SEDIMENTOLOGY, VOLCANOLOGY AND GEODYNAMICS OF THE REDBANK PACKAGE, McARTHUR BASIN, NORTHERN AUSTRALIA.

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Declaration

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David Rawlings
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David J Rawlings
Date: 29/1/2002
Abstract

The \( \text{-}1815-1705 \text{ Ma Redbank package} \) is a 3-6 km thick succession of shallow marine to braided fluvial sandstone and lesser conglomerate, mudstone, carbonates and rhyolitic-basaltic volcanics and high-level intrusions. It forms the base of the Palaeoproterozoic McArthur Basin in northern Australia.

In the southern McArthur Basin, the Tawallah Group is the best exposed stratigraphic component of this package. Coarse-grained facies at the base of the Group formed in a proximal-medial braided fluvial environment and are overlain by widespread sheets of supermature quartzarenite and intervening flood basalt. These enigmatic sandstone sheets contain features consistent with deposition in a complex high-energy shallow marine, fluvial and aeolian setting on an extensive low-gradient shelf. Overlying mudstones and carbonates were deposited on a shallow epeiric shelf and coastal sabkha fringe that onlapped basement tectonic ridges. A regional sequence boundary formed during subsequent regional uplift and local synsedimentary deformation, and was followed by deposition of another widespread quartzarenite sheet. The overlying succession of fine-grained sandstone, mudstone, carbonate and evaporitic redbeds suggest more diverse depositional settings. Marginal marine salina, near-shore peritidal, storm-dominated shelf and moderately deep water settings, with periodic restriction to the marine realm, fluctuating accommodation rates and minor synsedimentary faulting are all recorded.

Regional-scale dolerite sills and an extensive stacked succession of basalt sheets were emplaced sequentially as widely-dispersed invasive flows under a thin blanket of wet unconsolidated sediment and peperite. Volcanism was locally associated with uplift and emplacement of polymict debris flows and breccia bodies. This was followed by deposition of a complex association of clastic sediments and felsic volcanics and intrusion of high-level plutons (upper Tawallah Group). Sheet-like rhyolitic lavas with abrupt talus-lined margins evolved via non-explosive eruption and long-term viscous flow. This was facilitated by low water content and high and continuous eruption temperature and effusion rate. Complex ephemeral alluvial and debris flow aprons formed adjacent to the lavas, recording the generation, erosional denudation and final burial of a dynamic high-relief volcano-tectonic landscape. Epiclastic materials were reworked in bordering lakes and low-relief braidplains that prograded radially away from the volcanic centres. Periods between magmatic events were characterised by deposition of widespread immature sandstone sheets in extensive high-energy ephemeral to perennial braided fluvial settings and the development of low-relief regional disconformities. Concurrent pluton emplacement in the northern McArthur Basin generated a series of structural domes with peripheral deformation. Accommodation space for intrusion was provided by decollement at ductility transitions, upward flexuring, outward gravity slide and vertical displacement of overlying sediments.
Detailed stratigraphic and facies analysis of the Tawallah Group has enabled the development of a tectonostratigraphic framework for the entire Redbank package. Four second order subdivisions are recognised (Yirrumanja, Liverpool, Costello and Mitchell mesopackages) that facilitate a clearer, integrated regional understanding of the lithology, timing and geographic distribution of basin phases. The package concept is also applied to the composite McArthur Basin system as a whole. Five distinct and regionally coherent basin phases are recognised (Redbank, Goyder, Glyde, Favenc and Wilton packages). These were deposited in a dynamic tectonic environment over a period of ~350 m.y.

Geochemical characterisation of Proterozoic igneous phases in northern Australia has confirmed many lithostratigraphic correlations in the McArthur Basin. Felsic units show temporal and spatial variation in geochemistry that reflects partial melting of heterogeneous Archaean mafic lower crust due to the emplacement of large basaltic magma chambers and radiogenic heating. The McArthur Basin contains five main mafic igneous phases with typical flood basalt attributes, spanning a period of ~480 m.y. Magmas were derived by partial melting of chemically-stratified lower lithosphere and do not exhibit a plume or rift signature.

A convergent intracratonic setting is proposed for the Redbank package. Basin architecture reflects diverse subsidence mechanisms operating inboard of the active southern margin of the North Australian Craton (Strangways arc). Wedge-shaped and magmatic-related basin architectures formed during subduction. Subsidence was influenced by dynamic topography, thermally- and mechanically-driven viscoelastic behaviour of heterogeneous crust, magmatic underplating, lithospheric phase transformations, and local transtension and isostatic loading. Local growth-fault architecture formed by incipient back-arc extension. Magmatism was driven by a persistent thermal anomaly related to insulative heating and a transient convective roll emanating from the Strangways arc, that eroded the lower lithosphere and generated a magma pool. Migration of magma into lower-crustal magma chambers and to the surface took place at transtensional sites along lithosphere-scale strike-slip faults. Regional unconformities and elongate and wedge basin architectures formed in the Redbank package during periodic terrane accretion events at the Strangways arc. Subsidence was influenced largely by transmission of in-plane stress through the lithosphere to produce lithosphere-scale folding, viscoelastic deflections of the lithosphere, and transtensional strike-slip and flexural back-bulge basins. Local elongate magmatic grabens are interpreted as impactogens resulting from indentor tectonics.
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>TITLE PAGE</td>
<td>i</td>
</tr>
<tr>
<td>STATEMENT</td>
<td>ii</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>iii</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>v</td>
</tr>
<tr>
<td>TABLE OF CONTENTS</td>
<td>vi</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>x</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>xiii</td>
</tr>
<tr>
<td>LIST OF PLATES</td>
<td>xiv</td>
</tr>
<tr>
<td>LIST OF APPENDICES</td>
<td>xv</td>
</tr>
</tbody>
</table>

## 1. INTRODUCTION
1.1 Introduction                                                      1
1.2 Location, climate and physiography                                1
1.3 Previous work and concurrent studies                              3
1.4 Scope of research                                                 7
1.5 Methodology                                                       7
1.6 Thesis organisation                                               8

## 2. REGIONAL SETTING
2.1 Introduction                                                      10
2.2 Tectonic framework of Australia                                  10
2.3 Geology of the North Australian Craton                            15
2.4 Basement terranes of the McArthur Basin                           18
  2.4.1 Pine Creek Inlier                                             18
  2.4.2 Arnhem Inlier                                                 18
  2.4.3 Murphy Inlier                                                 20
  2.4.4 Other inliers                                                 20
2.5 McArthur Basin                                                    20
  2.5.1 Tectonic framework                                            21
  2.5.2 Lithostratigraphy                                             24
  2.5.3 Tectonic setting                                              30
2.6 Cover sequences                                                   30
2.7 Summary                                                           31

## 3. LOWER TAWALLAH GROUP
3.1 Introduction                                                      32
3.2 Lithostratigraphy                                                 32
  3.2.1 Westmoreland Conglomerate                                     32
  3.2.2 Yiyintyi Sandstone                                            36
  3.2.3 Seigal Volcanics                                              38
  3.2.4 Sly Creek Sandstone                                           45
  3.2.5 Rosie Creek Sandstone Member                                  48
  3.2.6 McDermott Formation                                           50
  3.2.7 Wununmantyala Sandstone                                      55
  3.2.8 Aquarium Formation and Wuraliwuntya Member                    63
  3.2.9 Settlement Creek Volcanics                                    69
3.3 Quartzarenite depositional model                                  79
  3.3.1 Epeiric platform                                              81
3.4 Depositional-volcanological model                                 84
3.5 Key outcomes                                                      86
7. JIMBU MICROGRANITE ................................................................. 253
  7.1 Introduction ................................................................. 253
  7.2 Geology and structure .................................................. 253
  7.3 Timing and depth of granite emplacement ......................... 265
  7.4 Relationships between plutonism, volcanism and sedimentation 267
  7.5 Timing of dome formation ............................................... 267
  7.6 Background on experimental models ................................... 268
  7.7 Application of the experimental models to the Mount Marumba area 271
  7.8 Discussion ................................................................. 273
  7.9 Regional geological considerations ................................... 274
  7.10 Metallogenic implications ............................................. 275
  7.11 Summary ................................................................. 276

8. TECTONOOSTRATIGRAPHIC FRAMEWORK FOR THE MCArtHUR BASIn 277
  8.1 Introduction ................................................................. 277
  8.2 Preamble ................................................................. 277
  8.3 Terminology and rationale ............................................... 278
    8.3.1 Packages ................................................................. 280
  8.4 Subdivision of the McArthur Basin ..................................... 281
  8.5 Redbank package .......................................................... 285
    8.5.1 Lithostratigraphic components ..................................... 288
    8.5.2 Higher-order tectonostratigraphy ................................... 301
  8.6 Upper McArthur Basin succession ...................................... 308
    8.6.1 Goyder package .......................................................... 309
    8.6.2 Glyde package ........................................................... 310
    8.6.3 Favenc package ......................................................... 311
    8.6.4 Wilton package .......................................................... 312
  8.7 Summary ................................................................. 313

9. GEOCHEMISTRY AND PETROGENESIS OF IGNEOUS UNITS .......... 314
  9.1 Introduction ................................................................. 314
  9.2 Felsic units ................................................................. 315
    9.2.1 Transitional phase 1 ................................................... 318
    9.2.2 Transitional phase 2 ................................................... 318
    9.2.3 Fagan phase 1 .............................................................. 318
    9.2.4 Fagan phase 2 .............................................................. 318
    9.2.5 Fagan phase 3 .............................................................. 324
    9.2.6 McArthur phase 1 .......................................................... 324
    9.2.7 Temporal trends .......................................................... 324
    9.2.8 Petrogenesis .............................................................. 327
  9.3 Mafic units ................................................................. 328
    9.3.1 Tawallah phase 1 & 2 ................................................... 328
    9.3.2 Fagan phase 1 .............................................................. 336
    9.3.3 Fagan phase 3 .............................................................. 338
    9.3.4 McArthur phase 2 .......................................................... 340
    9.3.5 Derim Derim Dolerite suite ............................................ 340
    9.3.6 Antrim Plateau Volcanics .............................................. 340
    9.3.7 Spidergrams ............................................................... 340
    9.3.8 Rare Earth Element (REE) spidergram ............................. 342
    9.3.9 Variation of Zr/TiO2 with depth of emplacement .................. 342
    9.3.10 Calc-Alkaline attributes .............................................. 343
    9.3.11 Mafic magma source ................................................... 346
  9.4 Mechanisms for magmatic events ....................................... 348
    9.4.2 Working model .......................................................... 352
  9.5 Summary ................................................................. 353

viIII
10. GEODYNAMICS OF THE REDBANK PACKAGE

10.1 Introduction .............................................................. 355
10.2 Preamble ........................................................................ 355
10.3 Evolution of the North Australian Craton
   10.3.1 Palaeoproterozoic crust development ..................... 356
   10.3.2 Ensialic model ..................................................... 358
   10.3.3 Plate tectonic model ............................................. 359
10.4 Tectonic models for the McArthur Basin
   10.4.1 The 'Plumb' model ............................................... 362
   10.4.2 The 'Etheridge and Wall' model ............................ 363
   10.4.3 The 'Rogers' model ............................................. 364
   10.4.4 The 'Leaman' model ............................................ 364
10.5 Models for the formation of basins
   10.5.1 Extensinal basins (rifts) ..................................... 365
   10.5.2 Highly extended terranes ................................. 368
   10.5.3 Intracratonic basins ........................................... 368
   10.5.4 Foreland basins ................................................. 371
   10.5.5 Transtensional wrench-related basins .................. 372
   10.5.6 Far-field in-plane stress .................................... 372
   10.5.7 Sedimentary loading .......................................... 373
10.6 Constraints on development of the Redbank package
   10.6.1 Active southern margin of the NAC ..................... 373
   10.6.2 Basement heterogeneity ..................................... 377
   10.6.3 Mafic underplate ................................................ 378
   10.6.4 Basin architecture ............................................. 379
   10.6.5 Internal unconformities ..................................... 386
   10.6.6 Basin duration & subsidence rate ....................... 387
   10.6.7 Magmatism & thermal regime ............................ 387
   10.6.8 Applicability of extensional models .................. 388
   10.6.9 Constraints from other provinces ....................... 390
10.7 Geodynamic model for the Redbank package
   10.7.1 Geodynamics during subduction ......................... 390
   10.7.2 Geodynamics during collision ........................... 392
   10.7.3 Chronological evolution .................................... 393
10.8 Analogues .................................................................... 394
10.9 Plate tectonic implications ........................................ 396
10.10 Summary .................................................................... 397

11. CONCLUSIONS .................................................................. 398
   11.1 Facies and event stratigraphy .................................. 398
   11.2 Tectonostratigraphy ................................................. 400
   11.3 Igneous geochemistry .............................................. 401
   11.4 Geodynamics ............................................................ 402
   11.5 Recommendations for future research ..................... 403

REFERENCES ....................................................................... 405

VOLUME 2 - APPENDICES

Appendix 1 - Sample catalogue .............................................. 440
Appendix 2 - Glossary, terminology and legend for sections & logs 451
Appendix 3 - Lower Tawallah Group ...................................... 455
Appendix 4 - Wollogorang Formation .................................... 473
Appendix 5 - Gold Creek Volcanics ....................................... 493
Appendix 6 - Upper Tawallah Group ...................................... 521
Appendix 9 - Geochemistry .................................................. 560
Appendix 10 - Supporting publications .................................. 575