Regolith 2004


Editor & Designer: Ian C. Roach.

Printer: Instant Colour Press, Belconnen, ACT.

Publisher: Cooperative Research Centre for Landscape Environments and Mineral Exploration, PO Box 1130, Bentley, WA, 6102.


CRC LEME is an unincorporated joint venture between CSIRO Exploration & Mining and Land & Water, The Australian National University, Curtin University of Technology, University of Adelaide, Geoscience Australia, Primary Industries and Resources SA, NSW Department of Mineral Resources-Geological Survey and Minerals Council of Australia, established and supported under the Australian Government’s Cooperative Research Centres Program.

Front cover:
The magnificent scenery of Wilsons Promontory, Victoria. Photograph is taken from Tidal Overlook, looking southeast towards Tidal River with Mount Oberon in the background. The photo highlights the relationships between regolith, landform, water and biota. Relationships include Melaleuca thickets in the swampy plains and low rises; Casuarina and Leptospermum heath on aeolian sandsheets at the base of Mt Oberon; mixed Eucalyptus/Casuarina low woodland on the colluvial mid-slopes; and, tall Eucalyptus woodland on the stony upper slopes of Mt. Oberon. This site is used for part of CRC LEME’s teaching activities for the Minerals Council of Australia’s Advanced Minerals Education Program.

ORGANISATION

Canberra Convener and Supervising Editor:
Dr Ian Roach, CRC LEME-Minerals Council of Australia/Australian National University

Assistant Editors:
Dr Steven M. Hill, CRC LEME/University of Adelaide
Dr Mehrooz Aspandiar, CRC LEME/Curtin University of Technology

Theme Conveners:
Dr Ravi Anand, CRC LEME/CSIRO Exploration & Mining
Dr John Chappell, CRC LEME/Australian National University
Dr John Keeling, CRC LEME/PIRSA
Dr John Magee, CRC LEME/Australian National University
Dr Bear McPhail, CRC LEME/Australian National University
Assoc. Prof. Ken McQueen, CRC LEME/Australian National University
Dr Colin Pain, CRC LEME/Geoscience Australia
Dr Steve Rogers, CRC LEME/CSIRO Land & Water

Review Panel:
Dr Mehrooz Aspandiar, CRC LEME/Curtin University of Technology
Dr Andy Christy, CRC LEME/Australian National University
Dr Jonathan Clarke, CRC LEME/Geoscience Australia
Dr Andrew Fitzpatrick, CRC LEME/Geoscience Australia
Dr Rob Fitzpatrick, CRC LEME/CSIRO Land & Water
Dr David Gray, CRC LEME/CSIRO Exploration and Mining
Dr Graham Heinson, CRC LEME/University of Adelaide
Dr Steve Hill, CRC LEME/University of Adelaide
Mr Rimas Kairaitis, Alkane Exploration Ltd.
Dr Ian Lambert, CRC LEME/Geoscience Australia
Assoc. Prof. Ken McQueen, CRC LEME/Australian National University
Dr Colin Pain, CRC LEME/Geoscience Australia
Dr Ian Roach, CRC LEME-Minerals Council of Australia/Australian National University
Dr K.P. Tan, CRC LEME/Geoscience Australia
Dr Sue Welch, CRC LEME/Australian National University

Sponsors:
Student Travel Bursary - the organisers are grateful for sponsorship provided by CRC LEME to allow students to travel to attend the different symposia in Adelaide, Canberra and Perth. CRC LEME's financial support is invaluable.

The organizers are grateful for the financial support of the Minerals Council of Australia, for committing the time of Dr Ian Roach
# CONTENTS

1. **Introduction**: I.C. Roach ................................................................. 1

2. **S. Abbott**:  
Airborne geophysical data, including electromagnetics, enhances rapid catchment appraisal in the Upper Kent Recovery Catchment ................................................. 2

3. **R.R. Anand & M. Cornelius**:  
Vegetation and soil expression of the Jaguar base metal deposit, Yilgarn Craton ......................... 7

Multiple hydromorphic dispersion of gold and ore related elements in transported overburden at the Lancefield gold deposit, Yilgarn Craton ........................................... 9

5. **N. Anderson, N.G. Direen & S.M. Hill**:  
The Warratta Fault: geophysical architecture and landscape evolution significance .................. 12

6. **M.F. Aspandiar**:  
Potential mechanisms of metal transfer through transported overburden within the Australian regolith: a review .................................................................................... 17

High resolution low altitude aerial photography for recording temporal changes in dynamic surficial environments .................................................................................. 21

8. **P.L.M. Bamford, K.G. McQueen & K.M. Scott**:  
Geochemical dispersion and under-cover expression of gold mineralisation at the Wyoming gold deposit, Tomingley, NSW ................................................................. 26

9. **K.A. Beckett**:  
Observations on the correlation between uranium and thorium radioelement channels in Western Australia airborne radiometric surveys ....................................................... 29

10. **A.D. Brown**:  
Production of geochemical atlas pages using DataDesk and ArcGIS ........................................ 32

11. **A.D. Brown & S.M. Hill**:  
Regolith-landform maps are an essential tool for interpreting regolith geochemistry: the White Dam, SA, experience ...................................................................................... 37

12. **J. Brugger, W. Liu, B. Etschmann & G. Foran**:  
Transition metals in hypersaline solutions: experiments and numerical modelling .................... 42

13. **C. Butt & R. Hough**:  
Gold nuggets: form and composition .................................................................................. 47

14. **K. Cahill, A. Fitzpatrick & K. Lawrie**:  
Frequency domain helicopter electromagnetics – reducing the costs of acquisition for salinity and groundwater mapping ................................................................................... 49

Development of a semi-distributed catchment hydrology model for simulation of land-use change stream-flow and groundwater recharge within the Little River catchment, NSW ....... 54

16. **J.D.A. Clarke**:  
Fan delta geometry of the Lower Burdekin River system, north Queensland .......................... 57

17. **J.D.A. Clarke**:  
Influence of fluvial architecture assumptions in aquifer models: lessons from the Lower Balonne, southern Queensland .................................................................................. 62

18. **R.C. Dart, P.D. Wittwer, K.M. Barovich, D. Chittleborough & S.M. Hill**:  
Strontium isotopes as an indicator of the source of calcium for regolith carbonates ............... 67

19. **T. Dhu, G. Heinson & J. Joseph**:  
Viewing the regolith through different eyes: a new way of interpreting resistivity data ............ 71

20. **P. English, P. Richardson & M. Glover**:  
Interpreting airborne electromagnetic data as an adjunct to hydrogeological investigations: Honeysuckle Creek Catchment, Victoria ......................................................... 76
Selective X-ray Bragg spectrometry: optimising fluorescence microprobe sensitivity for
precious metals ............................................................................................................... 81

22. D. Fabel:
Cosmogenic burial dating of shallow deposits – a preliminary study ......................... 86

23. A. Fitzpatrick & J.D.A. Clarke:
The potential of geophysics to map salt water intrusion in the Burdekin Delta ............... 88

24. A. Fitzpatrick, J.D.A. Clarke & K. Lawrie:
Multidisciplinary approach to salinity management in the Lower Balonne, southern
Queensland .................................................................................................................. 93

25. L. Gibbins, G. Heinson & J. Joseph:
Using complex conductivity to predict hydrology in the regolith ................................ 97

26. D. Gibson:
Colluvial slopes: not necessarily simple regolith-landform units ................................ 101

27. D.J. Gray & M. Pirlo:
Geochemistry of groundwaters at Tunkillia: similarities and differences to Yilgarn Craton
groundwaters .............................................................................................................. 103

28. C.J. Grose, D.B. Kidd, R.M. Moreton & S.E. Tate:
Quantifying trends in soil condition: gathering baseline data for developing targets and
supporting informed land management decision making ............................................. 107

29. C. Gunton:
Adsorption: should we care? ................................................................................... 112

30. K. Harvey & C.L. Moore:
Regolith-landform mapping: a tool for the strategic management of dryland salinity .... 117

31. A. Hashemi:
HoistEM data processing for discovery of conductive manganese ore under cover ....... 121

32. P.J. Heath & N. Direen:
Gravity and magnetic forward modelling of the regolith .......................................... 123

33. S.M. Hill:
Biogeochemical sampling media for regional- to prospect-scale mineral exploration in
regolith-dominated terrains of the Curnamona Province and adjacent areas in western
NSW and eastern SA ................................................................................................. 128

34. S.M. Hill, I.C. Roach & J.B. Field:
A collaborative undergraduate field school for regolith geoscience at Fowlers Gap, western
NSW: 2004 a regolith odyssey ................................................................................. 134

35. B. Hou & L.A. Frakes:
Tertiary sea levels and heavy mineral deposition in the eastern Eucla Basin, SA .......... 140

36. R. Hough, C. Phang, M. Norman & R. Anand:
Alunite as a mineral host in ferricrete from the Enterprise pit, Mount Gibson gold deposit.... 144

37. W.Y. Hui, C. Tenailleau, A. Pring & J. Brugger:
Experimental study of the transformation of pentlandite/pyrrhotite to violarite .......... 146

38. K.A. Hulme & S.M. Hill:
Seasonal element variations of Eucalyptus camaldulensis biogeochemistry and implications
for mineral exploration: an example from Teilta, Curnamona Province, western NSW .... 151

39. E.B. Joyce:
Integrating soils, regolith and slope dynamics in the study of the terroir of wine regions in
central Victoria, Australia .......................................................................................... 157

40. J. Keeling:
Metal ion dispersion through transported regolith cover at Moonta, South Australia .... 161
41. J. Keeling, A. Mauger & M. Raven:  
Airborne hyperspectral survey and kimberlite detection in the Terowie district, South Australia ................................................................. 166

42. M. Kehoe, S. Beavis & S. Welch:  
Investigating the role of biotic versus abiotic processes in the generation of acid sulfate soils in coastal NSW ................................................................. 171

43. K. Khider:  
Geochemical dispersion of elements in Byrock-Hermidale groundwaters, Cobar region NSW ................................................................. 175

44. S. Kim, G. Heinson & J. Joseph:  
Electrokinetic groundwater exploration: a new geophysical technique ................................................................. 181

45. R. Kriege:  
Determination of interfaces within the regolith using near-surface geophysical and petrographic methods at the Whirling Dervish gold project, Western Australia ................................................................. 186

46. I. Lau, G.S. Heinson & S.M. Hill:  
Explanatory notes for the 1:30,000 regolith-landform map of White Dam, Olary Domain, South Australia ................................................................. 188

Regolith constraints on modelling salt movements in upland landscapes in the Murray-Darling Basin ................................................................. 194

48. K. Lawrie & M. Williams:  
Improving salinity hazard predictions by factoring in a range of human impacts in the context of climate change ................................................................. 199

49. M. Lech, P. de Caritat, S. Jaireth & J. Pyke:  
Preliminary geohealth implications of the Riverina geochemical survey ................................................................. 204

50. M.J. Lenahan, D.M. Kirste, D.C. McPhail & L.K. Fifield:  
Hydrogeochemical controls of variable regolith materials on the distribution, mobility and age of salts: Barmedman Creek catchment, NSW ................................................................. 209

51. J.A. Leonard & J.B. Field:  
Differential distributions of cations in the regolith and vegetation ................................................................. 215

52. M.J. Lintern, M.J. Sheard & G. Gouthas:  
Key findings from the South Australian regolith project ................................................................. 220

53. D.A. Little, J.B. Field & S.A. Welch:  
The life and times of tree roots: elemental dynamics in the rhizosphere of co-occurring trees in a mixed-species dry sclerophyll forest ................................................................. 225

54. X. Luo, Z. Taofa & B. Hou:  
The geoelectrochemical extraction method (CHIM) in exploration for concealed ore deposits ................................................................. 230

55. A.J. Mauger, J.F. Huntington & J.L. Keeling:  
Mineral mapping and spectral logging of the Gawler Craton ................................................................. 234

56. L.B. McEntegart & A. Schmidt Mumm:  
Gold mobility within dune systems on the Barns prospect, Wudinna, South Australia: a partial extraction approach ................................................................. 235

57. K.G. McQueen, D.C. Munro, D. Gray & M. Le Gleuher:  
Weathering-controlled fractionation of ore and pathfinder elements part II: the lag story unfolds ................................................................. 241

58. A. Mee, D.M. McKirdy, E.S. Krull & M.A.J. Williams:  
Geochemical analysis of organic-rich lacustrine sediments as a tool for reconstructing Holocene environmental conditions along the Coorong coastal plain, southeastern Australia ................................................................. 247

59. D.C. Munro:  
Geochemical dispersion in the regolith of the CSA area, Cobar, New South Wales ................................................................. 252
60. R.R.P. Noble:  
Removing bias from geochemical interpretation: the application of hypergeometric statistics ................................................................. 256

61. A. Petts & S.M. Hill:  
Relating surficial regolith-landform attributes to 3D regolith architecture: preliminary thoughts and concepts ....................................................................................................................... 260

62. B. Pewkliang, A. Pring & J. Brugger:  
Opalisation of fossil bone and wood: clues to the formation of precious opal .................... 264

63. K. Pfeiffer, N.G. Direen & M. Sexton:  
Exploration under regolith cover, and the problem of remanent magnetism: an example from the Tanami Au province ........................................................................................................ 269

64. C. Phang, J. Wildman & R.R. Anand:  
Post-depositional weathering features and processes in sediments – based on selected sites in Australia .................................................................................................................. 273

65. B. Pillans:  
Talking about time: the geological time scale 2004 ............................................................ 276

66. B. Pillans:  
Tektites as chronostratigraphic markers in Australian regolith ............................................ 279

67. T.J. Raggatt & S.M. Hill:  
Regolith-landform mapping within Herrmanns Catchment, Mount Lofty Ranges, SA ......... 282

68. T.J. Raggatt, M. Lewis & R.W. Fitzpatrick:  
Spectral discrimination of soil and regolith attributes within Herrmanns Catchment, Mount Lofty Ranges, SA ............................................................................................................... 287

69. F. Reith & S.L. Rogers:  
Gold flakes and the art of molecular bioscience ..................................................................... 292

70. E. Rhodes, V. Farwig, J. Chappell & B. Pillans:  
Luminescence of single quartz grains to determine past movement and heating ................ 295

71. E. Rhodes, K. Fitzsimmons, J. Magee, J. Chappell, G. Miller & N. Spooner:  
The history of aridity in Australia: preliminary chronological data ......................................... 299

72. A.L. Riesz & D. Kirste:  
The origin and mobilisation of salt in the Upper Hovells Creek catchment, NSW ................ 303

73. I.C. Roach:  
Results of a preliminary biogeochemical survey of the Wyoming Au deposit, Tomingley, NSW ...................................................................................................................................... 307

74. B.P. Ruxton:  
Contrasting regolith structures: hydroplastic undulations or fluidised piercement giving megalobes .......................................................................................................................... 311

75. A. Schmidt Mumm & F. Reith:  
The biogeochemistry of calcrete forming processes .................................................................... 316

76. M.J. Sheard & I.D.M. Robertson:  
Regolith characteristics and geochemistry as aids to mineral exploration in the Harris Greenstone Belt, central Gawler Craton, South Australia ........................................................................ 321

77. M.L. Smith, S. Eggins & G. Mortimer:  
A lead isotope study of anatase in silcrete .................................................................................. 326

78. M.S. Smith, D.M. Kirste & D.C. McPhail:  
Mineralogy of alkaline-saline soils on the western slopes of northern New South Wales ........ 330

79. P. Somerville, S. Beavis & S. Welch:  
Spatial and temporal variability of acidity at a coastal acid sulfate soil site ................................ 335

80. P. Somerville, R. Greene, S. Beavis, I. White & S. Welch:  
The contribution of mineral weathering to stream salinity in the Boorowa River, New South Wales ........................................................................................................................... 340
81. K. Tan, T. Munday, D. Gibson & H. Apps:
The relationships amongst soil moisture content, pore water salinity, texture and apparent
electrical conductivity: evidence from the Riverland and Tintinara airborne EM projects .......... 345

82. G. Taylor & R.A. Eggleton:
"Little balls": the origin of the Weipa bauxite .................................................................... 350

83. M. Thomas, R.W. Fitzpatrick & G.S Heinson:
Regional prediction of salt-affected soils in an area of complex soil patterns in South
Australia .................................................................................................................................. 355

84. M. Thomas:
Biogeochemical data ranges from Tunkillia Prospect, central Gawler Craton, South
Australia .................................................................................................................................. 362

85. K.M. Tomkins, G.S. Humphreys, R.A. Shakesby, S.H. Doerr, W.H. Blake &
P. Wallbrink:
Mass movement events in the south-west Sydney Basin during the Holocene ....................... 365

86. M.L. Turner, C.H. Arns, A. Sakellariou, T.J. Senden, A.P. Sheppard, R.M. Sok,
A. Limaye & M.A. Knackstedt:
Obtaining hydraulic properties of unconsolidated porous material ........................................ 370

87. L.N. Tylkowski, D. Chittleborough & K.M. Barovich:
Origin and genesis of calcrete in the Murray Basin .................................................................. 375

88. V. Waclawik & S. Lang:
Geomorphometry of the Umbum Creek catchment, western Lake Eyre, central Australia ...... 380

89. L.J. Wallace, S.A. Welch, S. Beavis & D.C. McPhail:
Trace metal partitioning in acid sulfate soils, Mayes Swamp, Kempsey, NSW ......................... 385

90. S. Welch, S. Beavis & P. Somerville:
Biogeochemistry at Lake Tyrell ............................................................................................. 391

91. D. White, D.C. McPhail & D. Lawie:
Fractionation of Zn and Cd in soils proximal and distal to sulphide mineralisation .................... 394

92. M. Whitford:
Geophysical properties of the regolith near the Victory Gold Mine, Kambalda, Western
Australia .................................................................................................................................. 398

93. B. Williams & J. Walker:
Spatial variability in hydrological properties at the paddock scale using EM surveys .............. 400

94. P.D. Wittwer, K.M. Barovich & S.M. Hill:
Geology and geochemistry of regolith carbonate accumulations of the southwestern
Curnamona Province, SA: implications for mineral exploration .............................................. 402

95. V.N.L. Wong, R.S.B. Greene, B.W. Murphy, R. Dalal & S. Mann:
Carbon dynamics in salt-affected soils ..................................................................................... 407

96. T. Woolrych, K.G. McQueen & I.C. Roach:
Regolith-landforms of the Cobar gold field and geochemical dispersion at the Illewong
prospect ....................................................................................................................................... 411

97. M. Worthy & R.J. Wasson:
Fire as an agent of geomorphic change in southeastern Australia: implications for water
quality in the Australian Capital Territory .................................................................................. 417

Author index: .......................................................................................................................... 419
INTRODUCTION

Ian C. Roach

MCA Lecturer, CRC LEME, Department of Earth and Marine Sciences, Australian National University, ACT, 0200

This volume summarises papers that were delivered at the three national CRC LEME Regional Regolith Symposia, Regolith 2004. These occurred in Adelaide (10-12 November), Perth (18-19 November) and Canberra (24-26 November). The three symposia followed in the footsteps of the 2003 CRC LEME Regional Regolith Symposia, Advances in Regolith (Roach 2003), the first CRC LEME Regional Regolith Conference, Regolith and Landscapes in Eastern Australia (Roach 2002), earlier national conferences including Regolith '98 (Kalgoorlie; Britt & Bettanay 1998), Regolith '96 (Brisbane; Eggleton 1998), Regolith '94 (Broken Hill; Pain et al. 1994) and the first ever Australian Regolith Conference in 1988 (Canberra). Each of the papers are fully peer-reviewed and written by prominent or up-and-coming regolith researchers and their supervisors from Australian universities, government research institutions and state geological surveys, or by retired (but still very active) researchers.

Of the 97 papers and 417 pages in this volume you'll find a diversity of the research and training being conducted by staff and students within CRC LEME and by like-minded individuals in universities and state and federal government research organizations across Australia. Special themes for the 2004 symposia include: the microbiology of the regolith; mineral exploration under regolith cover; the history of aridity in Australia; natural resource management and the regolith; the hydrogeochemistry of the regolith; and, mineral exploration in the regolith in eastern, central and western Australia.

The CRC LEME Regional Regolith Symposia provide regolith researchers with a snapshot of how CRC LEME is performing on a yearly basis. It is precisely this kind of volume that is held up at reckoning time to gauge the success of any CRC. The abstract volume is also an important internal and external communication tool and an essential educational tool. Many of the papers published in these volumes (Roach 2002, Roach 2003) form the basis of on-going regolith education and training activities at the three CRC LEME core party universities: The Australian National University; The Curtin University of Technology; and, The University of Adelaide. Research published in these proceedings is ploughed back into the programs at each of these universities, enhancing the knowledge and skills of students and providing better graduates for the fields of natural resource management and mineral exploration. Dare I say, standing on the shoulders of giants?

I am very proud to be associated with the research contained within and congratulate all of the individuals who took the time to be a part of these proceedings.

Acknowledgments: The 2004 CRC LEME Regional Regolith Symposia would not have been possible without: assistant editors Mehrooz Aspandiar and Steve Hill; special theme conveners Ravi Anand, John Chappell, Steve Rogers, John Keeling, John Magee, Bear McPhail and Ken McQueen; secretarial assistance from Deborah Bordeau, Maureen Blake and Sarah O'Callaghan; the review panel Mehrooz Aspandiar, Andy Christy, Jonathan Clarke, Andrew Fitzpatrick, Rob Fitzpatrick, David Gray, Graham Heinson, Steve Hill, Rimas Kairaitis, Ian Lambert, Ken McQueen, Colin Pain, K.P. Tan and Sue Welch—apologies to those I may have inadvertently left out; CRC LEME for sponsoring for the student travel bursary; the Minerals Council of Australia; and, my family for enduring this again.

REFERENCES


