PROCEEDINGS OF

THE GEOLOGICAL SOCIETY

OF GLASGOW

Happy geologists exploring Knapdale in the sunshine. *Bill Gray*

Session 158 **2015-2016**

SESSION 158(2015-2016)

SESSION158 (2015-2016)

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Editors, Scottish Journal of Geology	Dr. Colin Braithwaite
	Dr. Brian Bell
Ordinary Members	Dr. David Brown
	Mr. Bob Diamond
	Dr. Walter Semple
	Miss Margaret Donnelly

President's report session 158

This time last year, I was coming to the end of a term as Meetings Secretary stretching back to last century. At Council in October, retiring President Brian Bell said, "You'll have nothing to do now, Jim. How about taking over as President?" It seemed so easy, and at the December AGM, that was it.

Things began happening straight away. An article in SJG by John Dewey and three others about the Neoproterozoic to Devonian evolution of Scotland had caused a considerable amount of unhappiness because it made no reference to the considerable contributions of the late Brian Bluck. Various discussions led to Chris Burton writing a formal letter of complaint to SJG, with full Council support. This, and a reply from Dewey will be in the next issue of the journal.

Another matter, namely Fossil Grove, which had been a source of concern for some time, became more serious because of the state of the building and of the fossils themselves following a significant period of neglect by Glasgow City Council. Council member Walter Semple took an interest in this matter, got himself elected to the Fossil 12

Grove Trust (FGT) and has got things moving during 2016, now being Chairman of FGT. David Webster has also become a trustee and other GSG people, including Margaret Greene, Alan Owen and Simon Cuthbert have also been active in trying to get the Fossil Grove into a satisfactory condition.

The Society's activities have continued in a vigorous manner with a variety of lectures – including one from the retiring Meetings Secretary on 25 years of meetings and lectures. The new person in the job – David Webster – has settled straight into the job and come up with an excellent programme for Session 159. There were various day and weekend excursions, including a memorable one in June when Chris Burton and Jim MacDonald led a group to Garabal Hill near the head of Loch Lomond on a day of beautiful weather.

It is reasonable to report that the Geological Society of Glasgow is in good shape and its members are looking forward to another successful year. I would like to thank members for supporting the Society again this session by attending lectures and field trips and I would also like to thank Council members for their efforts and out-going officers for their service.

Jim Morrison

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Membership Secretary's Report

At end Session 158(30 Sep 2016)		At end Session 157(30 Sep 2015)
Honorary Members	6	4
Ordinary Members	248	269
Associate Members	65	68
Junior Members	15	13
TOTAL Members	**334**	**356**

New Members	21	20
Memberships Closed	43	17

There was a higher number of memberships closed (memberships are closed either by resignation, non-payment of fees or death) than in Session 157. Resignations were higher than normal as were memberships closed due to long term non-payment of fees following the increase in fees in Session 156/157.
Overall membership numbers at the end of Session 158 were lower than in the previous Session 157 as a result. The new members joining rate in Session 158 was little lower than the long term average but higher than in Session 157.

Robin Painter

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Library Report

The Library continues to be used as a source of a wide range of books, memoirs, guides and journals for a small but dedicated group of regular users.
Loans:
This session 10 users recorded 49 loans over a very wide range of subjects as
16
follows: Excursion Guides: 20, Regional/National Geologies: 7, History of Geology: 3, Stratigraphy/Structure: 4, Mineralogy/Igneous/Metamorphic: 2, Other: 13 (including GGS Proceedings, Geomorphology Journals, etc.). This range not only shows the wide interests of members but also our library's extensive coverage - especially of geological excursion guides, many of which are not electronically available. The library is open from 7-7.30 pm on meeting nights and is well worth a visit!
Acquisitions:
A relatively small number of acquisitions have been received to date, notably a comprehensive set of volumes on the geology of Antarctica, as well as new maps from BGS.University Library.
Not all members may be aware that, on the production of their membership cards, they have access to the University Library, where they may borrow up to 20 volumes (any subject). The geological collections themselves are extensive, with world coverage.

Chris Burton

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Scottish Journal of Geology: Editors' Report

This has been a difficult year for the SJG. Members will already be aware that issue 52/1 was slim and regrettably 52/2 will be the same. Although our readership has risen dramatically as a result of our exposure in both the Lyell Collection and Geoscience

World (Steven Brusette's paper on trackways had 2351 readers in a matter of days!), and our impact value is now a respectable 0.87, formidable barriers remain. Not least among these is the shift in emphasis of how the performance of professionals is measured in universities and other institutions. Members of staff are advised (!) that only papers in high impact journals will count towards their assessment. This tenet is 17
apparently applied across the board and as a result we are ignored by staff and our offers of mentoring for students wishing to publish remain ignored. Apart from our specific problems, the fear is that this will result in a loss to science because papers that might otherwise be suitable for publication in SJG and similar journals will remain unwritten. A substantial number of papers published in recent years have been by retired persons who thankfully cannot be influenced in this way. We are grateful for their contributions but remind readers that we are also open to submissions from others. Geology is prominent among sciences where amateurs can become experts, but where are the papers?
The composition of the Board has changed dramatically in the last year. Robert Duck retired at the end of last year, after many years of service, and has been replaced by Martin Kirkbride (University of Dundee); Alan Stevenson has also retired, again after long service, and is replaced by Heather Stewart (BGS Edinburgh); Brendean Macgabhan has stepped down and we are currently seeking a palaeontological replacement. Finally, Sally Oberst, who has provided sterling service as our Production Editor at the Geological Society Publishing House, has resigned and is replaced by Patricia Pantoş. Fortunately this did not all happen at once.
The next year, 2017, promises to be challenging.

Colin Braithwaite

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Publication Report session

The bookshop has had another busy year. The new publications offered this session included the Geological .Excursion Guide to Stirling and Perth area, Photographic guide to Shetland's Geology, 2016 Lochaber Calendars and, at the end of the session, The Geology of Eigg. The Guide to Stirling and Perth and the Calendars sold out completely. Online orders for the Guides to Gigha and Madeira continued keep me busy. More than 30 Madeira Guides have been sold by mail and the Gigha Guides have sold out. Our overall profit for the year was a little over £400.

Mina Cummings

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Website Report for Session 158

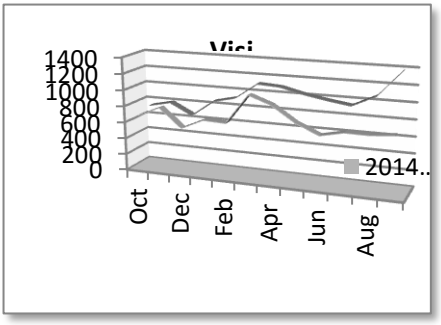
During Session 158, many new items were added to the website. The most significant of these was a new section devoted to displaying material from the society's archive. This section presently contains three main pages.
The Anniversaries page contains extracts from the society's proceedings at 25 year intervals from 150 years ago until 25 years ago, and will be updated every year.

The second page is devoted to James Croll, a Scottish geologist who published an astronomical theory of climate change in 1864, 60 years before the more famous Milutin Milankovitch published his very similar theory. Croll held the post of janitor at the Andersonian College and Museum in Glasgow from 1859 until 1867, and a paper on climate change was presented to the society on his behalf in 1866.

The third page is devoted to Arthur Holmes, an eminent English geologist of the 20th century, who, like Croll, was a man ahead of his time. Influenced by Wegener's hypothesis of continental drift, he developed a model that explained how mantle convection could lead to the breaking up of continents. This model was very similar to the concept of seafloor spreading developed 35 years later in the 1960s as part of the theory of plate tectonics. Holmes' first presentation of his ideas on mantle convection was to the Geological Society of Glasgow in January 1928, and the Arthur Holmes page contains a summary of his lecture, taken from the original account in the society's minute book.

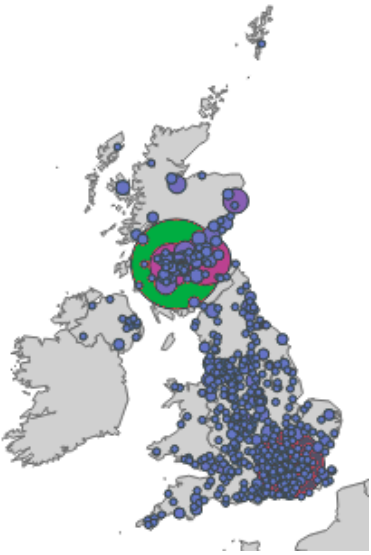
The material in the Archive section was prepared by the society's former honorary archivist, Seonaid Leishman (Arthur Holmes page) and the present honorary archivist Margaret Anderson. I am grateful to them for all their work, and look forward to many riches to come.

The traffic to the website has increased steadily since the website was launched in January 2011. In Session 158 there were 11590 visits to the site, an increase of 30.1% over the total for the previous session (8911). The number of visitors, as opposed to visits, was 8867, an increase of 36.5% over the previous session's total (6494). The chart shows the number of visitors each month for Sessions 158 (2015-2016) and 157 (2014-2015).



The increase in visits reflects increased traffic both from the UK and from abroad. The number of visits from the UK increased from 6317 in Session 157 to 7664. Outside the UK, the three most productive countries were the USA with 948 visits (389 in the previous session), the Philippines with 762 (not in top ten in Session 157) and India with 229 (88). Within the UK, Scotland accounted for 4373 visits (3768 in Session 157),

England for 2880 (2394), Wales for 103 (83) and Northern Ireland for 79 (66).



The map shows the amount of traffic from cities within the UK. Glasgow was the most productive city, with 1728 visits (1773 in the previous session), followed by London with 970 (899) and Edinburgh with 503 (581).

Apart from the homepage, the most popular pages were the Rock-forming Minerals page (5.3% of pageviews), the Local Rocks page (3.4%) and the Excursions page (3.4%). The Lectures, Scottish Fossils, Metamorphic Rocks and Membership pages all had 2% or more of pageviews. By far the most productive source of traffic to the website was Google, which was responsible for 7293 visits (4779 in the previous session), but the next most productive was direct logons to the website, which produced 2153 (1922) visits.

Bing produced 416 (253) visits and Yahoo 154 (167). The majority of the remaining visits resulted from referrals from other websites.

The most productive source of referrals was the Edinburgh Geological Society website (104 this session compared to 100 last session), thecampsies.co.uk (80 compared to 25) and the Geological Society of London website (52 compared to 51). The referrals from visitscotland.com were dramatically down from the previous session, from 352 to 29, and those from Facebook were also down (from 83 to 46). The reasons for these reductions are not clear.

The society's Facebook page continues to prosper and additional posts of news and society events are regularly added to it. One news post reached over 1,000 visitors. Over half of the visitors to the page are under the age of 24 and about half come from the UK. With 886 likes, the Facebook posts are doing very well and will hopefully lead to the recruitment of new young members to the society. If you have a Facebook account, or use other social media, please "like" and forward any society posts that you find particularly interesting.

As Webmaster, I am responsible for the day-to-day running of the website. In this task I am assisted by four society members. Neil Clark (Web Consultant) and Emma Fairley (Website Coordinator) assist with the development of the site and look after the society's Facebook page. Maggie McCallum takes care of the Geoconservation section of the site and Maggie Donnelly chairs the website working group. I am grateful to all four for their enthusiastic support.

The website requires a continuing input of news items and event details to keep it fresh and topical. I am grateful to society members who have provided such material in the past and encourage all members to continue to send relevant articles and information to: web@gsocg.org

. **Bill Gray**

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STRATHCLYDE GEOCONSERVATION GROUP ANNUAL REPORT 2015-2016

Governance:
The office bearers have not changed and Margaret Greene remains chairperson, David Hamilton as Treasurer and Barbara Balfour as Secretary. Maggie McCallum is in charge of website matters and Margaret Anderson in charge of archives.
Usually about 8 to 10 members attend the meetings.
Leaflets/Booklets/Geology walks:
SGG leaflets continue to be distributed. Where copies are scarce, laminated copies have been dispersed in appropriate outlets. A new leaflet entitled "The Orchard Beds Geo Trail" has been printed and distributed. This leaflet was produced by East Renfrewshire Council in partnership with SGG. Work has begun on a new booklet which will be about the geology of the tombstones and the quarry in the Glasgow Necropolis.
Margaret Greene led two walks in September as part of the program for Glasgow Open Doors and also led another walk for approx. 20 members of The Geologists' Association of London on Monday 3rd October utilising the Building Stones of Glasgow booklet. The latter donated £20 to SGG funds. SGG are also considering the future of linking leaflets to mobile phones and tentative steps have been made towards this. SGG leaflets are now available on the GSG website thanks to Bill Gray.
Local Authority Liaison:
SGG continue to work with Councils of East Dunbartonshire, West Dunbartonshire, South Ayrshire, North Lanarkshire (ably assisted by SGG members, Paul Carter and Mike Browne), in South Lanarkshire with the Clyde and Avon Valleys Landscape Partnership and in North Ayrshire with the North Ayrshire Landscape Partnership Group. This work entails help with Local Geodiversity Action Plans, help and advice with the geology associated with proposed trails and preservation of sites etc., and liaising with Councils re. identifying sites for inclusion in Local Development Plans.
Field Trips:
In July some SGG members visited Douglas Muir Quarry on the outskirts of Milngavie. One of our members, Campbell Fleming, who works closely in an environmental capacity with Tarmac, the owner, showed the group around with emphasis on new exposures. Tarmac is interested in having a board explaining the geology to which the SGG would be asked to contribute ideas.
Outreach:
Margaret Greene and Paul Carter continue to attend events where children especially may be introduced to geology. Margaret Greene continues to keep SGG members informed of proceedings at the Executive Committee meetings of the Scottish Geodiversity Forum including the Charter Working Group and other members attend meetings and workshops where possible.
Finances:
The SGG Treasurer reported that at 30th September, the end of the financial year the SGG funds stood at £222.
Archives:
Margaret Anderson, SGG archivist, has now archived all documents that had been passed to her and these are available to Geology Society members Fossil Grove:

SGG have been active in raising awareness about the state of FG. In April a working party cleared a lot of leaf debris from the side of the FG building and also cleared some of the overgrown part of the quarry.

Margaret Greene

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Geoconservation: Argyll and the Islands; Annual report 2015-2016

Due to illness there is not a lot to report for this year, however, the Oban U3A Geology group is back up and running again after a temporary cessation.
See
http://u3asites.org.uk/oban/page/2155

Alastair Fleming

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Proceedings editor's report

The proceedings for session 157 were distributed in good time. My thanks to those who produced the trip reports given the very wet conditions experienced on most days. Very few photos were produced because of the weather but I managed to find suitable images online and have credited the sources. I was also given permission to use a photo posted by the North Clyde Archaeological Society who had been on a field trip to the same area, the Rosneath Peninsula, on a better day

Mina Cummings

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Treasurer's report

More members are now paying our increased subscription. Some paid twice and were refunded. Subscription income is up. Gift Aid continues to make a substantial contribution to our funds. We continue to encourage members to sign Gift Aid forms for us.
We have been unable to progress on the Conoco-Philips prize which had been awarded to the most outstanding candidates in the Scottish Higher exam. This exam is now withdrawn and we seek an alternative use for this fund.
Following the death of Dr. Brian Bluck we have taken custody of the residue of his research fund to finance nineteen annual prizes of £500 to the best final year student.
The publishing costs for the Moine Guide were shared on a 50%/25%/25% basis between the National Museums of Scotland and the Geological Societies of Edinburgh and Glasgow who own the distributed stock in these proportions and pooled profits are shared accordingly. We have sold one copy. Stock reporting has always been unreliable and this year we have received no information from the new Edinburgh Society treasurer who should coordinate this information. Our publication sales returned a profit as below

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In House Publication	
Closing Stock 157	3889.53
Stock Revaluation Add	112.89
Opening Stock 158	4002.42
Add publications Purchased	206.00
Stock available for sale	4208.42
Deduct Closing stock at 30/9/16	3473.50
Stock assumed sold	734.92
Receipts	1197.88
Gross Profit	462.96
Deduct expenses	48.81
Net Profit	414.15

Room Hire for lectures is now agreed at this level for the next two years with minor increases in janitorial fees.
This year we received no requests for sponsorship. Suitable publicity might be appropriate.
This year there was no subscription to Paleontology. We paid £245 for Volume 58 in December 2014.
The increase in current market valuation of our investments by £10637 above the previous (cautious) valuation of £38355 for the Balance Sheet of September 2015 is sufficient despite these days of volatile markets for the Balance Sheet valuation to be increased at this time. I would suggest increasing it by roughly half of the current apparent under valuation to £44,000. This revaluation of £5645is entered on the Balance Sheet so as not to confuse it with genuine income.

THE GEOLOGICAL SOCIETY OF GLASGOW

Income and Expenditure Account for year ending 30th September 2016

			Session 158 2015 - 2016		Session 157 2014 - 2015	
Income	Note 1					
1. Subscriptions						
Received during year less refund			7386.74		7023	
Deduct paid in advance this year			-241.67		-93	
Deduct refunds			-110.00			
Add received in advance last year			92.50	7,127.57	120	7051
2. Investment Income						
Dividends			600.30		580	
National Savings			160.29	760.59	267	848
3. Gift aid	Note 2			1,196.06		1060
4. Conoco-Phillips prizes		ConocoPhillips 5yr contribution			0	
		Transfer from Conoco-pillips fund	0.00		150	
	Note 3	Edinburgh GS	0.00		83	
		Aberdeen GS	0.00	0.00	83	317
5. Received into Brian Bluck Fund	Note 4			9,500.00		
6. Publications	In house	net profit	414.15		573	
	Note 5	Stock revaluation	112.89	527.04		
	Moine Guide	net profit		14.40	74	647
7. Saturday excursions		net loss		-6.25		Profit 81
8. Week end excursions		Knappdale Profit	29.00			0
		N Ireland Loss	-1.62	27.38		
9. Donations (coffee collections)				227.30		227
Total income				**19,374.09**		**10827**
Expenditure						
1. Meetings incl speakers expenses, etc			576.90		626	
Meeting Secretary expenses			431.70		717	
Room Hire	Note 6		3698.88	4,707.48	3269	4612
2. Publication and postage of Proceedings				492.49		542
3. Strathclyde Geoconservation				0.00		100
4. Sponsorship	Note 7			0.00		1875
4. Library and Down to Earth	Note 8			215.00		455
5. Affiliation fees				90.00		90
6. Insurance				198.20		202
7. Conoco-Philips prizes				0.00		400
8. Brian Bluck Fund		Prize for 2016	500.00			
		Transferred to Reserved Fund	9000.00	9,500.00		
9. Website		Maintenance	360.00		384	
		Upgrade	62.38	422.38	1187	1571
10. Admin costs - postage, stationery, etc						
Hon Secretary expenses(Newsletter)			217.96		250	
Membership Secretary			513.16		711	
President & VP			40.15		0	
Treasurer			54.74	826.01	55	1016
11. Bank Charges				4.00		
Total expenditure				**16,455.56**		**11433**
Profit				**2,918.53**	**Deficit**	**-606**

THE GEOLOGICAL SOCIETY OF GLASGOW

Balance Sheet as at 30th September 2016

		Session 158 2015 - 2016		Session 157 2014 - 2015	
Members' Funds					
Balance as at 30/09/2015		**60,968.62**			
Add revaluation of Investments		**5,645.00**			
Add Surplus for the year		2,918.53		Loss 606	
Members Fund as at 30th September 2016			**69,532.15**		
Restricted Funds	TN George fund		380.00		380
	Brian Bluck fund		9,000.00		0
Note 3	ConocoPhillips fund		1,350.00		1350
Total Funds			**80,262.15**		
Represented by					
Current assets					
Cash at Bank					
Royal Bank of Scotland		15,542.22		4710	
National Savings		3,865.70	19,407.92	3705	8415
Cash in hand					
Publications sales officer		124.09		67	
Membership Secretary		586.84		0	
Hon Secretary		109.97		-372	
Meetings Secretary		112.05		0	
Treasurer		-56.77		-2	
Ordinary member/past Vice president		266.97	1,143.15	307	0
National Savings Income Bond		12,000.00		12000	
Current Valuation of investments	Note 9	44,000.00	56,000.00	38355	50355
Room Hire paid in advance			453.00		
Stock of Publications	In house		3,473.50		3890
	Moine Guide(pending further information)		131.25		131
		Total Assets	**80,608.82**		
LESS LIABILITIES					
Subscriptions paid in advance			241.67		
Debt for publications			105.00		
		Total Liabilities	**346.67**		
Net assets			**80,262.15**		62699

The financial statements were approved on ..... by the Trustees and signed on their behalf by

Signed as approved by the Trustees .....
President Dr J Morrison

Signed by the Independent Examiner
Dr Ian Anderson

Ben Brown

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Meetings Secretary's Report

Our first lecture of the session on the 8thOctober had Dr. John Mendum of the British Geological Survey giving us a fascinating insight into 'Problems of Highland geology, past and present'. He described the nature and origins of the major fold and thrust nappes that have been defined in the Highlands, ranging from the Moine Thrust Belt to the Highland Border, focusing at how such structures were recognised and defined. He discussed what mechanisms of generation and emplacement have been proposed, their consequences, and what problems still remain in their interpretation and finished it off with a enthusiastically-received 3D-demonstration of the possible evolution of the Tay Nappe involving audience participation and pieces of coloured carpet!

On the 12thNovember we awarded the T. Neville George Medal to Professor John Cope, of the National Museum of Wales. He then spoke on 'Redrawing the geological map of South Wales'. He explained that a keen Swansea extramural class in the mid-1970s had demanded more field-work. A geological mapping project was suggested, but had to be suitable for beginners and within an hour's drive. The area finally selected was south of Carmarthen where the 1-inch Geological Survey map showed Ordovician Arenig Series unconformably overlain by Old Red Sandstone. Both had several formations and there were also some Ordovician igneous rocks. Initial mapping of the basal ORS unconformity then progressed into the Ordovician outcrop, proving the Survey succession incorrect. A series of totally unexpected stratigraphical and structural results ensued together with many exciting new fossils. The lecture served to demonstrate that amateurs can really make valuable contributions to science.

Our retiring President Dr. Brian Bell, from the University of Glasgow, gave his presidential address after the brief AGM on the 10thDecember. His talk entitled 'Palaeogene magmatism in the British Isles: recent advances and current thinking' outlined the current understanding of the magmatism that occurred in the British Isles during the Palaeogene period. He used present field observations, together with geochemical and geophysical data, to explain the nature of the volcanic and intrusive activity in this spectacularly diverse magmatic province and set it in the wider context of the North Atlantic Igneous Province, which developed prior to and during the initial stages of ocean floor spreading.

Into 2016 and on the 14thJanuary another stalwart of the Society, Dr. Jim Morrison, who was the Meetings Secretary for 1990-2015, gave us an extremely entertaining personal review of the meetings and lectures which he has been involved in organising.
Jim has been Meetings Secretary for the Society for an unbelievable 25 years - a mammoth undertaking for which the Society is hugely indebted.

Professor Stephen Hesselbo, from the Cambourne School of Mines gave the Joint Celebrity Lecture on the 11thFebruary. Stephen is 'Mr. Jurassic' and he explained how the combination of traditional stratigraphy, increasingly sophisticated new geochemical methods and the generation of long continuous sedimentary records (such as the

Mochras borehole) is yielding new insights into the history of environmental change during the Jurassic 'greenhouse earth'. He placed a particular emphasis on the carbon cycle and the formation of black shales. We hope to ask him back when Mochras v2.0 is completed!

On the 10thMarch Dr. David Brown and team gave a very entertaining and informative account of the Glasgow University Tanzania Expedition visit to the East African Rift System in northern Tanzania and its spectacular geology. The purpose of the expedition was to teach both Glasgow and Dodoma students and local Masai people about the unique volcanology and tectonics of the area, and to promote future interaction between the two universities. The team focused on the geology of Embalulu Sekenge, a tuff ring that interacts with lavas and faults of the rift and visited the highly unusual carbonatite volcano, Ol Doinyo Lengai, where they witnessed an eruption. They outlined the inception and planning of the expedition, reported on their spectacular geological findings, and summarised the challenges and life-changing experiences they encountered.

The last lecture of the session was given by Professor Tim Lenton, of the University of Exeter on the 14th April entitled 'Revolutions that changed the Earth'. The talk traced the critical 'revolutions' in Earth history that have brought the planet to this point. The 'Inception Revolution', involved the origin of life some 3.7 billion years ago and the establishment of recycling ecosystems fueled by anoxygenic photosynthesis; The 'Oxygen Revolution', started by the origin of oxygenic photosynthesis some 2.7 billion years ago, culminated in the Great Oxidation of the Earth's atmosphere. The 'Complexity Revolution' started with the origin of eukaryotes and culminated in extreme glaciations and a Lesser Oxidation some 0.8-0.6 billion years ago. Tim explained that our planet is now in the midst of what might be a new revolution. A single species, namely our own, is in the process of transforming the planet. The Gaia hypothesis lives on!

Members' Night on the 12th May rounded off Session 158 in the usual fashion with several short presentations by members of the Society. Simon Cuthbert gave a talk on last year's 'Testimony of the Rocks' expedition which the Society and many generous individual Members supported. Walter Semple gave a short talk on Grand Canaria and Eve Gilmour spoke about her trip to Death Valley. Jim MacDonald's talk was entitled 'Hand me my Kalashnikov - some geological and mineralogical aspects of the Chernobyl catastrophe on its 30th anniversary'. Thank you to all the contributors for their input.

David Webster

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Lectures

8th October 2015

Dr. John Mendum, BGS Edinburgh

Problems of Highland geology, past and present

The application of tectonic concepts developed both in Scotland and different parts of the world has strongly influenced the interpretation of the geological structure of the Scottish Highlands for at least 170 years. Escher von der Linth first mapped thrusts and "overfolds" in 1841. Lapworth recognised cataclasis and mylonitisation along thrust planes in 1882-3, and Bertrand introduced "nappes de charriage" in 1884. Bailey, in a series of papers between 1910 and 1940, took alpine terminology and ideas as the basis for his tectonic interpretation of the Grampian Highlands. This talk will look at the nature and origins of the major fold and thrust nappes that have been defined in the Highlands, ranging from the Moine Thrust Belt to the Highland Border, focusing at how such structures were recognised and defined. It will discuss what mechanisms of generation and emplacement have been proposed, their consequences, and what problems still remain in their interpretation.

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12th November 2015

Professor John Cope, National Museum of Wales
T. Neville George Medal lecture

Redrawing the geological map of South Wales

A keen Swansea extramural class in the mid-1970s demanded more field-work. A geological mapping project was suggested, but had to be suitable for beginners and within an hour's drive. The area finally selected was south of Carmarthen where the 1 inch Geological Survey map showed Ordovician Arenig Series unconformably overlain by Old Red Sandstone. Both had several formations and there were also some Ordovician igneous rocks. Initial mapping of the basal ORS unconformity then progressed into the Ordovician outcrop, proving the Survey succession incorrect. A series of totally unexpected stratigraphical and structural results ensued together with many exciting new fossils.

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10th December 2015

AGM and lecture

Dr. Brian Bell, University of Glasgow

Presidential address: Palaeogene magmatism in the British Isles: recent advances and current thinking

I will outline our current understanding of the magmatism that occurred in the British Isles during the Palaeogene period. I will present field observations, together with geochemical and geophysical data, to explain the nature of the volcanic and intrusive activity in this spectacularly diverse magmatic province and set it in the wider context of the North Atlantic Igneous Province, which developed prior to and during the initial stages of ocean floor spreading.

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14th January 2016

Dr. Jim Morrison, GSG Meetings Secretary 1990-2015

A quarter century of society meetings and lectures (Sessions 133-157)

I will present a personal review of the quarter century of meetings and lectures in which I have been involved. This included Sessions 133 to 157 along with parts of Sessions 132 and 158. I will preface my comments on the lectures with some reflections on my own route into geology and my association with the society.

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11th February 2016

Professor Stephen Hesselbo, Cambourne School of Mines
Joint Celebrity Lecture with Edinburgh Geological Society

Rhythms of the Jurassic

The combination of traditional stratigraphy, increasingly sophisticated new geochemical methods and the generation of long continuous sedimentary records is yielding new insights into the history of environmental change during supposed "greenhouse" times in Earth history. In this lecture I will explore with new data the competing cyclic influences on Jurassic Earth history, with a particular emphasis on the carbon cycle and the formation of black shales.

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10th March 2016

Dr. David Brown, Dr. Daniel Koehn and students, University of Glasgow

The Glasgow University Tanzania expedition: the volcanology, tectonics and carbonatites of the East African Rift

The Glasgow University Tanzania Expedition comprised a team of Earth Science students and staff, together with students and staff from Dodoma University in Tanzania. In June 2015, this group visited the East African Rift System (EARS) in northern Tanzania to investigate its spectacular geology. The purpose of the expedition was to teach both Glasgow and Dodoma students and local Masai people about the unique volcanology and tectonics of the area, and to promote future interaction between the two universities. We focused on the geology of Embalulu Sekenge, a tuff ring that interacts with lavas and faults of the EARS, and visited the highly unusual carbonatite volcano, Ol Doinyo Lengai, where we witnessed an eruption. We will outline the inception and planning of the expedition, report on our spectacular geological findings, and summarise the challenges and life-changing experiences we encountered.

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14th April 2016

Professor Tim Lenton, University of Exeter

Revolution that made the Earth

Today, nearly four billion years after life first appeared on Earth, the planet hosts an abundance of complex life. Very recently, a new development – intelligence – has arisen. The varied and complex life on the planet today both maintains, and is supported by, fertile land and oceans and an oxygen-rich atmosphere. Life and the global environment have co-evolved such that neither would exist in its present form without the other. I will trace the critical "revolutions" in Earth history that have brought the planet to this point. They can be briefly summarised as:

1. The "Inception", involving the origin of life ~3.7 billion years ago and the establishment of recycling ecosystems fueled by anoxygenic photosynthesis;
2. The "Oxygen Revolution", started by the origin of oxygenic photosynthesis ~2.7 billion years ago and culminating in the Great Oxidation of the Earth's atmosphere;
3. The "Complexity Revolution", starting with the origin of eukaryotes and culminating in extreme glaciations and a Lesser Oxidation ~0.8-0.6 billion years ago

Our planet is now in the midst of what might be a new revolution. A single species, namely our own, is in the process of transforming the planet. But for the first time in the history of the Earth the agents of planetary change have a dawning collective awareness that they are

changing the world. We can't be sure if this will come to rank alongside the great revolutions that made the present Earth, not least because it is very much still underway. But the main preconditions for an Earth system revolution appear to be in place. The talk will address the question; what will it take for this to be a successful revolution?

12th May 2016
Members Night

Presentations were made by
. a) Simon Cuthbert who gave a talk on last year's 'Testimony of the Rocks' expedition which the Society and many generous individual Members supported.

b) Walter Semple who gave a short talk on Grand Canaria.

c) Eve Gilmour who spoke about her trip to Death Valley.

and finally

d) Jim MacDonald whose talk was entitled 'Hand me my Kalashnikov - some geological and mineralogical aspects of the Chernobyl catastrophe on its 30th anniversary'.
This was a very varied and interesting diet of presentations and was greatly enjoyed and appreciated by everyone.

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Excursions Secretaries Reports

Residential excursion report
This year started off with a residential weekend based in the Stag Hotel in Lochgilphead from 16th to 18th April. There were 20 participants including our leaders Dr. Iain Allison and Dr. Roger Anderton. We spent Saturday on the west side of Loch Sween in the Kilmory area. We followed this up with an excellent group meal at the Smiddy Bistro. On Sunday we drove along the east side of Loch Sween visiting structures along the western coast of the Tayvallich peninsula. Most of us enjoyed a bar meal in the hotel on Sunday night. On Monday we headed north examining the Quaternary geology in the Kilmartin, Ford, and Kilmichael Glassary area of mid-Argyll. Weather throughout the trip was on the good side for Scotland in April and an informative and enjoyable trip was had by all. Having four professional geologists on the trip meant that an interesting variety of explanations of the various features encountered gave plenty of food for thought. Many thanks to Eleanor Duncanson for arranging the meals and accommodation.
On 2nd September 10 participants and our leader Dr. Fiona Meade headed over to Warrenpoint in Northern Ireland for our second residential weekend. Some flew, some drove, most took the ferry but despite some acts of God delaying the journey, most met at lunchtime on Friday and visited the Silent Valley Park. The second day saw us all together to visit the Mourne intrusive complex followed by an excellent group meal

back at the Lough and Quay hotel. On day 3 we headed down to the republic and parked our cars at the partially mediaeval village of Carlingford, from where we ascended the lower slopes of Sieve Foye. We ended the day by taking the scenic drive through Slieve Guillion Forest Park up to the viewpoint which enabled us to comprehend the true size of the Slieve Gullion Ring Complex. Day 4 gave us the opportunity to visit the Cam Lough Quarry where several different rock types could all be seen in an easily accessible roadside location. Our thanks to Dr. Fiona Meade for providing a colourful ring bound excursion guide and also telling us about the many local legends which were an interesting alternative to the geological science information.

Roy Bryce

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Day Excursions report

The day excursions program started on June 11th with a visit to the Glasgow Museums Resource Centre in Darnley. The 12 participants made their own way to the centre. Many thanks to Ann Ainsworth for going above and beyond the call of duty to show our members some of the intriguing exhibits that are not usually on public display. Following such good feedback after the trip, I shall be organising a mid-week visit to the GMRC in 2017 for those who were unable to go on a Saturday.

The first day field trip was on 18th June when we took a coach to visit Garabal Hill and Glen Fyne by the bonnie banks of Loch Lomond. The 18 participants were led by Dr. Chris

Burton and Dr. Jim MacDonald. On a beautiful day we gently followed the Garabal Fault as we ascended the 485 metres to the top of Garabal Hill. At the end of the day Jim suggested that this may have been the last time he leads a field trip as he was finding it rather tiring. If this turns out to be the case, may I extend my deep felt thanks to Jim for all the time and effort he has spent over the years imparting his knowledge in such an enthusiastic fashion.

The second field trip was on 25th June and was a walk along the Berwickshire Coastal Path from Cove Harbour to Siccar Point. The 22 participants travelled by coach to Cove Harbour where we were joined by our colleagues from the Edinburgh Geological Society. The leader for the day was Angus Millar who did an excellent job of controlling the large party of c. 40 geo-enthusiasts. After Siccar Point both coaches returned to the rather excellent Mercat Grill in Musselburgh for a joint meal.

The third field trip was on 16th July to visit sites within the Queen Elizabeth Forest Park at Aberfoyle. The coach was rather empty as several of the 13 participants chose to go directly to the park visitor centre as it was closer to their homes than the Gregory Building! Dr. Iain Allison led us on a beautiful if strenuous walk along the Highland Boundary Fault to the Lime Crags Quarry and viewpoint. We then rejoined the coach and investigated an outcrop further up the Dukes Pass. Many thanks to Iain for his enthusiastic leadership.

Our final day field trip was a joint excursion with the Geologists Association on Sunday

2nd October to Balmaha. I initially baulked at agreeing this date since October storms are not rare, but we had the most marvellous weather for our English friends to enjoy the landscape and geological features. Plans for a joint dinner after the excursion had to be abandoned due to a Balmaha Festival, but everyone thanked Dr. Chris Burton and Dr. Simon Cuthbert for a grand day out.
As ever, could I also thank everybody who joined us on the excursions, without your participation we would not be able to make these trips happen.
On a final note, I am still struggling a little to get the best funding structure in place for the day trips – balancing whether people drive themselves or come on the bus, charging the correct amount then people dropping out at the last moment etc. To this end, it is my intention to ask for a £20 deposit for each excursion next year with the hope that I can then offer a small refund on the day rather than asking everyone for something extra on the bus. Hopefully everyone will be OK with that since the cost will still be the same as we always merely aim to break even on the cost of each trip

Roy Bryce

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Excursion Reports

Before we have the reports for session 158 I must, as promised, now deliver the report from Saturday morning 13th September 2014 at Banff which was missing from the session *156* proceedings .My apologies again to Liz Davenport and to the photographer Anne Burgess for the delay.

Session156
Tuesday 13 September 2014, morning session: Sandend West.
Reporter: Liz Davenport.
Objective: To examine rocks of the Appin Group (mostly).

The context of much of the morning was the Lochaber-Ballachulish subgroup transition, marked by a rapid change from calcareous semipelites and micaceous psammites to graphitic pelite and more pure finely banded limestones. This change can be observed extensively along the Dalradian outcrop though it may be noted that the Corriehabbie Quartzite is not exposed in this part of the s

Ben Browne standing on the Lochaber-Ballachulish subgroup transition, NJ 5548 6671 *Anne Burgess*

First locality: Garron Point (GPS NJ 553 669). We parked at NJ 555664, but the official car park is at NJ 554661. After scrambling down the succession over the beds of the Sandend Harbour Limestone (more on this below), we reached the narrow path to Garron Point. Here graphitic pelite passes into the lighter micaceous psammites and semipelites of the Garron Point Tremolitic Flag Member (of the Cairnfield Calcareous Flag Formation in the Lochaber Subgroup). On a group of small crags we searched for tremolite (an amphibole that is diagnostic of these units); here it takes the form of small pale grey laminae (3 to 4 mm long), difficult to detect on the cleavage surfaces of grey schistose pelites. On some crag faces we found barrel-shaped porphyroblasts (4 to 5 mm), possibly kyanite, interspersed with small garnets. The mineral source for these alumina-silicates was inferred to be a tropical soil washed into a gully. The tremolitic schists represent a major change in sedimentation at the junction of the Lochaber and Ballachulish Subgroups.

Second locality: Sandend Harbour Limestone Member (GPS: there would be a whole range because it's quite an extensive feature) of the Mortlach Graphitic Schist Formation of the Ballachulish Subgroup). Walking eastwards back up the succession we crossed interbedded cream to white metalimestone and graphitic pelite (dark grey to black, schistose and pyrite-bearing) beds of the Sandend Harbour Limestone Member. These steeply (ENE) dipping beds have been deformed into plunging folds with steep cleavage Photo 2); the bedding can be inferred from the lithology.

The Sandend Harbour Limestone Member with steeply (ENE) dipping beds, deformed into plunging folds with steep cleavage. *Anne Burgess*

An erratic Inchbae Granite boulder was spotted on our way to the east side of the harbour where we examined grey metalimestone and semipelite-pelite units showing open and tight folding and evidence for two stages of (F1 and F3) deformation (inferred from space and pressure cleavage and crenulation in impure limestones and pelites). The presumed context of deposition is marine transgression resulting in a relatively quiet lagoon environment; the carbon source for graphite is likely to have been algal or bacterial. These rocks are laterally equivalent to the Ballachulish Slate formation which has been dated at 659.6+/- 9.6Ma.

Third locality: path to the shore near Glenglassaugh Distillery (GPS NJ 5611 6586). Here we looked at flat-bedded basal Devonian conglomerate in a burn, and in a small cliff, overlain by till. This well-consolidated water-borne material was deposited at the edge of Lake Orcadie, a mid-Devonian vast inland sea, whose sediments are now lithified, and are extensively exposed in the North-East of Scotland from Shetland to the Banffshire coast.

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Residential Excursion to KNAPDALE:

Saturday 16th - Monday 18th April 2016
Leaders: Iain Allison & Roger Anderton Participants 20
Reports by: David Webster, Seonaid Leishman, Bill Gray

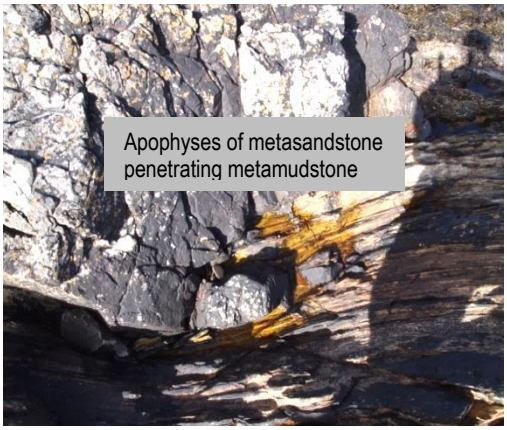
Saturday 16th April 2016
Report by David Webster

The entourage left the Stag Hotel in Lochgilphead in a fleet of cars. First stop was at Kilmory Chapel where Roger gave us a tour of the building stones and grave slabs inside. The geological interest was centred around the use of slabs of green schistose metabasite (which used to be called epidiorite) for lintels and the carved grave slabs. He noted that the use of the metabasite for building was supplanted by easier to work Carboniferous sandstone around 1840 so any building with green lintels would be older than that. However the main aim of the day was to make a traverse through part of the Late Neoproterozoic Dalradian succession, here comprising the Ardrishaig Phyllites and the overlying Crinan Grit Formations in the Kilmory Bay syncline. But before we got the see these rocks we had a brief stop to look at the coastal geomorphology.

Locality 1 [NR 70062 74200] Once on the coastal section Roger pointed out a 50m wide rock platform just above present sea level and a 10m high backing cliff. The same platform is found throughout this part of western Scotland and it is now believed that both the platform and the cliff were cut quite rapidly (maybe in 500 years) by intense periglacial freeze/thaw weathering during a brief cold spell at the time of the Loch Lomond Readvance about 11-10ka. This so-called 'Main Rock Platform' is slightly tilted by subsequent isostatic uplift, here it is a few metres above sea level whereas it is +13m near Oban to the NE and disappears below sea-level further SW in Islay.

Locality 2 [NR 70011 74038] At the small sandy bay called Port Ban we were asked to examine the sedimentary section in the Ardrishaig Phyllite Formation and discuss our findings. The main features here were an abrupt planar contact (striking about N30 and

dipping quite steeply NW) between laminated metamudstones with thin fine-grained metasandstones and a much thicker more massive metasandstone. The latter appeared to be about 3-4m thick and was overlain by more laminated brown and grey metamudstones, however, the top contact caused much puzzlement as it appeared to suddenly stop when traced laterally away from the centre of the locality and end abruptly at more sandstones. The overlying sequence of metamudstones was about 50-80 m or so thick, was quite deformed in many places and appeared to contain a number of discontinuous 'pods' of metasandstone maybe 2-5m thick and 10-20m in length. There were a number of necks of sandstone that appeared to connect the various sand bodies and on careful examination it could be seen that the base of the 'pods' were irregular, there were several examples of sandstone apophyses and - although shaped like a channel feature – it was better interpreted as an intrusive feature. Roger went on to explain that wet sand can behave like a fluid and can be injected into surrounding sediments in a similar way to igneous rocks.


Apophyses of metasandstone penetrating metamudstone

He thus interprets this sequence as a gigantic injection structure with all the pods connected by a series of feeder dykes from the main basal sandstone layer, which is now much thinned. He envisages the original sand body to be sand-bar comprised of quite well sorted sand which was buried by about 80-100m of mud and then fluidized by a major shock such as an earthquake which caused the liquid sand to inject rapidly upwards and outwards to form a series of interconnected dykes and irregular sill-like bodies in the overlying mudstone sequence.

Locality 3 [NR 70041 74340] We walked N for about 300m towards the sands of Kilmory Bay and on the S side of the bay came across an extensive area of interbedded metasandstones and metamudstones. The former were about 0.5 – 2m in thickness, f-m grained and showed some grading but were mostly quite featureless. They have been interpreted as turbidites and assigned to the Crinan Grit Formation. They represent much deeper water sedimentation, probably fault controlled. It is conceivable that the fault which produced the earthquake that caused all the dyke injection at Locality 1 was an active syn-depositional fault that was one of a series that resulted in the rapid basin deepening. The main feature of the locality was, however, some spectacular folding with a wavelength of several metres with some smaller-scale parasitic folding. The folds were generally markedly non-cylindrical and mainly plunged quite steeply NE. Ian explained that thicker more competent layers tend to buckle with a long wavelength and thinner interbedded less competent layers in the same area exhibit much shorter wavelength buckling. Ian drew a useful diagram for us which showed how bedding and cleavage are related in these types of folds and further explained that if the bedding and cleavage on a fold limb was 'Z'-shaped then the axial plane of an anticline was likely to be to the observers right and if 'S'-

shaped the anticline axis should be to the left. In the fold hinge the pattern would more likely be 'M' or 'W'-shaped as the cleavage became more axial planar. Many good examples of these shapes and configurations were found and we ended the stay at this locality with Ian leading a 'conga-line' along a 2m wide folded turbidite!

Ben examining one of the folds

Iain explaining the meaning of M, Z and S

Leading the conga line over a folded sandstone bed!

Locality 4 [NR 69683 74653] to [NR 69728 75128] We crossed the sandy bay (going over several fold axes forming the Kilmory Bay syncline) and for the next 500 m or so stopped in several places along the rock platform to examine the mainly SE dipping Crinan Grits on the NE limb of the Kilmory Bay syncline. Some more small-scale folds were encountered with spaced cleavage in the sandstones and tighter closer cleavage in the more mud-rich layers. Some interesting carbonate concretions were also found, mainly interpreted to be formed relatively soon after burial but some [NR 69673 74887] appeared to be synmetamorphic and demonstrating that the carbonate-rich metamorphic fluid must have flowed parallel to cleavage in the direction of maximum permeability.

These are quite common locally and have been mistaken for pre-historic ‘ring’ markings.

A 3m thick brown fine-grained unit which was sub-vertical and NE-SW trending was encountered [NR 69678 74994]. It had a persistent strike-parallel foliation and an apparent carbonate weathering appearance which was more intense along NW side. The central and SE parts had a more-spaced foliation and contained white crystals with the appearance of feldspar phenocrysts. It was thought to be an altered metabasite sill with its base on the more foliated side. Studies of these sills locally has revealed that the original pyroxene+plagioclase mineralogy was altered to amphibole + epidote + chlorite + albite during greenschist metamorphism and that in the parts of the sills (mainly the base) more exposed to infiltrating hot metamorphic fluids the amphibole and epidote were further broken down into quartz, calcite and more chlorite. The abundant chlorite is causing the foliation and the metamorphic calcite is weathering out. It is possible that the white feldspar crystals are albite porphyroblasts cored by remnant original igneous phenocrysts of more calcic plagioclase.

Locality 5 [NR 69778 75423] Another spectacular section in steeply dipping Crinan Grits.

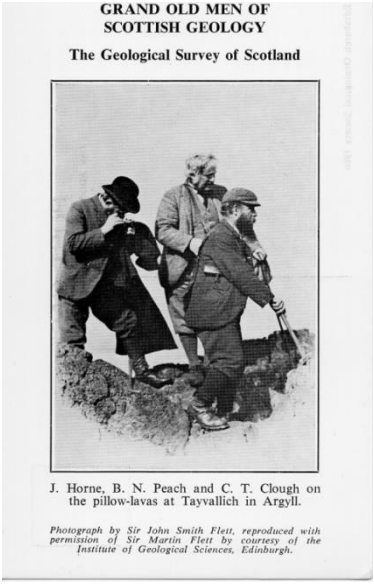
Locality 5: Channelised turbidites in the Crinan Grits

Here the metasandstones are much more conglomeratic and after careful examination we could see that several of the beds thickened along strike and that a channel-like base could be observed. The conglomeratic parts of the beds were better developed towards the axis of the channel body which was probably about 5-6m deep and typical of submarine fan systems like this one.

We then walked up and over the hill eastwards back to Kilmory and hence back to Lochgilphead where later that evening we all squeezed into the Smiddy Bistro for a fantastic meal and a well-earned drink or three.

Sunday 17th April 2016
Report by Seonaid Leishman

Kiells Peninsula


GRAND OLD MEN OF SCOTTISH GEOLOGY

The Geological Survey of Scotland

J. Horne, B. N. Peach and C. T. Clough on the pillow-lavas at Tayvallich in Argyll.

Photograph by Sir John Smith Flett, reproduced with permission of Sir Martin Flett by courtesy of the Institute of Geological Sciences, Edinburgh.

Today the plan is to study the top stratigraphical section of the Tayvallich subgroup exposed on the Tayvallich peninsula. It was on the west coast (An Aird) that Peach made the historic and important discovery of volcanics with pillow lavas when mapping for the Geological Survey in 1911.

Not only did these metabasites establish the sequence of the Argyll Group, but eventually assisted with dating the Dalradian. Throughout North Knapdale the metabasites and Crinan Grits form the higher ground.

We park in a small limestone quarry on the road alongside Linne Mhuirich where the rare grassland allows farming and settlements. At Barrahormid Farm (NR 716 838) we walk up the track heading for the western coast line and Port nan Clach Cruin. Just as we pass through a steep sided narrow passage in the top of one of the ridges of high ground, the farmer approaches and says he does not want such a big group on his land because of lambing. After some debate we reluctantly agree and return back to the road.

The change of plan is not a problem. Rubha na Cille at the southernmost tip of the Peninsula is full of interest. It lies on the steeply dipping/vertical NW limb of the Tayvallich syncline and contains historic geological exposures…., carved stones in the ancient Keills chapel…..evidence of sea floor spreading…. and the much debated Loch na Cille Boulder Bed. We are spoiled for choice.

Iain's diagrammatic Excursion Handout clearly identifies the different episodes of crustal stretching and thinning associated with opening of the Iapetus Ocean. The molten magma sometimes formed sills by hydraulic jacking up of soft sediment not yet lithified. This magma therefore never reached the surface. With mild metamorphism this became the Knapdale metabasite.

Having parked near Keilmore Chapel (NR 693 806) we walk south to the Main Rock Platform and start on the eastern shore of Rubha na Cille. By continuing SSW along strike we will be in the core and going up stratigraphy towards the nose of the syncline (To the west we will go down stratigraphy)

The first locality (NR 690 842) is black organic-rich micritic metalimestone with clear carious solution weathering. The gravel, sand and mud grains are clues to the origin of the sediment. The micrite pebbles are squashed and rotated perpendicular to the strain caused by shortening and extension. Some undeformed clasts indicate the original size of matrix grains.

Next stop is the famous Rhu na Cille 'boulder bed' (NR 687 799). The Scottish Journal of Geology Guide to the Dalradian Rocks of the South-west Highlands (published 1977) notes that the Survey suggested its origin as tectonic crushing or a conglomeratic mud-flow. Later proposals included dacite**,** porphorytic lava flow, hyaloclastic breccia or even tillite. The volcanics are accurately dated at 595-601 Ma. which does not match any tillite date. Roger intends to persuade us that …..

i) the total sequence fines up from volcano-clastic to ash to pillows.
ii) the feldspar crystals in this bed are important diagnostics. If they are fragmented they must have been *injected* at one stage.
iii) The 'boulder bed' is re-worked volcanic debris. It post-dates the actual volcanics so formed from material eroded *from* volcanics and washed in as ash or 'crystal tuff'. It is therefore a sediment.
iv) varied size of clasts could mean a moving flow in a delta.

At NR 688 799 kink folds are beautifully exposed in a sequence of metamudstones. Iain explains they are caused by buckling of one layer with a strong planar fabric in order to achieve shortening. Why only on this part of this layer? Local pressure means slippage and de-coupling of the other layers to allow shortening of the cleavage fabric. The shortening could have come from an igneous intrusion, evidence being a local lens-shaped (basaltic?) unit.

Kink Folds

Finally we arrive at the Pillows on the west coast of Rubha na Cille (NR 686 798)
I should explain here that on this trip we are being galvanised by a group of generous geologists! Not only Iain and Roger, but Brian Bell our past President, and Con Gillen lately of Edinburgh University. The debates and discussions are many and it is not possible to attend to them all!

Pillow with epidote

In the pillow field (we work out way- up because of their shape. The pillows have a curved top, a flatter base and sag into depressions giving a younging direction to the ESE. This confirms that the peninsula is on the NW limb of the Tayvallich syncline. Some show pillow rind – quenched glass (palagonite) – which also fills cavities. We find some good crystals of epidote exhibiting the typical pistachio green colour. Whereupon Iain produces a bag of nuts for us to munch! Epidote could be related to spilitic metasomatism (interaction with seawater resulting in Ca-plagioclase changing to albite and releasing Ca).

There is then a discussion between Roger and Brian (who have their heads on the pillows…). Was the eruption on the sea bed and into water OR injected into unconsolidated sediments – perhaps due to tectonics. Are we seeing hyaloclastite or peperite?

Heads down!

And the conclusion? Context is everything!

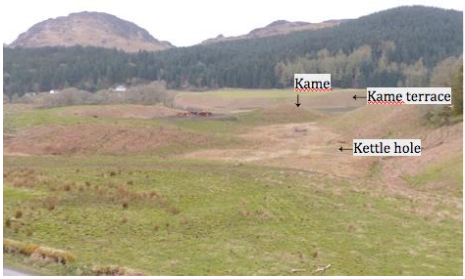
It has been cold and wet most of the day so we make our way to the shelter of the chapel at Keillmore via the peri-glacial Sea Stacks on the Main Rock Platform which had been a skerry at the time of the Loch Lomond Readvance 12 kya.

Monday 18th April 2016

Report by Bill Gray

Today saw a marked change in both our meteorological and geologic circumstances. In contrast to yesterday's cold and wet weather, we now enjoyed bright sunshine, albeit with a fresh west wind. Our geologic focus moved forward by 600 million years, from the Argyll group of the Dalradian to the late Pleistocene of the Quaternary. We had the privilege of spending our last morning doing a tour around several of the prime Quaternary localities in the Kilmartin area under the expert guidance of Roger Anderton.

We travelled between the various localities by car, using as few cars as possible. Our first stop was on the B840 just east of the village of Ford (grid reference NM 878 038). From a rise to the south of the road we had a marvellous panoramic view of kame and kettle topography, formed at around 12 ka, near the end of the last glacial of the Pleistocene (the Devensian). This locality is just to the west of the nose of Loch Awe, and we were again in the Loch Awe Syncline. We were near the terminus of the glacier that had filled Loch Awe, and the landforms that we saw were created as this glacier retreated. Roger described how, during the advance of the glacier, the direction of the ice flow was determined by the topography of the land surface. Of particular note was a kame terrace, a collapse structure formed from the moraine deposited against the sloping country rock at the margin of the ice sheet. This moraine collapsed when the ice that had formerly supported it melted. The kame and kettle moraine in this area is around 1 km thick.



Kame and kettle topography near Ford. *Bill Gray*

We now drove back westwards along the B840 to our next locality, passing some more kames and kettle holes, the latter now occupied by lochans, on our left (south). The second locality (NM 863 017) was a fluvial terrace adjacent to a minor road at Glennan, 2.5 km to the southwest of the first locality. We looked north to another kame and kettle vista, dominated by a lochan in the largest of the kettle holes. This point marked the southern extremity of the Loch Awe glacier, and the end of the kame and kettle topography. We were now introduced to the concept of a sandur, which is an Icelandic term for a glacial outwash plain. A sandur is formed beyond the terminal moraine of a glacier by sheets of sand and gravel carried by the meltwater pouring from the receding glacier. The land to

our left, all the way southwest to the sea, was basically a huge sandur. If sea level falls, rivers cut down through a sandur to form lower terraces. However, if the sea level rises, everything is filled in and terraces are obliterated. We would see evidence for progressively lower terraces later at Kilmartin. At the present stop we also visited a gravel bed beside a stream, which displayed ripple marks at the bottom and cross-bedding at the top. This bed was possibly formed when outwash from the retreating glacier filled a void beside the ice.

The view to the south from the car park at Kilmartin. The high terrace can be seen to the left, while the middle and lowest terraces are to the right. (The lowest has a cairn on it.) The flat area in the centre of the picture is the modern flood plain. *Bill Gray*

Our next stop was at the car park beside the museum at Kilmartin (NR 835 988), a further 3.5 km to the southwest. This is situated on the topmost of three terraces that were formed from glacial outwash towards the end of the Pleistocene. From here we had a glorious view to the southwest down Kilmartin Valley. This top terrace is a legacy of the sand and gravel sandur that originally filled the whole valley. The lower terraces were formed when the sea level fell in stages as the result of the isostatic rebound at the end of the Pleistocene. From our vantage point we could see both of the lower terraces and the present day flood plain below. The terraces slope by 5 m/ km towards the southwest, becoming horizontal at their southwest ends, which correspond to where the sandur plain reached sea level. The sand and gravel washed out from the valley as the lower terraces were formed were dumped downstream to create the extensive area of raised bog that now forms the Moine Mhor SSSI. The terraces were formed over a period spanning two millennia. The high terrace was formed at around 14 ka, when sea level was 36 m above the present level, and the lowest terrace was formed at 12 ka, when sea level was 9 m above the present level. The kame and kettle topography that we saw earlier and the main rock platform were also formed at this time.

The high terrace can be seen to the left, while the middle and lowest terraces are to the right. (The lowest has a cairn on it.) The flat area in the centre of the picture is the modern flood plain. *Bill Gray*

We now started making tracks back to Lochgilphead, but made three short stops on our way. The first was at Poltalloch (NR 816 966), where we had a brief look at a shingle ridge on the top terrace. The second was in Moine Mhor, where we had a brief chance to absorb the atmosphere of this special area before going on across the 13 m post-glacial raised beach, which was formed between 8 ka and 6 ka, to our final stop (NR 840 944). Here we stood on the raised beach, with the main rock platform (formed at 12 ka) 2 m below our feet, and looked across the A816 at a rock cliff formed at the same time as the rock platform.
We now returned to the Stag Hotel to join our cars for the journey home, full of the joys of spring and enthusiasm for the Dalradian, the Quaternary and the Knapdale area in general

Residential excursion to N.E Ireland

Exploring the Paleogene Volcanoes of NE Ireland.

Friday 2nd – Monday 5th Sept 2016.
Leader: Dr. Fiona Meade participants 10

Friday 2nd September
Report by Maggie Donnelly

Our group met up in the sunshine, outside the Lough and Quay Hotel, Warrenpoint at 1.30 pm. Unfortunately, our numbers were, at this stage, seven – one member had had to cancel, one's car had broken down in Belfast and two were still on the ferry having had to return to Cairnryan because of a sick passenger!!

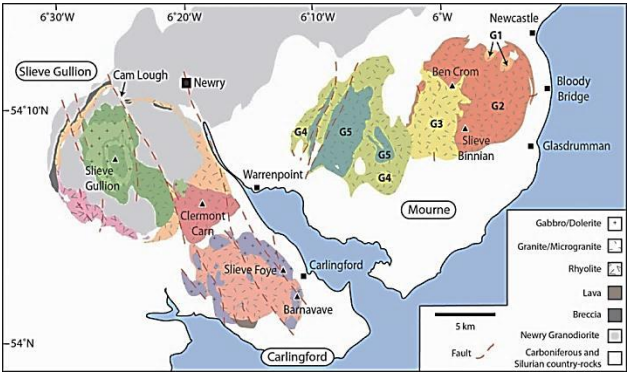


Figure 1. Geological map of the Mourne, Gullion and Carlingford igneous centres, after Cooper & Johnston in The Geology of Northern Ireland (2004)

Our leader, Dr Fiona Meade, gave us an introduction to the geology of the region from an excellent vantage point at the end of the pier. Across Carlingford Lough were the hills of the Carlingford Igneous Centre and the village of Carlingford tucked in by the shore, behind us to the east were the Mourne Mountains with a coastal plain stretching out at the base, and to the northwest lay the Slieve Gullion Ring Complex (Figure 1). We were in the 'Southern Uplands-Longford Down' terrane in which the country rock was Ordovician-Silurian – originally turbidites, accumulated on the floor of the Iapetus Ocean. Here they were more distal than in the Southern Uplands, and so much more finely

grained. As the Iapetus closed, the sediments had been compressed, tightly folded and metamorphosed to greenschist facies. The Iapetus suture lay about forty km to the south. Around 400 Ma the Newry granodiorite was emplaced.

During the Carboniferous Ireland lay on a shallow coastal shelf where the sediments were transformed into limestone. From our position we could clearly see this extending coastal slope which gave rise to the words of the song – 'where the mountains of Mourne sweep down to the sea'. About 65 Ma, a plume head impinged on the base of the Earth's crust, stretching it, producing volcanism, the North Atlantic Igneous Province and the opening of the Atlantic Ocean. Although the British and Irish Palaeogene Igneous Province lay at the south eastern edge of the NAIP, about 1000 km from the plume head, the thinned lithosphere of the Mesozoic Basins, aided by pre-existing crustal faults, directed magma migration. The central complexes arose at intersections of ancient Caledonian lineaments – terrane boundaries and the basement highs of the major Basins. Lava eruption began about 64 Ma (Skye, Antrim lava fields) from central igneous complexes in Skye, Carlingford, Mull and Rum, and waned about 58 Ma. A second phase took place around 56 Ma and the Mourne granites were intruded into the Carboniferous rocks. Magma sitting in large chambers at depth for long periods of time allows fractional crystallisation, but here the volcanism is known as 'bimodal' – basic and acidic intrusions/extrusions form, but very few that are intermediate (andesitic). It seems that a large amount of crustal melting occurred producing rocks rich in silica (granitoids).

The area was first mapped in 1925 by J. E. Richey[3] during his six week summer holiday. He identified five separate granite intrusions: G1 – G3 in the Eastern Mournes, G4, 5 in the West, and proposed a 'ring dyke' model, but this interpretation has now been revised by Stevenson (2007) using work by Hood[4] (1981) and Gibson[5] (1984) on grain size, mineralogy, petrology and his own work on mineral lineations. He suggested a laterally 'inflated laccolith model' in which the granites were intruded diagonally from the SE to higher crustal levels in the NW, as a series of individual sills, each underneath and 'jacking up' the preceding one(s), so that the oldest is at the top. The different granites can be identified by their contact zones, and by differences in their weathering and petrology.

We drove along the Mourne Coastal Route to Kilkeel, then to the Head Road for the Silent Valley and the gate of the park, J 3096 2046, where we collected detailed maps of the walking trails and sites of particular interest, before continuing up to a large car park near the café and visitors' centre. The latter had excellent displays concerning the geology, engineering works, flora and fauna of the Silent Valley – a perfect location from which to take in the 'big picture' of the Mourne granites. The Silent Valley reservoir was built in the early 20th Century to increase the water supply for the rapidly growing population and industry of Northern Ireland. An area of 9,000 acres in the Mourne Mountains (with high rainfall) was bought by Belfast Water Commissioners – now owned by Northern Ireland Water. Work to dam the Kilkeel River started in 1923, and the project completed in 1933. However, problems arose because the valley floor was covered in a thick layer of glacial deposits – large boulders had been mistaken for bedrock while in fact the base of G3 granite was at a much greater depth.

We continued the short distance to the Silent Valley reservoir and dam (Figure 2) where the scenery was stunning in the beautiful sunshine).

Slieve Binnian borders the eastern side of the reservoir, and high on its flank the boundary between the G2 (older) and G3 (younger) granites can clearly be seen. After taking several photos, we proceeded north about 600 m to the Slieve Binnian Tunnel, J 3090 2275, dug 3.6 km (1949 – 1952) through the Slieve Binnian granite to take water from the Annalong River in the adjacent valley, and so to increase the water supply (Figure 3).

Figure2. Silent Valley Reservoir, with the overflow spillway.
Margaret Greene

The tunnel was mapped before being concrete-lined revealing a host of minor intrusions, and suggesting that these many dykes are probably typical of the whole intrusive complex.

Continuing along the trail we arrived finally at the Ben Crom Dam, (J 3343 2546, 5 km from the park entrance) which towered majestically above us**.** We then had to climb up **'hundreds'** of **steep** steps to where we could walk along the road on the top of the dam – the view was spectacular! We resisted the temptation to head for the large quarry in G3, southeast of the dam, J 3126 2518, as it is now not easily accessible, the rock surfaces are no longer fresh, the floor is often water-filled and strewn with rock fall debris – in fact it is dangerous!

Figure 3. Slieve Binnian Tunnel.
Maggie Donnelly

Completed in 1957, the dam contains the reservoir between mountains which clearly display the contact between the G2 (older) and G3 (younger) granites along the western side (Figure 4). We ventured through the western gate on to the slope for a close look at the granite and to collect a few samples. After all this, we returned to the trail (finding our two members who had been delayed on the ferry!) and down to the café for a resume of what we had seen. To our disappointment, it was now past five o'clock and the café was closed!

We then set off westwards for about 400 m through trees and across open grassland to our final locality, the Mourne Wall, J 3012 2107. On the way we saw a beautiful glacial valley in the distance) and passed the site of 'Watertown' where the dam builders lived during its construction. We also experienced a completely different aspect and view of the Valley and Slieve Binnian. The Mourne Wall which encloses the Silent

Valley Park catchment, is up to 2.5 m high, about 1 m thick and 35 km long, and runs over 17 mountain peaks (Figure 5). Built of granite blocks, using the dry stone wall technique, between 1904 and 1922, it could be seen stretching off both north and southwards across the valley and up the precarious slopes of Slieve Binnian to the east. We reached a style and were able to climb onto the wall, taking numerous photos.
Finally, after a **really** good afternoon 'on the rocks', we made our way back to the cars, and back to the hotel for dinner, where we found our last missing member – we were now a completed party of 10 plus leader.

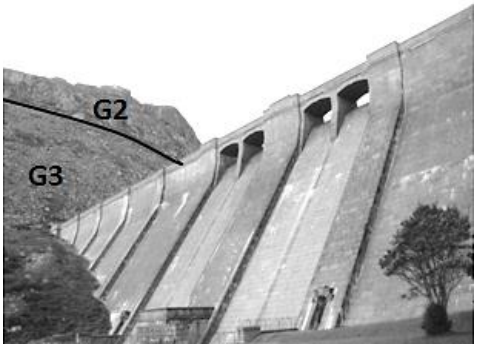


Figure 4. Ben Crom Dam and the two granites
Maggie Donnelly


Figure 5. The Mourne Wall.
Maggie Donnelly

<u>Sat 3rd Sept</u>
Report by: *Seonaid Leishman, Margaret & Phil Greene*
"Bouldering" and Regional metamorphism"

This morning we examined the effect of the Western Mourne granites on the surrounding country rock – the Longford-Down metasediments. The section is exposed in the Bloody Bridge River just south of Newcastle, so named after a massacre of the Irish Rebellion of 1841 when the river ran red. The route is known as the Brandy Path because it was used by smugglers taking goods from the coast up over the Mourne Mountains. Our very wet morning began on the beach examining the metamorphosed greywackes, the equivalent of the Southern Uplands Hawick Group.


'Bouldering' in the river.
Seonaid Leishman

The fine-grained siltstones and mudstones were laid down distally, far out in the Iapetus Ocean, from eroding island arcs, and so include volcanic minerals such as iron, colouring the weathered rock red. During closure of the Iapetus the rocks were metamorphosed to greenschist facies and folded isoclinally with a small dip striking NE – SW, producing green, grey and black layers.

On the river section several groups of young folk were 'bouldering', getting very wet, while we tried to keep at least our feet dry. Across river there was a section through glacial moraine, very poorly sorted with huge boulders so probably laid down as an outflow. We started to climb up through the metamorphic aureole, the result of the Mourne granite intrusion, which would have been at a temperature of 800^0 C. Here the contact is with G2. G2 is more fractionated than G1 and movement was from the SW so that younger granites were thrust under older. G1 through to G5 were emplaced over a 2Ma period. The plume head was situated beyond Skye so that the Mournes activity was on the edge, 1000 km from the centre. As a result, this volcanism could only have happened at terrane boundaries and where the crust is thinner. The layered metasediments began to show the effect of baking, converting to hornfels which is striped pale (quartz and carbonate) and dark (biotite rich). Near the edge of the aureole the granite is finer grained having cooled more quickly. It had little time to contract and so has no joints. Further up the mountain, in the middle of the intrusion, the granite stayed molten for longer allowing the crystals of feldspar, quartz and biotite to grow bigger. This coarse grained granite was quarried for Belfast cobbles. During intrusion, the hornfels would have become almost plastic and is crosscut by veins. Blocks have been fractured from the aureole, trapped in the magma and begun to melt. The granite is crosscut by tuffisite veins where fumaroles of gas, released by dehydration, focused on a zone, fracturing it and depositing material. When the country rock has organic content the gas will contain carbon dioxide and methane which in this case, could have contributed to the K – T extinction! It was still pouring with rain when we returned to the cars so a very pleasant lunch stop was made in the Galley café in Annalong!

Tuffisite vein
Seonaid Leishman

"Mixing and mingling" and the Glasdrumman composite cone-sheet.

After lunch we went down to the beach at Glasdrumman. It had stopped raining! The country-rock of Longford-Down metasediments is heavily folded like a rumpled carpet. Here it is cut by a cone sheet, one of a swarm related to the Western Mourne Centre. This is a form of dyke which intruded via an inward-dipping conical fracture. It is concentric to the granites and dips to north and west.

The cone sheet developed during an inflationary period and compares with the sills at Drumadoon and on Bute. It was the conduit for two types of intrusion. The margins of the dyke are basaltic and the centre quartz –feldspar rhyolite. Interestingly there are no internal chilled margins so both magmas must have been intruded at the same time, interacting during transport *and* once emplaced. The crystals of feldspar and quartz are rounded so they were not in equilibrium.

Heavily folded metasediments.
Seonaid Leishman

The hotter basalt on either side heats and lubricates the thicker more crystalline rhyolite in the centre, allowing it too to flow and produce magma mixing and mingling. This can result in an intermediate zone of darker hybridised rhyolite i.e. dacite. However, traversing south to north along the beach (this has to be at lowish tide) we saw many variations on this theme – basaltic enclaves in the rhyolite and vice versa, producing leopard-print rock. The lava lamp effect! There was also an occasional xenolith of the metasediment. At the northern end, the dyke narrowed and, as the flow rate was constant, the rhyolite and basalt are completely mixed due to turbulence. A dyke such as this may only have operated for a few days! What an amazing exposure and what an amazing day!!

Basalt and rhyolite mingling *Seonaid Leishman*

Our amazing leader *Seonaid Leishman*

Sun 4th Sept

Report by: Rhona Fraser

Carlingford Igneous Centre

Sunday's excursion to the Carlingford Igneous Centre required an hour's long drive via Newry and the crossing of the Irish border despite being only a mile across the water from Warrenpoint. Today's weather was wall to wall sunshine. Carlingford Igneous Centre, which is thought to represent the roots of a large central volcano active around 62 – 66 million years ago, consists of two main intrusions, a microgranite ring dyke with a gabbro infill (i.e. a lopolith if you are a proper geologist).

Figure 1. Metasediment and cone sheet contact at Carlingford. *Rhona Fraser*

Both of these intrusions are crosscut by swarms of basaltic cone sheets. The centre shows bimodal magmatism, typical of the North Atlantic Province with granite/rhyolite – gabbro/basalt and no rocks of intermediate composition. Our first locality was just before the bridge into Carlingford village and showed contact between the underlying Silurian Longford-Down meta-siltstone and the basaltic cone sheet (Figure 1 –ugh!!! A picture of me but it does show the contact). There was also a very attractive information board explaining the geology.

The main part of the day was climbing to the edge of the igneous centre via the well-marked Tain Way. The different geology of Slieve Foye was immediately obvious compared to the rounded granite Mourne Mountains as the Foye gabbro is extremely resistant to erosion and forms steep angular crags.

Figure 2. Slieve Foye and Tain Way. *Rhona Fraser*

Lunch was taken around the Slate Rock where in a very short distance we could see the local country rock which is the Carboniferous Carlingford limestone basal conglomerate (Figure 3), porphyritic basalt cone sheets (Figure 4) and the aureole between them (Figure 5)

Figure 3. Carboniferous Carlingford Limestone basal conglomerate. *Rhona Fraser*

Figure 4. Basalt cone sheet along the side of Slate Rock. *Rhona Fraser*

Figure 5. Hornfels basal conglomerate – compare with Figure 3. *Rhona Fraser*

Basaltic magma can be as hot as 1200^0 C, far hotter than granite, so when it is intruded into adjacent sedimentary rock such as the conglomerate, the latter starts to melt with siltstones forming hornfels and limestones marble. As the cone sheet intrudes it inflates, thus potentially cracking and deforming the local rock. The basaltic cone sheet which could be traced along the north slope of the hill consisted of varying amounts of plagioclase feldspar crystals in a basaltic groundmass. . At times the rock consisted of over 90% phenocrysts which would have made it too thick to flow (Figure 6).

Figure 6. Basalt of cone sheet-packed with phenocrysts. *Rhona Fraser*

Figure 7. Microgranite blocks with veining with gabbro on summit...and Maggie for scale!!!! *Rhona Fraser*

After lunch we continued up to the col between Slieve Foye and Barnavave where we reached the contact between the microgranite ring dyke and the overlying gabbro. After the Carlingford volcano ceased erupting about 59 million years ago the region remained geologically active for some time producing large strike slip faults across the area which formed clefts on the ridges. One such defile, our last locality, showed the contact between the knobbly gabbro on top and large blocks of micro granite beneath. The latter was often cut by microgranite veins, the theory being that these were formed by hotter and therefore more liquid parts of the intrusion.

After completion of this most enjoyable and hot day the only thing for it was ice creams back at Carlingford. Then, because some of the party were leaving us, Fiona was presented with a 'thank you' gift, and thanked profusely and most sincerely for leading us on such a fascinating and amazing field trip.

Mon 5th Sept

Report by: Muriel Alexander

Our final visit was to Slieve Gullion and the Slieve Gullion Ring Complex which lie to the west of the Mourne Granites and north of Carlingford. On the previous evening we had driven to Black Mountain and from the height of Clermont Cairn had viewed the spectacular scene of Slieve Gullion and the almost complete ring complex of low hills surrounding it. These were formed by the collapse and erosion of the volcano that was active in the Palaeocene, 60 Ma. Now we were setting off for a much closer view.

We drove on a traverse west through Newry and then on country roads until we turned into a car park on our right which overlooked Cam Lough, J0376 2411. From here Slieve Gullion towered above us across the loch and on looking northwards, we could identify a fault which formed the loch and valley in which we were standing. In the

distance this fault had cut the ring dyke and moved the edges dextrally about 2 km apart, almost NW to SE, on either side of the loch.

With fewer cars we returned a short distance to a quarry, J 0362 2458, where the ring dyke was well exposed, sliced through, and with the surrounding rock also exposed. The ring dyke was formed in the Palaeocene by the inflation, then collapse of the roof of the magma chamber under the volcano, causing magma to be forced up the cracks encircling it. We spent some time here identifying the lighter coloured microgranite of the ring dyke on the left, dipping outwards and arched over and the darker metamorphosed sedimentary rock into which the dyke had been intruded. The contact is known as the ring fault down which the rocks above the now empty magma chamber had collapsed. To the right on the quarry wall we found 400 Ma Devonian Newry granodiorite which is also seen in the low area between Slieve Gullion and the ring dyke. On the floor of the quarry some loose rock showed black tuffisite veins cutting through the microgranite. These were caused by gases escaping to the surface during intrusion. After much discussion and hunting around for the ideal specimens we returned to our cars.

Cam Lough Quarry. *Rhona Fraser*

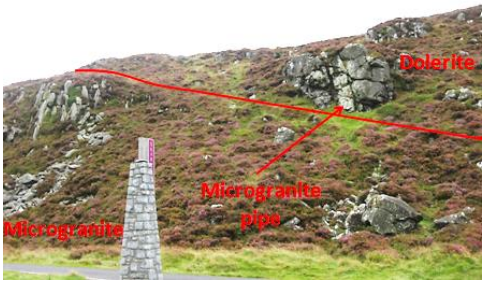
Cam Lough Quarry. *Maggie Donnelly*

The final location was the Slieve Gullion summit car park, J0181 2003. As we drove up the forest road we looked over at the microgranite of Black Mountain where we had stood the previous evening. This was produced towards the end of the volcanic activity and we again observed where the granodiorite is found on the low ground towards the ring complex. We then continued on to our last stop at the summit car park. Here on the hillside we saw at least two sloping bands of rock, the lower one being lighter grey and lumpy, a felsic microgranite, with a much darker, denser sheet of mafic gabbro above. This is the 'Central Layered Complex' which in total, is formed of thirteen layers – again a 'bimodal' model. A large mafic magma had been injected into the south western granodiorite of the Newry Igneous Complex during the Palaeocene. Fractionation of this basalt and melting of the surrounding granodiorite and metasedimentary crust would have produced more silicic melt. These mafic and felsic melts were then emplaced as alternating sheets, becoming dolerite and microgranite, to form the 'Central Layered Complex'. Lastly, there was a microgranite pipe, created where the less dense felsic

magma rose up through the partially solidified denser gabbro. A very interesting information board described this igneous activity.

Geology over, we now headed back down to the Forest Park Courtyard and gathered in the café where we enjoyed lunch and said a BIG THANK YOU to Fiona for spending time with us and for a really happy, interesting and thought provoking weekend.

Our group at the summit car park. *Rhona Fraser*



View at summit the car park. *Maggie Donnelly*

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Geology Collection at Glasgow Museums Resource Centre
Sat 11th June 2016
Leader: Ann Ainsworth, Curator of Geology Participants 10 Reporter: Maggie Donnelly

Ten of us met up at 10.30 am on a damp morning at the Glasgow Museums Resource Centre (a most impressive building), 200 Woodhead Road, South Nitshill Industrial Estate, Glasgow, G53 7NN, where we were met by our guide for the morning, Ann Ainsworth, Curator of Geology. Most museums can exhibit only a tiny proportion of their objects, and museum stores are rarely accessible to the public. With the current gallery space, only 2% of Glasgow's vast and varied collections can be displayed at any one time and as a result, GMRC is the store for the remainder of these collections (started in 1870). It is a vast building with 17 purpose-built and environmentally controlled storage 'pods' housing around 1.4 million objects. The main collections are Archaeology, Art and Painting, Arms and Armour, Natural History, Transport and Technology and World Cultures. Glasgow's store is exceptional in that it stores one of the finest museum collections in Europe and the public can explore it and its collections through a wide range of tours, talks and activities for all ages, including school visits and events for families with children. It is free to visit GMRC, but all visits must be booked in advance. http://www.glasgowlife.org.uk/museums/GMRC.

Our guide led us into a long narrow locker room where large bags and any food /drinks had to be left and which acted as an 'airlock' from the outside world. We exited by a second door at the far end and found ourselves in a **big** room, where the geology collection of 62,000 specimens, together with the botany and insect collections, are held. The room contained numerous rows of steel cabinets, each about 6 feet tall, and our interest lay in three of these rows at one end of the room. Each row was made up of eight cabinets which revealed, when opened, two columns of twenty-one trays. The geology collection is divided into four sections, and we started off with the **'minerals'** section with 8,000 specimens. We were shown a fascinating selection of native metals – platy copper and dendritic copper, chromium, gold, platinum, aluminium from Lochaber (1930), tungsten labelled 'Tungsten Ltd Glasgow' and sulphur, and also a number of metal ores many of which are Scottish:
Copper ores – chalcopyrite (copper sulphide with its characteristic blue iridescence) and red needles of bornite (a copper-iron sulphide)
Zinc blende and stibnite, an ore of antimony
Semi-precious gemstones – pale red spinel, known as false ruby, sapphire, a whole tray of agates, and several coloured and clear rock crystals (quartz)
A selection of fluorite specimens, whose crystals are octahedral, including banded blue and yellow Blue John (its name comes from the French 'bleu jaune'), as well as other banded purple, green and white samples.
Green malachite
Botryoidal (bunch of grapes or kidney-shaped) haematite which was shiny and with quartz
Many trays of calcite including 'Dog's tooth', stalactites and platy samples

Galena (lead ore) from Wanlockhead, Lead Hills, Southern Uplands and the Clyde Plateau Lavas
Smokey quartz from Cairngorm, actinolite (prismatic and dark blue) from Skye, and talc/soapstone
The samples were all labelled with a number, using the nationally recognised 'Hey's Catalogue of Minerals' in which they are ordered by chemical composition.

We then came to the **'rocks'** section with 4,000 specimens. This included Permian red sandstone, blonde sandstone from Giffnock, red sandstone with load casts, Rhynie chert with plant remains, Lochaline glass (made from a very pure sand of tiny fragments), pure basalt, amygdaloidal basalt, obsidian from Iceland, gneiss, gabbro, larvakite, shale with a cone in cone structure, several granites including grey Rubislaw, landscape marble and several limestones. Lastly there were a number of fulgarites, created when lightning strikes and penetrates a bed of sand causing the quartz to melt and then fuse.

The **'fossils'** section came next……and it was **huge** with some 50,000 specimens, many of them Scottish. There were 2,000 Devonian and Carboniferous fish, and our guide picked out some of the more interesting – a Carboniferous dorsal fin bone, very small fish embedded in Caithness flags, a 5 inch long Megaladon tooth from the Cretaceous of America (the Megaladon was a gigantic shark, similar to the great white but much bigger), lots of fish from southern England, a whole fish in shale/sandstone from Fife, Devonian fish with scales and fins from Orkney, a half jaw of a rhizodont with one 4 inch incisor plus a half an incisor and lots of very small teeth. The fossil bones were mostly of non-Scottish Jurassic fish, but there were also 200 non-fish vertebrates including the paddle bones of a Plesiosaur from Peterborough, East Yorkshire, rhinoceros teeth from North America, the tooth of a small horse (Eohippus, Eocene) and the big leg and foot bones of a Moa from New Zealand. Among the invertebrates were numerous, mostly Carboniferous, colonial and solitary corals, several of which were sliced and polished. At this point one of our group asked why all the labels were still handwritten, and not typed, and we were told that, in the interests of conservation, acid free ink and paper had to be used. There were abundant brachiopods (some giants and eight inches in diameter), a variety of graptolites, some coiled, from Dob's Lynn, and pieces of Orthocones (unusually long straight shells of a nautiloid cephalopod). There were also (mostly bits of) fossils of Euripteryd, a kind of Silurian sea scorpion, in shale, from the Southern Uplands, and – the best preserved – a whole body with claw, head and tail, from Lesmahagow. It seems that many of these would have been moults, and that all the animals came together to moult and to grow and harden a new shell. The Clyde Bed fossils, 13 -11,000 ka, contained various gastropods indicating the change from fresh, cold to warm, saline waters as the ice melted, as well as bivalves, barnacles, pearls, tiny sea urchins, starfish and echinoid spines. There were rare Carboniferous ammonites (nautiloids) from High Blantyre and a Productus with spines. We moved on to plants – a large number of Lepidodendron leaves and cones, in both 2D & 3D, stigmaria (the root system), seed ferns and horse tails (calamites). Eocene leaves from the Mull leaf bed included birch, beech, holly, gingko and magnolia, 50 Ma, found between the lava and ash beds. These, of course, are the same trees as those of the present day.

Lastly our guide led us to a display of '**rare minerals'** laid out on a table:
Strontianite, collected in the 1790's
Greenockite, collected in 1899, this is orange and formed in cold conditions in the River Clyde. There was also 'Lanarkite' and 'Lead Hillite'!
Ikanite – a calcite pseudomorph, a hydrated form of calcite. Dredged from the Clyde, it is an indicator of Snowball Earth
Azurite from the Lead Hills, garnets from Rosshire, topaz from the Cairngorms, Ailsa Craig riebeckite, kyanite, zircon, Iceland spar and barite.
There was a touch of 'Geo tourism' in the form of 'lava embedded with a coin' from Pompeii and a sample of Mt St Helen's ash, Carboniferous raindrops from the Campsies, a piece of limestone with tiny folds, graphic granite, deformed trilobites, jawless fish, an Elgin fish fin with its body, and a fish model made of clay. Finally, there was a fascinating box of replica famous historical diamonds such as the Koh-I-Noor, a set of crystal models demonstrating different crystal structures, a box of samples of the chemical elements from 1896, and an amazing slice of flexible sandstone from Massachusetts which our guide was able to flex up and down as if it were a wave! She explained that this was because of its unique porosity, due to the specific spaces between the quartz grains.

As we made our way to the exit, we were able to view several large specimens (up to a metre in diameter) of rocks and minerals (several of blue and green fluorite), and an iron meteorite from Namibia. Ann was then thanked most sincerely for a very interesting and entertaining tour.

Investigating the samples in a cabinet. *Photo by Hugh Leishman*

GGS excursion to The Berwickshire coastal Path, 9 Km from Cove Harbour to Siccar Point

Joint excursion of Glasgow Geological society with Edinburgh Geological Society
Saturday 25 June 2016
Leader Dr. Angus Miller
Report by David B. Hollis

Participants From Glasgow 20
From Edinburgh 20

The area of interest lies on the Berwickshire coast path south of Barns Ness lighthouse and Torr Cross nuclear power station, on O.S. Landranger sheet 67 : Duns and Dunbar, or O.S. Explorer sheet 346: Eymouth, and on and on B.G.S. 1:50000 sheet 34: Eymouth. The nomenclature used here is that which is still familiar to most of us. It was in current use until about year 2000. In a later revision of "Geology of Scotland", 4th edition, edited by N.H. Trewin, a more recent revision of nomenclature of geological strata, in use in recent works, is presented. A bibliography is included at the end of this report, for further reading.

About 20 G.G.S. members, and a similar number of E.G.S members met at Cove car park [O.S. NT 778 718]. We followed down the stratigraphic succession along the cliff path (the Berwickshire Way) from Lower Carboniferous sandstones of Cove Harbour, through the Old Red Devonian sandstones of Pease Bay, to the Devonian-Silurian unconformity at Siccar Point. [(O.S. NT 812 711]

We first visited cove Harbour [O.S. NT 788 718] to study Carboniferous sedimentary rocks. As a result of drag on the strata by the Cove Fault, the strata dip steeply to the sea. The beds consist of oxidised sandstones which show evidence of soil horizons (clay shale beds with plant fragments)
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Steeply dipping terrestrial sandstone at Cove Bay

Some "seed ferns" have been found at Cove Harbour; this indicates a terrestrial environment. Occasional incursions of the sea in Visean times gave marine sediments which contain pieces of Crinoids**.**

Marine and lagoonal beds at cove Harbour

But as our leader pointed out, well preserved fossils are rare in this locality. The general facies are those of river laid deltaic and lagoonal sediments. These beds are possible equivalents of the Ballagan Beds which exist north of Dumbarton near Glasgow. Alternatively, these beds are believed to correlate to the West Lothian Oil shale Beds. Indeed, on the north-west cliff of Cove Bay (best seen from Cove village), an oil shale bed does exist.

North-west cliff at Cove Bay

However, apart from a few shaly bands, the strata at Cove Harbour are almost free of oil shales**.**

We then returned to the cliff path to follow the coastal path southwards to Pease Bay. En-route, some discussion ensued about the exact boundary between Devonian and Lower Carboniferous rocks. On the beach below the cliffs, the strata dip seawards. The Devonian strata are closest to the cliffs, while the Carboniferous strata are further away. However, the boundary between the two was not easy to discern**.**

Dr. Miller discusses the Devonian-Carboniferous Unconformity

At Pease Bay [O.S. NT 795 710], we had lunch, before examining the Devonian sedimentary strata in the cliff at the north- west end of Pease Bay**.(P5)**

The north-west cliff at Pease Bay

Channels showing flow from north to south are incised into more or less flat beds which dip down seawards at about 30 degrees. One striking example of a channel had partly collapsed into the underlying strata

The channel had collapsed into the strata beneath it

The sea had eroded these, to form a cave beneath the sediments deposited within the channel. The strata into which the channels are incised, and which show flow from West to East-South East, consist of material which is sourced from the Caledonide Uplift. Bright red clasts, a few centimetres in size, of hard material, within the beds were noted. The formation of these nodules within the sandstone strata indicate periods of concretion and desiccation, with the formation of caliche and cornstone. Also noted were green "reduction spots" in numerous places. Indeed, one thin, green stratum could be traced over several tens of metres. Possible evidence of Aeolian wind-blown material was also considered. Crossed bedding and foresets, some of which were "beheaded" by subsequent erosion and overlay of later material, were evident**.**

The "beheaded" crossed bedding

All these features indicate periodic aerial and sub aqueous conditions, such as in flash floods, and formation of temporary wadis. Since few large clasts were found, the inference is that these beds are distal from the source of material.

The party continued along the cliff path to the Old Chapel [O.S. NT 804 697]. The view northwards towards Barns Ness (Torr Cross) lighthouse, showed the downward succession from the chimney of the cement works (marine carboniferous limestone workings) to the famous Barns Ness Carboniferous coral beds near the lighthouse. On the east side of the Torr Cross nuclear power station, Bass Rock (a Carboniferous basalt/phonolite plug dating from mid-Visean times) was visible. Just west of the power

station was visible the top of North Berwick Law, another Carboniferous basalt plug. Nearer at hand were the Carboniferous sandstones of cove Harbour. Closer still were visible the Devonian sandstones of Pease Bay. Again, en-route, the exact location of the boundary between the Upper Devonian and Lower Carboniferous was questioned.

Our final goal was Siccar Point [O.S. NT 813 710], which lies beyond the Old Chapel [O.S. NT 804 697]. Several of the party descended to the shore down the steep slope.

Descent to Siccar Point

All returned to the top safely. Others went inland a few hundred metres and then turned to the cliff edge, where a fine view of the South-east elevation of the unconformity is clearly visible

Southern aspect of Siccar Point

The near vertical grey Silurian marine turbidites are overlain by near horizontal sandstone beds. Pre Devonian earth movements, during the closure of the Iapetus Ocean, uplifted the Silurian sediments, and placed them in a near vertical position. Subsequent erosion, which removed any Devonian and lower Carboniferous beds (if these were ever deposited), resulted in a serrated land surface, in which the softer, more clay rich, Silurian beds were partly removed, giving clefts between the more resistant silica rich beds. The sandstones

directly above the Silurian beds contain fragments of the Silurian greywackes. That indicates erosion with subsequent redeposition, with continuity into the higher sandstone beds. The higher sandstone beds are of mid to upper Visean age. The dull, misty weather made the contrast between the overlying red Devonian rocks (which dip seawards) and the underlying nearly vertical grey Silurian strata less striking than it would have been on a sunny day**.**

We returned to the Siccar Point car park. The contrast between the red colour of the soils derived from weathering of the Devonian rocks in the fields near the top of the cliffs, and the pale ochre colour of the soils derived from the Silurian rocks near the Siccar Point car park is plainly apparent.

Our coaches took us to the Mercat restaurant near Musselburgh where, in company with our counterparts from Edinburgh, we enjoyed a high tea which consisted of a cooked meal followed by cakes and coffee. The two groups then said their goodbyes and went their separate ways.

A special mention should be made of a professor of geology from Northridge College, University of California, near Los Angeles in California- "Peggy", alias Martha Ahlstrom, who was touring around Scotland. She made a special effort to contact the Glasgow Geological Society so that she could visit the Siccar Point exposure. She took the trouble to descend to the beach, and take photographs which she will show to her students on return to America. We pointed out to her that the rocks of Scotland are "part of America", and that England (south of the Iapetus Suture) is "foreign"!

Finally, special thanks are due to the Edinburgh Geological Society for organising such an interesting visit, and their leader, Dr. Angus Miller, who gave erudite and succinct explanations of the geology, and answered our many questions.

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Excursion to Queen Elizabeth Forest Park
Saturday 16th July 2016

Leader Dr. Iain Allison Participants 15
Report by Roy Bryce

The coach that left from the Gregory Building was rather empty as several of the 13 participants chose to go directly to the park visitor centre as it was closer to their homes than the Gregory Building! We all congregated at the Lodge Forest Visitor Centre where we took advantage of the facilities and topped up our supplies before being given a brief introduction by Dr. Iain Allison.
The excursion largely followed the Red Trail on the Forestry Commission leaflet of walks from the lodge so allows good footing plus an opportunity for a family visit with the geologically interested parties spending time looking at the outcrops while the rest of the family enjoy the views. We started off with a walk through the trees of approximately one kilometer following the path along the Highland Boundary Fault to the Lime Crags Quarry. The quarry is around 100 metres to the south of the HBF and offers exposures of Lower Old Red Sandstone conglomerates, Ordovician limestones, serpentinite-limestone mixtures, serpentinite and a trace of the Gualann Fault. The quarrying work allows a clear visualisation of the different rock types. Care however needs to be taken when entering the quarry as there is a lot of loose rock underfoot.

Iain explained that the Old Red Sandstone is very resistant to weathering and so the HBF is marked by a line of hills from Conic Hill on Loch Lomond across to the hill we were standing on then on to Loch Venacher. The sandstone was formed from the detritus of very large rivers running down from the North East – possibly from Scandinavia since the cobbles are almost pure quartzite and contain no Highland (Dalriadian) rocks.

It can be seen that some of the cobbles would require a very large river to roll and shape the hard rock.

A further interesting feature of some of the clasts in the ORS is that they can be seen to have been faulted (broken in two) then re-cemented forming unusual shapes. We spent around an hour examining the various rock types. Con Gillan managed to find an outcrop of serpentinite on the left of the quarry. It was possible to see the veins where iron and calcite were being weathered out the rock.

We tried to find an outcrop of shale which had been uncovered during the initial quarrying excavations but it seemed likely that this has now been overgrown and is no longer exposed.
As the weather was at least dry, we decided to continue our walk up to the top of the hill to the old radio mast where we could enjoy the views of Ben Ledi, Ben Venue and Ben Lomond as well as the view south over the low-lying Flanders Moss and Carse of Stirling to the Campsie Fells beyond. A perfect spot for lunch.
We then descended the hill again on our way back to the visitor centre. Our eagle-eyed leader spotted an outcrop of slate in a drainage ditch by the side of the forestry path. As Iain said it is only by finding such small outcrops that geologists have been able to piece together a picture of the history of the rocks in the Aberfoyle area. We spent a short while in a hide hoping to spot some red squirrels but without any luck.
We then went back to the coach and travelled a couple of miles up to the Dukes Pass. We then crossed the moorland to an outcrop of a thick turbidite unit. We spent some time examining the bedding surfaces which were steeply dipping, with particle sizes coarsening up from pebbles to granules up to muds. Iain explained that on the cleavage we have a downward facing structure which is evidence for the famous Aberfoyle anticline.

We then returned to the coach and dropped off the members of our group who had travelled directly to the Lodge. Many thanks to Iain for his enthusiastic leadership

The remaining two reports have been unavoidably delayed and will be included in the proceedings at a later date.

Intimations

We regret the passing of

Margaret Orr - member from session 130 to 157(1988-2015) who died on 1st May 2016 Margaret Orr passed away peacefully on the 1st of May in the Renfrew Care Home, she was 90 years old. She was a staunch member of the Geological Society in the 1990s and completed the certificate course in the early 1990s and took part in many field trips run through the society and DACE at home and abroad

And also

Dr. Mike Golden – member from session 109 to157 (1968-2015) who died on 31st August 2015

Mr. Cyril Halsted- member from session 100 to 157(1959-2015) who died on approx.15th September 2015

Dr. Brian Finnie- member from session 146 to 158(2003-2016) who died on 3rd August 2016

Our group at the Slieve Gullion summit car park.
N.E Ireland *Rhona Fraser*

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