PROCEEDINGS OF

THE GEOLOGICAL SOCIETY

OF GLASGOW

Session 152 **2009 – 10**

SESSION 152 (2009 – 2010)

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Members of Council

President	Miss Margaret Donnelly
Vice Presidents	Dr Alan W. Owen
	vacancy
	vacancy
Honorary Secretary	Dr Iain Allison
Treasurer	Mr Michael J. Pell
Membership Secretary	Dr Robin A. Painter
Minutes Secretary	Mrs Margaret L. Greene
Meetings Secretary	Dr Jim Morrison
Publications	Miss Muriel Alexander
Librarian	Dr Chris J. Burton
Asst Librarian & Hon Archivist	Mrs Seonaid Leishman
Proceedings Editor	Miss Margaret Donnelly
Publicity	Dr Neil D.L.Clark (web)
	Dr R. A. Painter (meetings etc)
Excursion Secretaries	Mr Jim Martin (Saturdays)
	Mr David McCulloch (Residential)
Strathclyde Geoconsrvation Group	Mrs Margaret L. Greene
Rockwatch Representative	Ms Katerina Braun
Junior Member	Mr. Robert Jamieson
Journal Editors	Dr Colin J.R. Braithwaite
	Dr Brian Bell
Ordinary Members	Mrs Barbara Balfour
	Mr Charles M. Leslie
	Ms Mina Cummings
	Ms Emma Fairley
Independent Examiner	Mrs Beth Diamond

PRESIDENT

Membership of the Society has remained steady at 390. The eight evening Meetings of the Society were all well attended as were the three 'day' field trips, the two evening excursions and the two residential excursions to Skye and to the Solway Coast. Professor Nigel Trewin of the University of Aberdeen received the Society's T. N. George Medal at the opening Meeting of the Session.

In October 2009, a subcommittee of three was set up to investigate the modernisation of our Society's website with a view to promoting the Society and to attracting new members. A new web designer has been engaged and the establishment of the new website is now well advanced. Many thanks are due to all the hard work of the subcommittee and of the various Members of Council who have expended a great deal of time and effort on this project. It is hoped that our new website will be available online in the near future.

The long established Strathclyde RIGS (Regionally Important Geological and Geomorphological Sites) group, a subcommittee of the Society's Council, has continued to be very active in promoting geology in the wider community. In the spring of 2010 it changed its name to the Strathclyde Geoconservation Group (SGG) in line with the UK RIGS name change to GeoConservation UK, and progress continues on a number of sites – Campsie Glen, Douglas Muir Quarry, Portencross, Spireslack and Rouken Glen among others. As part of this work the Fossil Grove Steering Group, which includes representatives from our Society's Council, was established and following a meeting in January the Fossil Grove Trust was reactivated. Seven Trustees were appointed, including Dr Iain Allison, our Honorary Secretary, to provide geological input. Plans have been drawn up for a series of building works to repair and maintain the site, and also for its future development and interpretation. Fossil Grove was open to the public from April to September and visitor numbers were markedly increased compared to those of recent years. The two other subcommittees, Argyll and the Islands Geodiversity Group and Geodiversity Dumfries and Galloway, are also making progress. A representative of each attends one Council Meeting per year (March) and all three provide a report for each Council Meeting.

The Geological Society of London Publishing House now publishes the two parts of the Scottish Journal of Geology on behalf of ourselves and the Edinburgh Geological Society both in hard copy and electronically, while the entire back run has been converted to both electronic and digital versions as part of the GSPH 'Lyell Collection'. In January 2010, the electronic versions became available online. A complete set of the transactions of the Society are in the process of digitisation and inclusion in the Lyell Collection. Our annual edition of the Society's Proceedings was published in April, and 'An Excursion Guide to the Moine Geology of the Northern Highlands of Scotland' was published jointly by our Society and the Edinburgh Geological Society in the spring of 2010.

As part of 'Scottish Geology Month' in September, our Society held a highly successful one day interactive display in the Glasgow Science Centre, which attracted much public attention. Representatives of numerous groups from across Scotland, including ourselves, have been meeting regularly to promote this Festival and

Geodiversity in general. Over time, the number of events hosted by these groups throughout the year has increased, and been posted on the 'Scottish Geology' website. At a meeting in June it was felt that this loose organisation was morphing into a 'Scottish Geodiversity Forum'. A meeting was arranged for October 2010 at which the development of this proposal could be further considered.

Margaret Donnelly

MEMBERSHIP

	At end Session 152 30 Sep 2010	At end Session 151 30 Sep 2009
Honorary Members	5	4
Ordinary Members	288	294
Associate Members	71	68
Junior Members	21	24
TOTAL Members	385	390
New Members	26	40
Memberships Closed	31	24

Overall membership numbers in Session 152 saw a small decline from the previous Session, where the new members joining rate had been particularly high due the incorporation of RIGS groups into the Society. The number of memberships being closed was a little higher than in the previous Session 151.
(The 'memberships closed' category rolls up the numbers resigning and the terminations due to non payment of subscriptions.)

R. A. Painter

LIBRARY

It has been a relatively quiet year for the Society's library, in that normal business has only briefly been interrupted by what is hoped to be the last of a series of 'reorganisations' – largely of non-society origin.

Relocations and reorganisations

The Society's library underwent a further round of reorganisation this session as the Department of Archaeology carried out a refurbishment of the room, including painting, updating of the lighting and some changes in the wall benches. This involved our librarians in some work removing the remaining out of date journals (to the journal collection or to the skip) and relocating all of the stock on the tops of the bookshelves in order to allow work to proceed. The refurbishment has produced a pleasant, bright room to house our library.

The journal and map collection which is currently housed in Room 516 may have to be moved yet again, since acute shortage of space within the Gregory Building may mean that the room will be converted into staff or other accommodation for members of the School of Geographical and Earth Sciences. Any developments will depend on other accommodation changes within the building and there is no firm decision as yet.

Map Collection

We continue to receive the latest maps from BGS, and we now possess extensive coverage of the UK. The latest maps received are:

Scotland:

1: 50 000 Scotland Sheet 14W Moffat. Bedrock

1:50 000 Scotland Sheet108W Ben Hee. Bedrock

1:25 000 Scotland Ardnamurchan Central Complex. Bedrock and Superficial Deposits

England and Wales

1:50 000 England/Wales Sheet 155 Coalville. Bedrock and Superficial Deposits

1:50 000 England/Wales Sheet 210 Fishguard. Bedrock and Superficial Deposits

1:50 000 England/Wales Sheet 164 Llanidloes. Bedrock and Superficial Deposits

1:50 000 England/Wales Sheet 174 Thetford. Bedrock and Superficial Deposits

1:50 000 England/Wales Sheet 203 Bedford. Bedrock and Superficial Deposits

1:50 000 England/Wales Sheet 224/242 Colchester and Brightlingsea. Bedrock and Superficial Deposits

Offshore

1:250 000 Offshore Sheet 51^0 50' N - $06^0$24'W St. George's Channel (Bedrock with Tertiary subcrop).

Those wishing to consult the map collection should contact the Librarian in the first instance.

Library Use

Library use has continued at the levels of previous years, with the emphasis of borrowing being on field guides – to a very wide range of locations worldwide – and introductory texts. The attention of members is drawn to the extensive coverage of both these and most other geological subjects within our library, and a search for information should always include either a visit to the collection or an enquiry of either of the librarians, who are always willing to help.

C. J. Burton, Librarian, and S. Leishman, Assistant Librarian.

SCOTTISH JOURNAL OF GEOLOGY

The usual two full issues were published during the year. A broad range of topics was covered such as aeromagnetics, offshore glacial geology, zircon provenance, radon potential, igneous and metamorphic basement geology, and palaeontology – a wider range than in the previous year and a welcome development. It included papers dealing with events from 2004 to 1700 Ma and covering areas from the NW Highlands and Islands to the Borders region. The relatively small number of papers submitted to the journal remains a constant concern to the Editorial Board. However, in the last three months of 2009 the submission rate increased. During this period, 8 papers and 2 books were submitted for review and possible publication. None were rejected and this reflects the hard work of the editors who were responsible for bringing all papers up to the required standard.

The process of preparing all back issues of the SJG for online publication within the Lyell Collection was completed by the end of 2009, and the journal successfully went online in January 2010 when all issues dating back to the journal's inception in 1965

became available. This had an immediate effect on the journal's 'visibility' with over 77000 abstracts and 11000 full texts being viewed online during the year. This should increase citations and encourage potential authors to submit papers.
The process of preparing back issues of the Transactions of the two owning societies (Edinburgh and Glasgow) for online access was started. A paper outlining some of the numerous Transactions' highlights was prepared for publication in 2011.
Costs to the two societies have been reduced by online publication and financial matters simplified by the agreement between the GSPH and the Councils of the two owning societies. A small surplus has been established which can be allocated at the discretion of the Editorial Board, and may be available to authors to offset colour printing costs, hence improving the quality of diagrams in the journal.

C.J.R. Braithwaite

PROCEEDINGS

The Proceedings for Session 151 (2008 – 2009) were printed in April 2010, again by Pandaprint, of Garscube Road, Glasgow, who continue to provide an excellent service at very competitive rates. About 85 copies were distributed by hand in May, leaving the remainder of about 300 to be delivered by post.

Margaret Donnelly

PUBLICATIONS

It is always encouraging to see the enthusiasm with which members browse the display of Geological items on sale on Society nights and are tempted to widen their interest by purchasing new additions for their personal collections. Maps, field guides, lenses and books cater for students, interested amateurs and dedicated geologists and I thank all the members, students and DACE classes who have supported the bookshop throughout the year.
We are always adding new publications to our stock such as "Amber" by Neil Clark and Nigel Trewin's "Excursion Guide to the Geology of East Sutherland and Caithness". Most recently we have joined with two other groups to support the publication of a new Moine Guide which will be interesting reading to many and a "must" to all intending to visit the area. At present we are working to set up a publications page on the proposed new website which we hope will be of help to members and others wishing to access our book stock. Our other publication, "A field guide to the Geology of Madeira", has been requested by several booksellers as well as by private purchasers intending to visit the island.
Once again my thanks to all the many people who help me in so many ways on Society evenings and behind the scenes.

Muriel Alexander

WEBSITE

Neil Clark has continued to maintain the Society's web-site hosted at the Hunterian Museum. Earlier this session Council took the decision to develop a new web-site and the contract was awarded to RedPaint, a local firm. A small working group was established to see this important project through to completion. We are in the closing stages of preparing our new web-site and it should be ready to go live in a matter of

weeks. A number of the sections are ready for review and others have some minimal work to be finished off. One technical problem remains to be solved.

Jim Martin

TREASURER

Income and Expenditure Account for Year Ended 30th September 2010

(Scottish Charity Number SCOO7013)

		Session 151 2008-09	note #		Session 152 2009-10
Income					
1. Subscriptions					
Received by Bankers Order	4,018			3,973	
Received by payment to Memb Sec	2,454			2,575	
Deduct paid in advance this year	-61			-40	
Add received in advance last year	41	6,452		61	6,569
2. Investment Income					
Dividends	594			457	
National Savings	1,747	2,341		301	758
3. Tax refund (Gift Aid) (payment awaited)		1,000		900	
Under accrual on 2009 gift aid		16		68	
4. ConocoPhillips prize		133		133	
5. Net surplus Publications sales		403		491	
					1592
6. Saturday excursions income	1300			904	
expenditure	1290	10		882	22
7. Weekend excursions income	840			1,684	
expenditure	823	17		1,450	234
8. Donations (coffee collections)		224			298
Total income		**£10,596**			**£9,473**

Expenditure	**2008-09**	**2009-10**
1. Scottish Journal of Geology	5,088	2,500
2. Meetings incl speakers, meals, etc	535	1210
Room hire session 151a	713	0
Room hire session 151b (accrual in session 151)	1,189	0
Room hire session 152a	0	966
Room hire session 152b	0	1,455
3. Publication of Proceedings	541	346
4. Billets, production incl Hon Sec's expenses	568	529
5. Sponsorship grants	600	1,000
6. Library and Down to Earth	635	132

7. Insurance	166			166
8. ConocoPhillips prizes	400			400
9. RIGS	480			300
10. Website	0			746
	2008-09		**note #**	**2009-10**
11. Affiliation fees	328		**3**	373
12. Admin costs – postage, stationery, telephone etc				
Membership Sec	433			422
President & VP	112			222
Treasurer	75			75
Total expenditure	**£11,863**			**£10,862**
Profit/loss	**-£1,267**			**-£1,389**

Balance Sheet as at 30th September 2010

	2008-09			**2009-10**	
Members' Funds			**note#**		
Balance as at 30/09/2009	£60,035			£59,517	
Add back Room hire 149b accrual not invoiced	60			1,043	
Surplus/deficit for the year	-£1267			-£1,389	
Revised valuation fund for investments	£689			0	
Balance as at 30th September 2010	**£59,517**				**£59,171**
Restricted Funds					
TN George fund	380			380	
Total Funds	**£59,897**				**£59,551**
Represented by	**2008-09**			**2009-10**	
Current assets			**note#**		
Cash at Bank:					
Royal Bank of Scotland	2,661			882	
National Savings Investment	33,892	36,553	**1**	32,193	33,075
Cash in hand:					
Publications Sales Officer	63			0	
Membership Secretary	0			0	
Secretary	0			71	
Meetings Secretary	0			0	
President	0	63		142	21

National Savings Income Bond		12,000		12,000	
Current Valuation of Charifund investment		8,355	**4**	8,355	
Debtors – Publications at 30/9/10		63		0	
– EGS Conoco Philips		0		67	
– Aberdeen Conoco Philips		0		67	
– Gift Aid		1016	**2**	900	21,389
Stock of Publications – in House		4,140		4,040	
– NMS Moine Guide		0	**5**	2,131	6,171
Current assets		**£62,190**			**£60,848**
LESS LIABILITIES					
Subscriptions paid in advance	-61			- 40	
Moneys due by Society	-1,043			0	
(Room hire Sessions 149b) written back 2010					
Moneys due by Society	-1,189			-1,189	
(room hire Sessions 150b)					
Moine Guides paid in advance GSG income	0			- 68	
					- 1297
Net assets		**£59,897**			**£59,551**

Signed as approved by the Trustees: …….
Dr Alan Owen President and Trustee on behalf of all the Trustees
Signed by the Independent Examiner …….
Mrs Beth Diamond

Notes to the Financial Statements
For the Year Ended 30th Sept 2010

Accounting Policies

Accounting convention: The financial statements have been prepared under the historical cost convention, and in accordance with applicable accounting standards. The accounts are also set out to comply with guidance from OSCR.

The principal accounting policies adopted in the preparation of the financial statements are as follows:

All income from membership subscriptions, excursions, publications, bank interest and donations is accounted for on an accruals basis.

Resources expended are accounted for on an accruals basis and are recognised when there is a legal or constructive obligation to pay for expenditure.

All costs have been directly attributable to one of the functional categories of resources defined in the Statement of Financial Activities.

Expenditure on equipment is charged to Revenue in the year of purchase.

Notes on entries.

1. A £2000 transfer from the National Savings Account into the Bank was needed to cater for excess expenditure during the year.

2. Application has been made to the Inland Revenue for Gift Aid repayment. The accrual of £900 quoted is our assessment of the payment expected.

3. Affiliation fees are payable to The Geologists' Association, The Palaeontological Association and the Palaeontographical Society.

4. The Stock Market has shown an improvement this year and the value of investments is slightly higher than in 2009 but the Balance Sheet value of £8355 has been retained as a precautionary measure.

5. The publishing costs paid for in July for the Moine Guide have been put straight into the Balance Sheet as Current Assets but no sales have been shown in the I & E account this year because trading only commenced in September. However, over £250 in sales income has already been received, £68 of which is shown in the BS since it was paid into the bank before the year end and the rest, coming from the National Museum and Edinburgh GS, was deposited in October.

6. The annual account summaries for three sub-committees of the Society, "Strathclyde Conservation Group", "Geodiversity Argyll and the Islands" and "Geo-conservation Dumfries and Galloway", have been added to the accounts this year.

Michael Pell

STRATHCLYDE GEOCONSERVATION GROUP

Strathclyde Geoconservation has continued to support the Petition to the Scottish Parliament that Scotland's geodiversity should be protected in statue. As a result, the Petitions Committee commissioned a BGS/SNH study into Scotland's geodiversity which the Committee will consider at a hearing on 23 November 2010.

In order to increase awareness and understanding of Scotland's world-class geodiversity, a National Forum is being formed of all those involved, including Geoconservation, in order to co-ordinate efforts on education, promotion and policy. Strathclyde Geoconservation is assisting with the formation of this Forum.

In the meantime Group members are busy dealing with old and new issues. The Site Assessment workshop on 6 November, to which all Society members were invited, was very successful. The geology of Dumbarton Rock and the Bute columnar sandstone can now be put forward for Local Authority LGS (Local Geodiversity Site, previously RIGS) designation. The next site to be assessed this way is Auchenreoch which some of you will have visited with the Society or DACE. You may have seen us at the Glasgow Science Centre on 4th September where we had a display of the two fantastic sites at Dumbarton Rock and Bute, along with activities for children including a "live" volcano!

Earlier in the year the Loch Lomond Countryside Rangers really appreciated the interpretation event supported by Chris Burton and Angus Miller, based on our Balmaha trail leaflet. We were also delighted when this leaflet got a commendation in the Down to Earth ENI competition. Those of you who were on the evening excursion to Victoria Park and Fossil Grove on 2nd September lead by Iain Allison, now a Trustee of the Fossil Grove Trust, will know that immediate repairs are taking

place this winter and there will be displays and activities available when Fossil Grove opens again at Easter 2011. After a survey of the quarry, Strathclyde Geoconservation will advise on its use as an interpretation resource in the major redevelopment proposals being considered by the Fossil Grove Trust. In Rouken Glen Park, John Faithfull, who helped produce the trail leaflet, is now contributing the geological input to East Renfrewshire's Heritage Lottery Fund application for improvements to the Park. Two new members of the Group investigated the conservation needs and interpretation opportunities of Dumbarton Rock, for consideration at the Workshop. On the other side of the River, at Gleniffer Braes, we once again had the advice of Chris Burton on the geological input to a series of trail leaflets being produced by the Green Network Heritage Action Team. The Braes will also feature in an exhibition at Paisley Museum next summer. Look out for details in the Billet. At a recent site visit to Craigmaddie Conglomerate quarry at Douglas Muir we were joined by Mike Browne, Chair of GeoConservationUK. We will provide East Dunbarton Council with details of good exposures and interpretation ideas for the eventual restoration of the site once extraction is finished.

Please get in touch with any member of Strathclyde Geoconservation on a lecture night if you would like to get involved. Or contact us on strathrigs@tiscali.co.uk. Much more information will soon be available on our exciting new website.

Margaret Greene, Chair of Strathclyde Geoconservation

GEODIVERSITY: ARGYLL AND THE ISLANDS

The group is beginning to form an operational structure to achieve its aims, as we hope the following report will demonstrate. Membership now stands at 9 members.

Four members of the group, including the three officers, are also members of the Oban U3A Geology group, and it is in this context that some of the progress has been made. We are beginning to see some keen amateurs potentially emerging from this source, and it has also given us a context in which to carry out field reconnaissance in the area, and so begin to identify sites.

The first field trip this summer for the U3A group took place on Mull, and was led by James Westland, another member of the Geodiversity Argyll group. James made use of a coastal site near Lochbuie which he has been studying, and suggests as a suitable site for RIGS status. Another field trip in South Kintyre in early September identified a number of useful sites, and we keenly await the GSG field guide for this area due to be published later this year.

In August contact was established with Donald Fisher, recently appointed as Geo-Ranger for the North-West Highlands Geopark and given the task of producing a Geodiversity Audit for the Geopark. This process will be of considerable interest to us, as it seems likely to be an important stage in the future in Argyll.

Recent informal contact with the Biodiversity Officer for Argyll & Bute Council indicates that any formal system of site records maintained by the Council seems unlikely in the foreseeable future. The suggestion is that a simple computer based data file maintained and made available in, for example, a public library might be the best approach. This presents a problem, as elsewhere RIGS records are not public,

but are made available as a commercial resource that funds further RIGS work in the area when developers request and pay for details of sites. It may be possible to have a public list of sites with basic information, but full information available only on payment of a fee. Other RIGS groups within the Geological Society of Glasgow may have their own experiences or views, as may the Society itself. A common approach might be beneficial to all.

GAI have produced a draft data file framework in Microsoft Excel for the recording of basic information of geological sites in Argyll and the Islands that might fit the requirements of a public list. This draft is being circulated for comment and suggestions for improvement.

On 26 October, an initial meeting of a new organisation, the Scottish Geodiversity Forum, was held in Perth. There are concerns about potential duplication of effort with the existing Geoconservation UK Scotland organisation, and needs to be resolved to ensure unity of purpose and effort. GAI are awaiting further developments within the next six months, but we would all like to see the national scene in Scotland becoming more active and effective, providing an authoritative framework for geoconservation work and enhancing public appreciation of Geodiversity. As usual, this meeting was particularly useful in renewing contacts with other organisations in Scotland, and indeed forming new contacts.

Finally we would like to repeat our request made in an earlier report to Council. If any members of the Geological Society of Glasgow have their own favourite geological and geomorphological sites in Argyll and the Islands, the sub-committee would be very pleased to have information about such sites as potential candidates for the Geodiversity records. Brief notes on location and why the site may be worth recording would be gratefully received by email (fleming.a.z@btinternet.com) or post (23 Cullipool, Isle of Luing, Oban. PA34 4UB).

Alastair Fleming (Chairman) and Zoë Fleming (Secretary)

GEOD – GEODIVERSITY IN DUMFRIES & GALLOWAY

The main events of this session are briefly described below.

Thursday 4th February

Solway Firth Partnership Conference 2010 – Rock Display and Advertising Board designed to attract new members. Eight new members signed up.

Saturday 6th March

Dumfries Environmental Fair 2010 – Rock display with activities for all ages – "Magnify Minerals", "Fossil Rubbing", "Make your own Fossils" and "Build the World and Eat It". Five volunteers helped out. 300 people visited our stand, 15 new people signed up to the group. Out of 35 stalls we won 1st prize for "Best stall attracting visitors".

Monday 15th March

Council Planning Department Meeting – Stuart Graham SNH, Peter Norman Council Biodiversity Officer, Dumfries Council Planning Dept., Jim Floyd and I have formed a Planning Sub Group to plan a way forward for registering sites with the Council. I

assessed ten suitable sites and sent letters for "Permission to Register" to the landowners.

Sunday 28th March

Excursion to Loch Doon – Looked at the aureole around the granite pluton. Led by Dr Jim Floyd with 5 members attending.

Saturday 17th April

Excursion to Kirkconnel Opencast Coal Mine and Lagrea Burn. Looked at faults, fossils, dykes etc. Led by myself with 10 members attending.

Thursday 6th May.

Dumfries Science Festival – Three volunteers and myself gave 5, ½ hour awareness sessions on fossils, minerals, earth structure, plate tectonics, and the rock cycle to 70 Higher grade pupils at Wallace Hall Academy.

Saturday 8th May.

Dumfries Science Festival – Three volunteers, Mike Browne [BGS] and myself held our Rock Road-Show Exhibition [rock identification, fossil, mineral and world building activities for kids] at the first Dumfries Science Festival at University of Glasgow, Dumfries Campus.

Wednesday 26th May.

I gave a slide show and talk on "Geology in Dumfries and Galloway" to Thornhill Rotary Club.

Sunday 6th June.

Three volunteers and myself held our Rock Road-Show Exhibition etc. at Solway Firth Partnership's WOW Day at Rockcliffe, repeated on the 13th June at Port William.

Tuesday 5th October

First meeting with DuPont Teijin Films [previously ICI] to discuss GeoD's next project – the resurrection of the Doweel Formation core from DuPont site into public display. This core was extracted for water supply purposes by the ICI and the BGS in 1963.

Saturday 9th October

Volcano Fun Day – Rock Display and Digital Microscope Activities for children in Edinburgh with Rockwatch

21st June – 31st July and 1st October – 1st November

The recording of 25 sites for SNH and Dumfries Council is now complete and has been a great challenge and learning curve for me that I have thoroughly enjoyed. We have funding to receive for these and more funding in place for the next 25 sites for 2011. I will begin assessing next month. SNH now have 43 sites for consideration for submission to Dumfries Council. In order to carry out these events, over the year I have attended over 20 meetings with those organisations mentioned above.

In April this year I sent out an email, as I always do annually, to see who is still interested in the group. 16 people returned their membership forms and out of those five of us are currently carrying out activities. Membership has gone down over the years but a small working core is keeping the GeoConservation word spreading! Three other excursions due to take place this year, led by BGS and SNH had to be cancelled for various reasons. They have been rescheduled for April 2011. The road shows have been a great success and the Rotary slideshow was very well received.

Wallace Hall Academy awareness sessions were very challenging for us but the feedback from their teacher was very positive.

Diana Turner, Secretary.

MEETINGS

Nigel Trewin, University of Aberdeen, returned to talk in October 2009, and this time to receive the T N George Medal and tell us about Scotland's classic fossil localities and open our 152nd Session. Rob Ellam gave the November talk discussing the various attempts to determine the age of the earth and the role of Glasgow scientists in this endeavour. On the evening of the AGM, Alan Owen, our retiring President, brought his expertise to bear on telling us about life in the Ordovician, a time when oceans were at near-maximum extent.

January 2010 brought David Large from Nottingham to say that predictions of the death of coal, like that of Mark Twain, are somewhat exaggerated. Marten Krabbendam in February explained how the study of areas of low strain in the Morar Group of the Moine has revealed that these rocks share a common Grenvillian provenance with the Torridonian, giving new support to one of the ideas of Ben Peach from 100 years ago.

Glasgow graduate Clark Fenton returned from the deep south in March to relate how earthquakes are not confined to places like the "Ring of Fire" and to discuss 'stable' craton tectonics. The last talk of the session was delivered in April by Professor Peter Westbroek from Leiden University in the Netherlands who delivered the Joint Celebrity Lecture with the optimistic title 'Earth – from global menaces to planetary hope'. Members' Night closed the season with the usual interesting and varied program of talks and demonstrations.

Jim M. Morrison

Thursday 8th October 2009

After the following citation delivered by Dr Alan Owen, the **Professor Thomas Neville George Memorial Medal** was presented by Dr Chris Burton to:

Professor Nigel Trewin, University of Aberdeen

The breadth of Professor Nigel Trewin¹s research is remarkable. His PhD at the University of Keele was on the palaeontology, sedimentology and stratigraphy of Carboniferous rocks in Staffordshire. Since then he has made significant contributions to these three fields from settings ranging in age from the Lower Palaeozoic to the Recent, from the British Isles to the Falkland Islands, Aberdeen to Australia – and in doing all of this he has inspired others to follow him into our science.

Nigel Trewin¹s considerable expertise in clastic sedimentology shines through in many of his palaeontological works, not least in his research in palaeoecology and in numerous publications on both marine and non-marine trace fossils. He has been involved in the discovery, identification, description and interpretation of a prodigious

range of fossils from bacteria through invertebrates to vertebrates. Amongst the last of these, his painstaking studies of the fish from the Devonian Orcadian Basin are particularly noteworthy.
Even more renowned is Nigel's work on the world famous Rhynie Chert – the early Devonian hot spring deposit in which the exceptional preservation of plants and an increasing array of animals has provided a unique window into life on Earth during the colonization of the land by complex organisms.
In addition to all of this primary research, Nigel has also found time to edit geological field guides and, importantly, the most recent edition of the Geology of Scotland – a daunting task for which those of us who use the book are extremely grateful. Most recently he has made an impact on the world of popular science with his acclaimed book "Fossils Alive".
The T.N. George Medal is awarded "for excellence in palaeontology and/or stratigraphy". For the breadth and quality of his contributions, especially in palaeontology, Professor Nigel Trewin is a very worthy recipient of the award and I am pleased to call on our Vice President, Dr Chris Burton, to make the award.

Professor Trewin then addressed the Society on

FOSSILS ALIVE! INTERPRETING SCOTLAND'S CLASSIC FOSSIL LOCALITIES

Fossils, combined with the sedimentology of the rocks in which they are found provide us with factual information from which we can interpret ancient environments. However, the information is never complete, and our interpretations generally include speculation on the biota that was not preserved, the climate, and the palaeogeography. In the presentation we will visit Scottish localities ranging from Devonian to Jurassic age, to assess the fossil evidence and imagine what it would have been like to visit the area in the geological past. Amongst a number of localities we visit Caithness to see the Devonian fish in the Orcadian lake, Aberdeenshire for the celebrated biota of the Rhynie chert, and Skye for the rich Jurassic fauna that lived in warm shallow seas. New material is constantly being found, particularly by amateur collectors, enabling constant updating of our interpretations.

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Thursday 12th November 2009
Dr Rob M. Ellam,
Scottish Universities Environmental Research Centre, East Kilbride

A GLASGOW LEGACY: THE SCIENTIFIC DETERMINATION OF THE AGE OF THE EARTH.

The age of the Earth has been a central philosophical and spiritual question since 17th century theologians like Archbishop Ussher and John Lightfoot constructed chronologies based on biblical interpretation. Their results were stated very precisely but are now considered highly inaccurate. James Hutton's concept of "no vestige of a

beginning, no prospect of an end" greatly challenged contemporary orthodoxy and is perhaps an underestimated contribution to the Scottish Enlightenment. As geology gained confidence, eminent Victorians such as Lyell, Playfair and Darwin found their evidence for the vastness of geological time at odds with the thermodynamics of the Natural Philosophers, led from Glasgow by Lord Kelvin. As we now know, Kelvin's calculations failed to take account of, yet to be discovered, radioactive heat. In 1913, Frederick Soddy, working in the Department of Chemistry in the University of Glasgow, introduced the concept of isotopes. It is a delicious irony that the same radioactive isotopes that solved the thermodynamic conundrum of how an ancient Earth had stayed warm have also been exploited to date that very antiquity. This talk will explore the development of thinking on the age of the Earth with particular focus on the contribution from Glasgow.

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Thursday 10th December 2009

ANNUAL GENERAL MEETING

Thanks were expressed to:
Retiring members of Council Dr Alan Owen – President, Dr Iain Allison – Hon Secretary, Mr Michael Pell – Treasurer, Meetings Secretary – Dr Jim Morrison, Dr Chris Burton – Librarian, and Mrs Margaret Greene – Minutes Secretary and Ordinary members – Dr Simon Cuthbert, Dr Tim Dempster, Mr Robert McNicol and Mrs Margaret Rollo, for their contribution to the work of the Society over the past three years;
The Editors of the Scottish Journal of Geology, Dr C.J.R. Braithwaite and Dr Brian Bell, who are elected annually.

This was followed by the Election of Office Bearers, and by the Presidential address.

Dr Alan Owen, University of Glasgow
Presidential Address

LIFE IN THE ORDOVICIAN WORLD

A spectacular increase in biodiversity during an interval of about 25 million years in the Early and Mid-Ordovician ("The Great Ordovician Biodiversification Event") established the overall patterns of the composition and ecology of life in the marine realm for the rest of the Palaeozoic Era. The sea floor was home to a multitude of organisms, many now preserved as 'shelly fossils' such as trilobites, brachiopods, gastropods, bivalves, echinoderms and corals. The water column saw a revolution in the plankton (including the graptoloids) and an expansion of groups such as nautiloid cephalopods and fish. The Ordovician world was one of widely dispersed continents with very extensive shelf seas (especially in the tropics), a cooling climate, periodically very high global sea-levels, intense volcanic activity, orogeny, and the disruption of habitats caused by an episode of meteorite bombardment. Some or all of

these factors may have promoted the major increase in biodiversity. The end of the Ordovician was marked by one of the 'big five' mass extinctions yet life bounced back to the pre-extinction levels of diversity and general ecological structure early in the succeeding Silurian.

The business of the AGM was followed by our annual Christmas social including wine, soft drinks and nibbles.

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Thursday 14th January 2010
Dr David Large, University of Nottingham

MAKING THE MOST OF COAL – APPLICATIONS IN PALAEOENVIRONMENT AND HUMAN HEALTH

The value of coal in the geological record is grossly underestimated. This presentation aims to illustrate novel ways in which coal and lignite can be used to understand the evolution of the Earth's environment and the link between palaeoenvironment and human health. Starting with ways of estimating time in coal seams this will be developed to illustrate how estimated rates of atmospheric deposition in coal can be used to explore the link between massive volcanism and climate change. Finally a fascinating case study linking environmental change at the Permo-Triassic Boundary and human health will be discussed.

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Thursday 11th February 2010
Dr Maarten Krabbendam, British Geological Survey, Edinburgh

CANADIAN SAND IN SCOTLAND: ARE THE MORAR AND TORRIDON GROUPS THE FORELAND BASIN TO THE GRENVILLE MOUNTAIN BELT?

The Torridon sandstone in NW Scotland represents a very thick pile of fluviatile sandstones of early Neoproterozoic age. Discussions about potential correlations across the Moine Thrust with the vast tract of metasedimentary Moine rocks date back to the 19th century geologists Peach, Horne and Clough. I will present recently-discovered sedimentary structures on the lowest Moine rocks in Sutherland and Ross-shire, suggesting deposition as high-energy, braided fluvial deposits. I will compare and contrast the Torridon and Morar groups and show that the two groups are similar in lithology, stratigraphy, sedimentology, geochemistry and detrital zircon ages. I will argue that the Torridon and Morar group can be directly correlated across the Moine Thrust and that both deposits formed part of a large foreland basin in front of the *ca.*1000 Ma Grenville Mountain Belt, similar to the Ganges Basin in front of the Himalayas today.

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Thursday 11th March 2010
Dr Clark Fenton, Imperial College, London

EARTHQUAKES IN UNUSUAL PLACES: 'STABLE' CRATON TECTONICS

The majority of earthquakes are relatively well-behaved and occur where we would expect, along plate margins where contemporary crustal deformation is concentrated. However, a small but significant number of damaging earthquakes occur in regions far from plate boundaries, including Precambrian shields, which would normally be considered aseismic. The sources of these earthquakes are often cryptic, having no prior surface expression, making the identification of potentially active structures very difficult, if not impossible. These events have recurrence intervals in excess of 10^5 years and in some cases occur on faults that show no evidence for brittle behaviour in the last billion years! The occurrence of such earthquakes poses a major problem for seismic hazard assessment and consequently safe civil engineering design. Exceptionally long recurrence intervals and a lack of surface expression means that such events are often not preserved in the geological record. Thus, 'traditional' palaeoseismic techniques are often of little use. However, by studying the surface effects of recent surface faulting earthquakes in stable continental interiors and also detailed analysis of intraplate seismicity allows an insight into the seismotectonics of 'stable' plate interiors.

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Thursday 8th April 2010
Professor Peter Westbroek, Universiteit Leiden, The Netherlands

EARTH – FROM GLOBAL MENACES TO PLANETARY HOPE.

Global heating, overpopulation, exhaustion of natural resources, globalization ... all these problems are connected and affect the Earth at large. The world leaders pull their levers, but, whatever they do, things only get worse. An epidemic of global fear is spreading and already shows its ugly face in outbreaks of intolerance, fundamentalism, and xenophobia. This fear is the worst of all our predicaments. What we need is an inner light, an attitude of detachment, a balanced state of mind. This, I argue, is what geology can bring about. Through our science we can gaze into the abyss of time, fathom the depth of our roots, witness the immense creativity of emergence, and admire the majestic odyssey of our planet's history. Geology is a neglected treasure trove bringing admiration for this planet and confidence in ourselves. Its method is universal and its results are open to everybody. Thanks to geology we are in a position to overcome our fears, properly address the problems ahead and experience our life as a unique adventure.

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Thursday 13th May 2010

MEMBERS' NIGHT

Once again we had a good range of talks and displays, and we acknowledge with thanks the contribution of our members noted below to the success of this evening.

Short talks

Undergraduate Research on zeolite minerals in Iceland.
Kamil Swiatek, Stephen Fullerton, Freyea Marks.

The Eyjafjallajokull Eruption, Iceland, 20th March & 15th April, 2010.
Dr J MacDonald.

Madeira, 2010. Dr Mike Keen.

A curious tourist in Gotland, Sweden. Walter Semple.

Displays

Zeolite minerals from Eastern Iceland.
Kamil Swiatek Stephen Fullerton, Freyea Marks.
Ultrabasic rock from Bute. .Marion Ballantyne.
Banded agates and sedimentary agates from Dryhead, Montana. Julian Jocelyn.
Skye excursion photos Bill Gray.
Photos from Madeira. Margaret Donnelly.
Photos and specimens from New Zealand. Seonaid Leishman.
Madeira. Ian McCallum .

EXCURSIONS

Evening and Saturday Excursions

This year we had two evening excursions and three day excursions, all of which were well supported:

Saturday 24th April - Dobbs Linn.
Dr. Euan Clarkson led us on this joint trip with our sister organisation - the Edinburgh Geological Society. Afterwards we all enjoyed high tea in Moffat.

Thursday 20th May (evening) – Glasgow Necropolis.
Annette Mullen of Friends of the Necropolis gave us a guided tour of the graveyard and our own Dr. Iain Allison described the geological aspects of the location.

Friday 25th June – Locharbriggs Quarry and Castledykes Park, Dumfries
Dr Andrew McMillan and Stancliffe Stone. On this Friday excursion we were guests of Stancliffe Stone at their quarry and stone processing site at Locharbriggs near Dumfries. Afterwards they generously provided us with lunch during a presentation by their technical and managing directors. In the afternoon Andrew guided us in a study of the geology of Castledykes Park, where Andrew described its context within the wider environment of the Solway Basin.

Saturday 31st July – Fife Earth Project.
Our visit to this open cast coal mine near Kelty in Fife was hosted by Jim Duffy and Neil Gray of Scottish Coal. We were shown round the works and given a short presentation on the imaginative restoration project which is planned for the site once extraction is complete.

Thursday 2nd September (evening) – Fossil Grove
Dr Iain Alison described both the geological detail and the significance of the Fossil Grove site within and around the exhibition building.

Tyndrum Gold Mine. For various logistical reasons we were not able to schedule this trip. I apologise to those of you who expressed an interest and were disappointed.

The success of all of our trips depends on the goodwill of the learned individuals who are prepared to lead us. Without their kindness and willingness to share their knowledge so generously our trips would be impossible. I thank them all on behalf of all who attended. Finally, thanks to everyone who helped organise, attended or agreed to write up the proceedings for our excursions.

Jim Martin

Residential Field Excursions

Two residential trips took place in 2010. In early May Dr Brian Bell (University of Glasgow) led 24 members to south Skye to study basalts and igneous intrusions. Brian was ably supported in the field by our secretary, Iain Allison. In October Dr Alan Gibbs of Midland Valley Exploration led 15 members to the Solway coast around Rockcliffe.
I will be standing down at the AGM after six years and eleven trips. In my first year I asked members to fill in a questionnaire to tell me where they would most like to visit on residential trips. I am pleased to report that during the following five years we managed to visit many of the places on the wish list namely Assynt, Torridon, Western Isles, Mull and Islay. Unfortunately I wasn't able to organise trips to the more distant locations such as north and west of Ireland, Cornwall, Wales or Isle of Man; however maybe my successor will be able to rise to that challenge!
At the risk of this sounding like an Oscar ceremony, I would like to thank all the leaders who gave of their time so generously and put up with all my emails when planning the trip. Thanks to those members who deputised for me on the trips I was unable to attend personally, and thanks to Mervyn Aiken and Michael Pell for helping me bank income and pay outgoings so promptly. Thanks to those who 'volunteered'

to write up a note of the trip for the Proceedings (and I'm sorry if I ever used strong arm tactics) and I am very grateful to Iain Allison for his help in finding suitable leaders. Finally the trips could not have taken place without all those members who have supported them so regularly and loyally over the years.

David McCul1och

DOB'S LINN : 24 April 2010
Leaders : Professor Euan Clarkson
Report by : *Bill Gray* Participants : 21
Joint Excursion with EGS

The purpose of this excursion was to examine the exposures of the Moffat Shale Group at the world-famous site of Dob's Linn (NT 197158). This is the area where Charles Lapworth carried out his pioneering studies in the 1870s, in which he established the usefulness of graptolites for correlating different strata within the Ordovician and Silurian periods. It is also the location of the Global Boundary Stratotype Section and Point (GSSP) for the Ordovician-Silurian boundary, informally known as the 'golden spike'. This was a joint excursion with the Edinburgh Geological Society, and we met up with their group, which was of a similar size to our own, on a clear and bracing spring morning at the parking area on the A708 just a little northeast of the large car park for the Grey Mare's Tail. The handout for the excursion included the map for the Dob's Linn excursion from Geological Excursions around Glasgow and Girvan, and the locality numbers given in this report correspond to the numbers on that map.

The leaders gave a brief introduction to the geology of the area, in which they pointed out that the dominant rock type of the Southern Uplands, the Silurian Gala Greywacke, is underlain by the Upper Ordovician/Lower Silurian Moffat Shale Group. The Moffat Shale Group is exposed in a series of faulted inliers formed by imbricate thrusting, and Dob's Linn is one such inlier. The Moffat Shale was deposited in the Iapetus Ocean over a period of 28 Ma, and it is composed of four main units; in chronological, and depositional, order, these are: the Glenkiln Shale, the Lower Hartfell Shale, the Upper Hartfell Shale and the Birkhill Shale. The first three of these were deposited in the Late Ordovician, while the Birkhill Shale was deposited partly in the Ordovician but mainly in the Llandovery epoch of the Silurian; the Ordovician-Silurian GSSP lies 1.6 m above its base. We were reminded that, as Dob's Linn is part of the Moffat Hills SSSI, no hammering of the rock faces was allowed; however, graptolites could be collected from the scree. The plan was to walk northwards along the valley of the Long Burn, a tributary of the Moffat Water, and then along the Linn Branch gorge, which joins this valley from the west after about 400 m. We started off along the sheep track into the valley, but after a short time Euan stopped the party and invited us to observe the white cottage that had just come into view at the top of the valley. This was Birkhill Cottage, where Charles Lapworth had lived between 1872 and 1878, while carrying out his graptolite studies. Euan gave us a brief account of Lapworth's life and work, after which we could appreciate why he held Lapworth in such high esteem.

The view to the north-east along the Long Burn valley. The Main Cliff is on the left, and the Linn Branch gorge joins the valley on left beyond the Main Cliff. Birkhill Cottage is on the horizon. ***Bill Gray.***

We stopped briefly at Locality 1, where there is an exposure of the Glenkiln Shale, the lowest unit of the Moffat Group. The exposure is covered by scree, and not easily seen, but several graptolite specimens were found in the scree. We proceeded along the valley until we arrived at the base of the Main Cliff, where there are exposures of the Lower Hartfell Shale (Locality 2) and Upper Hartfell Shale (Localities 3 and 4). However, the exposures are situated part of the way up the cliff, and not readily accessible, so we observed them from a distance and looked for graptolites at the foot of the slope. Cecilia explained why graptolites are useful for stratigraphical correlation and dating, and Euan gave us an insight into the graptolite mode of life. Graptolites constitute the class Graptolithina within the phylum Hemichordata, which is distantly related to our own phylum, the Chordata. There are two orders of graptolites, the Dendroidea and the order to which the Moffat Shale graptolites belong, the Graptoloidea. Three factors make graptolites extremely useful for stratigraphy: their rapid evolution, their wide geographical range, and the fact that they are generally well preserved after death (because of the anoxic conditions on the sea floor). Graptolites are therefore excellent for defining biozones (e.g. the *Dicellograptus anceps* zone, which is found in the Upper Hartfell Shale). The absolute age of a biozone can be determined by radioactive dating of volcanic layers interbedded with the shales. While early graptolites were benthic creatures, living on the ocean floor, the Graptoloidea were planktonic, floating in the surface layers of the ocean, and this was an important factor in their wide geographic distribution. The Upper Hartfell Shale (Localities 3 and 4) is generally barren of graptolites because it was deposited towards the end of the Ordovician, when the climate was cooling. An influx of cold water from polar regions caused oxygenation of the deep ocean waters, and this caused the graptolite skeletons to decay before they could be fossilised.

However, there were brief warmer periods within this general cooling when conditions were more favourable to preservation, during which the fossiliferous Anceps and Complanatus Bands within the Hartfell Shale were formed. These bands are present at Localities 3 and 4, but we did not have time to study them.

Our next stop was at a bank above the foot of the Linn Branch gorge (Locality 5), where the objective was not to look for graptolites but to find a suitable spot for lunch. From here we had an excellent view of the Dob's Linn waterfall tumbling over the Gala Greywacke at the top of the gorge. Euan explained that the waterfall was named after the Scottish Covenanter Halbert Dobson, who successfully hid from his English pursuers in a cave near the waterfall for several weeks in the 1690s.

Lunch at Dob's Linn. ***Bill Gray.***

After lunch came what many of us expected to be the highlight of the day: the visit to Locality 6, a trench on the north side of the Linn Branch that contains relatively undisturbed sections through the top of the Hartfell Shale and the base of the Birkhill Shale, and where the GSSP for the Ordovician-Silurian boundary is situated. The path in the trench was very narrow and the area in front of the GSSP area could accommodate only a few people at a time, and so Cecilia and Euan described the main features of the locality to several groups of us in turn. The strata here are inverted and young upstream (towards the waterfall). The top layers of the Hartfell Shale contain the Anceps *(Dicellograptus anceps)* and Extraordinarius *(Normalograptus extraordinarius*) Bands, and the late Ordovician mass extinction took place between the deposition of the Anceps and Extraordinarius Bands. The Birkhill Shale lies in contact with the Extraordinarius Band, and the first graptolite zone in it is the *Normalograptus persculptus* zone; the GSSP is 1.6 m above the base of the Birkhill Shale, at the base of the *Akidograptus ascensus* zone. All of the zone fossils in the exposure are rare, and certainly cannot be seen in situ. It was therefore not clear exactly where the GSSP lay, although a rough idea of its position could be obtained by mentally measuring 1.6 m perpendicular to the strike from the base of the Birkhill Shale. The lack of a clear indication of the position of the 'golden spike' left us with a vague feeling of anti-climax. One other feature of this section was the occurrence of layers of metabentonite interleaved with the shale layers. These are composed of volcanic tuff that was probably ejected from volcanoes associated with the closure of the Iapetus Ocean and was subsequently highly altered by reaction with seawater and tectonic compression.

The final locality that we visited was Locality 9, a little further upstream along the Linn Branch gorge, where the top (Silurian) zones of the Birkhill Shale are represented. By the time these strata were deposited, the most abundant type of graptolite was the monograptid, and some monograptid specimens were found here. Specimens of the Ordovician genera *Dicranograptus* and *Dicellograptus* were also found. The excursion was now drawing to a close, and we retraced our steps to the foot of the Linn Branch gorge. By now the chilly spring morning had blossomed into a warm summer afternoon. Most of the party made their way straight back to the bus, but some decided to climb to the top of the Main Cliff to see the view of the north side of the Linn Branch gorge that was sketched in the handout. This was a very rewarding detour, as it afforded a scenic panorama of the U-shaped valley of the Moffatdale to the east, with Birkhill Cottage in full view, and thus providing a satisfying symmetry to the excursion.

The excursion ended with a visit to the Annandale Arms in Moffat for drinks and high tea with our companions from Edinburgh. One of the Edinburgh group proposed a well-earned vote of thanks to Euan and Cecilia for their sterling efforts, and Jim Martin of the GSG presented each of them with a bottle of wine. We found many fossil graptolites during the excursion. While it is relatively easy to recognise the suborder and sometimes the genus to which a particular graptolite belongs, it is usually difficult to assign a species, and even professional geologists have to send specimens to an expert for species identification. Therefore our leaders could help us to identify the specimens to a certain extent, but not down to the species level. The following photograph shows two typical samples collected from the scree.

Shale samples containing fossil graptolites. The left sample contains a graptolite from the suborder Diplograptida, and dates from the Ordovician, while the graptolites in the right sample belong to the suborder Monograptida, and date from the Silurian

Bill Gray.

Further reading.

Williams and Lawson give a clear and detailed description of the stratigraphy and fossils of Dob's Linn; however, some of the biozone information, particularly that relating to the Ordovician-Silurian boundary stratotype, is now out of date. Up-to-date information on the assignment of biozones for the Ordovician and Silurian is given by Ogg et al. Doyle provides a very clear description of zone fossils,

biozones and graptolite taxonomy, morphology and evolution. Clarkson and Upton present a very readable account of the history of the Iapetus Ocean which also discusses graptolites, the Moffat Shales and the work of Charles Lapworth, while Oliver et al. provide a more advanced account of current ideas on the formation of the Southern Uplands terrane

1. Clarkson E & Upton B. 2009. *Death of an Ocean. A Geological Borders Ballad.* Dunedin Academic Press. Edinburgh.
2. Doyle P. 1996. *Understanding Fossils. An Introduction to Invertebrate Palaeontology*. Wiley. Chichester.
3. Ogg JG, Ogg G & Gradstein FM. 2008. *The Concise Geological Time Scale*. Cambridge University Press. Cambridge.
4. Williams SH & Lawson JD. 1992. Excursion 32, Dob's Linn. In Lawson JD & Weedon DS (eds): *Geological Excursions around Glasgow and Girvan*, 440 – 462. Geological Society of Glasgow.
4. Oliver GJH, Stone P & Bluck BJ. 2002. The Ballantrae Complex and Southern Uplands Terrane. In Trewin NH (ed.): *The Geology of Scotland*, 167 – 200. The Geological Society, Bath.

SKYE: Friday 30 April – Monday 3 May 2010
Leader: Dr Brian Bell, University of Glasgow
Reports by: Eleanor Duncanson, Katerina Braun, Seonaid Leishman

Participants: 23

In the Hebridean Hotel in Broadford, where most of our group was staying, our leader introduced us to the geology we would be seeing over the weekend. We would be studying igneous and volcanic activity associated with the Skye volcanic story, as well as its related contact metamorphism. Brian's in-depth knowledge and infectious enthusiasm had been gained while mapping the area in the 1980's and we were to benefit hugely from these over the course of the weekend. The area has now been remapped [1:50 000 maps of Minginish (sheet 70) and Broadford (sheet 71W) and includes a cross-section of the Strathaird Peninsula].

In the Palaeogene, rifting began along the line of the present North Atlantic Ocean and Greenland began to split from north-western Europe. This rifting caused MORB (mid-ocean-ridge) magma to rise into the mantle, which in turn caused the country rock to dome up. Subsequent erosion of the country rock meant that lava flowed onto Jurassic, Pre-Cambrian Torridonian sandstone and even basement Lewisian Gneiss. Cretaceous rock may have been deposited here and subsequently stripped off or, alternatively, may not have been deposited at all. Since clasts of Cretaceous material appear between lava flows in Mull, the consensus is that it had also been present on Skye though no evidence has been found.

There would be three lithographical themes to the weekend:

1. Lava (Sunday): First lavas were fed by fissures; Lavas are sub-divided by sediment at base of flow; North Skye, which is mostly lava covered, was last surveyed in 1950's.
2. Basic/Ultra Basic Complex (Saturday): This was hosted by these lava fields

and then lava was erupted by the complex itself.

3. Granite (Monday): Complex was later disturbed by intrusion of granite.

Saturday 1st May.

We drove along the Broadford – Elgol (B8083) road down the east side of Loch Slapin, and parked the cars at Kilmarie (NG 545172) at the start of the landrover track across the Strathaird peninsula to Camasunary at the base of the Cuillins). In geological terms, we would be walking across a metamorphic aureole to the base of the gabbroic root of the central volcanic complex, and we were to look for evidence of contact metamorphism in the country rock and work out the chronology of events. At first the track crossed flat, boggy, infertile land where glacial debris had been deposited on Jurassic Estuarine Group. We stopped to examine one of the dykes, which crossed the track. The intrusion was a fine/medium grained dark grey/greenish basic rock with a 'pockmarked' appearance. Like most dykes in the area, it was a porphyritic feldspar-phyric dolerite dyke emplaced with a single pulse of magma. Its greenish colour came from the presence of chlorite, and weathering out of feldspar crystals had given the rock its 'pockmarked' appearance. The magma had been rich in plagioclase feldspar crystals accumulated 'on the way up'. Amphiboles were also present but could not be seen in the field.

Soon beautiful Camasunary Bay was spread out below us with hills of the central complex towering above. The path from Sligaghan to Camusunary has become a popular mountain bike route and groups of cyclists could be seen shuddering their way down into the bay. The Camasunary fault, a continuation of the Great Glen fault, runs down through the bay and out to sea with the younger lava covered Jurassic strata on the downthrown side (but on higher ground!) and older Torridonian rock on the upthrown side (but on lower ground!). The actual fault could not be seen but was obvious from the change in topography. Brian pointed out dykes and cone-sheets intruding the gabbro of Sgurr na Stri, on the west side of the bay. During rifting, stretching of the crust took place causing the mantle to decompress and basaltic lava rose to the surface through the resultant fissures – the Skye dykes and magma chamber are formed from the same gabbroic material. During the rifting event there were periods when no stretching took place and it was then that melted mantle material formed a shallow magma chamber at about 1km depth, the eroded remains of which provide us with the magnificent Cuillins. The cone sheets are concentric sloping sheets, several kilometres in diameter at the surface, curving inwards at depth towards the centre of the magma chamber – their geometry a result of being emplaced when no stretching was taking place. The notches in the awe-inspiring Cuillin Ridge are caused by their erosion. The cone sheets were injected late in the Skye volcanic story from lava of Mid Ocean Ridge Basalt (MORB) type chemistry – the basalt of Preshal Mhor near Talisker has the same chemistry.

The track now led us down into the bay, crossing the Camasunary fault on the way, to the bridge over the Abhainn nan Leac (stream of the rock slab) where Pre-Cambrian Torridonian sandstone, criss-crossed by small dykes, was exposed in the stream section. Some of us found it difficult to accept that this pale grey 'blocky' sandstone was the same as the red sandstone which forms the spectacular mountains in Torridon. The sediment could have originally been pale grey here or the colour

could have been altered by hydro-thermal activity during the emplacement of the central complex. Some sedimentary features, including fine scale laminations, could be seen and the sandstone looked virtually unaffected by metamorphism. Brian also drew our attention to a patch of bright green vegetation amongst the Torridonian, which grew on a small outcrop of Lower Jurassic marble.

We had lunch is this beautiful setting with the sun warming us and, as we moved towards the base of the Cuillins, we began to see clear evidence of contact metamorphism. At first minor, light coloured veining appeared in the sandstone due to hydrothermal fluids circulating, and the dyke/sandstone contacts were sharp indicating that the sandstone was still cold and brittle when the dykes were emplaced. One dolerite dyke, cross cutting basalt lava, caught our attention because it showed a chilled margin with narrow 2cm wide jointing perpendicular to the contact with the lava indicating that the dyke margin had cooled rapidly, whereas the centre of the dyke had much wider jointing indicating slower cooling further from the cooling surface. Moving towards the gabbroic magma chamber, the effects of metamorphism became progressively more pronounced with the hydro-thermal veining becoming more frequent and wider, and the dyke/sandstone contacts becoming irregular indicating that the dykes were now being injected into sandstone that was plastic due to the proximity of the hot gabbroic magma. Even nearer the gabbro, there had been partial melting of the Torridonian and the resultant pale granitic material had infiltrated the Torridonian itself and also the dykes, to form pods and ribbons.

We arrived at the contact of the Torridonian with the central complex and could see that the large slabs of gabbro, smoothed and polished by the passing of glaciers, were also infiltrated by pods and ribbons of this pale granitic material. In turn, the gabbro itself had partially melted and invaded the Torridonian to form large, irregular pods. This process is referred to as back-veining. Gabbro, beloved of climbers in the Cuillins, is a dark rock consisting of olivine, pyroxene and plagioclase feldspar. Weathering causes the pyroxene crystals to stand proud giving the rock its legendary frictional properties, while the olivine crystals weather to rusty coloured spots. Although layering in the gabbro appears spectacularly in other places, there was none to be seen here. As the gabbroic magma intruded into the basaltic lava, it tore off large angular pieces, which could now be seen in the gabbro slabs. Elsewhere other xenoliths had been deformed and elongated by the heat and pressure. One pod, which looked like yet another xenolith, was in fact a pegmatite produced when high temperatures of about 1100ºC had produced magma with a high percentage of volatiles.

Partial melting of the Torridonian nearest the magma chamber had produced a coherent sheet of Coire Uaigneich granite. Exposures were to be seen on the far side of the river round the base of Sgurr na Stri – unfortunately the river proved too full to cross. The granite could also be seen forming the pale coloured scree high above us in Corrie Uaigneich on the east side of Bla Bheinn. However, thankfully our leader kindly found some for us in the local farmhouse wall and we all had a good look at this pale granite with large hypersthene crystals – which saved us from drowning or having to be mountain goats. Brian pointed out that this was very different from the granite that formed the Red Hills of Skye. While our explorations in the bay had provided us with lots of evidence for the effects of contact

metamorphism, we also enjoyed the challenge of working out the chronology of events from cross-cutting relationships and the effects of intrusions and country rock on each other. Brian pointed out that a temperature difference of more than 300ºC was required before an intrusion could result in a chilled margin in the country rock – drawing the useful parallel between this and putting our faces near an oven at 200ºC. A very happy group then made its way back over the peninsula after a day of stimulating geology in spectacular surroundings. Brian had very successfully helped our understanding of the complex geology.

Sunday 2nd May

We left Broadford heading west along the A87 to Sligachan Hotel, where we turned left onto the A863 towards Bracadale. At Glendynoch Lodge, we turned left again onto the B8009 for a short distance until we reached Merkdale and Carbotsmore, where we turned left yet again to Talisker Bay (NG 330330). This road is situated along Gleann Oraid, which has been eroded by the River Talisker. The site of interest is situated some 500 metres east of Talisker House and about 800 metres south of the road. The topography here is variable. A series of stepped, sub-horizontal cliff faces form the valley sides. These stepped cliff faces were formed from lava flows, which are the oldest lava deposits observed in the region. These lava flows predate the fissure vents seen during the previous day's excursion, which formed when the earth's crust was being stretched and extended by earth movements.

Excellent examples of columnar jointing in fallen boulders.

Katerina Braun

These lava flows therefore predate the period of crustal extension and later Cuillin volcanic activity; hence must have originated from elsewhere. As we looked towards the south, we were faced by the northern face of Preshal More, which consists of a 50 metre high scree slope and overlying 120 metre high, dark vertical cliff face. Preshal More forms a discrete area of higher ground that peaks at 320 metres. Numerous gigantic boulders lay strewn across the grassy slopes below the scree slope. We strolled across the gently sloping grassed slopes towards the base of

the scree slope and inspected some of the fallen boulders. These boulders had fallen from the cliff face above and were excellent examples of columnar jointing.

At the foot of the scree slope, Brian introduced the geology of Preshal More. Preshal More is actually formed from a lava flow that originated from the Cuillin volcanoes. This lava flow is much younger than the surrounding lava flows and forms an outlier, which is where younger rocks are surrounded by older rocks. This Cuillin lava flow has a Mid Ocean Ridge Basalt (MORB) composition and is tholeiitic. This younger lava flow must be tougher and less resilient to weathering in comparison with the adjacent lava deposits, since this younger lava has formed areas of locally higher ground. We observed the shape of the outcrop and Brian pointed to the unconformity between the younger lavas above and the older lavas below to the east of the cliff face. This unconformity is an angular discordance and is inclined to the east and relatively flat within the centre of the cliff face. It is thought that this lava flow emanated from its Cuillin volcanic source to the southeast along a steep sided palaeoriver system. This hypothesis explains the deposit's discrete exposure and uniqueness and also the apparent profile of the underlying unconformity.

We traversed up the scree slope, to the base of the vertical cliff face. Conglomerates lie below the younger lava deposits, marking the position of the unconformity. The lava columns at the boundary are relatively small and are composed of fine grained basalt that lacks any phenocrysts. The basalt lava is brecciated and infilled with hydrothermal fluids to form a volcanic breccia. Fresh lava flowing along the valley probably came into contact with stream water along the valley floor to locally form Hyaloclastite. As the lava cooled after its deposition, cooling joints developed perpendicular to the contact surface. Vertical joints therefore formed where the contact is flat towards the centre of the outcrop and inclined/sub-horizontal joints formed where the lava was in contact with the valley sidewalls. The steeper the sidewall angle, the more horizontal the columns. We then clambered up hill yet again, to the rear of Preshal More. Here, we first had views of another discrete area of higher ground referred to locally as Preshal Beg. Preshal Beg lies two kilometres further to the south of Preshal More and peaks about 345 metres. At the base of Preshal Beg is a thick trachyte flow, which is a bit paler and greyer than the basaltic rocks visible at Preshal More. Conglomerate underlies the intervening area of low ground. This conglomerate is exposed at the base of Preshal Beg. Unfortunately we didn't make it to Preshal Beg due to lack of time available after having been distracted with the fabulous exposures at Preshal More. Brian informed us that basalt and odd Torridonian clasts are present in the conglomerate, which suggests the material was worked from an older basement. The conglomerate thins to the west and eventually becomes absent west of Preshal More. We paused for a well-deserved lunch break in the sunshine.

After lunch we observed the south facing cliff face of Preshal More, which consists of a lower zone of massive vertical columns and an upper zone of randomly jointed and fractured rock. This portion of the lava flow must have been deposited along the centre of the palaeovalley, since no inclined or sub-vertical columns were apparent. This tells us that the principal cooling direction was vertical, through the top of the lava flow and the base of the lava flow. The upper zone of randomly oriented and fractured columnar mass is thought to have formed due to the percolation

of water through the lava as it cooled. This percolating water may have flowed from a stream flowing along the palaeovalley (if the lava didn't completely infill the valley) or from rainfall. This percolation of water through the top of the lava would have disrupted the cooling pattern and caused disruption on the jointing direction within the upper zone of the lava flow. The columns within this upper zone are disoriented, irregular and fractured. This particular cooling pattern is referred to by geologists as 'Entablature'. There is a type locality at Giant's Causeway. We then traversed around the western side of Preshal More back to the car park, admiring the fantastic coastal views in the sunny weather.

The group after lunch at Preshal More ***Margaret Donnelly***

Our last site visit for the day was at Glen Eynort to a rocky outcrop locally referred to as Cnoc Scarall (NG 390280). The rock forming this outcrop is an extremely strong dark grey fine grained trachyte, also known as the 'ringing stone'. This rock type is dominated by amphibole and biotite and is 90% alkali feldspar. Trachyte is the most geochemically evolved MORB lava on Skye with a high alkali and high silica content, making it very viscous. Trachyte lavas tend not to flow too far from their vents due to their high viscosity, as these more viscous magmas begin to cool near the surface. The vent from which this trachyte lava flowed must therefore not be too far away and must be either below or near to the trachyte outcrop. Vents emanating such viscous lavas often become blocked, resulting in explosive eruptions with potential for pyroclastic eruptions. The feldspar minerals in this outcrop are aligned. This alignment of the feldspar crystals occurred when the lava was molten and flowing. The feldspar crystals have weathered more than the surrounding groundmass, making the mineral alignment apparent without the need for a hand lens. The alkali feldspar crystals must have been crystallising out of the

magma when the lava came to the surface; hence they aligned with the flow direction of the magma.

Columnar jointing and entablature on Preshal More. ***Katerina Braun***

As we clambered around the rock outcrop for closer inspection of the fabric, dark clouds loomed in the distance over the Cuillins. It was therefore time to head back to the cars..... Thankfully we made it just in time!

Monday 3rd May

The three main Skye granites – Strath na Creitheach, Western and Eastern Red Hills – post-date the central complex gabbros by approximately 1 Ma. Interestingly this is marked by a magnetic polarity reversal. We visited Strath Kilcrhist (NG 618206) for the contact of the Strath na Creitheach with Cambro Ordovician dolostone, Rhubh an Earannaich (NG 645248) for an unusual composite sill and Loch Ainort (NG 550285 – 560320) for cone sheets of the Western Red Hills.

Strath Kilchrist. The 'big picture' as seen from the Old Manse across the road from Cill Chroisd churchyard includes:

1. North of the Loch are sediments formed from erosion of central complex volcaniclastics.
2. Southeast are multiple dykes cut by the granite and post-dating the Durness limestone. Pulses of granitic magma used the fissures which had previously fed the surface volcanics, now eroded off.
3. Southwest the dip on the Cuillin skyline is the Coire Uaigneich granite (formed from melted Torridon sandstone). This was seen from Camasunary on Saturday.

4. Northwest of the Loch is the youngest granite, Beinn Dearg Bheag , with a dyke on its eastern slope.

The contact to the east is marked by a very distinct vegetation change from green grass on the alkaline limestone, to peat and heather on the acidic granite. This is the clearest example our leader has seen. The contact is irregular, perhaps caused by solution weathering of the limestone forming caves, therefore a subterranean topography, which would be infilled if the intrusion was a sill. This could also be the reason for the 'islands' of limestone within the granite. However it is not known whether we are looking at the base (sill) or roof of the intrusion (pluton). The limestone is dolomitic. Inclusion of cherty nodules plus contact metamorphism (granitic magma temperature was 750^0 C) forms forsterite from the magnesium and silica. This can then be serpentinised at 600^0 C. In the marble quarry the green coloured rock includes some unaltered olivine. Formations which could be microbial mats might be the source of the chert. An anti-form plunging ENE is cut by the granite. Further from the contact we could see good examples of stylolites, which here are parallel seams formed by pressure solution at burial.

Stylolites at Kilchrist

Seonaid Leishman

The 30 metre wide dolerite dyke is also cut by the granite but it had only experienced fluid alteration. Dolerite crystallised at 1100^0 C therefore the olivine, pyroxene and plagioclase are 'not bovered' when the granite intrudes at 700^0C. However the reaction of fluids from the granite with the dolostone precipitates high temperature minerals such as tungsten and magnetite forming a SKARN. Metasomatic rocks such as this form this fourth category in addition to sedimentary, igneous and metamorphic. Another rock formed by metasomatism is pegmatite. It is not usually economic to mine skarn, though there was an exposure of magnetite at Kilbride. Here we just upset our compasses by crossing and re-crossing the contact!

Before moving onto the next locality Brian discusses the current thinking on the Skye granites. How is the space formed? How deep are the plutons? What is the source? Where are the lost silicic volcanic rocks from the Red Hills? Very briefly my understanding is that:

Space – can be provided by thermal erosion within the crust or doming as other rock is pushed aside.
Depth – gravity anomalies identify a cylinder of dense rock beneath quite shallow granites. This will be the gabbro.
Source – there is already evidence of melting of country rock (Torridon at Camasunary). If the HUGE volume of very high temperature basaltic magma of the Cuillin complex sits in the crust there is time for fractional crystallisation (only need 3 – 4 %) and melting of country rock. Interestingly we are told that the dominant signature is Lewisian gneiss. Lead isotope studies show the granites plotting in the middle of a ternary diagram for Lewisian granulite facies – Lewisian amphibolite facies – mantle.
Lost volcanics – these would have been intermediate and explosive giving agglomerates, tuffs and ignimbrite. Only a few ignimbrites have been found (Sgurr of Eigg) but the source for these is not yet known.

Rhubh an Earannaich . After a well-earned lunch on the beach amongst the Jurassic bioturbated mudstones and sandstones and the odd *Gryphea Arctuata* from the Triassic beneath, we inspected the interesting large sill, which forms the point of Rubh an Earannaich.

Rubh an Earannaich, the composite sill. ***Seonaid Leishman.***

It is a concordant composite intrusion injected parallel to bedding. The top and bottom (about 1 metre each) are basic basaltic but the middle mixing zone, the largest proportion, is felsite rhyolite microgranite. The first basic injection and the second felsic more evolved one used the same conduit. The contacts are gradational giving a 'compositional gradient' which means that both magmas were liquid and at high

temperature so the mixing was diffusional, that is, a physical mechanical process. Brian suggests we think of mixing water and treacle! Brian emphasised the importance of magma mixing in the Palaeogene Igneous Province. It can be by convection if basic and silicic magmas are able to mix in a chamber and are then pulsed up. However if there is a large input of hot basalt the silicic magma can heat up before mixing can occur. This degases thus increasing pressure. An increase of only 0.5 Kb is required to allow volatiles to escape into the upper chamber resulting in an explosive volcanic eruption such as occurs in Iceland to this day. The jointing of the basic top and bottom of the sill is wider than the silicic centre which started cooler so cools to its jointing temperature more quickly. This temperature gradient is opposite to normal in sills.

Loch Ainort. From the Moll road we appreciate the beautiful views up Loch Ainort to the Red Cuillins. Brian explained that the Western Red Hills Ring dyke is cut off by the Eastern Red Hills. We saw the Northern Porphyritic Felsite which is flow-banded and has an ignimbrite texture which means that though it was intrusive and fine-grained, it was pretty near the surface so is fragmented (i.e. it was explosively expanded but trapped). There are some inclusions of rounded basalt which was added as a liquid. The heat of this might have helped move the intrusion nearer the surface. Making our way along the road we looked for contacts – the felsite with Marcosite, Glamaigite with Marcosite, Marcosite with the Maol na Gainmhich granite. During the evolution of the Western Red Hills granite a central block of earlier granite dropped down allowing more magma to rise near the surface round the edges of the block resulting in the ignimbritic fabric and preventing thorough mixing, whereas the ferro diorite and felsite are at the same temperature so can mix. This is another example of how important magma mixing is on Skye. After Moll we reach the almost vertical contact between the felsite and the country rock – metamorphosed Torridonian sandstone. Across the water is the Island of Raasay with its lava field outlier of Dun Caan.

A number of the party had left for the south after lunch, but the remaining enthusiastic members thanked Brian for (patiently) explaining over three very full days, some of the complexities of the Palaeogene volcanic district of Skye. We were privileged to be led by one of the editors of the recent BGS Memoir on the Palaeogene of Scotland who had also produced the original survey maps.

NECROPOLIS, GLASGOW : Thursday 20 May 2010
Leader : Dr Iain Allison, Annette Mullen
Report by : *Jim Martin* Participants : 30

In the evening around 6pm, our members gathered at the gates of the Necropolis to meet our guides. Two were from the "Friends of the Necropolis", Michelle, a knowledgeable and entertaining guide assisted by Robert, and Dr Iain Allison our geological guide. Our "Friends" gave us a brief history of how the Necropolis came into being. Glasgow Merchants bought the land in 1650 from the Wester Craigs Estate, but were unable to develop the west side as planned as it was too rocky (a dolerite sill). Instead they planted fir trees which led to the area

becoming known as Fir Park. In the early 1800's the fir trees died and were replaced by elms and willows and the area became an arboretum. The Glasgow Merchants being shrewd business men saw an opportunity to create a burial ground for Glasgow – plans were drawn up and a landscape gardener employed to create the Necropolis.

We toured most of the 37 acres stopping at graves and vaults of note. Thirty-two graves are listed monuments, and many famous people were laid to rest here including Linda Lee (Queen of the Gypsies) and William Miller (poet of "Wee Willie Winkie" fame). There is a wide spectrum of rock types used for headstones, but time did not allow us to fully investigate these. On a geological note Iain explained the landscape and showed us where we were on a geological map. We saw the site of a quarry where whinstone (dolerite) was removed and used as an aggregate in road making as was dolerite blocks or "sets" (not cobble stones).

Everyone agreed that they would return to investigate this site to do it justice. Our guides were given a hearty vote of thanks for a most enlightening tour.

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LOCHARBRIGGS : Friday 25 June 2010
Leaders : Dr Andrew McMillan.
Report by : *Mina Cummings* Participants :24

The two sites which we would be visiting on this trip lie within the fault bounded Dumfries Basin. This Basin is a notable aquifer and evidence of the effects of water can be seen in many of the exposures. At its western side the basin is infilled with strata of the Doweel Breccia composed mainly of sedimentary breccias interbedded with thin sandstones. As these strata extend eastwards they interfinger with the Locharbriggs Red Sandstone which fills the eastern portion of the basin. The Locharbriggs Sandstone comprises two facies, the orange-red cross-bedded sandstone interpreted to have accumulated as a migrating dune field in arid desert conditions, and thin bedded, laminated orange-red silty sandstone containing locally derived pebbles. This was produced by fluvial reworking of breccias and sandstone. There is little direct evidence for dating the Dumfries Basin rock but it has shown close similarity to better dated rocks of the Penrith Sandstone Formation in Cumbria and the Collyhurst Sandstone Formation of the East Irish Basin. This suggests that these rocks are early to mid-Permian in age. These rocks, trapped as they were in a basin 1000 m at its deepest, are the evidence for the environment of the period as all surface evidence has been eroded by weathering and by glaciations.

The group arrived at Locharbriggs Quarry at about 10.30 am on a very pleasant, warm, dry June morning where we were met by Beverly Hill and introduced to the site manager Craig. After ensuring everyone was equipped with hard hats and hi-vis vests we were issued with earplugs for use when we toured the works area. The group was then split into two smaller parties for the tour. The quarry produces red sandstone for use in building, facing and edging. Within the quarry most of the rock was already in large blocks ready to be moved to the works for cutting and polishing as required. Craig explained that they had almost reached the end of the usable rock at the present level but were planning to pump out water from lower levels and keep the quarry active for the foreseeable future. On the exposures present we could see

some evidence of the aeolian cross-bedding which could also be seen on the surface of some of the cut blocks. Craig told us that many customers reject these blocks preferring blocks with little or no surface interest. It hardly needs saying that we all preferred the beauty of the stone with evidence of the dunes. Cross-bedding is not the only kind of marking to be seen in these rocks however, there are also dark bands parallel to the bedding in some sections of the rock and in some there are curved and seemingly random streaks. Andrew explained that the dark material was probably deposited by water flowing through the rock carrying minerals in solution which precipitated out into the sandstone. He could not say for certain how the large curved streaks had formed but was sure they had the same source.

The sandstone is worked in different ways according to its strength, the more fragile strata called Ashler is used to make smaller units and bricks while the stronger rock or slab is cut into larger masonry blocks and beautifully cut edging. This takes place in the works and we soon discovered the need for the earplugs. The rock is trimmed and cut by huge saw blades. The blades are cooled and the rock dust kept under control by water and the noise of both the saws and the water would be deafening without protection. The trimmed rock is cut into large masonry blocks, thinner facing blocks and edging blocks before being polished to remove all tool marks and create the beautiful, smooth surfaces we see on the finest buildings in Britain. Stancliffe have several quarries around Britain each producing a different colour and type of sandstone. At Locharbriggs there were samples of some of these rocks types. Lazenby from the Penrith quarry in Cumbria is another Permian sandstone but very pale unlike the orange-red of the Locharbriggs material. There was also a sample of Dorrington Sandstone from Northumberland, and Carboniferous sandstone of fluvial deposition which is pink and has more cross-bedding than Locharbriggs. After the tour we were taken to a hotel where a light lunch of soup and sandwiches were provided prior to a very interesting presentation about the uses to which Stancliffe Sandstone has been put for 150 years or more. The visit finished with the representatives of Stancliffe being thanked for the excellent morning in the traditional way and the group members being presented with brochures containing a lot of information about the different sandstones quarried by Stancliffe, and a Locharbriggs Sandstone paperweight.

The second site to be visited now lies within a lovely public park which has been created on the site of Castledykes Quarry. The exposures we were there so see formed three sides of the rose garden. Andrew challenged us to investigate the site for ourselves using an interpretive diagram drawn by Mike Brookfield in the 1980s. We began at the SE corner where breccia and sandstone dykes were clearly seen. There were many questions about how a sandstone or breccia dyke could be formed. The first point to be decided was whether it had been upthrust through a fissure or a fissure filled in from above. As there are many small shards of pale material sitting vertically, almost in a column, within the dyke it was clear that the dykes were upthrust and Andrew compared this to water rising through sand when it's put under pressure, bringing up sediment from below. Moving west along the face we found, as indicated on Brookfield's diagram, extensive beds of pebbly sandstone overlying framework breccia. This led to yet another breccia dyke. The pebbly sandstone then continued overlying aeolian sandstone. At the western end of this face the pebbly

sandstone petered out leaving the dune bedding well exposed. Moving round to the western face we saw aeolian sandstone underlying breccia and pebbly sandstone again; beyond a section hidden by foliage the framework breccia was found again with pebbly sandstone above followed by another bed of breccia. This is interpreted by Brookfield as braided stream and sheetflood deposits. At the NW corner facing south there is a superb exposure of thick strata of cross-bedded aeolian sandstone clearly eroded and overlain by thinner strata of cross-bedded sandstone at a shallower angle. This is then topped by pebbly sandstone and finally by breccia. As Andrew said this is an excellent piece of visual evidence of the changing environment throughout the period of deposition. Finally as we moved to the NE corner we found, as shown in the diagram, a huge expanse of very rough material with some granite contained within the mixture. Brookfield interpreted this as streamflood breccia and it could be seen at the extreme NW corner that this was lying over aeolian sandstone.

This brought us to the end of a fascinating field trip full of interest and variety. Andrew had our wholehearted thanks for a wonderful day.

Reference: Excursion notes provided by Dr Andrew McMillan.

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FIFE EARTH PROJECT OPENCAST COAL MINE : 31 July 2010
Leader :Dr Chris Burton, Neil Gray
Report by : *Allison Drummond* Participants : 22

We arrived at 10 am and were issued with safety hats and fluorescent jackets and were then joined by Dr Neil Gray, a geologist with Scottish C oal, who was to be our guide for the excursion. He started by giving us some background information about the site. Until the late 1960s there was deep mining in the area with open cast mining starting just after the Second World War. However this was only shallow mining until the mid-1970s when they were able to work much deeper due to the introduction of better machinery.

Overview of the site showing part of the landscaping in the distance.

Allison Drummond

Scottish Coal started to develop the site at St Ninians in 1998.The mine is part of the Fife Earth Project and Scottish

Coal have been working with Professor Charles Jencks, the world renowned land artist, to transform the reclaimed land into a landscaped work of art with a loch in the shape of a map of Scotland as its centrepiece, and it is hoped that when finished it will become a major tourist attraction. We then set off in several vehicles to a vantage point where we got a panoramic view of the site.

The major fault which runs east/west through the site.

Allison Drummond

The coal being mined here is from the Limestone Coal Group Sequence which has over twenty named seams and the basin showed all the seams in the sequence. The present seam being worked is the Lochgelly Splint. There is a major fault running east to west through the site and the geology is further complicated by a syncline with the axis dipping to the south steepening up as you go down the sequence. In addition there is a dolerite sill which was full of serpentinite veins which made it difficult to work but it was being quarried for use as aggregate.

We then drove down to the coal face to examine the area in more detail. Cycles of sandstone/mudstone, coal and seatearth and were clearly visible. The coal seams varied in thickness from 0.5 m to 2 m and during extraction the coal, in the middle of the seam, was taken straight for use while the ceiling and floor (seatearth) of each seam was sent to a barrel washing process which extracted the remainder of the available coal.

Example of fossilised plant rootlet.

Allison Drummond

Seatearth is a palaeosol, i.e. soil of past geological ages and can often contain fossilised plant rootlets. Several members of our group did find examples of plant

remains. In addition Dr Chris Burton found examples of coal from four different named seams. These were the Swallowdrum, the Lower Jersey, the Upper Jersey and the Kelty Main. After we had finished our examination of the coal face we returned to the site office where we were shown a fossilised tree trunk which had been found at the site. Dr Gray was then thanked for giving us a very interesting insight into the workings of the mine.

As the geology excursion was now over it was suggested that as a bonus we should detour to Bo'ness to see the Steam Railway. Here we had a very pleasant afternoon with several members of our group actually going on the train. We then returned to Glasgow having had a most enjoyable day.

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FOSSIL GROVE, GLASGOW : Thursday 2 Sept 2010
Leader : Dr Iain Allison
Report by : *Barbara Balfour* Participants : 16

We all assembled at the Victorian building housing the Fossil Grove, and Dr Iain Allison, our leader for the evening explained about the discovery, geology and the future of the Fossil Grove. Fossil Grove was discovered in 1887 when workmen landscaping a disused quarry on the park boundary, part of the new Victoria Park opened in July of that year. The quarry had been worked for dolerite or whinstone used locally for road making. The dolerite had been removed in places to reveal the underlying sandstone and shale, but it was the men landscaping the area that noticed the tops of the fossil trees and with careful excavation the rock around the trees was removed. Fortunately it was realised that this was an important geological site and after being temporarily covered to protect the site from the Scottish weather, a permanent building was built and opened to the public only three years after the Grove's discovery.

In the Lower Carboniferous period, the area which is now Glasgow was enjoying a hot, wet and steamy tropical climate. Vast forests of primitive trees grew in steamy swamps. It was in such conditions that the trees, now fossilised in the Fossil Grove, grew about 330 Ma. These great forests would eventually give rise to the many coal seams underlying the city. There are eleven fossilised tree stumps and their main roots, with a large section of fallen trunk and several fragments of branch, preserved in their original positions. The trees were lycopod trees with scale-like markings on the surface of the bark, of the genus *Lepidodendron*, related to upland club mosses, and would have stood approximately 40 metres high. These were shallow rooting trees with a small number of major roots, *Stigmaria*, spread out widely and almost horizontally to anchor the plant. The trunk divided initially into four roots at its base and each of these usually divided only twice to form the main network. This is known as a bifurcate root system. The trees were possibly killed off by either being permanently flooded with storms breaking the trunks or by a catastrophic flood where levees were breached causing sand and mud to cover the forests. As these types of trees were soft internally, like the present day Japanese knotwood or elder, the fossil stumps and log we see are internal moulds. At the same

time as the stumps were being buried with the deposition of sand, the sand was being washed into the rotted hollow stump and roots, forming the fossils we see today. The stumps were then preserved within layers of sandstone and shale.

On the left hand side, looking from the viewing platform in the Fossil Grove building, are finely laminated silty shales and fine sandstones at the level of the tree stumps. Directly below the platform is a thin layer of dolerite, part of the intrusion into the sandstone. There are also some ripple marks in the sandstone, which may have been caused by either marine or fluvial water action.

A model of Fossil Grove showing a fallen trunk, stumps and roots.

Barbara Balfour

About 40 million years after the death of the Fossil Grove trees, in the Upper Carboniferous, there was volcanic activity in the area. As a result a quartz dolerite sill intruded the sandstone and shale. The main part of the intrusion formed the walls of the quarry and lies above the fossil bed. Other offshoots forced their way between the sediments at a lower level and one of these forms some of the floor of the Grove under the fossils.

The Fossil Grove. Shale and sandstone to the left of the fossilised tree stumps and their roots.

Barbara Balfour

Our group then moved out of the Victorian building housing the Fossil Grove to examine the surrounding area of the disused quarry. We descended some steps and passed through a passageway cut into the quartz dolerite about 6 metres in height. Moving a few more steps down to what at one time had been a landscaped fishpond, now rather overgrown with weeds, we examined medium grained igneous rock displaying onion weathering. Adjacent to

this was a fine grained chilled margin, evidence of contact between the intrusive quartz dolerite sill and the country rock of sandstone. There was also some shale and sandstone exposed at the western end of the fishpond. The height from the chilled margin area to the level of the fossil trees was about four metres which gave an insight into a cross section of the area.

The fine grained, chilled margin, between the intruded dolerite sill and the sandstone.

Barbara Balfour

We are so fortunate that Glasgow City has looked after these fossils for over a hundred years when conservation was in its earliest days. The Fossil Grove is really a remarkable asset to the city and the significance of it has been recognised through its designation as a Site of Special Scientific Interest, although this does not include the disused quarry area. Several bodies work enthusiastically to preserve, enhance and promote the Fossil Grove. If you haven't visited then perhaps you might think about visiting sometime in the future. It's a Glasgow gem.

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SOLWAY: Friday 1 – Sunday 3 October 2010
Leader : Dr Alan Gibbs
Report by : *David Hollis* Participants : 15

The North Solway Fault: a study in fault architecture

The purpose of this visit was to gain an understanding of the development of the Solway Basin by means of observing the geological formations at four locations. The formations which were observed could be interpreted in terms of closure of the Iapetus Ocean between the two continents Avalonia and Laurentia, in which subduction to the south of the suture led to formation of the Solway Basin, and volcanic activity in the region covered by the present Lake District of England. Subsequent spreading and subsidence led to the formation and later filling of the Solway Basin. Some geological formations demonstrate later recompression during closure of the Solway Basin. Most of the group arrived on the Friday night and a few arrived on the Saturday morning; we were based at the Douglas Arms Hotel, Castle Douglas. The study area is covered by O.S. Landranger 84, and O.S. Explorer 313. It extended from Balcary Bay (NX 82-48-) to Rockcliffe (NX 85-53-), and further northeast to Powillimont (NX 89-56-), and Southwick (NX 92-56-). Figure 1 is a

sketch map of the area, which shows the locations of the sites, and the approximate position of the North Solway Fault.

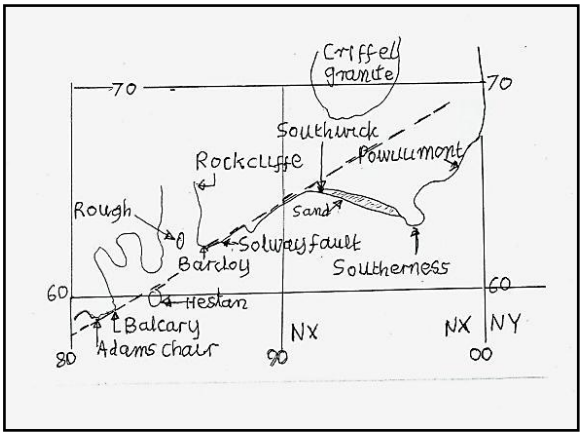

Figure 1. The various localities.

David Hollis

Saturday 2nd Oct

After a hearty breakfast, the leader, Dr Alan Gibbs, gave the group a brief outline of the proceedings for the weekend. He outlined the strike of the North Solway Fault. It follows a generally east-north-east direction, which forms the coastline in the vicinity of Balcary Bay (Airds Point to Balcary Point), and continues through a step northwards to Barcloy Hill (NX 85-52-) and "Lot's Wife" (NX 910558). Thereafter, it forms the southern edge of the hills to the northwest of the main A710 road to New Abbey.

Dr Gibbs directed the group to the car park at Balcary Bay (NX 820494). From there we walked to the old lifeboat station (now a private house) close to another cliff formation also known as "Lot's Wife" (NX 825485). Although the major structural features of the area trend west-south-west to east-north-east, a complementary set of faults follows trends north-south, and east-west. One of these forms the fissure down which the former lifeboat was launched from the station into the sea. The proximity of the Solway Fault was demonstrated by the high ground behind the former lifeboat station. One of the north-south faults was demonstrated by the presence of breccia in the fissure directly at the lifeboat launch ramp. At that same location, the "country rock" (Silurian deep sea turbidite) was evident. The more agile members of the party walked along a cliff path southwest to a cove known as "Adam's Chair" (NX 822485). There, it was possible to observe the nearshore conglomerates, the far shore sandstones, and, at low tide, the deeper water limestones of the evolving Solway Basin. After some intermittent rain, the group retreated to the car park for lunch, to escape a heavy downpour!

Bearing in mind the weather forecast for Sunday, our leader decided to go on Saturday afternoon, to Powillimont, on the Solway coast. The purpose was to examine the area offshore of the Solway Fault. The Solway Fault lies northwest of Powillimont, about 4 km inland of the present coastline, such that the rocks exposed at the present coastline give evidence of the evolution of the deeper waters of the Solway Basin. At Powillimont, there is a gently sloping present day wavecut shoreline, which reveals a remarkable fold structure, plunging east at 20^0. This feature is interpreted as evidence of later compression, after subsidence had ceased. These strata contain such estuarine features as thin coal seams, mudstones with worm

burrows, and bryophyte clusters. Further northeast along the beach is a large sandstone ridge. Dr Gibbs explained that this feature originated from an offshore sand bar, from which sand had been wind-blown inland. The palaeowind direction was deduced by Dr Gibbs by looking at some of the foresets and cross-bedding of the sandstone.

The Arundian-Holkerian (Dinantian) estuarine strata at Powillimont, showing the compressional fold.

David Hollis

Furthermore, the strata were tilted. To obtain the original orientation of the strata, a palaeo vertical feature was required. To obtain this calibration, Dr Gibbs found a perfectly formed sand volcano, which, at the present day, leans southeast by about 20^0. Bearing in mind the present day tilt of the sand volcano and the orientation of the foresets, the conclusion was that the wind which formed these drifts of sand came from a (present day) direction of southwest. To study the development of the basin as subsidence continued, the more intrepid members of the group disappeared north eastwards along the coastline in search of a fault near the "Grey House" at Arbigland (NX 995570). Here, the throw of that fault brings up deeper strata of the basin, such that the later evolution of the offshore features of the Solway Basin is revealed. Members of the group found fossils typical of a shallow tropical sea of the Dinantian Carboniferous period. These included *Lithostrotion* corals, Productid shellfish, and the broken stems of "Derbyshire screws" (crinoid worm stems). Further intermittent rain caused a return to the hotel.

Later that evening, the group attended the "Ten o'clock lecture" in which Dr Gibbs explained some of the latest computer based mapping techniques performed by his company for the commercial world. Modern computer capacity and speed, and the development of 3D graphic displays, together with onboard computer based GPS location, allow direct plotting of field discoveries and notes onto maps of the area being studied while in the field. Many problems associated with conventional mapping, such as trying to write on soggy paper, and the mistakes in location and ambiguities typical of field notes, can be eliminated. Furthermore, the result of a day's work can be transmitted direct to headquarters for recording and evaluation. The group thanked Dr Gibbs for an interesting talk, and went to bed.

Sunday3rd Oct

We visited Rockcliffe and several objectives were pursued. First, we climbed Barcloy Hill (NX 85-52-), to allow views of the continuation of the North Solway Fault from Balcary Bay to Barcloy Hill, and further northeast of Barcloy Hill). From Barcloy Hill, a steep path leads down to a bay known as Gutcher's Isle. There the North Solway Fault forms a near vertical cliff feature which extends towards Powillimont. The photograph below can only give a partial impression of this feature, which is several hundred feet high. A wavecut platform was revealed by a low tide that afternoon. Several interesting features were observed.

The Solway Fault seen from Barcloy Hill, looking east north east.

David Hollis

A conglomerate mass was found near the cliff base. Further away from the cliff, and somewhat further northeast, the limestone facies was found again. In a number of places, copper minerals which had been altered by reaction with seawater gave a blue colour to the quartz veins. It is conjectured, but not yet conclusively proved, that these veins, and others observed later that day, are all related to circulation of fluids into north-south tensional fissures which are associated with the opening of the Solway Basin. A further, more far reached conjecture would relate these ore deposits to those in the north of the Isle of Man, and those of the Creetown district of South Scotland.

On the return from Barcloy Hill and its near environs, time was spent on the beach between Barcloy Hill and Rockcliffe. Here, porphyry intrusions enter Silurian greywackes and fill tensional (extension) faults which formed during the subduction period. The pink colour of these intrusions contrasted remarkably with the blue and grey colour of the greywackes, even in the rather damp weather which existed during the day. There are only a few places where the contact metamorphic grade has risen as high as the chlorite facies. Although many of the porphyry intrusions showed crystalline features, some of the porphyries were of a uniform red colour indicative of fast cooling which suppressed crystal formation. These same pieces showed later quartz veins, possibly caused by reheating and "sweating out" of excess silica into later tension cracks. It was interesting to see two or three water rounded and transported boulders (of the typical black speckled white granite of the Dalbeattie area) crossed by veins of the pink porphyry. It seems that the porphyry intrusions were formed during a late event in the emplacement of the granite. The shore at

Rockcliffe showed clear lineaments of these intrusions. Back-projection of these lineaments north eastwards leads to an area just south of Dalbeattie, from which the white granite has been quarried over many centuries.

The view along Rockcliffe Bay shows the west-south-west strike of the porphyry intrusions

David Hollis

Folding of the greywackes gave evidence of the later compressional forces associated with closure of the basin. Dr Gibbs explained these to the group.

On Sunday afternoon, a final visit was made to more of the north-south trending ore veins. Near Southwick Church (NX 925571), on the seaward side of the A710 road, a wide track leads to the shore. This was the site of investigations in the 1950's by the precursor of the present B.G.S. into the radioactive constituents of the porphyry intrusions which exist there. The group went down the track through a Pleistocene sea arch to a boggy area, and turned back toward the former (Pleistocene) cliff line**.** There, a large number of broken pieces of porphyry contained black particles of radioactive material. Dr Gibbs explained that these were a glassy form of uranium sulphate which had probably been formed as crystals in the porphyry, but had subsequently been disordered as a result of the radioactivity of the uranium. A test with a Geiger counter gave a count rate about three times that which one would experience in Glasgow. The group hastily departed. Then a short discussion ensued, about the many and various sources of nuclear radiation to which we human beings are subject, including our own bones, our partner!, a five hour high altitude aircraft flight to the U.S.A., and an x-ray at the hospital. The conclusion was that, in spite of all these possible sources of radioactivity, the human race is still here, so we are all right! As a final gesture, Dr Gibbs kindly invited us to his family home (a former mediaeval tower house). Some members immediately returned to Glasgow; others went to see work in progress at the tower, and continue informal discussions.

We all wish to thank David McCulloch for making the arrangements for this visit, the staff of the Douglas Arms, Castle Douglas for giving us a pleasant and well-fed stay, and, above all, Dr Gibbs for preparing an excellent set of notes in the form of a spiral bound handout, and giving lucid and patient explanations to our endless questions.

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GENERAL INFORMATION

Scottish Geological Societies-ConocoPhillips Awards.
These were awarded to pupils from

Ullapool High School	Int. L 1
Langholm Academy, Dumfriesshire	Int. L 2
Alness Academy l	Higher

Scottish Festival of Geology. 1st to 30th September 2010.
Our Society held a highly successful one day interactive display in the Glasgow Science Centre, on 4th Sept. The BGS Open Day was on Sat 25th Sept. Details of various events across Scotland were available on the website: www.scottishgeology.com

Expedition Funding.
A grant of £500 was given to each of Meriel Young, a sixth year pupil at Dundee High School, and Tim Hunter, a gap year student between school and University from Ayr, to help fund a BSES expedition to Svalbard, with the usual proviso that they give a presentation at the following Members' Night.

INTIMATIONS

With regret we record the passing of

Dr Aled L. Evans, member since Session 120 (1977 – 78), who died on 9th Nov 2009.

Mr Charles Leslie, 1929 – 2010. Member since Session 132 (1989 – 90), who died on 6th April 2010.

Charles was a keen and enthusiastic member of the Society for 20 years, and was on Council continuously for the last fourteen of these, contributing enormously to the organisation and operation of the Society. He seldom missed a lecture, took a very active part in all the excursions and was a regular contributor to Members' Night.

Charles was born and grew up in Aberdeen. His secondary school career coincided with the war years and he once recounted a story of having been caught in the Aberdeen Blitz at the age of 13, when he had to dive for cover in the street. He completed a degree in Electrical Engineering at Aberdeen University in 1949 before joining the RAF Education Branch to serve his National Service. He then obtained an Honours Degree from Aberdeen University in 1952, and subsequently became a Graduate Apprentice, employed first by Marconi Wireless Telegraph in Chelmsford and then Marconi Research Laboratories, Great Baddow in Essex, where he worked on the development of television transmitter aerials, including the installation and tuning of the first STV transmitter at Blackhill, Lanarkshire. It was during this time that he married Cynthia, and he pursued his love of music by joining the local choir. He returned to Scotland in May 1959 as Production Engineer at Honeywell Control Systems, Newhouse, where he was involved, particularly, in the means of the efficient use of energy. He obtained a Diploma of Management at evening classes in Strathclyde University, becoming a member of the British Institute of Management, and then lectured on parts of that course for two years. He began a favourite pastime of playing golf when he joined Shotts Golf Club, enjoying the open air, and this he continued for many years. Charles travelled widely across Europe on Honeywell business, and to their headquarters at Minneapolis. Restructuring by Honeywell led to his early retirement in Sept 1987.

In February 1988 he took up an appointment as Administrator at Glasgow University Department of Adult and Continuing Education (DACE) where he came into contact with members of the Geology Department. Having always had an interest in the subject, he furthered this at DACE classes, progressing to the Certificate Course in Geology and the Environment, and then to membership of the Geological Society of Glasgow. With a flair for photography, he found plenty of subject matter in the field trips and enjoyed printing and cataloguing his results. While at DACE he learned to swim at the nearby pool – a practice he regretted not having undertaken when young. He continued regular swimming for the rest of his

time, having previously given up golf, and he continued with his love of music, becoming a patron of the Monkland's Light Opera Group. He retired in 1994.

Charles was initially an Ordinary Member of Council before taking over as Proceedings Editor for two years. Many will remember him as Membership Secretary, a post he held for five years, before becoming a Vice President and latterly an Ordinary Member again. He also stepped in for a time to help with the organisation of the summer excursion programme. He was generous, and wise, with his advice on all aspects of Society business and his ability to help out in whichever task was paramount. Recently, with the scanning of past issues of the Scottish Journal of Geology into the Lyell Collection, he did excellent work in compiling the data for a quality assurance check on the final product, a role suited to his meticulous attention to detail. If Charles did it you knew it would be complete and accurate.

Charles was an enthusiastic and faithful member from the beginning (2003) of the newly formed Strathclyde RIGS Group (now Strathclyde Geoconservation). He was continually involved in suggesting sites, assessing their geodiversity, producing trail leaflets, and setting up procedures for this promotional and educative role of the Society. He could see the use of a spread-sheet for anything!

Charles had a boundless knowledge of and enthusiasm for geology. He made careful and precise recordings of all the information delivered by our experienced excursion leaders, and his thorough transcriptions were offered freely to those of us who had been detailed to write the report and whose notes were sparse! He was renowned for his unfailing attendance at DACE geology courses where he gathered in new members to the Society, for the manner in which he encouraged some of us to do 'service', and above all for his friendliness, both on lecture nights and on excursions. As Membership Secretary and Council member he knew all existing members and quickly persuaded many newcomers to join, introducing them to the Society. Many of us would not be active in the Society without his encouragement and continued nurturing of our involvement in various sections. He was a man who persevered and eventually you just could not say no to him!! He was also renowned, and not least, for his photographic record of nearly all the Society's excursions – mostly of great rocks but also of members enjoying themselves, in good weather…….and wet!

Charles will be sadly missed for all these things – both on a personal level and for his contribution to the role of the Society in general. He truly helped to make it a very sociable and supportive place. Our condolences are extended to his wife Cynthia, his two sons, and two daughters-in-law and to his four grandchildren.

Margaret Donnelly, Seonaid Leishman

Front cover photograph – Vertical and Inclined Columnar Jointing on Preshal More, near Talisker Bay, Skye. *(Margaret Donnelly)*

Edited by M. Donnelly,. Published by the Geological Society of Glasgow, c/o School of Geographical and Earth Sciences, Gregory Building, University of Glasgow, G12 8QQ. www.geologyglasgow.org.uk/. **I.S.S.N. 0141 1839**

Printed by **Pandaprint**, 104 Park Road, Rosyth, Fifr, KY11 2JL. Tel: 01383 411863 www.panda-print.co.uk. October 2012.