

CRUSTAL STRUCTURE OF THE ARCHEAN GRANITE-
GREENSTONE TERRANE IN THE NORTHERN PORTION
OF THE KAAPVAAL CRATON

J.H. de Beer (National Physical Research Laboratory, CSIR, P.O. Box 395, Pretoria 0001, S. Africa), E.H. Stettler (Geological Survey, P.O. Box X112, Pretoria 0001, S. Africa), J.M. Barton Jr, D.D. van Reenen and J.R. Vearncombe (Dept. of Geology, Rand Afrikaans University, P.O. Box 524, Johannesburg 2000, S.Africa).

Recent investigations of the electrical resistivity, gravity and aeromagnetic signatures of the various granite-greenstone units in the northern portion of the Kaapvaal craton have revealed three features of significance: 1) the Archean greenstone belts are shallow features, rarely exceeding 5 km in depth; 2) the high resistivity upper crustal layer typical of the lower grade granite-greenstone terranes is absent in the granulite facies terrane and 3) the aeromagnetic lineation patterns allow the granite-greenstone terrane to be subdivided into geologically recognisable tectono-metamorphic domains on the basis of lineation frequency and direction.

In the Pietersburg, Sutherland and Murchison greenstone belts geoelectrical investigations showed that the greenstone lithologies have a lower resistivity than the surrounding granitic terranes. Positive gravity anomalies over the greenstone belts are related to more dense metamorphosed ultramafic and mafic rocks in the belts compared to surrounding granitic rocks. Numerical modelling of the geophysical data indicates that the greenstone belts are asymmetrical structures, being thicker along the southeastern flanks. The belts are underlain by high resistivity, low density granitic rocks of which two types are distinguished by their average densities: a lower density series (density = 2600 kg m^{-3}) corresponding to 2650 Ma granodioritic plutons and a higher density series (density = 2670 kg m^{-3}) comprising the older gneissic terrane. The younger series is well developed along the southern margins of the greenstone belts and occurs locally along the northern margins. Primary layering and tectonic fabric within the greenstone lithologies are subvertical. Thicknesses measured across layering exceed the depth of

the belts, suggesting no simple rotation of the greenstone lithologies but instead a truncation at shallow depths of structurally repeated (folded and imbricated) greenstone belts. This truncation may be a major recumbent deformation zone, recumbent syntectonic granite or a late intrusive contact.

Deep resistivity soundings indicate significant changes in the regional structure of the crust in the northern portion of the Kaapvaal craton corresponding to changes in metamorphic grade and tectonic style. In the low-grade granite-greenstone terrane the upper 10 km or less of the crust is characterized by high-resistivity rocks (approximately 100 000 ohm.m) overlying a more conductive layer (approximately 5 000 ohm.m) to a depth of about 35 km. Below this possible mantle rocks with a resistivity of about 50 ohm.m occur. Where the granulite facies rocks of the northernmost Kaapvaal craton (southern marginal zone of the Limpopo belt) occur the approximately 100 000 ohm.m layer is absent and rocks with a resistivity of 5 000 ohm.m extend to a maximum depth of 35 km, where they overlie possible mantle rocks. The significance of these variations in the physical properties of the Kaapvaal craton will be addressed.

The aeromagnetic lineation pattern in the study area can be divided into distinct domains on the basis of the lineation frequency and direction. Although these magnetic anomalies are due to mafic and ultramafic dykes they reflect an inherent fabric in the crust. The domain boundaries correspond to known tectonic and/or metamorphic transitions. One such boundary being the orthoamphibole rehydration isograd that marks the transition between the granulite facies terrane of the southern marginal zone of the Limpopo belt (northern Kaapvaal craton) and the lower-grade rocks to the south. It is clear that the lineation pattern does not reflect the different lithological units in the area and the Sutherland and Pietersburg greenstone belts are, for example, not reflected in the aeromagnetic lineation pattern. This suggests that they are an internal component of certain domains and not marking domain sutures.