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Sedimentation and geochemistry of the Loxton-Parilla Sands in the Murray Basin, southeastern Australia

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Submitted in fulfilment of the requirements of the degree of

Doctor of Philosophy

February 2016

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Abstract

The Loxton-Parilla Sands are a well-preserved Neogene strandplain sequence in southeastern Australia. They provide an opportunity to understand the interactions of fluvial and shoreline sedimentary systems, groundwater and subaerial weathering, with implications for mineral exploration within the strandplain and its underlying geology. I undertook a detailed paleogeographical and geochemical study of the western Murray Basin from the scale of the basin to individual grains to assess the geochemical processes and depositional environment of Neogene sediments.

The observed distribution of heavy minerals supports previous studies that found that temporal and spatial variations in heavy mineral assemblages and zircon populations is related to access to different source regions and local depositional processes. Detrital zircon ages, from six locations including HMS deposits, range from the Cretaceous to the Mesoproterozoic and are consistent with major sediment sources in the neighbouring Adelaide Fold Belt, Lachlan Fold Belt, Grampians, Coleraine Volcanics, New England Fold Belt and Whitsunday Volcanic Province (WVP). Zircons from the WVP travelled up to 3000 km and are most likely to have been recycled through the Eromanga Basin. Gold is locally present at low concentrations and is distributed near the goldfields of Victoria. Geochemistry of Au that is non-repeatable, unrelated to the Fe-oxide indurated horizons, pathfinder elements, and heavy mineral concentrations is consistent with a detrital origin.

I used geological logs from over 8000 drill holes to model the geometry of the Loxton-Parilla Sands and associated Neogene units in 3 dimensions. Curvilinear depocenters are interpreted to represent the path of ancient channels draining the Murray Basin during the Neogene. The Murray River west of Balranald has migrated north up to 80 km while the outlet of river has moved 300 km to the northwest of its former location near Edenhope to its current location. There was a major confluence of Neogene drainage channels east of Ouyen.

Detailed whole rock geochemistry, mineralogy, and major element mapping indicates the two major controls on geochemistry in the Loxton-Parilla Sands are detrital minerals and post-depositional weathering. The post-depositional geochemistry is characterised by accumulation of secondary goethite and hematite (up to 80 wt. %) and silica, clay minerals, and minor carbonate and sulphate. Incorporation of Al into secondary Fe-oxides, mobilisation of Si in the weathering profile, and precipitation of barite point to strongly acidic weathering conditions as the result of acid sulphate soil development and ferrolysis. The range of morphologies of indurated materials is consistent with progressive induration and formation which began with interaction of groundwater and oxidised sediments in the coastal and near-coastal system. As the ocean further regressed, leaving the dunes 'stranded', the induration was overprinted by disaggregation, transport, and further induration of ferricretes to produce a range of internal textures.

Whole rock geochemistry and element mapping reveal complex patterns of major and trace element distribution within Fe-oxides from indurated horizons in the Loxton-Parilla Sands. These patterns record fluctuating Eh and pH conditions related to wetting and drying of coastal sediments during and immediately following deposition. Concentrations of trace elements that are important pathfinders for a range of mineralisation styles are heterogeneous and reflect these temporally varying groundwater interactions rather than proximity to mineralisation. The Loxton-Parilla Sands and associated weathering profile are a complex system of sedimentary and post-depositional geochemical processes superimposed on eustuatic and neotectonic processes. This study underlines the importance of understanding the whole system in order to identify weathering processes and their application to regional mineral exploration.

Statement of originality

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in any other university or tertiary institution to Stephanie Margaret McLennan and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide.

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Stephanie Margaret McLennan

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Acknowledgements

This thesis, like the Loxton-Parilla Sands, has undergone years of evolution and modification and there is no single defining control on the resultant thesis/stratigraphy. The sand analogies will stop there. I am indebted to my supervisors Prof. David Giles, Dr Steve Hill, and Prof. Karin Barovich for their insight, guidance, wisdom, and good humour. I am grateful for the expertise of Dr Ben Wade and Aoife McFadden at Adelaide Microscopy (and assurance that, "it's meant to make that sound"). The assistance of Acme Laboratories in Vancouver and Adelaide Petrographic Laboratories as well as the core repositories of the Geological Survey of South Australia (GSSA), Geological Survey of Victoria, and Geoscience Australia is gratefully acknowledged. I would like to thank Simon van der Wielen from the Deep Exploration Technologies Cooperative Research Centre (DET CRC) for his assistance and expertise with GOCAD® and 3D modelling. Further thanks go to Georgina Gordon of the GSSA and Matilda Thomas at Geoscience Australia for their expertise in HyLogger™. I am grateful for the outstanding support and opportunities provided by the DET CRC throughout my PhD and for Geoscience Australia for providing the flexibility and support to complete this thesis while working full-time.

On a personal level, I'd like to thank my family especially my mum (sorry about all the rocks in the shed) and Andrew, Jessica, Patrick, and Georgia. Mum, thank you for instilling in me a passion for learning and supporting me in your own gently inimitable way. Dad, I'm sorry you didn't get to read this; I think you really would have got a kick out of it. To Simon, the love of my life, words fall short of capturing my gratitude for your support, humour, and encouragement during this undertaking. No more late night lab visits. I promise. A huge thank you to the Gunson family, the van der Wielen family, Dr Ashlyn Johnson and Charlotte Mitchell, and the postgraduate cohort at Adelaide. Thank you to my friends and colleagues at Geoscience Australia for keeping me somewhat sane in this last year.

Finally, I'd like to acknowledge the exceptional research that has come before me, the scientists whose shoulders I stand on: Drs Tony Stephenson and the late Campbell Brown, as well as Drs Jim Bowler, Louise-Goldie Divko, Andrew Kotsonis, Phil Macumber, Sandra McLaren, John Miranda, Mark Paine, Peter Roy, and Keith Sircombe.