Bowen Basin structural geology 2007 – A new interpretation based on airborne geophysics

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The Bowen Basin Structural Geology 2007 map is a collaborative research project between CSIRO Exploration & Mining and the Queensland Department of Mines & Energy (DME), conducted during 2003 and 2007. Its aim was to work towards a new solid geology map of the Bowen Basin by providing an updated structural interpretation. The main new tool aiding the interpretation is regional airborne magnetic and radiometric data recently acquired by the DME. These new surveys join with existing data over adjacent basement terranes for a complete coverage over the Bowen Basin. The new interpretation was undertaken at 1:250,000 scale for a 1:500,000 scale final product.

The dominant structural grain on the basin was imposed by the protracted Late Permian to mid-Triassic Hunter-Bowen collision which caused a transition from thermal sag to foreland basin deposition, and was associated with brittle-ductile deformation and eventual closure of the Bowen Basin. Deformation style varies across the basin from the high-strain east to low-strain west and can be described in five belts each with distinct structural style.

The Gogango and Dingo fold-thrust belts along the eastern margin of the basin are separated by, but most likely continuous beneath the younger Duaringa Basin. The Gogango fold-thrust belt contains upright moderately tight folds and east-over-west fold limb thrust faults that clearly involve the underlying igneous basement. Folding in the Dingo belt produced steep bedding dips but remained intra-formational. The Jellinbah thin-skinned thrust belt to the west of the Gogango and Dingo belts is a zone of complex thrust faulting up to 80 km wide. The majority of the thrust faults dip at shallow angles to the east and sole out within the Permian sediments. Seismic data show a complex interaction of multiple faults with hangingwall anticlines, backthrusts and normal accommodation faults. While most of the thrust faults trend northwest, a group of faults in the northern basin trends north-south suggesting interference from older basement structures. Minor shortening within the Denison Trough focused along large thrust faults with relatively simple geometries, positioned among gentle open folds. The thrust faults strike north-south and dip at moderate angles to the east or west. Seismic data show that most of the faults have well developed hangingwall anticlines. Where the seismic data image basement, it is clear that the thrust faults are inverted Early Permian growth faults. Previous studies recognised three phases of inversion during the Hunter-Bowen event. The Springsure Shelf consists of a thin veneer of Permian sediments above metamorphic basement. Most structures are reactivated from older Pre-Permian faults.

Some of the regional basement controls on the structural styles in the Bowen Basin can be demonstrated with the regional gravity data from Geoscience Australia. The main basin compartments between the exposed igneous and metamorphic terranes are well defined. The Springsure and Collinsville shelves have a high gravity signature, while the thick Permian and Triassic successions in the Denison and Taroom Troughs and the Duaringa Basin show as gravity lows. The structural domains correlate just as well with the gravity signature. The fold-thrust belts of the east are confined to gravity highs (basement highs) suggesting basement involvement as a dominant control on deformation. The Jellinbah thrust belt is confined to the thick weak sedimentary successions at the synclinal core of the basin, running out against a basement high in the south. Structures are confined to the sedimentary pile and strongly influenced by the presence of weak rocks such as coal seams. North-south structures in the Denison Trough and the northern Bowen Basin are most likely reactivated from older Pre-Permian structures in the basement that reactivated first as growth faults in the south and later as thrust faults across the basin.

In conclusion our new structural interpretation builds strongly on previous studies over well-explored parts of the Bowen Basin, and offers for the first time a coherent structurally focussed map of the exposed parts of the Bowen Basin. The map highlights distinct structural belts along the basin whose deformational style is a function of the amount of crustal shortening, proximity to basement, availability of weak stratigraphy and the presence of older basement structures.

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