Project n°: 237203
Project Acronym: PostOroLand
Project Full Name:
The Evolution of Post-Orogenic Landscapes: Bedrock Rivers, Lithology and Relief Development

Marie Curie Actions

IEF-IOF-IIF- IIFR Final Report

Period covered: from June 1 2009 **to** May 31 2011
Period number: Final
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Project beneficiary name: Professor PAUL BISHOP
Project beneficiary organisation name : University of Glasgow
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Duration: 24 months
Version: Final

1. FINAL PUBLISHABLE SUMMARY REPORT

Summary description of the project objectives

The aim of this project is to use analysis of digital terrain data, terrestrial cosmogenic nuclides (TCNs), and long profiles in the Lachlan River – a large (20,000 km^2) Australian drainage basin with a well-constrained Cenozoic evolution – to assess lithological control of the rate and style of landscape evolution in a typical post-orogenic setting. The project achieved this aim (i) by quantifying rates of landscape evolution, and (ii) by assessing how landscape evolution is slowed by resistant lithologies, a key but neglected issue in understanding post-orogenic setting (Bishop 2007). The project engages with enduring questions in geomorphology, namely, does lithology (rock type) influence landscape morphology, and if so, how does it exert this influence? In summary, the objectives were:

1. To map the spatial distribution of knickpoints in the bedrock drainage net of the Lachlan catchment and their association with lithology;
2. To use TCN analysis of modern bedrock channels and fluvial sediments to determine the spatial pattern of bedrock channel incision and catchment lowering; and
3. To use TCN analysis of Early Miocene fluvial sediments to test the hypothesis that the spatial distribution of denudation rates revealed in 2 has pertained since before the Early Miocene.

As part of meeting objective 2, a sub-objective was set up after the first field campaign to use optically stimulated luminescence (OSL) to assess the ages of widespread valley-bottom sediments that may have shielded channel beds from cosmic radiation (and hence compromised the record of terrestrial cosmogenic nuclides (TCNs) that underpin this work).

Results

All three objectives have been addressed, but, as noted in the periodic report, we await the results of the TCN analyses, the delays to which have arisen from events completely beyond our control or influence.

The work has shown that steep bedrock river reaches do indeed coincide with resistant lithologies, as we had hypothesized. We hypothesize – and will test using TCN analysis – that the rates of denudation and bedrock incision downstream of the lithologically controlled knickpoints will be equivalent to the rates of trunk stream incision (i.e., 1-10 m Myr^{-1}, driven by denudational isostatic rebound – Bishop 1985), whereas the rates upstream of the lithologically controlled knickpoints will reflect the 'top-down' process rates governed by discharge, sediment flux and slope. These rates upstream of the lithologically controlled knickpoints may match those downstream of the knickpoints but we hypothesize further that they will be lower than the downstream rates, reflecting the low gradients and low sediment fluxes in these upstream catchments. Those remain our expected results and we await the results of the TCN analyses.

OSL analyses were undertaken on the swampy meadow (SM) sediments that underlie the valley-bottom-blanketing sediments commonly known as post-settlement alluvium (PSA). This 'PSA' designation reflects the almost-universal interpretation that these blanketing sediments were mobilised when Europeans settled the area in the 19th century, extensively clearing the catchments, triggering catastrophic catchment erosion and downstream movement of massive amounts of sediment that is now stored in valley bottoms (e.g., Prosser 1991; Wasson et al. 1998). Butzer and Helgren (2005) have recently questioned this interpretation, using early explorers' accounts and diaries to argue that inland SE Australia was quite extensively gullied and 'disturbed' when Europeans arrived. Resolution of this issue is important here: massive valley-bottom sedimentation substantially earlier than the 19th century means that there is the potential to perturb the acquisition of TCNs, invalidating the approach we are taking here.

The objective of the dating exercise was to determine the depositional age of the PSA, but because of the clearly unbleached character of the PSA (Munoz-Salinas et al. 2011), we concentrated the OSL dating exercise on the SM sediments underlying the PSA and then

projected the sedimentation rate of the SM to its contact with the base of the PSA. Kinnaird et al. (2011) report that the samples exhibit good OSL sensitivity and produced acceptable SAR internal quality control performance. Age estimates of 5.17 ± 0.30 ka (163 cm depth) and 2.43 ± 0.14 ka (103 cm depth) were obtained for the SM deposit (Fig. 1).

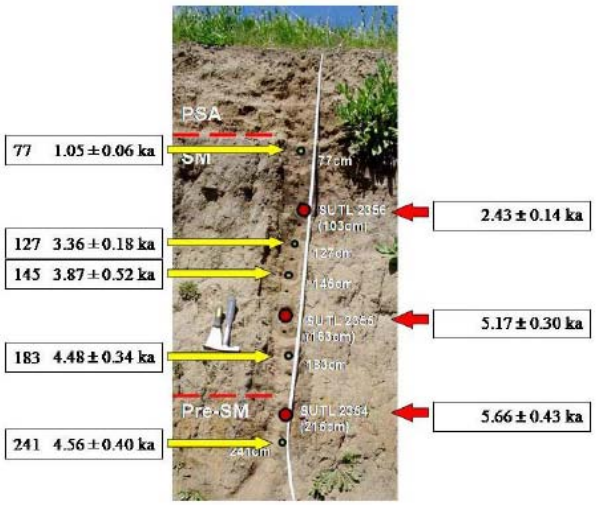

Figure 1 *The sampled section in Grabben Cullen Creek, New South Wales, Australia, annotated with apparent ages from OSL full dating samples (red) and laboratory profiling samples (yelllow)*

A series of profiling samples (yellow samples on Fig. 1) were converted to ages, by combining the stored dose in these profiling samples and the field-measured dosimetry of the full dating samples (the red samples in Fig. 1). A linear extrapolation through the profiling apparent ages gives an estimate the age of the SM/PSA contact at ~ 390 yrs.

Thus, it is apparent that the contact between the SM and PSA, which we interpret to be the onset of the PSA sedimentation in the valley bottom, is associated with a date of about 400 years. Intriguingly, this age pre-dates the arrival of Europeans in inland southeastern Australia but, that conclusion notwithstanding, an age of four centuries (or less) creates few issues in relation to shielding of the channel bed from cosmic radiation.

Conclusion

We await the CIAF's notification of the results of the TCN analyses but can conclude, meanwhile, that the issue of shielding of the bed by thick deposits of sediment resulting from upstream erosion is not one of concern in this TCN analysis. That issue notwithstanding, the OSL dating results are intriguing: they hint that the catastrophic erosion responsible for the thick sheet of valley-bottom-blanketing sediment may pre-date the arrival o Europeans in this area. This is an intriguing and even provocative conclusion because it implies one or both of two possible conclusions: (i) that substantial shifts in climate in the last 500 years (for which, incidentally, there is little independent evidence) have triggered massive catchment erosion, and/or (ii) that indigenous land-use practices were not as sympathetic and 'low-impact' as is traditionally believed. We are seeking to build on this aspect of the Marie Curie work by having a PhD student undertake more mapping and dating of these deposits. As indicated in the periodic report, our hypotheses for the rates of erosion/denudation to be revealed by the TCN analyses remain as they were when this project was proposed for Marie Curie support, and we await the results of the TCN analyses to test these hypotheses.

References

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Kinnaird, T.C., Sanderson, D.C.W., Bishop, P. and Muñoz-Salinas, E. 2011. *OSL dating of sediment from the Grabben Gullen Creek, upper Lachlan River Catchment, SE Australia*. Unpublished OSL Dating Report of the Scottish Universities Environmental Research Centre, East Kilbride, Glasgow.

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Prosser, I.P. 1991. A comparison of past and present episodes of gully erosion at Wangrah Creek, Southern Tablelands, New South Wales. *Australian Geographical Studies* 29, 139–154.

Wasson, R., Mazari, R., Starr, B., Clifton, G. 1998. The recent history of erosion and sedimentation on the Southern Tablelands of southeastern Australia: sediment flux dominated by channel incision. *Geomorphology* 24, 291–308.

2. USE AND DISSEMINATION OF FOREGROUND

Section A (public) – DISSEMINATION MEASUR ES

This section should describe the dissemination measures, including any scientific publications relating to foreground and specify any applications for patents etc in accordance with article II.11. Its content will be made available in the public domain thus demonstrating the added –value and positive impact of the project on the European Community.

Planned Dissemination activities

The major planned dissemination activities will be via the usual academic route, namely, conference presentations and publications. We plan a major publication based on the long profile analyses and TCN analyses. We intend this for one of the highest impact Earth sciences journals (either *Earth & Planetary Science Letters* or *Journal of Geophysical Research – Earth Surface*) and it will be a major, stand-alone and complete statement of the substantive findings of the project. We also intend to present these findings at the 2012 EGU meeting in Vienna (and perhaps at the annual meeting of the Geological Society of America [to be decided with the researcher, who is now in Mexico to take up her new post]).

- **Publications (peer reviewed)**

LIST OF SCIENTIFIC (PEER REVIEWED) PUBLICATIONS, STARTING WITH THE MOST IMPORTANT ONES								
NO.	**Title**	**Main author**	**Title of the periodical or the series**	**Number, date or frequency**	**Publisher**	**Place of publication**	**Year of publication**	**Relevant pages**
1	Interpreting luminescence data from a portable OSL reader: three case studies in fluvial settings	E. Muñoz-Salinas	*Earth Surface Processes and Landforms*	Volume 36	Wiley		2011	pp.651–660
2	OSL applications for understanding sedimentological processes in hydro-volcanic (lahar) events: Case studies in the Tenenepanco and Huiloac gorges, Mexico	E. Muñoz-Salinas	*Geomorphology*	In press	Elsevier		2012?	In press

Section B (confidential) - EXPLOITABLE FOREGROUND AND PLANS FOR EXPLOITATION

Not applicable

3. SCIENTIST IN CHARGE QUESTIONNAIRE

RESEARCH TRAINING (IEF-IOF)/TRANSFER OF KNOWLEDGE (IIF) ASSESSMENT:

What is the size of the hosting research group?	Glasgow Earth Systems Research Group currently 20 academic staff, 16 postdoctoral research associates, and 25 PhD students

How many researchers have you supervised, within the past 10 years? Of which funded by:	
EC/Marie Curie actions	One (this project)
EC Other Funding	Nil

University fellowships	Three
National public bodies	Six
Industry	Nil
Other, please specify	Nil

How many researchers have you supervised within this project?	One
Corresponding to how many person months?	Twenty four

Number of publications resulting directly from the research project:	
Recruited researcher(s) and yourself	Two
Recruited researcher(s) alone	Nil
Recruited researcher(s) with authors other than yourself	Nil

Participation of the fellow researcher at conferences (number):	
Passive	Two
Active	Eight
How do you rate the overall success of the research training (IEF, IOF)/ transfer of knowledge (IIF)?	Highly successful

General assessment: This project has been very successful, notwithstanding the delay in the cosmogenic nuclide analyses at the NERC Cosmogenic Isotope Analysis Facility. The researcher has worked extremely hard and been very diligent, taking the work into the areas of OSL that we had not envisaged when proposing the work for Marie Curie funding. Most satisfying project.

Researchers assessment:

Rate the overall level of the fellow researcher integration in the research team and the host organisation with regards to:	
participation in meetings/seminars	Attended all group seminars and integrated very well
discussions of results and project-related topics	I had many discussion meetings with the researcher and we, of course, had many days & evenings to discuss the research during fieldwork
co-operation with other team members	Excellent; fitted in very well with a large research group with multiple people wanting access to the mineral separation facilities and other equipment
co-operation with other researchers of the host institution	Very good

Rate the overall performance of the fellow researcher with regard to:	
originality of fellow approach towards research (initiative/independent thinking)	Very pleasing: has really pushed our knowledge forward
capacity to develop new skills and to benefit from training	Again excellent: has picked up all techniques (e.g., mineral separation and purification, OSL

	analyses) well and very efficiently
productivity (research results/publications/ international conference attendance)	Produces results and wrote publications very efficiently, and was a enthusiastic attendee of major conferences
communication skills	Generally good
group leader skills (collaboration with other groups/project management)	All fine
training and/or teaching skills	Little teaching done, as she was so keen to get on with the research
Please comment: Overall, Esperanza Muñoz-Salinas was a most satisfactory Marie Curie Fellow who was a pleasure to have as a collaborator and co-researcher.	

RESEARCH TRAINING OUTCOMES (IEF-IOF)/TRANSFER OF KNOWLEDGE (IIF):

Has this project provided additional links with other research groups or institutions?	Yes. The researcher has developed very close links with the Scottish Universities Environmental Research Centre
If yes, indicate the number of contacts in each case	
Universities	Two
Research Centres	Three
Industry/private companies	Nil
If Other, please specify:	Nil

Rate the importance of the following outcomes of the research training/transfer of knowledge: *It is not clear what is being sought here. Do you mean the importance of the following matters generically or the relative importance of their contributions to the success of this particular research project?*	
results of the research	
number of publications	
establishment of international collaborations	
transfer of knowledge/technology	
training of researcher	
further academic qualifications (PhD, habilitation etc.) for fellows	
Please comment:	

YOUR OPINION ABOUT THE MARIE CURIE ACTIONS:

Do you have any other comments or suggestions of how to improve the concerned Marie Curie actions? Yes, the whole process is almost unbelievably bureaucratic (and I do literally mean "unbelievably"), so please make it all less bureaucratic. The amount of paperwork and its complexity, relative to the duration of the Fellowship, make the whole process marginal in attractiveness for busy, successful, supervising scientists. Why does it have to be so complex? Secondly, these various reports are repetitive within each report. I struggled to know what was wanted in each section, and there seems to be repetition between sections. Again, excessive work and complexity, all of which takes up valuable time.

Did you have previous knowledge of the Marie Curie actions?	Yes
If yes, what sort of image do you think that the Marie Curie actions have among the scientific community in your research area?	Good training opportunity but the excessive bureaucracy is a strong disincentive to make applications to the scheme
Attachments:	Nil

Date: 5 September, 2011 **Signature Scientist in Charge:** 	**Date:** 5 September, 2011 **Signature Researcher:**