Geophysical investigation of the Marble Hall Fragment of the Bushveld Complex

By

OLUSEYI KAYODE TIMMY BABAYEJU

Submitted in partial fulfillment of the requirements for the degree

of

Master of Science

in the Faculty of Science

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DEDICATION

I dedicate this study to my entire family who have been full of prayers and support for me for as long as this research lasted.

ACKNOWLEDGEMENT

The completion of this research would not have been possible without the assistance of many others who contributed financially, logistically, critically and morally.

First, I thank the Lord Almighty, my creator and my redeemer for leading the way for me throughout the duration of this research project and for His grace in making meet with the favour of people in the study area.

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The effort of every other person not mentioned and who has contributed one way or the other to the success of this research is also appreciated.

I thank you all.

OPSOMMING

Die geologiese struktuur van die Marble Hall Fragment van die Bosveldkompleks in die Mpumalanga Provinsie is ondersoek met behulp van gravitasie en hoë-digtheid lugmagnetiese data. Tydens die gravitasieondersoek is 'n regionale ondersoek oor 731 vierkante kilometer gedoen. Altesaam 731 swaartemetings, met 'n 1 kilometer interval, is ingesamel oor die Transvaal Supergroep, die mafiese gesteentes en die omliggende graniet. Die magnetiese data is gevlieg op 'n hoogte van 60 meters met 'n 87 meter lynspasiëring. Verskeie filters is toegepas op die magnetiese data met behulp van OASIS Montaj sagteware, en die struktuurelemente in die Fragment is omlyn met eerste-afgeleide data.

Die Wonderkopverskuiwing in die noordweste en 'n beduidende noordsuid-strekkende verskuiwing aan die ooste begrens die Marble Hall Fragment aan beide kante. Die helling van die noordsuid-strekkende verskuiwing aan die oostekant van die Fragment kon nie vasgestel word nie omdat die verskuiwing nie dagsoom nie. Die sterk magnetiese anomalie wat in die oostelike flank van die Swartkop-Marble Hall-antiklien voorkom is die oppervlakmanifestasie van die Hekpoort Andesietformasie. Daarenteen is die oorsprong van 'n verskuifde, goedgedefinieerde halfmaanvormige liggaam, met 'n sterk magnetiese patroon, langs die Swartkop-Marble Hall antiklien, nie duidelik nie aangesien dit nie met enige geologiese dagsoomverskynsel gekorreleer kan word nie.

Twee-en-'n-half-dimensionele interpretasie van beide die gravitasie en magnetiese data is uitgevoer langs geselekteerde profiele. Uit die modelle is dit duidelik dat 'n digte magnetiese propvormige liggaam, geleë in die senter van die Marble Hall Fragment, in die gesteentes van die Transvaal Supergroep ingeplaas is. Die intrusiewe liggaam het 'n sentrale subvertikale

gedeelte en word omring op vlakker diepte deur subhorisontale plaatvormige liggame. As gevolg van die nie-eenduidigheid van die potesiaalveldmetodes kan die werklike diepte en dikte van die mafiese plate nie bepaal word nie, en dit is begryplik dat die plate moontlik dunner en nader aan die oppervlakte kan wees as wat die modelle aandui. Uit die modelle volg dit dat die mafiese gesteentes jonger is as die plooiing en, moontlik selfs, sommige van die verskuiwings. Die Fragment kan beskou word as geplooide vloer van Transvaal Supergroep wat as 'n horst na die intrusie van die Rustenburg Gelaagde Suite ingeplaas is.

ABSTRACT

The geological structure of the Marble Hall Fragment of the Bushveld Complex in Mpumalanga Province, was investigated using gravity and high density airborne magnetic data. The gravity investigation amounted to a regional survey over an area of approximately 750 square kilometres. A total of 731 measurements, at 1 kilometre intervals, were made of the gravitational attraction on the Transvaal Supergroup, the mafic rocks and the surrounding granite. The magnetic data was flown at a terrain clearance of 60 metres and 87 metres line spacing. Several filters were applied to the magnetic data using OASIS Montaj software and the structures observed on the Fragment were delineated using the first vertical derivative data.

The Wonderkop fault, in the north-west, and a major north-south trending fault to the east were shown to border the Fragment on either side. The dip of the north-south trending fault to the east of the Marble Hall Fragment, could not be determined because there is no surface expression of the fault. The high magnetic signature associated with the eastern limb of the Swartkop-Marble Hall Anticline, running from the south towards the east-north-east, is the surface expression of the Hekpoort Andesite Formation. However, the origin of a faulted, well defined, crescent shaped body, with high magnetic signature to the north, along the axis of the Swartkop-Marble Hall Anticline, is not obvious, because of non-compatibility with outcropping geology in the area.

Two and a half-dimensional interpretation of both the gravity and magnetic data were carried out along five selected profiles. From the models it is evident that a dense magnetic plug-like body, situated in the centre of the Marble Hall Fragment, was emplaced in the Transvaal Supergroup rocks. The intrusive body has a central sub-vertical core section surrounded at shallower levels

by sub-horizontal sill-like sections. Due to non-uniqueness in potential field situations, the exact depth and thickness of the mafic sills cannot be categorically stated, and it is conceivable that the sills might be thinner and closer to the surface than implied by the models. It follows from the models, that the intrusion of the Bushveld mafic rocks post-dates the folding and perhaps some of the faults in the Fragment. The Fragment could be seen as folded floor of Transvaal Supergroup that was emplaced as a horst after the intrusion of the Rustenburg Layered Suite.

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