

# Advances in Regolith

Ian C. Roach

Editor

Proceedings of the  
CRC LEME Regional Regolith Symposia  
2003





**Published by:** Cooperative Research Centre for Landscape Environments and Mineral Exploration (CRC LEME).

©November 2003: Cooperative Research Centre for Landscape Environments and Mineral Exploration (CRC LEME).

This book is copyright. Apart from any fair dealing for the purposes of private study, research, criticism or review, as permitted under the Copyright Act, no part may be reproduced by any process without the written permission. Inquiries should be addressed to the publisher.

**National Library of Australia**

**Cataloguing-in-Publication:**

Advances in Regolith

ISBN 0-7315-4815-9 (CD-ROM)

Bibliography  
Includes index

**Editor & Designer:** Ian C. Roach

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

WWW: <http://crcleme.org.au/>.

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, University of Canberra, 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.

**General Reference:**

ROACH I.C. ed. 2003. *Advances in Regolith*, 446 p. CRC LEME.

**Example Specific Reference:**

FITZSIMMONS K. 2003. Longitudinal and transverse dunes of the Lake Eyre Basin. In: ROACH I.C. ed. *Advances in Regolith*, pp. 5-7. CRC LEME.

**Front cover:**

The superb tor-field landscape near Tibooburra, NW NSW, showing the interactions between slightly weathered granitic bedrock, aeolian cover and biota.

Photograph © Ian Roach, 2003.



Cooperative Research Centre for  
Landscape Environments and Mineral Exploration

# **Advances in Regolith**

Editor: Ian C. Roach

Assistant Editors:  
Mehrooz Aspandiar  
John B. Field  
Rob W. Fitzpatrick  
Steven M. Hill

**Proceedings of the**  
**CRC LEME Regional Regolith Symposia 2003**



## **ORGANISATION**

### **Canberra Convener and Supervising Editor:**

Dr Ian Roach, CRC LEME-Minerals Council of Australia/Australian National University

### **Node Conveners and Assistant Editors:**

Dr Steven M. Hill, CRC LEME/University of Adelaide

Dr Mehrooz Aspandiar, CRC LEME/Curtin University of Technology

### **Co-conveners and Special Theme Co-conveners:**

Dr Patrice de Caritat, CRC LEME/Geoscience Australia

Dr John Field, CRC LEME/Australian National University

Dr Rob Fitzpatrick, CRC LEME/CSIRO Division of Soils

Dr Alex Nemchin, CRC LEME/Curtin University of Technology

Mr Paul Wilkes, CRC LEME/Curtin University of Technology

### **Student representatives:**

Mr Chris Gunton, CRC LEME/Australian National University

Mr Martin Smith, CRC LEME/Australian National University

Ms Karen Hulme, CRC LEME/University of Adelaide

Mr Andrew Baker, CRC LEME/University of Adelaide

Mr Mark Paine, CRC LEME/Curtin University of Technology

### **Review Panel:**

Dr Mehrooz Aspandiar, CRC LEME/Curtin University of Technology

Dr Patrice de Caritat, CRC LEME/Geoscience Australia

Dr Jonathan Clarke, CRC LEME/Geoscience Australia

Dr John Field, CRC LEME/Australian National University

Dr Rob Fitzpatrick, CRC LEME/CSIRO Land & Water

Dr Richard Greene, CRC LEME/Australian National University

Dr Graham Heinson, CRC LEME/University of Adelaide

Dr Steve Hill, CRC LEME/University of Adelaide

Associate Professor Patrick James, CRC LEME/University of Adelaide

Dr Anton Kepic, CRC LEME/Curtin University of Technology

Dr D.C. "Bear" McPhail, CRC LEME/Australian National University

Associate Professor Jason Meyers, CRC LEME/Curtin University of Technology

Dr Alex Nemchin, CRC LEME/Curtin University of Technology

Dr Colin Pain, CRC LEME/Geoscience Australia

Dr Ian Roach, CRC LEME-Minerals Council of Australia/Australian National University

Mr Keith Scott, CRC LEME/CSIRO Exploration and Mining

Professor Graham Taylor, University of Canberra

### **Sponsors:**

*Student Travel Bursary* - the organisers are grateful for sponsorship provided from the proceeds of the first ever Australian Regolith Conference held in Canberra in 1988, organised by Bob Galloway and Gerry Wilford, and to Tony Eggleton, Cliff Ollier and Graham Taylor who were integral to it.



## CONTENTS

1.	Introduction: <b>I.C. Roach</b> .....	1
2.	<b>A.K.M. Baker &amp; R.W. Fitzpatrick:</b> Lead isotopes for constructing geochemical dispersion models in sulfidic wetlands .....	2
3.	<b>K.A. Beckett:</b> Airborne geophysics applied to groundwater modelling .....	8
4.	<b>D.A. Bennetts, J.A. Webb &amp; C.M. Gray:</b> Distribution of Plio-Pleistocene basalts and regolith around Hamilton, western Victoria, and their relationship to groundwater recharge and discharge .....	11
5.	<b>E.A. Bestland, G.P. Green &amp; K. Rivett:</b> Sources of base cations in soil solids and soil water; examples from Red Brown earths of South Australia.....	16
6.	<b>K.E. Bewert, K.G. McQueen &amp; D.C. McPhail:</b> Regolith-landform mapping and soil survey for mining rehabilitation and environmental management in the Cadia Valley, central NSW .....	19
7.	<b>A.D. Brown &amp; S.M. Hill:</b> Litter dams: a new method of mapping surface dispersion vectors at the White Dam Prospect, Curnamona Craton, SA .....	24
8.	<b>M.C. Brown:</b> Palaeogene lakes and drainage evolution in the Shoalhaven and Wollondilly catchments, southeast NSW .....	29
9.	<b>A.G. Cadd, N.G. Direen &amp; P. Lyons:</b> Geophysical investigations of crustal architecture around the Challenger Au mine, Gawler Craton, South Australia: a basic step towards understanding Au dispersion pathways .....	34
10.	<b>J.R. Campbell:</b> Limitations in the laser particle sizing of soils .....	38
11.	<b>N. Cantwell:</b> High resolution geophysical methods for gold exploration under regolith cover, Songvang Prospect, Agnew, Western Australia .....	43
12.	<b>H. Carey, G. Heinson &amp; M. Sexton:</b> Lighting up the regolith: applied potential exploration methods .....	45
13.	<b>P. de Caritat, D. Kirste, G. Carr &amp; M. McCulloch:</b> Vectoring towards mineralisation undercover using groundwater geochemistry: an example from the Curnamona Province .....	49
14.	<b>P. de Caritat &amp; C. Reimann:</b> Baseline geochemistry of surficial regolith, Broken Hill region, Australia.....	53
15.	<b>K.D. Carthew, R.N. Drysdale &amp; M.P. Taylor:</b> Tufa deposits and biological activity, Riversleigh, northwestern Queensland .....	55
16.	<b>T. Chamberlain &amp; M. Grundy:</b> Predicting key regolith attributes for salinity assessment—a flexible approach for broad areas in Queensland.....	60
17.	<b>J. Chappell:</b> New determinations of the long-term production and migration of soil, our largest mineral deposit.....	66
18.	<b>C. Chor, N. Nitschke &amp; M. Williams:</b> Ice, wind and water: Late Quaternary valley-fills and aeolian dust deposits in arid South Australia.....	70
19.	<b>J.D.A. Clarke:</b> The limits of regolith: a planetary scale perspective .....	74
20.	<b>M.E. Clissold, P. Leverett &amp; P.A. Williams:</b> Gaspéite-magnesite solid solutions and their significance.....	78

21.	<b>T.J.F. Cook, R.T. Watkins &amp; R.J. Watling:</b> The effectiveness of Continuous Deflective Separation (CDS) pollutant traps in reducing geochemical input into urban wetlands: a comparative study of two contrasting stormwater catchments, Perth, WA .....	80
22.	<b>D. Csaky &amp; P. Please:</b> Salinity hazard mapping methodologies: the past, present and future .....	82
23.	<b>K. Czarnota:</b> An integrated geoscience approach to salinity hazard mapping .....	84
24.	<b>A. Davey, J. Joseph &amp; G. Heinson:</b> 2D regolith mapping with ground penetrating radar and time domain EM at a recently discovered Cu-Au orebody: White Dam, Curnamona Craton, SA .....	86
25.	<b>P. De Deckker:</b> Saline playa-groundwater in the Western District of Victoria.....	91
26.	<b>T. Dhu, G. Heinson &amp; J. Joseph:</b> The hydraulic and electrical fractal dimension of regolith .....	95
27.	<b>K.M. Dowell, J.A. Mavrogenes, D.C. McPhail &amp; J. Chappell:</b> Fantastic Australian opals .....	100
28.	<b>A. Duk-Rodkin, R.A. Chan &amp; K.G. McQueen:</b> Drainage evolution and implications for neotectonics and mineral exploration in the Cobar uplands, NSW .....	104
29.	<b>M.D. Edwards &amp; J.A. Webb:</b> Ground-truthing of a TEMPEST airborne electromagnetic survey in the salinised Kamarooka catchment, near Bendigo in central Victoria.....	110
30.	<b>J.B. Field:</b> Biota, regolith and landscapes: at the hillslope, profile and lesser scales.....	115
31.	<b>J.B. Field &amp; G.R. Anderson:</b> Biological agents in regolith processes: case study on the Southern Tablelands, NSW .....	119
32.	<b>R.W. Fitzpatrick:</b> Overview of acid sulfate soil properties, environmental hazards, risk mapping and policy development in Australia .....	122
33.	<b>K. Fitzsimmons:</b> Longitudinal and transverse dunes of the Lake Eyre Basin .....	126
34.	<b>J. Foster &amp; D. Chittleborough:</b> Soil development on dolomites of the Cambrian Normanville Group at Delamere, South Australia.....	131
35.	<b>K.A. Foster:</b> Detailed regolith-landform mapping for mineral exploration: the Wahratta 1:25,000 regolith-landform map.....	133
36.	<b>D. Gibson:</b> A new regolith/geology/landform framework for hydrogeological investigations in the Angas Bremer Plains area, SA .....	137
37.	<b>F.X. Gingele &amp; P. De Deckker:</b> Fingerprinting Australia's rivers using clays and the application for the marine record of rapid climate change .....	140
38.	<b>D.H. Glanville, I.C. Roach &amp; K.G. McQueen:</b> Regolith-landform mapping, leucite basalt and the landscape evolution of the Byrock region, NW NSW .....	144
39.	<b>R. Grzegorzek:</b> The regolith and landforms of the Anstey Hill Recreation Park, with particular emphasis on the Gun Emplacement.....	149
40.	<b>C. Gunton:</b> The role of salinity on the formation of geochemical anomalies in the regolith .....	154

41.	<b>D.M. Hart &amp; G.S. Humphreys:</b> Phytolith depth functions in surface regolith materials .....	159
42.	<b>A. Hashemi:</b> HoistEM EM for exploring under regolith cover .....	164
43.	<b>P. Heath:</b> Evolving the regolith from gravity and magnetics tensor data: theory and preliminary results .....	165
44.	<b>P.P. Hesse, G.S. Humphreys, B.L. Smith, J. Campbell &amp; E.K. Peterson:</b> Accumulation and preservation of loess deposits in the Central Tablelands of New South Wales.....	170
45.	<b>W. Hicks, R. Fitzpatrick &amp; G. Bowman:</b> Managing coastal acid sulphate soils: the East Trinity example .....	174
46.	<b>W. Hicks, R. Fitzpatrick, S Lamontagne &amp; S. Rogers:</b> Risks of water quality degradation during the remediation of floodplain salinity in the River Murray .....	178
47.	<b>S.M. Hill:</b> An undergraduate regolith-landform education and training program within the Shoalhaven River catchment, NSW .....	182
48.	<b>S.M. Hill &amp; L.J. Hill:</b> Some important plant characteristics and assay overviews for biogeochemical surveys in western New South Wales.....	187
49.	<b>S.M. Hill &amp; I.C. Roach:</b> The regolith-landforms of Sandstone Paddock, Fowlers Gap, western NSW .....	193
50.	<b>R. Hough, C. Phang &amp; R. Anand:</b> Mineral hosts for gold: a study of transported overburden at the Enterprise Pit, Mount Gibson gold deposit .....	201
51.	<b>K.A. Hulme &amp; S.M. Hill:</b> River red gums as a biogeochemical sampling medium in mineral exploration and environmental chemistry programs in the Curnamona Craton and adjacent regions of NSW and SA.....	205
52.	<b>G.S. Humphreys:</b> Evolution of terrestrial burrowing invertebrates .....	211
53.	<b>G.S. Humphreys, R.A. Shakesby, S.H. Doerr, W.H. Blake, P. Wallbrink &amp; D.M. Hart:</b> Some effects of fire on the regolith .....	216
54.	<b>D. Hunter:</b> Forward modelling Surface NMR for hydrogeological applications in Australia .....	221
55.	<b>P.R. James:</b> Linking Research and Teaching in the Earth and Environmental Sciences through the CRC LEME Education and Training Program .....	225
56.	<b>J.L. Keeling, A.J. Mauger, K.M. Scott &amp; K. Hartley:</b> Alteration mineralogy and acid sulphate weathering at Moonta copper mines, South Australia.....	230
57.	<b>A.L. Kernich &amp; C. Pain:</b> Geomorphology mapping for NRM issues, southern Queensland.....	234
58.	<b>A. Kotsonis &amp; B. Joyce:</b> Regolith mapping at Bendigo, and its relationship to gold in central Victoria, Australia.....	239
59.	<b>S. Lamontagne, W. Hicks, R. Fitzpatrick &amp; S. Rogers:</b> Sulfidic materials: an emerging issue for the management of saline areas in the River Murray floodplain.....	244
60.	<b>I.C. Lau, T.J. Cudahy, G. Heinson, A.J. Mauger &amp; P.R. James:</b> Practical applications of hyperspectral remote sensing in regolith research.....	249

61.	<b>S. Lee:</b> Groundwater geochemistry and associated hardpans in southwestern Australia .....	254
62.	<b>M.J. Lenahan:</b> Origin and accumulation of salts in the regolith: Bland Basin, NSW .....	259
63.	<b>J. Leonard &amp; J.B. Field:</b> The effect of two very different trees on soil characteristics .....	263
64.	<b>P. Leverett, A.R. McKinnon &amp; P.A. Williams:</b> Mineralogy of the oxidised zone at the New Cobar Orebody.....	267
65.	<b>D. Little &amp; B. Field:</b> The rhizosphere, biology and the regolith.....	271
66.	<b>D. Little, J.B. Field &amp; J.C.G. Banks:</b> Soil & regolith patterns and nutrient processes across an abrupt woodland-grassland ecotone .....	275
67.	<b>A. Lockheed &amp; K.M. Barovich:</b> Finding blind orebodies: geochemical exploration for large nickel-copper PGE sulphides on the western Gawler Craton .....	279
68.	<b>S. McDermott:</b> The regolith-landforms of the lower Onkaparinga River, SA.....	282
69.	<b>D.C. McPhail, E. Summerhayes, S. Welch &amp; J. Brugger:</b> The geochemistry and mobility of zinc in the regolith .....	287
70.	<b>A. McPherson:</b> Salt sources and development of the regolith salt store in the upper Billabong Creek catchment, SE NSW .....	292
71.	<b>K.G. McQueen &amp; D.C. Munro:</b> Weathering-controlled fractionation of ore and pathfinder elements at Cobar, NSW.....	296
72.	<b>D. Mitchell, M. Lewis, B. Ostendorf &amp; D. Chittleborough:</b> Mapping surface and subsurface soil properties using geophysical remote sensing and regolith information .....	301
73.	<b>A. Nemchin:</b> U and Th decay chains: application to regolith chronology .....	304
74.	<b>R.R.P. Noble, J. Watling, R. Watkins &amp; J. Dugdale:</b> Recognition of buried gold ore bodies in western Victoria based on soil bacterial leaching and other chemical leach analyses.....	306
75.	<b>C. Pain &amp; P. Kilgour:</b> Regolith mapping - a discussion .....	309
76.	<b>M. Paine:</b> Nature and extent of Pliocene strandlines on the Dundas Tableland, southwestern Victoria.....	314
77.	<b>A. Pengelly &amp; P. James:</b> Regolith mapping and interpretation of airborne hyperspectral data for zinc silicate/oxide mineralisation near Beltana in the northern Flinders Ranges of South Australia .....	319
78.	<b>R.T. Pidgeon:</b> Application of the (U-Th)/He geochronology to date hematite and other iron minerals produced during weathering.....	321
79.	<b>B. Pillans:</b> Dating ferruginous regolith to determine seismic hazard at Lucas Heights, Sydney .....	324
80.	<b>M. Raghimi:</b> Properties of soils affected by saline and acid seeps, West Dale, Southern WA .....	328
81.	<b>M.R.W. Reilly, S.C. Lang &amp; S.M. Hill:</b> Landforms and sediments of Umbum Creek and adjacent plains, Lake Eyre Basin, South Australia.....	332

82.	<b>F. Reith:</b> Evidence for a microbially mediated biogeochemical cycle of gold—a literature review .....	336
83.	<b>E. Rhodes, J. Chappell &amp; N. Spooner:</b> Age and mobility of arid regolith: assessment by luminescence dating methods.....	342
84.	<b>I.C. Roach:</b> Three years of MTEC .....	345
85.	<b>L.M. Roberts, J. Wilford, J.B. Field &amp; R.S.B. Greene:</b> High-resolution ground based gamma-ray spectrometry and electromagnetics to assess soil properties at Boorowa, NSW.....	352
86.	<b>C. Robertson:</b> Relationships of regolith and tree survival in a eucalyptus blue gum plantation.....	358
87.	<b>S. Rogers, R. Fitzpatrick, S. Lamontagne &amp; W. Hicks:</b> Application of functional molecular biology technologies to the study of biological processes in sulfidic environments .....	360
88.	<b>M.S. Rosid &amp; A.W. Kepic:</b> Electrokinetic sounding method to map hydrogeological boundaries .....	364
89.	<b>B.P. Ruxton:</b> Kinetics of organic matter in soils .....	369
90.	<b>S. Simons:</b> Application of SHRIMP for U-Pb and U-series dating of opal.....	373
91.	<b>M. Smith:</b> Preliminary investigation of salinisation at Bellata, NSW .....	375
92.	<b>M. Smith:</b> Soil hydrological processes of salinisation in the Bamganie-Meredith district, Victoria .....	382
93.	<b>M.L. Smith, S. Eggins &amp; B. Pillans:</b> U-Pb dating of anatase in silcrete.....	388
94.	<b>N. Stahl &amp; J.B. Field:</b> Stream salinity in a coastal catchment, Bega, NSW: a conceptual Model.....	391
95.	<b>K.P. Tan:</b> The distribution of pathfinder elements at the North Portia Prospect, Lake Frome Embayment, South Australia .....	394
96.	<b>S.E. Tate, R.S.B. Greene, K.M. Scott &amp; K.G. McQueen:</b> Characterisation of regolith materials in the Girilambone region, northwestern Lachlan Fold Belt, NSW.....	399
97.	<b>B. Thomas, R.W. Fitzpatrick, R. Merry &amp; W. Hicks:</b> Managing coastal acid sulfate soils: The Barker Inlet example .....	406
98.	<b>M. Thomas, R.W. Fitzpatrick &amp; G.S. Heinson:</b> Mapping complex soil-landscape patterns using radiometric K%: a dry saline land farming area case study near Jamestown, SA.....	411
99.	<b>K.M. Tomkins &amp; P.P. Hesse:</b> Post Mid-Miocene evolution of the Macquarie River valley, New South Wales .....	417
100.	<b>M. Turner, A. Sakellariou, C. Arns, R. Sok, A. Limaye, T. Senden &amp; M. Knackstedt:</b> Towards modelling regolith permeability with high resolution X-ray tomography .....	421
101.	<b>V. Waclawik:</b> Neo-tectonism and Lake Eyre .....	426
102.	<b>J.-A. Wartho:</b> Ar-Ar and K-Ar dating of continental weathering .....	431

103.	<b>J. Webb:</b> The role of soil shrink-swell in the formation of patterned ground .....	432
104.	<b>S.A. Welch &amp; D.C. McPhail:</b> Mobility of major and trace elements during biologically mediated weathering of granite .....	437
105.	<b>M.T. Wilkinson, G.S. Humphreys, J. Chappell, K. Fifield &amp; B. Smith:</b> Estimates of soil production in the Blue Mountains, Australia, using cosmogenic $^{10}\text{Be}$ .....	441
106.	<b>L. Worrall:</b> Exploring through cover on the Gawler Craton: reducing risk by integrating the interpretation of geophysical and geochemical data on the regolith .....	444
	<b>Author index:</b> .....	445