

SERVICES & FACILITIES ANNUAL REPORT - FY April 2014 to March 2015

SERVICE CIAF	FUNDING Block	AGREEMENT R8/H10/42	ESTABLISHED as S&F 2004	TERM 5 years
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TYPE OF SERVICE PROVIDED:

Analysis of the long-lived cosmogenic radionuclides ¹⁰Be, ²⁶Al and ³⁶Cl can be used to constrain the timing of events on timescales from 10³ to a few times 10⁶ years. Such analysis of these cosmogenic nuclides is, in contrast to radiocarbon and luminescence dating, not as limited to rather specific field / sampling conditions. Since its establishment in the late 1980s the use of terrestrial in-situ produced cosmogenic nuclides for geomorphological applications has been rapidly growing, and there is now a well-established community in the U.K. Established in 2004, the Cosmogenic Isotope Analysis Facility (CIAF) at SUERC provides access for the UK Earth and environmental sciences community to sample preparation facilities and measurement of targets using the 5 MV Pelletron Accelerator Mass Spectrometer.

The CIAF Head of Facility is Prof. Rob Ellam, scientific support is provided by Facility Scientists Dr Ángel Rodés and Dr Delia Gheorghiu, and Technical Specialist Mr. Allan Davidson. Facility science quality is maintained by the Steering Committee of the CIAF (currently G6 and above for postgraduate student projects and G7 equivalent for higher level research). To date, CIAF SC has received 159 grant applications which reflect the strong existing and sustainable demand (11 grant applications during 2014) for its service. Training in cosmogenic nuclide dating is provided for motivated doctoral students, post-doctoral fellows and project leaders, as well as for other visiting scientists, as a priority of the Facility.

The CIAF has been involved in projects focusing mostly on climate change. Establishing the time of ice deglaciation around the world has given a better picture of the past climatic changes (Hein et al., 2009; Hughes et al., 2012; Ballantyne et al., 2013). The CIAF has also done intensive work on samples collected from the remote areas of Greenland and Antarctica (Lane et al., 2009, Glasser et al., 2014; Dyke et al., 2014). Increasing awareness on the cosmogenic nuclide applications led to a wider scientific interest. Slope readjustments and rock failures following deglaciation has been investigated (Ballantyne & Stone, 2013; Ballantyne et al., 2014). High quality science has been produced in studies of sand residence of 1 mil years in the Namib Sea (Vermeesch et al., 2010), erosion rates to understand rates of river incision (Anton et al., 2012), and upstream knickpoint retreat which have a critical role in landscape evolution (Jansen et al., 2011). Although CIAF has been supporting the scientific community with dating various landforms and processes it has also contributed majorly to development of the methodology (Xu et al., 2010; Wilcken et al., 2013; Rodés et al., 2014).

The Facility has successfully used beryllium carrier solutions with extremely low ¹⁰Be/⁹Be ratios obtained from a NERC capital bid. Thus, the Facility responded to the increasing demand for the analysis of low ¹⁰Be concentrations (e.g. to determine high erosion rates) by producing an in-house low Be carrier. CIAF staff have been authors or co-authors on 101 published, peer-reviewed manuscripts since 2004. This publication record demonstrates sustained and high scientific output of work related to the CIAF Facility. It also reflects the scientific contributions of Facility staff to Steering-Committee approved projects.

ANNUAL TARGETS AND PROGRESS TOWARDS THEM

Within the financial year 2014-2015 (FY14/15) the CIAF has been involved in 28 funded projects and received 14 new applications (7 from new users). Eight peer-reviewed manuscripts were published based on CIAF-related research with CIAF staff as author or co-author on all of them. CIAF staff were also authors or co-authors of 5 presentations at national and international meetings and conferences in the FY14/15. One PhD thesis based on CIAF-related research were defended. ³⁶Cl samples have been prepared and the facility is currently testing the accuracy of the recently produced targets.

SCORES AT LAST REVIEW (each out of 5)			Date of Last Review: 2009	
Need 5.0	Uniqueness 4.5	Quality of Service 4.5	Quality of Science & Training 4.5	Average 4.63

CAPACITY of HOST ENTITY FUNDED by S&F	Staff & Status	Next Review (March)	Contract Ends (31 March)
100%	Dr Ángel Rodés (level 7) Allan Davidson (Technician Level 6) Delia Gheorghiu (Level 7)		2016

FINANCIAL DETAILS: CURRENT FY						
Total Resource Allocation £k 335	Unit Cost £k 1.457			Capital Expend £k	Income £k	Full Cash Cost £k 335
	Sample preparation and data analysis 138	Work on proposal and manuscripts 44	Development, in-house and admin. 46			
FINANCIAL COMMITMENT (by year until end of current agreement) £k						
2014-15	335	2015-16	330			

STEERING COMMITTEE	Independent Members	Meetings per annum	Other S&F Overseen
NIGFSC Subcommittee	4	2	

APPLICATIONS: DISTRIBUTION OF GRADES (current FY — 2014/15)

	10	9	8	7	6	5	4	3	2	1	0	R*	Pilot
NERC Grant projects*		1	1	1								1	
Other academic			1	2								4	
Students			1									2	
TOTAL		1	3	3								7	

APPLICATIONS: DISTRIBUTION OF GRADES (per annum average previous 3 financial years —2011/2012, 2012/2013 & 2013/2014)

	10	9	8	7	6	5	4	3	2	1	0	R*	Pilot
NERC Grant projects*			1	1.67		0.67							
Other academic			0.67	1.67	0.33	0.33	0.33						
Students			1	0.67	1	0.67		0.33	0.33				0.33
TOTAL			2.67	4	1.33	1.67	0.33	0.33	0.33				0.33

PROJECTS COMPLETED (current FY – 2014/15)

	10 (α5)	9	8 (α4)	7	6 (α3)	5 (α2)	4	3 (α1)	2	1 (β)	0 (Reject)	Pilot
NERC Grant projects*												
Other Academic				1								
Students				1	1							

Project Funding Type (current FY – 2014/15) (select one category for each project)

Grand Total	Infrastructure						PAYG					
	Supplement to NERC Grant *			PhD Students		NERC	Other	NERC Grant*	PhD Students		NERC Centre	Other
				NERC	Other				NERC	Other		
28	4			7	3	1	13					

Project Funding Type (per annum average previous 3 financial years - 2011/2012, 2012/2013 & 2013/2014)

Grand Total	Infrastructure						PAYG					
	Supplement to NERC Grant *			PhD Students		NERC	Other	NERC Grant*	PhD Student		NERC Centre	Other
				NERC	Other				NERC	Other		
25.66	0.33			5	4	2	14.33					

User type (current FY – 2014/15) (include each person named on application form)

Academic 11	NERC Centre 0	NERC Fellows 3	PhD Students 10	Commercial 0
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User type (per annum average previous 3 financial years - 2011/2012, 2012/2013 & 2013/2014)

Academic 14.33	NERC Centre 2	NERC Fellows 0.33	PhD Students 9	Commercial 0
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OUTPUT & PERFORMANCE MEASURES (current year)

Publications (by science area & type) (calendar year 2014)											
SBA	ES	MS	AS	TFS	EO	Polar	Grand Total	Refereed	Non-Ref/ Conf Proc	PhD Theses	
0	10.4	2	0	0	0.5	2.1	15	9	5	1	

Distribution of Projects (by science areas) (FY 2014/15)

Grand Total	SBA	ES	MS	AS	TFS	EO	Polar
28	0	18.6	0.3	0	2.2	5.2	1.7

OUTPUT & PERFORMANCE MEASURES (per annum average previous 3 years)

Publications (by science area & type) (Calendar years 2011, 2012 & 2013)											
SBA	ES	MS	AS	TFS	EO	Polar	Grand Total	Refereed	Non-Ref/ Conf Proc	PhD Theses	
0	11.67	0.67	0	0	0.33	3.67	16.33	7.33	8	1	

Distribution of Projects (by science areas) (FY 2011/2012, 2012/2013 & 2013/2014)

Grand Total	SBA	ES	MS	AS	TFS	EO	Polar
25.67	0.37	18.63	0.32	0.33	0.53	0.53	4.95

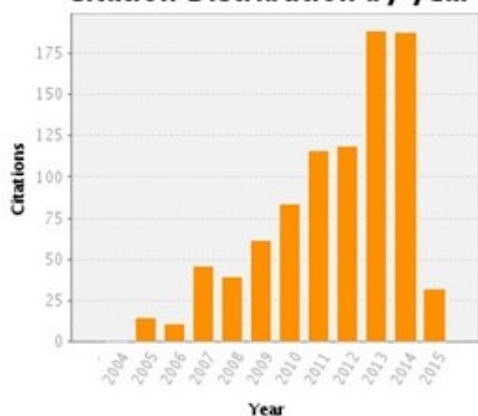
Distribution of Projects by NERC strategic priority (current FY 2014/15)

Grand Total	Climate System	Biodiversity	Earth System Science	Sustainable Use of Natural Resources	Natural Hazards	Environment, Pollution & Human Health	Technologies
28	6	0	17.15	0	4.85	0	0

*Either Discovery Science (Responsive Mode) or Strategic Science (Directed Programme) grants

NOTE: All metrics should be presented as whole or part of whole number NOT as a %

Citation Distribution by year



OVERVIEW & ACTIVITIES IN FINANCIAL YEAR (2014/15):

Analytical programme:

During FY14/15 the CIAF have completed analysis for 3 projects and provided 84 unknowns and 18 for blanks and duplicates to the Accelerator Mass Spectrometer. 113 ^{10}Be , 19 ^{26}Al , 6 ^{36}Cl analytical results were reported in the FY14/15.

The CIAF has worked on 28 different projects, involving 21 PI's from 14 different institutions. As one of the biggest CIAF projects, the BritIce Consortium has been approved 92 samples from 8 transects from the continental shelf to onshore across the British Isles for constraining the timing and dynamics of the collapsing British Irish Ice Sheet.

Publications: CIAF publications and output continue to have impact in the community. CIAF staff are authors and co-authors on 8 peer-reviewed publications on in-house and CIAF-project related work in international journals in the past year. One PhD thesis related to CIAF projects was presented in 2014 (Standell, Loughborough, CIAF 9115-0412). CIAF staff have also contributed to 5 conference abstracts.

New technical developments: A new complex extraction method of ^{10}Be separation was successfully tested and other ^{10}Be preparation procedures were improved to speed up the process.

A new in-house ^{10}Be carrier has been obtained from phenakite. This very low carrier, together with the introduction of a new method of mineral separation (froth floatation) and diversification of the ^{10}Be and ^{26}Al extraction methods (column chemistry and solvent extraction) will allow to apply the ^{10}Be dating to a wider spectrum of lithologies and ages.

A new separation method for ^{10}Be and ^{26}Al for samples with high Al content has been tested. It has proven successful for recovery of the ^{10}Be from the ion exchange chromatography.

New Science areas: Besides the geomorphological applications of cosmogenic nuclide dating, CIAF has started using meteoric ^{10}Be as a radiometric method (CIAF project 9043.1007) and in-situ ^{10}Be as a burial dating method in marine sedimentology (CIAF project 9137.1013). Depth profile modelling involving several cosmogenic isotopes has recently proved to be successful (CIAF project 9127.1012).

Laboratory and building work: A new quartz etching laboratory is currently being fitted in SUERC. This will permit a more efficient way of cleaning and purifying the quartz and it will allow us to use the clean laboratory solely for the separation and isolation of ^{10}Be and ^{26}Al isotopes.

Collaboration: All projects funded by NERC during the FY 14/15 were declared collaborative with the CIAF on the proposal form. The CIAF staff have been involved in projects through 1) data accumulation for funded projects, 2) training of visitors, 3) data reduction, 4) contribution to papers. Effort was also put in continuing the staff's personal research (Gheorghiu et al., in press).

Conferences and workshops: CIAF was present at the following conference meetings during the 2014: Nordic workshop on Cosmogenic Nuclide Dating, Aarhus (Denmark), EGU General Assembly, XIII Reunión de la Sociedad Española de Geomorfología, Cáceres (Spain), Goldschmidt Conference.

Student training, training and visits: Within the past year, two PhD students (Laurence Dyke – Swansea University & Duna Roda – Imperial College) and one PI (Tristram Hales) visited CIAF and were trained in sample preparation and data analysis.

SCIENCE HIGHLIGHTS.

Evidence for the asynchronous retreat of large outlet glaciers in southeast Greenland at the end of the last glaciation

Project CIAF 9098.1010 and 9123.1011

^{10}Be chronologies of two large fjord systems in southeast (SE) Greenland are compared with existing data from the centre of the sector to examine the timing and style of deglaciation at a regional-scale. The exposure ages (11.8-10.4 ka) demonstrate a disparate timing of deglaciation across the SE region may be primarily explained by the varying influence of the warm Irminger Current; glaciers in southern SE Greenland were isolated from warm Atlantic waters during the Younger Dryas by complex shelf bathymetry. In all fjord settings ice retreat was rapid and persistent, consistent with the absence of geomorphological evidence for readvance events. Ice retreat was accompanied by rapid thinning and likely continued to well within present-day ice sheet margins. ^{10}Be age determinations and geomorphological observations show no evidence for Holocene readvance events prior to the Little Ice Age (LIA).

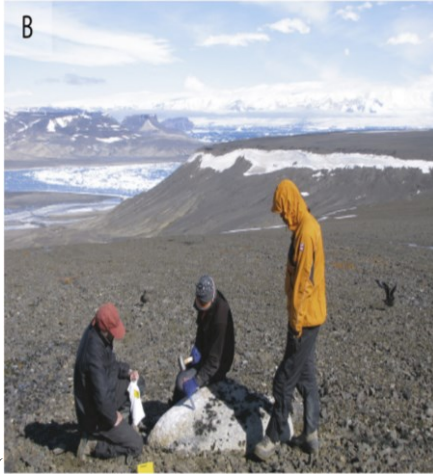
L.M. Dyke, A.L.C. Hughes, T. Murray, J.F. Hiemstra, C.S. Andresen, **Á. Rodés**. *Quaternary Science Reviews* 99 (2014) 244-259.

***Ice-stream initiation, duration and thinning on James Ross island,
Northern Antarctic Peninsula.***

Project CIAF 9035.0407

This study focuses on understanding the response of the Antarctic Ice Sheet to climate change by looking at the ice-sheet extent, thickness and dynamical behaviour during the Last Glacial Maximum (LGM). Cosmogenic isotope exposure-age dating (^{26}Al , ^{10}Be and ^{36}Cl) of erratic boulders took place on ice-free land on James Ross Island, north-eastern Antarctic Peninsula. The data provide evidence for a transition from a thick, cold-based LGM Antarctic Peninsula Ice Sheet to a thinner, partially warm-based ice sheet during deglaciation.

N. Glasser, B. Davies, J. Carrivick, **A. Rodés**, M. Hambrey, J. Smellie, and E. Domack. *Quaternary Science Reviews* 86,



(2014) 78-88.

Cape Lachman, northern promontory on James Ross Island. Numerous granite boulders are present in the saddle at the neck of the promontory.

Combined uranium series and ^{10}Be cosmogenic exposure dating of surface abandonment: A case study from the Ölgü strike-slip fault in western Mongolia

Project CIAF 9058.1008

Time-averaged fault slip-rates can be established by reliably dating the abandonment of an alluvial deposit that has been displaced by Quaternary movement along a cross-cutting fault. This study combines ^{10}Be exposure dating of boulder tops and U-series dating of layered pedogenic carbonate cements accumulated on the underside of clasts from two separate alluvial surfaces. These surfaces are both displaced by the active Ölgü strike-slip fault in the Mongolian Altay Mountains. The combination of ^{10}Be and U-series dating methods allows bracketing of the abandonment ages of the two surfaces as 18.0-28.1 kyr and 38.4-76.4 kyr. The ages combined with measurements of the displacement of the surfaces, yield a right-lateral slip-rate for the Ölgü fault of 0.3-1.3 mm yr⁻¹, showing that it is a relatively important structure within the active tectonics of Mongolia and that it constitutes a substantial hazard to local populations.

L.C. Gregory, A.L. Thomas, R.T. Walker, R. Garland, C.M. Niocaill, **C.R. Fenton**, A. Bayasgalan, T. Amgaa, B. Gantulga, S.Xu, **C. Schnabel**, A.J. West. *Quaternary Geochronology* 24 (2014) 27-43.

Enhanced rock-slope failure following ice-sheet deglaciation: timing and causes.

Project CIAF 9046.0308

The temporal pattern of rock-slope failures (RSFs) following Late Pleistocene deglaciation on tectonically stable terrains is controversial. Proposed models are tested through ^{10}Be exposure dating of five closely-spaced quartzite RSFs on the Isle of Jura, Scotland. All five dated RSFs occurred at least 720–2240 years after deglaciation, with the probability of failure peaking ~2 ka after deglaciation, consistent with millennial-scale delay model. Retreat of the last Pleistocene ice sheets across tectonically-stable mountainous terrains was succeeded by a period of enhanced rock-slope failure due to deglacial unloading and probably uplift-driven seismicity. The great majority of RSFs in the British Isles outside the limits of Loch Lomond Stadial glaciation are of Lateglacial (pre-Holocene) age. Numerous RSFs must also have occurred inside Loch Lomond Stadial (LLS) glacial limits, but that runout debris was removed by LLS glaciers.

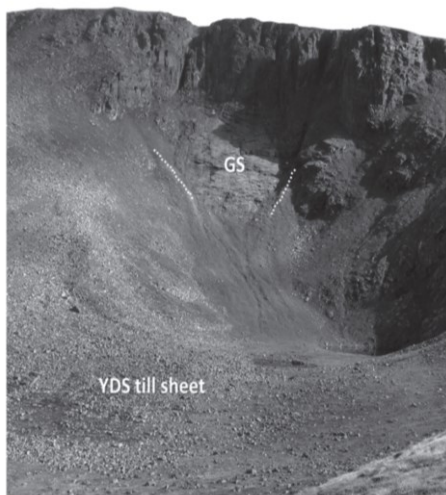
Ballantyne, C. K., Wilson, P., **Gheorghiu, D.**, and **Rodés, Á.** *Earth Surface Processes and Landforms* (DOI: 10.1002/esp.3495, 2013)

Late Holocene and Younger Dryas glaciers in the northern Cairngorm Mountains, Scotland.

Project CIAF 9095.0308 and 9011.0405

This study provides the first evidence of a late-Holocene glacier in the British Isles. A small slab-like glacier with an equilibrium line altitude (ELA) at c. 1047 m deposited a moraine after c. 2.8 kyr (^{10}Be). The late-Holocene glacier was characterised by rapid firmification and a dominance of sliding, enabling the glacier to construct moraine ridges in a relatively short period. The boulder till age of c. 12.3 kyr confirms the time when the glacier reached its maximum when the ELA was at c. 963 m altitude during the Younger Dryas Stadial (YDS). Both glaciers existed because of enhanced accumulation from wind-blown snow, but the difference in ELA of only c. 84 m belies the YDS–LIA temperature difference of c. 7°C and emphasises the glacioclimatic contrast between the two periods.

M.P. Kirkbride, J.D. Everest, D.I. Benn, **D. Gheorghiu**, and A.G. Dawson, A.G. *The Holocene*



View from the north into Coire an Lochain. Little ice age moraines (dotted lines) and the Younger Dryas till sheet have all been dated with ^{10}Be .

24, (2014) 141-148.

FUTURE DEVELOPMENTS/STRATEGIC FORWARD LOOK

Laboratory

- To introduce an alternative method for quartz isolation in the CIAF laboratory. This method is based on froth floatation of feldspars. The new quartz etching laboratory will allow us to be more efficient and introduce more separation methods for the cosmogenic isotopes.
- To test the possibility of measuring ^{10}Be in whole rocks, after successfully isolating ^{10}Be from phenocrysts.
- To further test a method for separating ^{10}Be and ^{26}Al in samples with high Al content. This method has proven successful for recovery of the ^{10}Be from the ion chromatography.
- Measuring and reporting ^{36}Cl results

Science

- As soon as we start isolating ^{10}Be routinely from different minerals the CIAF will be able to intercalibrate production rates of ^{10}Be in different minerals

Outputs

- CIAF is making effort to secure some funding in order to organize a cosmogenic meeting/workshop in Glasgow. The last NERC funding application was rejected, CIAF is currently working on finding alternatives.