Loess and floods: late Pleistocene fine-grained valley-fill deposits in the Flinders Ranges, South Australia

(excerpt from Hans Heysen 1929: “Foothill of the Flinders”, Morgan Thomas Bequest Fund 1939)

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Contents

Thesis abstract

Terrace remnants of late Pleistocene fine-grained valley-fills, at present eroded by ephemeral traction-load streams, are reported from many semi-arid and arid parts of the world. While they present promising palaeo-environmental archives for recent geological times such as the Last Glacial Maximum (LGM) for which few other terrestrial depositional records exist, their poorly understood nature has limited their significance. This study examines the fine-grained valley-fill deposits from the Flinders Ranges in South Australia, here called Flinders Silts. It establishes the timing, mode and environmental controls of deposition as opposed to their advancing erosion under the current climate. A regional chronostratigraphy based on 124 numerical dates is discussed, of which 43 radiocarbon and 22 luminescence ages were obtained from 12 sections across three major catchments within the scope of this thesis. Regionally significant intervals of rapid aggradation, relative surface stability and erosion are established. Regional climatic controls are differentiated from intrinsic catchment- and site-specific effects on the system. Further, individual age proxies and age models are critically assessed in how far they reflect depositional events. The final aggradational interval bracketing the extended LGM is discussed in detail on a continuous layered to laminated stratigraphic sequence. The provenance question of the fine-grained sediments and the depositional environment of the Flinders Silts are further addressed by high-resolution particle-size analysis. In order to study the subtle variations within the fine-grained partially-aggregated material, an original parametric sediment-sizing approach is employed. Finally, a range of traditional and emerging analytical techniques are applied to improve our understanding of palaeo-environments promoting aggradation. In conclusion, arid intervals throughout the last glacial cycle resulted in significant quantities of proximal dust being deposited as loess mantles within the catchments of the Flinders Ranges, acting as a near-longitudinal dust trap in the centre of the late Pleistocene “dust bowl”. The fine-grained aeolian accessions were repeatedly eroded by low-frequency high-magnitude precipitation events and redistributed as loess-derived alluvium, congesting narrow gorges and raising the base level for tributaries. Locally, backflooding resulted in the aggradation of layered to laminated slackwater deposits, the most continuous recording at least 12 large and numerous smaller flood events between 24 ka and 18 ka. The synchronous termination of the Flinders Silts coincides with early Deglacial climatic amelioration. The re-establishment of a perennial plant cover stabilising both dune fields and slope mantes is discussed as a potential scenario that would have discontinued dust supply to the fluvial system, in turn promoting incision and erosion. The studied aeolian-fluvial interplay of loess and floods has large implications for our understanding of landscape evolution in semi-arid Australia.

Thesis declaration

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution to me 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.

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David Haberlah Adelaide, August 2009

* list of all publications contained in this thesis:

Refereed papers

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Haberlah D., McTainsh G.H. 2009. Quantifying particle aggregation in fluvial sediments. *Sedimentology*, **in revision**.

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Haberlah D. 2008. Response to Smalley's discussion of 'A call for Australian loess'. *Area* **40.1**, 135-136.

Haberlah D. 2007: A call for Australian loess. *Area* **39.2**, 224-229.

Haberlah D. 2007: Depositional models of late Pleistocene fine-grained valley-fill formations in the Flinders Ranges, South Australia. *In:* Fitzpatrick R.W., & Shand P. (eds) 2007, *Regolith 2006—Consolidation and dispersion of ideas*. Cooperative Research Centre for Landscape Environments and Mineral Exploration, Perth, 122-126.

Conference abstracts

Haberlah D., Williams M.A.J., Hill S.M., Halverson G., Suto A., Glasby P., Butcher A.R., Hrstka T. 2009. The Flinders Silts: a last glacial alluvial loess record from South Australia *(oral presentation at 7th International Conference on Geomorphology 2009)*

Haberlah D., Hill S.M., Strong C., Butcher A.R., McTainsh G.H., Hrstka T. 2009. Dust fingerprinting in regolith: an integrated high-resolution parametric particle-size analysis quantitative spectral mineralogy approach *(poster presentation at 7th International Conference on Geomorphology 2009)*

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Co-author contribution declaration

For the following joint and multiple-authored papers, my co-authors kindly acknowledge their contributions as stated below and agree for a similar version of our paper to be included in this thesis:

1) **Loess and floods: high-resolution multi-proxy data of Last Glacial Maximum (LGM) slackwater deposition in the Flinders Ranges, semi-arid South Australia. Quaternary Science Reviews,** *(in submission)*

David Haberlah: conceptualisation of study, field work, laboratory work, paper writing

Martin A.J. Williams: PhD supervision, joint field work, editing

Galen Halverson: supervision of isotopic study, discussion of results

Tomas Hrstka: QEMSCAN® operation, discussion of results

Alan R. Butcher: QEMSCAN® supervision

Grant H. McTainsh: supervision of granulometric study

Steven M. Hill: PhD supervision, editing

Peter Glasby: GIS for figures 1 and 2, joint field work

2) **Quantifying particle aggregation in fluvial sediments. Sedimentology,** *(in revision)*

David Haberlah: conceptualisation of study, field work, laboratory work, paper writing

Grant H. McTainsh: project supervision, discussion of sample preparation, data analyses and results, editing

3) **"Of droughts and flooding rains"*: an alluvial loess record from central South Australia spanning the last glacial cycle. In: Bishop, P. & Pillans, B. (eds) 2009, Australian Landscapes. Geological Society, London, Special Publications,** *(in press)*

David Haberlah: conceptualisation of study, field work, AMS and OSL sample preparation (except stated otherwise), all age calculations, paper writing

Peter Glasby: contribution of 6 AMS and 2 OSL ages from section Cascades 1, and 6 AMS ages from section BRA07-SD included in tables 1 and 2, joint field work

Martin A.J. Williams: contribution of 3 OSL ages from section BRA-SG discussed in the text and included in tables 1 and 2, joint field work, editing

Steven M. Hill: PhD supervision, editing

Frances Williams: supervision of luminescence work, operation of OSL reader for all Adelaide samples (AdGl)

Edward J. Rhodes: operation of OSL reader for 6 samples from the Hookina catchment, discussion

Victor Gostin: PhD supervision, editing

Anthony O'Flanery: GIS for figure 1

Geraldine E. Jacobsen: supervision of AMS sample preparation and combustion at ANSTO (lab code OZK), editing

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The teacher who is indeed wise does not bid you to enter the house of his wisdom but rather leads you to the threshold of your mind – Khalil Gibran

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