SERVICES & FACILITIES ANNUAL REPORT - FY April 2010 to March 2011

SERVICE	FUNDING	AGREEMENT	ESTABLISHED as S&F	TERM
Isotope Community Support Facility	**Block**	**F14/G6/11/01**	**1991**	**4**

TYPE OF SERVICE PROVIDED:

The Isotope Community Support Facility (ICSF) meets the need in the Geoscience Community for isotopic analyses and training in support of research related to **Earth System Science** and **Sustainable Use of Natural Resources** and **Pollution**, but impacting on all seven of the NERC Science Themes. Training of postgraduate students in the principles and practice of stable isotope geochemistry, together with support to largely grant-funded PI's lie at the core of ICSF support (currently 53% student projects). ICSF gives PI's access to a suite of international-class isotope systems at SUERC for analyses of minerals, fluids and organic compounds. ICSF offers a unique environment (SRG2009 mark α5) with the highest level of service (SRG2009 mark α5), as reflected in our formal 2008/9 user survey (100% users think overall service is excellent; 92% consider student training excellent, 8% judging it good). Our users also benefit from the complementary expertise of ICSF being embedded in SUERC.

The Facility is headed by **Dr. Fin Stuart** and managed by **Dr. Adrian Boyce** with technician (60% time) **Mrs Alison McDonald**. We also had the support of **Dr. Craig Barrie** to help with/develop projects this year, as well as to assist commissioning of our new S isotope mass spectrometer. Access is through (i) application to the NERC Isotope Geoscience Facilities Steering Committee (NIGFSC); and/or (ii) pilot studies preparatory to future applications. Analyses are produced for successful projects (≥α3H for postgraduate, or ≥α4 for higher level research) directly, or through intensive, one-to-one postgraduate supervision. Output is primarily measured by (i) peer-reviewed publication, and (ii) the production of motivated young scientists, trained to fulfil the strategic needs of the NERC and the UK. Since the last SRG, 100% of research students from ICSF approved projects have gone on to work in the exploration/environmental industries (66%) and the rest in government/survey and academia.

The NERC Strategy states "*NERC needs to develop a programme of work dedicated to improving its approach to knowledge exchange, including strengthening engagement and collaboration between world-class research groups and external stakeholders.*" ICSF facilitates this exchange particularly through our student-centred project portfolio, 60% of which receive direct external stakeholder funding, with several holding NERC CASE awards. We are also evolving the Facility towards a broader, PI-based focus in response to demands from the community. Around 65% of this year's projects are in direct support of grant awards (~60% NERC awards including New Investigators as well as Standard Grants, also 25% EPSRC & Leverhulme awards).

This year 12 approved and 4 pilot projects were supported from 10 UK Institutions. 11 PhD students underwent in-depth training in stable isotope principles, making extensive use of 8 isotope ratio mass spectrometers and 11 conventional, on-line and laser preparation systems at SUERC. In this way ICSF promotes the government's priority for the long-term health of the science base.

ANNUAL TARGETS AND PROGRESS TOWARDS THEM

ICSF will continue to support a diverse portfolio of projects, and seek to alert new PI's to the utility of stable isotope analyses for their projects.

We have an acknowledged expertise in **mineral deposit science**, and we will focus efforts on key resource areas or mines. We have advised the Sustainable Use of Natural Resources Theme Leader on development of a specific mineral-related thematie programme during this year. This year we also began to support research on the UK's only metal mine (Cononish gold mine), which is scheduled to open in 2012.

Our work on **pollution**, which seeks to elucidate the *geological* understanding of the mechanisms and rates of mineral carbonation in natural analogues, produced its first PhD this year, and we anticipate future publications.

We will also ensure that **ICSF supports new NERC science** through grant applications, with formal letters of support and cost accounting.

We have now commissioned a new workhorse S mass spectrometer, and developing an on-line *in situ* laser S system for this Thermo Fisher MAT253 system. We note **increased Community demand** for ^{33}S and ^{36}S analyses, of which this new machine is capable. This system is now fully functioning, and is housed in SUERC's newly purpose-built NERC Facilities building.

SCORES AT LAST REVIEW (each out of 5)			Date of Last Review :	2009
Need	**Uniqueness**	**Quality of Service**	**Quality of Science & Training**	**Average**
α5	**α5**	**α5**	**α4.5**	**α4.88**

CAPACITY of HOST ENTITY FUNDED by S&F	Staff & Status	Next Review (March)	Contract Ends (31 March)
100%	**1 Manager – Dr. Adrian Boyce (RA3) (100%)** **1 Part-time Technician – Mrs Alison McDonald (Grade E)**	**2013**	**2014**

FINANCIAL DETAILS: CURRENT FY						
Total Resource Allocation £k	**Unit Cost £k**			**Capital Expend £k**	**Income £k**	**Full Cash Cost £k**
	Half Day of Full Facility Time	**Unit 2**	**Unit 3**			
282	**0.537**			0	0	196.45

FINANCIAL COMMITMENT (by year until end of current agreement) £k				
2010-11 282.77	**2011-12 252.37**	**2012-13 255.00**	**2013-14 260.00**	**2014-15**

STEERING COMMITTEE	Independent Members	Meetings per annum	Other S&F Overseen
NIGFSC	8	**2**	**AIF, OUUSF, NIGL**

APPLICATIONS: DISTRIBUTION OF GRADES (current FY — 2010/11)								
	α5	α4	α3	α2	α1	β	R*/Pilot	Reject
NERC Grant projects*								
Other academic		2					2	
Students		2	1				2	
Pilot								
TOTAL		4	1				4	
APPLICATIONS: DISTRIBUTION OF GRADES (per annum average previous 3 financial years —2007/2008, 2008/2009 & 2009/2010)								
	α5	α4	α3	α2	α1	β	R*/Pilot	Reject
NERC Grant projects*	0.3	1						
Other Academic		1					2	
Students		2	2				2	
Pilot								
TOTAL	0.3	4	2				4	

PROJECTS COMPLETED (current FY – 2010/11)							
	α5	α4	α3	α2	α1	β	R*/Pilot
NERC Grant projects*							
Other Academic							
Students			1				
Pilot							

Project Funding Type (current FY – 2010/11) (select one category for each project)										
Grand Total	Infrastructure					PAYG				
	Supplement to NERC Grant *	Student		NERC C/S	Other	NERC Grant*	Student		NERC C/S	Other
		NERC	Other				NERC	Other		
20	3	5	6		6					
Project Funding Type (per annum average previous 3 financial years – 2007/2008, 2008/2009 & 2009/2010)										
Grand Total	Infrastructure					PAYG				
	Supplement to NERC Grant *	Student		NERC C/S	Other	NERC Grant*	Student		NERC C/S	Other
		NERC	Other				NERC	Other		
24	4	6	3	1	10					

User type (current FY – 2010/11) (include each person named on application form)				
Academic	Centre/Survey	NERC Fellows	PhD	Commercial
35	1	0	11	0
User type (per annum average previous 3 financial years - 2007/2008, 2008/2009 & 2009/2010)				
Academic	Centre/Survey	NERC Fellows	PhD	Commercial
35	1	0	9	0

OUTPUT & PERFORMANCE MEASURES (current year)										
Publications (by science area & type) (calendar year 2010)										
SBA	ES	MS	AS	TFS	EO	Polar	Grand Total	Refereed	Non-Ref/ Conf Proc	PhD Theses
	19			0			19	15	3	1

Distribution of Projects (by science areas) (FY 2010/2011)						
SBA	ES	MS	AS	TFS	EO	Polar
	19					

OUTPUT & PERFORMANCE MEASURES (per annum average previous 3 years)										
Publications (by science area & type) (Calendar years 2007, 2008 &2009)										
SBA	ES	MS	AS	TFS	EO	Polar	Grand Total	Refereed	Non-Ref/ Conf Proc	PhD Theses
1	16						17	12	3	2

Distribution of Projects (by science areas) (FY 2007/2008, 2008/2009 & 2009/2010)						
SBA	ES	MS	AS	TFS	EO	Polar
	17			2		

Distribution of Projects by NERC strategic priority (current FY 2010/11)						
Climate System	Biodiversity	Earth System Science	Sustainable Use of Natural Resources	Natural Hazards	Environment, Pollution & Human Health	Technologies
0.6	1.2	11	3.3	1	2.9	0

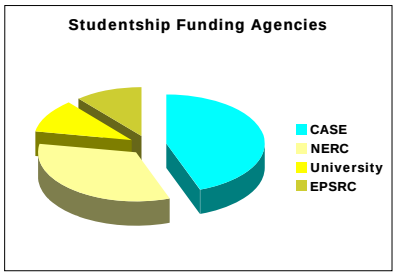
**Combined Responsive Mode and Directed Programme grants*

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

OVERVIEW & ACTIVITIES IN FINANCIAL YEAR (2009/10):

TRAINING – A CORE EFFORT

NERC's current strategy *Next Generation Science for Planet Earth* indicates that NERC *"…plays a crucial role in supporting the training of the next generation of environmental scientists"*. ICSF is committed to contributing to this aim. In the past year ICSF has supported 10 students who received training in the principles and practice of stable isotope (C,H, S and O) geochemistry. The majority of these projects relating to **Sustainable Use of Natural Resources** and **Pollution**. Seven of these students received NERC grants, with 3 CASE students (Figure).



Six presented data to national conferences, 3 had papers published in peer-reviewed journals (e.g. *Chemical Geology; Environmental Earth Sciences*). Training starts with project development, through formulation of the application in close consultation with Dr. Boyce. On-site training and data acquisition then forms the central part of ICSF support, which ends with thesis completion and peer-reviewed publication. Through NERC CASE and external stakeholder-linked studentships there is a strong interaction with industry. Grants to 6 of the 10 students who received training this year were part-subsidized by external stakeholders.

PROJECT THROUGHPUT

15 approved and 4 pilot projects, involving 24 researchers, were supported by ICSF this year. The bulk of effort went into four areas, (1) data accumulation and training for recently approved projects; (2) paper redaction; (3) development of new projects with academic partners; (4) personal research and technical development. Dr. Boyce takes a hands-on role in developing new projects, contributing as early as possible to new projects once approached by PI's.

RESULTS – PAPERS

Since last year, 15 peer-reviewed papers were published or are in press in international-level journals (Annex 6), incorporating an extensive database acquired from ICSF. All the published papers are collaborative, reflecting the collaborative nature of the Facility. The applied and international nature of the project work has resulted in 100% of these papers having an overseas author. These efforts highlight the commitment of the Facility to produce and foster quality, international-level science, and tangible measures for the NERC portfolio.

PERSONAL RESEARCH – ADDING VALUE

Whilst NIGFSC-approved projects remain central to ICSF's mission, Dr. Boyce is keen to be involved in projects and processes that bring added value to the Facility. Thus, he maintains an international collaboration profile in areas that are of direct relevance to PI's (e.g. Zambian Copperbelt studies with University of Leuven – in direct compliment to two current approved projects). He also just completed a 3 year stint on NERC PRC, and uses this experience as a yardstick for quality in ICSF project applications.

PROJECT DEVELOPMENT – SUSTAINED TEMPO

This year has brought 6 new projects to ICSF. Since 2005, on average 5-6 new projects are approved each year. This has been achieved whilst diversifying our portfolio, and increasing our user base, with 3 new users this year.

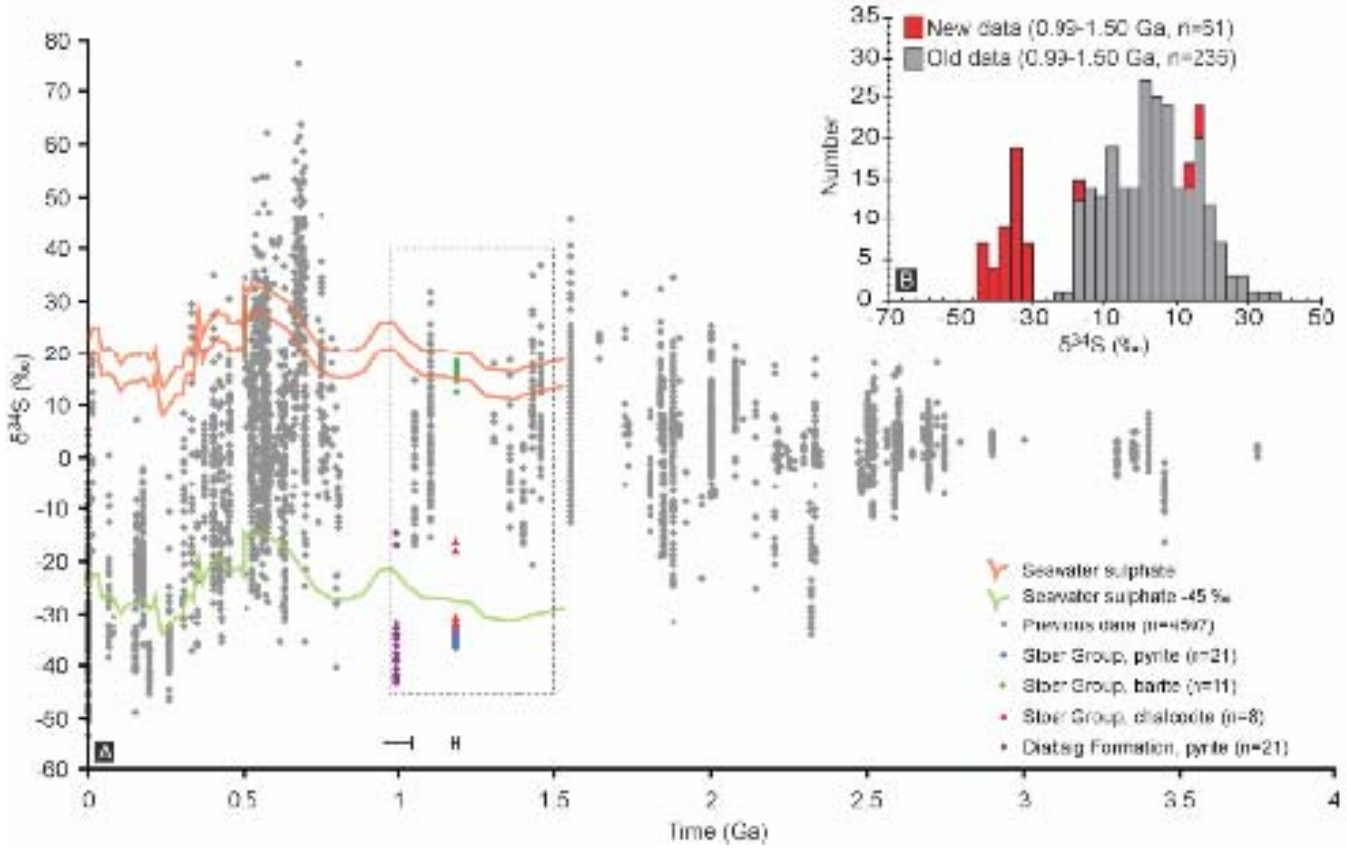
SCIENCE HIGHLIGHTS:

Sulfur isotope signatures for rapid colonization of an impact crater by themophilic microbes. GEOLOGY, 38, 271-274. (Prof. John Parnell; Aberdeen University)

Widespread hydrothermal sulfide mineralization occurred in breccias formed following the meteorite impact that created the 23-km-diameter Haughton structure in sulfate-rich bedrocks of the Canadian High Arctic. The sulfides exhibit extreme sulfur isotopic fractionation relative to the sulfate, requiring microbial sulfate reduction by thermophiles throughout the crater. This evidence of widespread microbial activity demonstrates that colonization could occur within the lifetime of a moderately sized, impact-induced hydrothermal system. The pyrite was subsequently oxidized to jarosite, which may also have been microbially mediated. The successful detection of evidence for microbial life – with *in situ* laser S isotope analyses key - suggests that it would be a valuable technique to deploy in sulfate-rich impact terrain on Mars**.** This paper generated considerable media interest, and also appeared as a Highlight of NERC National Capability in their latest Annual Report, as well as a full article in the Autumn issue of Planet Earth.

Sulphur disproportionation in the Mesoproterozoic Terrestrial record. NATURE, 468, 290-293. (Prof. John Parnell, University of Aberdeen and Dr. Darren Mark, SUERC/AIF)

Geochemical data from ancient sedimentary successions provide evidence for the progressive evolution of the Earth's atmosphere and oceans. Key stages in increasing oxygenation are postulated for the Palaeoproterozoic (~2.3Ga) and the late Proterozoic (c. 0.8 Ga). The late Proterozoic rise in atmospheric oxygen is implicated in the subsequent metazoan evolutionary expansion. In support of this rise, a large database shows a marked change in the bacterially mediated fractionation of seawater sulphate to sulphide ($\Delta^{34}S = \delta^{34}S_{sulphate} - \delta^{34}S_{sulphide}$) between the mid-Proterozoic (before 1 Ga, fractionation typically 20-25 ‰) and Neoproterozoic and younger (0.64 Ga and younger, fractionation often 50 ‰ or more- see Figure). In this research we have found $\Delta^{34}S$ values exceeding 50 ‰ from a terrestrial Mesoproterozoic (c. 1.18 Ga) succession. This level of fractionation implies disproportionation in the sulphur cycle, not evident in the marine record from $\Delta^{34}S$ data. Disproportionation indicates that the Mesoproterozoic terrestrial environment was sufficiently oxygenated to support a biota adapted to an oxygen-rich atmosphere.



This paper, combining support from ICSF and AIF, generated considerable media interest, including an interview for our PI on Radio 4 Tonight programme. Future articles for Planet Earth and elsewhere are in preparation. Research continues with this work (See Mark et al, (2011), #5, Annex 6).

The nature and genesis of marginal Cu–PGE–Au sulphide mineralisation in Paleogene Macrodykes of the Kangerlussuaq region, East Greenland. (In Press) MINERALIUM DEPOSITA. *(Dr. David Holwell, Leicester University)*

The Kangerlussuaq region of East Greenland first became subject to geological expeditions and studies in the 1930s, during which time the spectacularly layered gabbroic Skaergaard Intrusion was discovered. The Skaergaard Intrusion subsequently received a large amount of petrological attention and became a type locality for igneous layering. It has had a profound impact on the development of theories relating to magmatic differentiation and magma chamber processes: the classic works of Wager and Brown are renowned in the history of Geological Sciences. But along with the classic igneous petrography, the region is fast becoming a significant area for the strategically important platinum group elements. Our paper (#4, Annex 6: IP/1200/1110) provides the first description of a new prospect in the area, and considers its nature and genesis. Our first set of S isotope data imply a local crustal source of S in these ores, from pyritic sediments of the Kangerlussuaq Basin. Proving that the S comes from an external source, considerably enhances the prospectivity of this extraordinary terrane. The project continues.

FUTURE LOOK

Commissioning of the new Thermo Fisher MAT 253 dual inlet S isotope mass spectrometer.

The high international profile of ICSF rests partly on its demonstrated expertise in S isotope geochemistry. In order to maintain this profile, we took receipt of a new workhorse Thermo Fisher MAT 253 mass spectrometer. The machine was commissioned in December, 2010. The work of our colleague, **Dr. Craig Barrie** has been particularly noteable in regard to bringing this machine to full use for all our approved projects currently running S isotopes. The new machine has been designed to take a newly built *in situ* laser S system (currently being designed and built in-house at SUERC, again with inout from Dr. Barrie).

This machine has been designed with the capability of measuring ^{33}S and ^{36}S through SF_6. ICSF has been assessing the demand from the Community for this type of analyses, and there is no doubt that the demand is growing – including a recent enquiry to request such data in a formal application. We therefore suggest that ICSF investigates costings for such development, subject to clarity on future NERC funding of Facilities.

Development of and assistance from Dr. Craig Barrie

Dr. Barrie was welcomed to ICSF in January 2010 to take up a one-year appointment. He assistance to ICSF and our users and students was invaluable, particularly with the commissioning of the MAT 253, and with a particularly large and technically remanding laser fluorination study (with Dr. Colin Macpherson of Durham Univesity: IP/1034/0508). In all these tasks, we believe that Dr. Barrie gained relevant and considerable technical and scientific experience to ensure his future research profile is enhanced. SUERC are currently funding his direct support part-time to ICSF. Whether we can continue to benefit from his assistance is currently under consideration.

Investigating the Thermo Fisher Delta V for carbonate work

The potential of this mass spectrometer system to run automatic carbonate analyses has been trialled, and results are proving promising. If successful, this will substantially extend our user capability in terms of decreasing our current minimum 1mg samples size (on VG machine, and only for calcite) to an optimum of 300µg (and including other carbonate phases). This work is being carried out in collaboration with LSMSF.