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AN INTEGRATED GEOPHYSICAL INVESTIGATION OF THE TAMWORTH BELT AND ITS BOUNDING FAULTS

By

Bin Guo

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DOCTOR OF PHILOSOPHY

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SUMMARY

This thesis presents new magnetic and gravity data for the Southern New England Fold Belt (SNEFB) and the Gunnedah Basin that adjoins to the west along the Mooki Fault in New South Wales. The SNEFB consists of the Tamworth Belt and Tablelands Complex that are separated by the Peel Fault. The Tablelands Complex to the east of the Peel Fault represents an accretionary wedge, and the Tamworth Belt to the west corresponds to the forearc basin. A total of five east-north-east trending gravity profiles with around 450 readings were conducted across the Tamworth Belt and Gunnedah Basin. Seven ground magnetic traverses of a total length of 60 km were surveyed across the bounding faults of the Tamworth belt, of which five were across the Peel Fault and two were across the Mooki Fault. The gravity data shows two distinct large positive anomalies, one over the Tamworth Belt, known as the Namoi Gravity High and another within the Gunnedah Basin, known as the Meandarra Gravity Ridge. All gravity profiles show similarity to each other. The magnetic data displays one distinct anomaly associated with the Peel Fault and an anomaly immediately east of the Mooki Fault. These new potential field data are used to better constrain the orientation of the Peel and Mooki Faults as well as the subsurface geometry of the Tamworth Belt and Gunnedah Basin, integrating with the published seismic data, geologic observations and new physical properties data.

Magnetic anomalies produced by the serpentinite associated with the Peel Fault were used to determine the orientation of the Peel fault. Five ground magnetic traverses were modelled to get the subsurface geometry of the serpentinite body. Modelling results of the magnetic anomalies across the Peel Fault indicate that the serpentinite body can be mostly modelled as subvertical to steeply eastward dipping tabular bodies with a minimum depth extent of 1-3 km, although the modelling does not constrain the vertical extent. This is consistent with the modelling of the magnetic traverses extracted from aeromagnetic data. Sensitivity analysis of

a tabular magnetic body reveals that a minimum susceptibility of 4000×10^{-6}cgs is needed to generate the observed high amplitude anomalies of around 2000 nT, which is consistent with the susceptibility measurements of serpentinite samples along the Peel Fault ranging from 2000 to 9000 $\times$ 10^{-6} cgs. Rock magnetic study indicates that the serpentinite retains a strong remanence at some locations. This remanence is a viscous remanent magnetisation (VRM) which is parallel to the present Earth's magnetic field, and explains the large anomaly amplitude over the Peel fault at these locations. The remanence of serpentinite at other localities is not consistent enough to contribute to the observed magnetic anomalies. A much greater depth extent of the Peel Fault was inferred from gravity models. It is proposed that the serpentinite along the Peel Fault was emplaced as a slice of oceanic floor that has been accreted to the front of the arc, or as diapirs rising off the serpentinised part of the mantle wedge above the supra subduction zone.

Magnetic anomalies immediately east of the Mooki Fault once suggested to be produced by a dyke-like body emplaced along the fault were modelled along two ground magnetic traverses and three extracted aeromagnetic lines. Modelling results indicate that the anomalies can be modelled as an east-dipping overturned western limb of an anticline formed as a result of a fault-propagation fold with a shallow thrust step-up angle from the décollement. Interpretation of aeromagnetic data and modelling of the magnetic traverses indicate that the anomalies along the Mooki Fault are produced by the susceptibility contrast between the high magnetic Late Carboniferous Currabubula Formation and/or Early Permian volcanic rocks of the Tamworth Belt and the less magnetic Late Permian-Triassic Sydney-Gunnedah Basin rocks. Gravity modelling indicates that the Mooki Fault has a shallow dip (~25°) to the east. Modelling of the five gravity profiles shows that the Tamworth Belt is thrust westward over the Sydney-Gunnedah Basin for 15-30 km.

The Meandarra Gravity Ridge within the Gunnedah Basin was modelled as a high density volcanic rock unit with a density contrast of 0.25 tm^{-3}, compared to the rocks of the Lachlan Fold Belt in all profiles. The volcanic rock unit has a steep western margin and a gently dipping eastern margin with a thickness ranging from 4.5-6 km, and has been generally agreed to have formed within an extensional basin.

The Tamworth Belt, being mainly the product of volcanism of mafic character and thus has high density units, together with the high density Woolomin Association, which is composed chiefly of chert/jasper, basalt, dolerite and metabasalt, produces the Namoi Gravity High. Gravity modelling results indicate that the anomaly over the Tamworth Belt can be modelled as either a configuration where the Tablelands Complex extends westward underthrusting the Tamworth Belt, or a configuration where the Tablelands Complex has been thrust over the Tamworth Belt. When the gravity profiles were modelled with the first configuration, the Peel Fault with a depth extent of around 1 km can only be modelled for the Manilla and Quirindi profiles, modelling of the rest of the gravity profiles indicates that the Tablelands Complex underthrust beneath the Tamworth belt at a much deeper location.

STATEMENT

I hereby certify that no part of this thesis has been presented to any other university or insititution for the purpose of obtaining a higher degree.

Guo Bin

BIN GUO

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