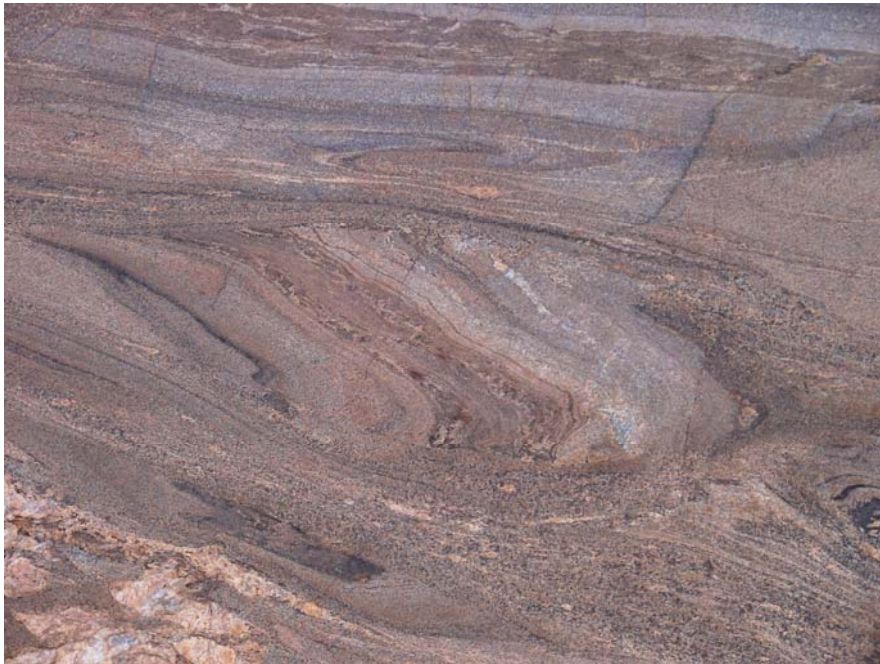


# Isan deformation, magmatism and extensional kinematics in the Western Fold Belt of the Mount Isa Inlier

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A thesis submitted for examination for the degree of  
Doctor of Philosophy

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Date: December 2004

# Abstract

The Mount Isa and May Downs Faults are part of a network of significant faults that define, control, or partition deformation in the Early to mid-Proterozoic Mount Isa Inlier. The middle Proterozoic deformation history includes at least two extensional basin-forming events (Leichhardt Superbasin: ~1800 Ma to ~1700 Ma and Isa Superbasin: ~1700 Ma to ~1600 Ma) and a major protracted contractional orogenic event (Isan Orogeny: ~1585 Ma to ~1500 Ma).

Uplift between the Mount Isa and May Downs Faults during the Isan Orogeny has exposed mid to upper amphibolite facies rocks of the structurally deeper levels of the early rift systems. Also exposed is the Sybella Granite, a composite batholith of variably deformed gneissic granite, which, at ~1660 Ma, is broadly coeval with inception of the Isan Superbasin basin.

Two prevailing kinematic models had been proposed for the fault systems during Isan Superbasin formation. The traditionally accepted model involves episodic E-W or NW-SE extension with the N-S Mount Isa Fault, but Southgate *et al* (2000b) presented an alternative sinistral strike-slip model in which the May Downs Fault acted as a releasing bend fault associated with motion on the Mt Isa Fault. In the Southgate model, the Sybella Granite was interpreted as syn-tectonically filling the dilational releasing bend.

This study provides a detailed structural analysis of the 100 km by 40 km area west of Mount Isa City lying between the Mount Isa and May Downs Faults. The aim was to resolve a number of outstanding issues, including those outlined above. The resultant 1:250 000 structural map of the area is based on: reconnaissance-scale mapping; aerial photography, satellite, magnetic and radiometric image interpretation; field observations at locations throughout the area; and local detailed mapping (1:12000 scale or less).

The mapping and associated geometrical analysis of the area has shown that the Sybella Batholith consists of two granite sills and a more globular body of microgranite. The deepest, gneissic, sill is up to 5 km thick and was emplaced at about 15 km below the basal Mount Isa Group unconformity (palaeosurface). The other, less deformed, sill formed higher in the crust, and the microgranite intruded to within 1-2 km of the palaeosurface. The two sills are located between two major fault systems (Mount Isa and May Downs Faults) that developed from inherited basin margin faults. The fault systems dip toward each other and the rocks between them have been folded into a single large antiform and uplifted as a wedge. Previous interpretations of the area have suggested that the batholith consists of a single sill folded by tighter, shorter wavelength folds.

A cross-sectional reconstruction of the study area suggests that thin-skinned processes dominated much of the Isan Orogeny, contrary to previous interpretations. A three-dimensional reconstruction of the area, evaluated by comparing the predicted strain and amount of shortening with measured strain and shortening estimates, suggests deformation was driven by a rigid block to the west of the May Downs Fault moving toward the northeast.

In the restored pre-Isan geometry, both the margins of the lowermost gneissic granite sill and its immediate country rocks have a strong, horizontal, layer-parallel, shear foliation

with top-to-the-east asymmetry. The fabrics are strongly constrictional and the stretching lineation trends east-west. Field observations and thin sectional analysis of these fabrics provide positive evidence that the Sybella Batholith was syn-tectonically emplaced in a basin-forming environment.

A kinematic model is presented to show that these features are consistent with granite emplacement into a dilational jog in a sub-horizontal shear zone with a top-to-the-east shear sense. A component of east-west directed horizontal simple shear across the dilating zone explains the strongly constrictional fabrics in the granite. Under these conditions significant north-south shortening in the deforming zone leads to the initiation of folds parallel to the stretching direction (as observed).

The shear zone into which the granite was emplaced developed at about fifteen kilometres depth and was probably at or near the brittle-ductile transition. The consistent shear sense, very high strains and implied 30 km of translation required to accommodate the sill indicates that this was a major crustal structure, rather than a simple detachment at the brittle-ductile transition in a crustal pure shear extension. The results are consistent with the east-west extensional model for basin development and totally inconsistent with the sinistral strike-slip model.

# Contents

<b>ABSTRACT</b> .....	2
<b>CONTENTS</b> .....	4
<b>PREAMBLE</b> .....	ERROR! BOOKMARK NOT DEFINED.
<i>Thesis Structure</i> .....	<i>Error! Bookmark not defined.</i>
<i>Nomenclature and conventions</i> .....	<i>Error! Bookmark not defined.</i>
<b>INTRODUCTION</b> .....	ERROR! BOOKMARK NOT DEFINED.
<i>Aim</i> .....	<i>Error! Bookmark not defined.</i>
<i>Geological background</i> .....	<i>Error! Bookmark not defined.</i>
<i>Outline of this study</i> .....	<i>Error! Bookmark not defined.</i>
<b>PART A: STRUCTURES, FABRICS AND 3D GEOMETRY OF THE MAY DOWNS - CARTERS BORE AREA</b> .....	ERROR! BOOKMARK NOT DEFINED.
CHAPTER 1: GEOLOGY WEST OF THE MOUNT ISA FAULT IN THE MAY DOWNS - CARTERS BORE AREA .....	ERROR! BOOKMARK NOT DEFINED.
<i>Map Units</i> .....	<i>Error! Bookmark not defined.</i>
<i>Major structures</i> .....	<i>Error! Bookmark not defined.</i>
<i>Mica Creek Area</i> .....	<i>Error! Bookmark not defined.</i>
CHAPTER 2: FABRICS AND GEOMETRY OF THE MAY DOWNS - CARTERS BORE AREA .....	ERROR! BOOKMARK NOT DEFINED.
<i>Fabrics</i> .....	<i>Error! Bookmark not defined.</i>
<i>Interpretation of structures</i> .....	<i>Error! Bookmark not defined.</i>
<i>Key map areas and map problems</i> .....	<i>Error! Bookmark not defined.</i>
<i>Cross-sections through the May Downs - Carters Bore Area</i> .....	<i>Error! Bookmark not defined.</i>
<i>Magmatism and metamorphism in the May Downs - Carters Bore Area</i> .....	<i>Error! Bookmark not defined.</i>
<i>Discussion</i> .....	<i>Error! Bookmark not defined.</i>
<i>Conclusions</i> .....	<i>Error! Bookmark not defined.</i>
<b>PART B: ISAN DEFORMATION IN THE MOUNT ISA INLIER</b> .....	ERROR! BOOKMARK NOT DEFINED.
CHAPTER 3: EVOLUTION OF THE MOUNT ISA FAULT SYSTEM IN THE MICA CREEK AREA .....	ERROR! BOOKMARK NOT DEFINED.
<i>Introduction</i> .....	<i>Error! Bookmark not defined.</i>
<i>Step-forward thrusting model</i> .....	<i>Error! Bookmark not defined.</i>

*Metamorphism in the Mount Isa Fault System ..... Error! Bookmark not defined.*

*Conclusions..... Error! Bookmark not defined.*

**CHAPTER 4: THE ISAN OROGENY IN THE WESTERN FOLD BELT****ERROR! BOOKMARK NOT DEFINED.**

*Introduction..... Error! Bookmark not defined.*

*A two dimensional model of the Isan Orogeny ..... Error! Bookmark not defined.*

*Isan development of the May Downs - Carters Bore Area in three-dimensions***Error! Bookmark not defined.**

*Discussion..... Error! Bookmark not defined.*

**PART C: EXTENSIONAL KINEMATICS AND THE EMPLACEMENT OF THE SYBELLA BATHOLITH .....ERROR! BOOKMARK NOT DEFINED.**

**CHAPTER 5: THE SYN-TECTONIC EMPLACEMENT OF THE SYBELLA BATHOLITH****ERROR! BOOKMARK NOT DEFINED.**

*Introduction..... Error! Bookmark not defined.*

*Magmatic phases in the lower sill ..... Error! Bookmark not defined.*

*Identifying syn-tectonic intrusions..... Error! Bookmark not defined.*

*Evidence for syn-tectonic emplacement of the Sybella Batholith***Error! Bookmark not defined.**

*Conclusions..... Error! Bookmark not defined.*

**CHAPTER 6: KINEMATICS OF BASIN FORMATION** **ERROR! BOOKMARK NOT DEFINED.**

*Introduction..... Error! Bookmark not defined.*

*Previous models of basin formation ..... Error! Bookmark not defined.*

*F<sub>1</sub> strain characteristic..... Error! Bookmark not defined.*

*Kinematic models of the F<sub>1</sub> high strain zone ..... Error! Bookmark not defined.*

*Discussion..... Error! Bookmark not defined.*

**CONCLUSIONS .....ERROR! BOOKMARK NOT DEFINED.**

**REFERENCES.....ERROR! BOOKMARK NOT DEFINED.**

**APPENDICES .....ERROR! BOOKMARK NOT DEFINED.**