Report on grant scheme award (1st session, 2008) ***David Haberlah***

Late Pleistocene aeolian-fluvial interactions in southern Australia

In accordance with the grant proposal, 34 sediment samples were analysed in collaboration with Intellection Pyt. The Euro 1,000.- (approximating AUD 1,700.-) were spent to cover the subsidised sample preparation cost of AUD 50.-/sample.

So far, the study resulted in three papers; two presentations at the 7th International Conference on Geomorphology held 6 - 11 July 2009 in Melbourne, and one in submission with a high-impact peer-reviewed journal.

The abstracts of all three papers are listed below, highlighting the reference to the funded study. IAS is acknowledged on all the papers/presentation/posters. An excerpt of a figure of the QEMSCAN® analyses is attached. The key paper is still in submission.

1) Loess and floods: high-resolution multi-proxy data of Last Glacial Maximum (LGM) slackwater deposition from South Australia

David Haberlah, Martin A. J. Williams, Galen Halverson, Tomas Hrstka, Alan R. Butcher, Grant H. McTainsh, Steven M. Hill, Peter Gasby

Terrace remnants of late Pleistocene fine-grained valley-fills (Silts) deeply entrenched by ephemeral traction load streams have puzzled geoscientists in many (semi-)arid parts of the world. Their enigmatic presence, perhaps most widely discussed for the Namib Silts, was attributed to depositional environments ranging from lake beds to floodplains. Similar fine-grained deposits in the Flinders Ranges (South Australia) are the latest to attest such succession of palaeo-environmental interpretations. A more than 7 m thick layered to laminated stratigraphic section from the Brachina catchment, arguably Australia's most impressive terrestrial sedimentary sequence deposited over the Last Glacial Maximum (LGM), is here addressed by a centimetre-scale multi-proxy study. The results of detailed lithostratigraphic mapping, high-resolution parametric particle-size analysis, **quantitative spectral mineralogy**, magnetic susceptibility, carbon stable isotope geochemistry, and a chronostratigraphy based on 27 AMS radiocarbon and 6 luminescence ages are discussed in terms of sediment provenance, depositional environment, weathering and local hydrology with the aim to reconstruct the regional palaeoclimatic history. From the data we infer a fluctuating aeolian-fluvial interplay dominating the LGM environment that had a greater impact on landscape evolution than combined geomorphic processes ever since. Proximal dust accessions (loess mantles) were eroded and entrained by numerous small and at least a dozen large-scale flood events and trapped in an intra-montane floodplain extending into the Brachina Gorge. Upstream of this narrow constriction, backflooding resulted in rapid fallout of suspension load, aggrading as meter-thick slackwater deposits. Aggradation and incision of the floodplain appear to be largely controlled by sediment supply. In conclusion, we demonstrate how dust storms and flooding rains can account for "pluvial"

features previously explained by the opposing effects of reduced precipitation and evaporation in the colder more arid glacial landscape of South Australia. ***(10,000 word paper in submission)***

2) Dust fingerprinting in regolith: an integrated high-resolution parametric particle-size analysis quantitative spectral mineralogy approach

David Haberlah, Craig Strong, Alan R. Butcher, Grant H. McTainsh, Tomas Hrstka

Loess-derived alluvium is widely recognised in; mountainous catchments downwind of deserts, formerly exposed continental shelf areas and large playa lakes. A prominent example from South Australia is the late Pleistocene Flinders Silts; up to 18 m thick fine-grained valley-fill deposits choking narrow gorges and mantling the piedmont plains of the Flinders Ranges. In order to assess their impact on landscape evolution, deposition rates of dust need to be estimated for a given time period and area. This is best achieved by quantitatively differentiating the allochthonous aeolian component from in-situ weathering products within chronostratigraphic sequences along a downwind transect. Here, we present the results of an integrated approach employing high-resolution three-dimensional particle-size analyses using a Multisizer 3 COULTER COUNTER® and **automated mineralogical QEMSCAN® technology**, a combination of features found in other analytic instruments such as Scanning Electron Microscopes (SEM) and Electron Probe Micro Analysers (EPMA). Parametric analysis of the particle-size data is performed on both fully-dispersed and minimally-dispersed sediment samples, the latter approximating transport-stable conditions in turbulent fluvial flow. Aggregation is further explored by "mapping" the sample mineralogy, thus visualising the spatial distribution of minerals in the form of discrete particles and compound aggregates. Disaggregation is digitally performed by the software package iDiscover™. The results underline the importance of analysing soils and sediments in its naturally-occurring partially-aggregated state, with certain forms of aggregation being indicative of fluvial transport. Apart from the palaeo-environmental implications, there are many other potential fields of application of integrated quantitative dust fingerprinting in regolith, ranging from more efficient prospecting and mining to monitoring of human health and climate change.

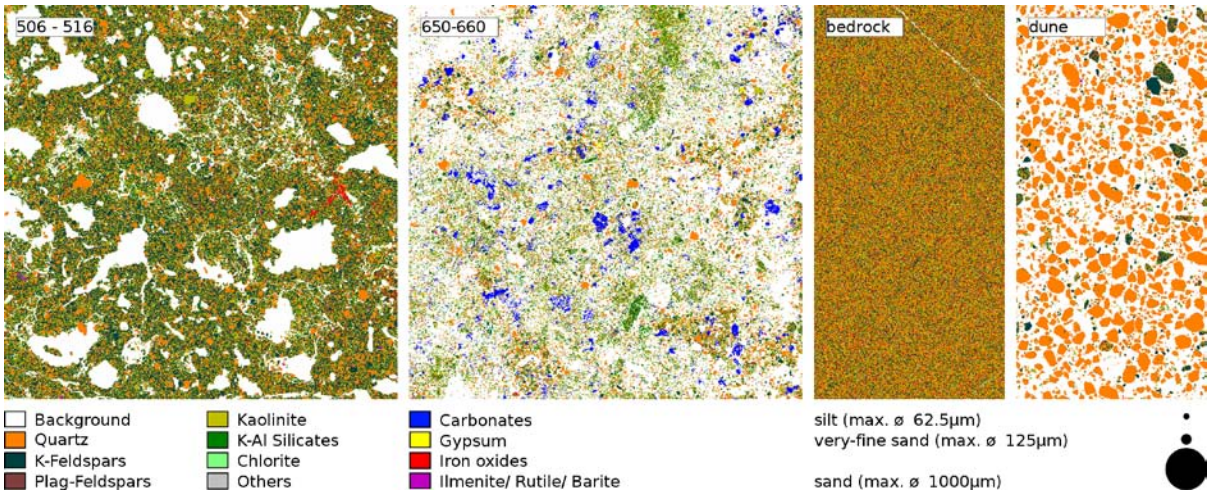
3) The Flinders Silts: a last glacial alluvial loess record from South Australia

David Haberlah, Martin A. J. Williams, Steven M. Hill, Galen Halverson, Amy Suto, Peter Glasby, Alan R. Butcher, Tomas Hrstka

Remnants of late Pleistocene loess-derived valley-fills (Silts) are a common occurrence in mountainous catchments downwind of deserts, formerly exposed continental shelf areas and large playa lakes. The Namib Silts within the Great Escarpment of Namibia and the Sinai Silts of Egypt have been studied by Quaternary geomorphologists for decades. However, their depositional nature remains a matter of controversy, making it difficult to interpret their rich palaeo-environmental archives. Here we present the largely unnoticed but equally spectacular Flinders Silts from South Australia. Situated in the midst of the last glacial continental "dust bowl", the longitudinal Flinders Ranges trapped large quantities of proximal dust. At present, the Silts are entrenched up to 18 meters by ephemeral traction load streams. Fifteen stratigraphic sections from four catchments

were logged and dated by 94 AMS radiocarbon and 30 OSL ages. All sections are put in geomorphological context by stratigraphic mapping, and, within the Brachina catchment, by means of a differential GPS survey. Multi-proxy studies involving high-resolution parametric particle-size analyses, magnetic susceptibility, ICP-MS, carbon, oxygen, and nitrogen isotope geochemistry and spectral mineralogy employing HyChips™ and **QEMSCAN® technologies** were performed. The results of the regional study indicate that over the last glacial cycle, particularly over its culmination in the Last Glacial Maximum (21±3 ka), loess blown into the catchments was episodically entrained and re-deposited by floods, choking narrow gorges and backflooding into tributaries and embayments. Here, successive floods resulted in the deposition of layered to laminated slackwater deposits, presenting a near continuous terrestrial palaeo-environmental archive. The multi-proxy record suggests that the last glacial represents an overall arid but complex interval, significantly altering the landscape by dust storms and flood events. The study of fine-grained valley-fills from south-eastern Australia can help to resolve the prolonged discussion over the nature of Silts in other parts of the world.

Excerpt of figure



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