



Contribution ID: 15

Type: not specified

A systematic approach to the interpretation of conductivity anomalies recorded with the Geonics EM34-3 electromagnetic instrument across intrusive dolerite dykes and sills in the Karoo Supergroup

Thursday, 2 October 2014 16:30 (15 minutes)

Groundwater exploration has become increasingly dependent on the use of geophysical techniques to gain insight into the subsurface conditions to minimise the risk of drilling unsuccessful production boreholes. Dolerite dykes and sills are often targeted during groundwater exploration programmes in Karoo rocks. Due to the high pressures and temperatures that reigned during the emplacement of these structures, the sedimentary host rocks along the margins of the intrusive structures are typically strongly altered. These altered zones are often heavily fractured and, as a result, have increased hydraulic conductivities as compared to the unaltered host rock. The altered zones often act as preferential pathways for groundwater migration, making them preferred targets during groundwater exploration.

In conjunction with magnetic methods, electromagnetic (EM) methods are the techniques most often used for groundwater exploration in Karoo rocks. In South Africa, the ground EM system most commonly used is the Geonics EM34-3 frequency-domain system. This system has already been in use for a few decades, yet a great deal of uncertainty still remains regarding the interpretation of anomalies recorded over geological structures associated with lateral changes in electrical conductivity. This uncertainty results from the fact that the Geonics EM34-3 system employs measurements of the out-of-phase components of the secondary magnetic field relative to the primary magnetic field to calculate an apparent conductivity for the subsurface. The apparent conductivity profiles across lateral changes in conductivity often do not make intuitive sense. This project focuses on the development of guidelines for the interpretation of anomalies recorded with the EM34-3 system across intrusive structures of geohydrological significance in Karoo rocks. Geophysical surveys were conducted across known dykes and sills in an attempt to systematically investigate the responses recorded across these structures. Data from magnetic and two-dimensional electrical resistivity tomography surveys, as well as from geological borehole logs in some cases, were used as controls to assist in the interpretation.

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Session Classification: Rocks

Track Classification: Oral and Poster Presentation