The bulk density of the igneous bodies is, therefore, likely to be closer to that of the S-type granitoids and, where these occur in any significant volume, would give rise to negative Bouguer Anomalies.

The post-Kibaran, G4, “tin granites” are poorly recognized and documented for Rwanda but indications are that they are leucogranites, similar to the Kalima batholith in eastern-central Congo, and would also be of relatively low density. The pegmatites and quartz veins, both barren and those that host most of the Sn-Nb-Ta-W mineralization, are also of low density but probably volumetrically insignificant in terms of their contribution to the anomalous gravity field at the spatial resolution measured by the airborne survey. The relatively high density of the mineralization itself would, in addition, offset the low density of the host pegmatites and quartz veins.

Other low density units that would contribute to negative Bouguer Anomalies include Quarternay intermontain molasse and alluvial deposits.

Gravity and Geoscience Database for Rwanda

The Rwanda Geology and Mines Authority (O.G.M.R.) over the last decade has compiled one of the most complete geoscientific databases available in Africa today. The latest addition to the countrywide database is complete coverage of airborne gravity. The survey was flown in 2008 and the compiled results, along with complete countrywide coverage of aeromagnetics, radiometrics, geology and mineral occurrences are available in digital form and as 1:100,000 scale maps.

The airborne gravity survey was flown at a line spacing of 4 km and the residual isostatically corrected Bouguer gravity is shown in Figure 2. This residual field indicates a strong regional gradient across the country from W to E reflecting the mantle rise beneath the present-day rift to the west of Rwanda and the contrast in the thickness/geology of the Proterozoic pre-Kibaran basement that underlies the western domain of the NE Kibaran belt and the thicker, Achean Tanzanian Craton that underlies the Eastern Domain of the NE Kibaran belt, see Figure 1.

A long wavelength (200 km) regional field has been removed from the isostatically-corrected data to provide a residual Bouguer anomaly map that better reflects density variations within the upper crust as shown in Figure 3. The complete horizontal gradient of the resulting residual Bouguer anomaly provides an image that locates the edges of density contrasts, including those arising at the boundaries of less dense voluminous granites as shown in Figure 4.

Geophysical Interpretation, Gravity Modelling/ Inversion and Target Selection

A detailed geophysical interpretation of Rwanda was completed at the 1:100,000 scale based on the geological map sheet outlines. Five interpretive aspects were incorporated in the final composite map:

- Structural Interpretation — determined from aeromagnetics, gravity and mapped surficial structures;

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- Voluminous Granites — interpreted and modelled from gravity and aeromagnetics;
- Surficial Granites — interpreted from magnetics and radiometrics;
- Alteration Zones and Major Magnetic Units — interpreted from processed aeromagnetics and radiometrics;
- Mineral Occurrences and Mapped Granites.

Two aspects of the granitic intrusions that have been mapped from the geophysical data are **a)** the location of the most voluminous granites (greatest depth extent) as shown on Figure 5A, and **b)** the differences in radioelement contents (as shown on Figure 5B). Large negative Bouguer Anomalies combined with complementary magnetic textures indicate the presence of voluminous granites, the edges of such bodies being located by maxima in the horizontal gravity gradient and/or abrupt lateral changes in magnetic relief. Correlations with mapped geology corroborate the geophysical signatures of the granites where they outcrop. Extension of these bodies beneath surface has then been mapped from the continuation of characteristic geophysical signatures. Similar gravity and magnetic signatures in areas where no granite is seen at surface, and no alternative explanation is apparent, have been tentatively interpreted as sub-surface granites.

All areas that have been geologically mapped as granites have been mapped on the basis of the radioelement ternary image and classified in terms of their relative K, U and Th contents using the three individual element grids. In some cases distinctive radiometric signatures are noted in areas where granite is not mapped at outcrop but gravity and magnetic anomalies indicate their presence. Radiometric signatures interpreted as due to alteration by either magmatic fluids or hydrothermal systems focused on granitic bodies have also been tentatively identified – details of the location of these with respect to voluminous granites and faults in close proximity were presented on the 1:100,000 scale interpretations.

Gravity modelling along selected profiles and three dimensional modelling over specific buried granitic bodies were the primary tool used to select targets for detailed study and exploration.

Example Area: Central Rwanda Prospective Region

This area was selected based on the presence of known mineralized granitic bodies and the presence of well defined gravity anomalies over unexplored regions (see Figure 6). This map of Central Rwanda illustrates the extent of the mapped granites, the location of known mineralization as well as the newly interpreted extent of the voluminous granites along with modelled inversions indicating the varying depth extent of the intrusions. A number of profiles were selected for modelling and the results will be used to focus detailed ground exploration.

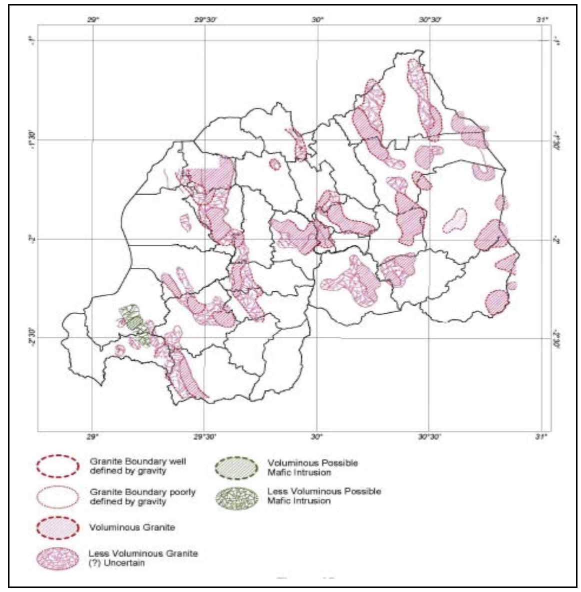

Figure 5A: Voluminous Granites: Gravity Interpretation

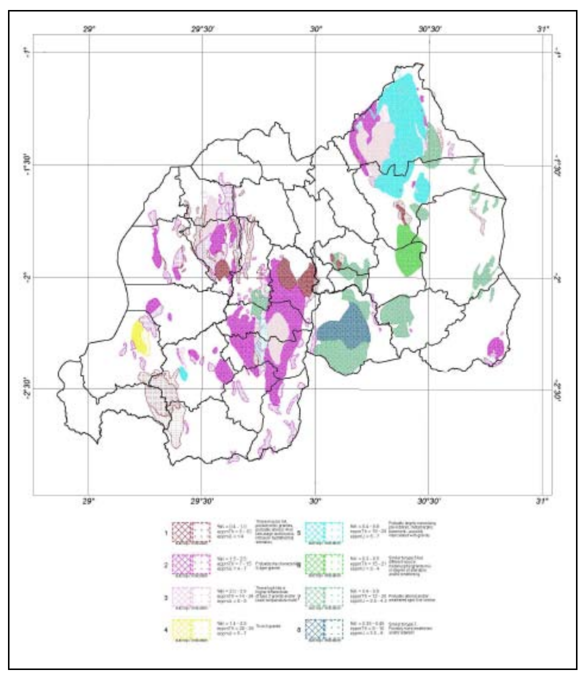

Figure 5B: Surficial Radiometric Signatures of Granites and Gneisses.

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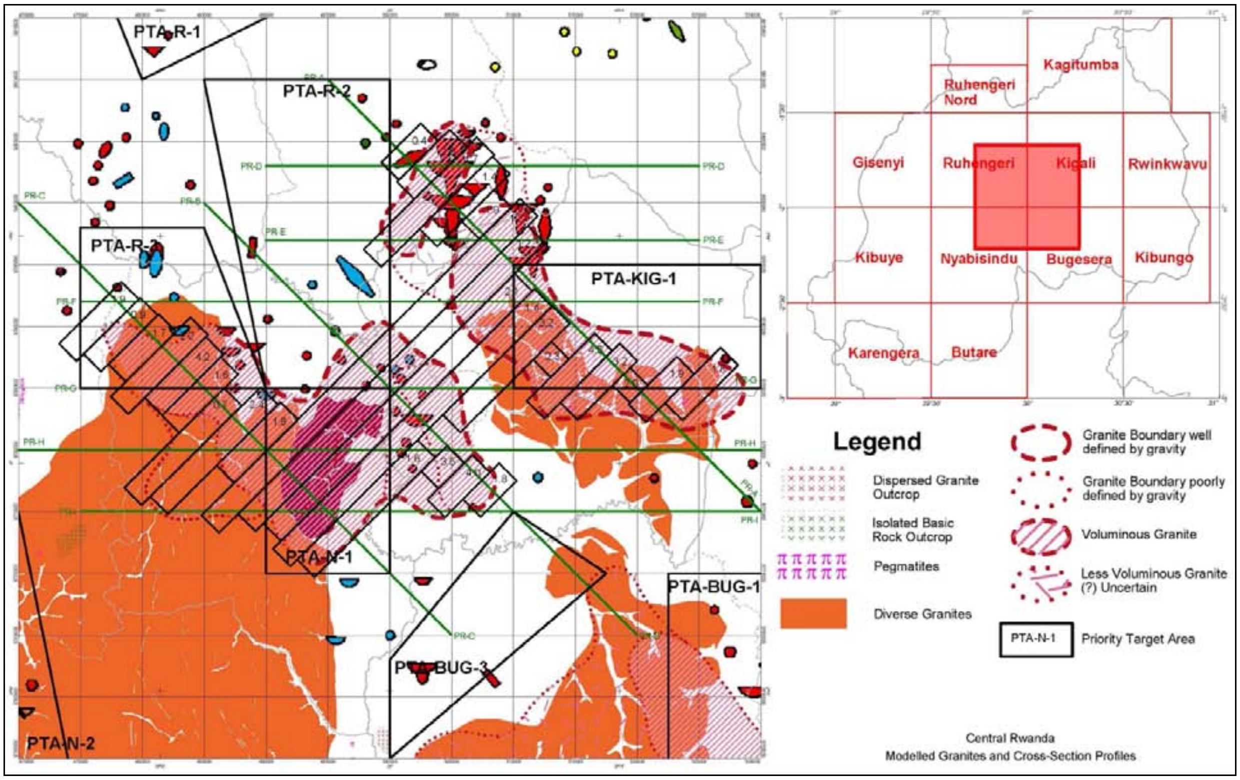

Figure 6: Central Rwanda: Modelled Granites and Cross-Section Profiles.

Central Rwanda Profile A (PR-A) as shown in Figure 7 extends NW–SE across the Kigali granite and presents the Analytic Signal of the T.M.I. and the Calculated Residual Bouguer Gravity along with the aspects of the Interpretation. The profile indicates that the maximum thickness of the voluminous granite is approximately 4 km under the selected target area (PTA KIG-1) and that the granite extends for at least 8 km further to the northwest than is presently mapped.

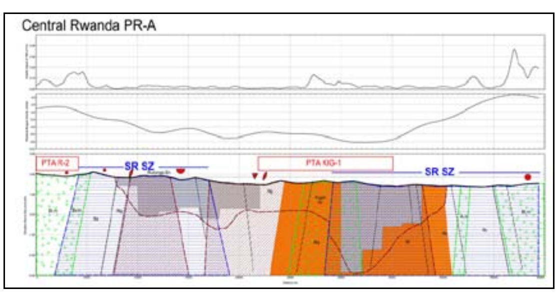

Figure 7.

Conclusions

Based on the interpretation and modelling of geophysical data, especially airborne gravity, a Mineral Prospectivity Map of Rwanda has been compiled. The results of the study indicate new targets for buried intrusives that have excellent potential for new discoveries of Sn and W-Nb-Ta.

The results also indicate the value to both major mining companies and national governments of a commitment to the acquisition of regional airborne gravity over greenfields areas of mineral exploration.

Acknowledgments

We wish to thank the Rwanda Geology and Mines Authority (O.G.M.R.) for permission to use the geophysical datasets of Rwanda. All enquiries regarding the availability of the geoscience databases for Rwanda should be directed to the Director, O.G.M.R., Kigali, Rwanda.

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