PROCEEDINGS OF

THE GEOLOGICAL SOCIETY OF GLASGOW

Our group beside the Kentallen information board. *Maggie Donnelly*

Session 159 **2016-2017**

SESSION 159(2016-2017)

SESSION159 (2016-2017)

Members of Council

President	Dr. J.M. Morrison
Vice Presidents	Dr. Brian Bell
	Dr. B. Browne
Secretary	Mr. W. Semple
Treasurer	Dr. Ben Browne
Membership Secretary	Dr. Robin Painter
Meetings Secretary	Mr. David Webster
Librarian	Dr. Chris J Burton
Assistant Librarian	Mrs. Margaret Anderson
Excursions Secretary (Day)	Mr. Roy Bryce
Excursions Secretary (Residential)	Ms. Maggie Donnelly
Minutes Secretary	Mrs. Margaret Greene
Junior Members' Representative	Mr. Mathew Staitis
Proceedings Editor	Mrs. Mina Cummings
Publications Officers	Mrs. Mina Cummings / Mr. Bob Diamond
Webmaster	Dr. Bill Gray
Web Consultant	Dr. Neil Clark
Website Coordinator	Miss Emma Fairley
Publicity (General)	Dr. Robin A Painter
Newsletter Coordinator	Mr. David Webster
Strathclyde Geoconservation Chair	Mrs. Margaret Greene
Argyll & Islands	Mr. Alistair Fleming
Editors, Scottish Journal of Geology	Dr. Colin Braithwaite
	Dr. Brian Bell
Ordinary Members	Dr. David Brown
	Mr. Campbell Forrest
	Dr. Simon Cuthbert
	Dr. Neil Clark
	Dr. Helen Kennedy
Independent Examiner	Dr. Ian Anderson

President's report session 159

During season 159 the Society's activities-lectures, excursions, Council meetings etc. have continued in a lively manner.
Our membership currently stands at 336 according to new Membership Secretary Campbell Forrest. Campbell is planning to obtain new software which will make the data more accessible. Warmest thanks are due to retiring Membership Secretary Robin Painter who has given 12 years of excellent service to the Society. Our present membership figure is sound because of Robin's sterling efforts to have a genuinely 'current' list.
On a retirement note, copious thanks are due to Dr. Chris Burton who is retiring as Society Librarian after an incredible 44 years in post. Chris has also been an almost inexhaustible fount of geological wisdom - fortunately we will not be losing that aspect of his many talents!
Our lectures have maintained their high standard and have been well attended and appreciated. Our speakers seem to enjoy their visits and the interaction with members at tea and coffee afterwards.
Some of the summer day excursions were not as well attended as usual, perhaps as a result of the indifferent 'summer' weather. In contrast those of us lucky enough to attend the second weekend excursion to Ardgour in May with Jim Blair of Lochaber Geopark experienced four days of perfect weather and some wonderful geology.
A 'one-of' event this year was on the investment front when the firm with whom we have dealt for some years informed us that our account was too small and they were stopping the service. Our financial sub-committee met several times to discuss this situation and come up with an alternative. This has now been implemented and should provide a better income with which we can support appropriate geological activities. Our treasurer, sensibly, ensured that we did not saddle his successors with annual decisions on investments. Thanks are due to Walter Semple and Robin Painter for supplying expertise and hard work which aided the decisions of the sub-committee.
I can report that the Geological Society of Glasgow is in healthy condition and its Council and members are looking forward to another successful session in 2017-2018.

Jim Morrison

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Membership Secretary's Report

At end Session 159(30 Sep 2017)		At end Session 158(30 Sep 2016)
Honorary Members	5	6
Ordinary Members	246	248
Associate Members	68	65
Junior Members	13	15
TOTAL Members	**332**	**334**
New Members	23	21
Memberships Closed	25	43

Overall membership numbers at the end of session 159 were little changed, as was the new member joining rate. The number of memberships closed (memberships are closed by resignation, non-payment of fees or death) in session 159 was almost in balance with the number of members joining

Robin Painter

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Library Report

Once again, the Library has provided a wide range of books, memoirs, journals and, above all, guides for our regular users. Loans this session ranged over topics as widespread as the geology of the Antarctic and, at the opposite end of the planet, the geology of Greenland, igneous geology -from the mantle upwards, and many guides to UK localities. The Library also has a comprehensive coverage of UK geological maps, including most Scottish sheets – these can be supplied by the Librarian on meeting nights between 7 and 7.30 pm.

Chris Burton

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Scottish Journal of Geology: Editors' Report

Members of both Societies will be aware that the Scottish Journal is experiencing difficult times. The last issue of 2016 (volume 52-2) included only four papers, totaling 43 pages. The first issue of 2016 (volume 53-1) was again only 4 papers totaling 39 pages, and it is likely that 53-2, now in production, will be 45 pages and will be online on 15th November. This is not a reflection of either the quality of production, or the quality of the papers published. The issue lies with the rate of submissions. We have previously reported reasons why this may be so but knowing the cause of the problem does not solve it.

The Board is actively discussing ways of attracting more submissions but a recent meeting with representatives from the Geological Society Publishing House has indicated a number of improvements that can be expected to influence matters. First, the Lyell Collection where the Journal is posted online has been upgraded to a new platform (http://sjg.lyellcollection.org/)The new website is "cleaner" and easier to navigate and browse and both articles and attached data can be opened and read by subscribers. This new platform also allows papers on a specific topic or theme to be bundled together into a collection. These collections can then be promoted to a broad readership and made available free of charge for an agreed period. The change from lithographic to digital printing has

reached a point where the disparity between costs has closed and the quality of digital printing is now equal to that of previous methods. While this does not yet apply to SJG we are not unaffected. Both the Lead Time and Production Time are decreasing thanks to efforts by the SJG Editors to speed up peer review and GSL efforts to publish papers as soon as possible Online First. Colour printing will now become the norm with authors able to use colour as they see fit at no charge. Ultimately, reviewed and accepted manuscripts, formatted by the author, will appear online immediately, protected behind a paywall, and only followed later by copy-editing and formatting to SJG standards (that are the same for all GSL published journals) in regular issues of the journal. There is a developing use of what we might call alternative metrics. These are designed pick up references in other journals and in social media, demonstrating impact beyond simple citations. GSL has 36,000 Twitter followers and ~10,000 on Facebook and gathers data on "most read" articles and online impact. It also produces and distributes regular electronic newsletters to authors, librarians and researchers, highlighting key papers and other developments.

All GSL publications are stored in CLOCKS, a "dark archive" that collects all published papers. This is designed for the unlikely event that any Journal should fail, so that all published articles would be made available on an open access basis

About 18% of GSL sales (that include SJG) are in the UK with 25% in the rest of Europe, and the remainder world-wide. In addition to the Lyell Collection, all articles are hosted on GeoScienceWorld (http://sjg.geoscienceworld.org/), which has 450-500 institutional subscriptions (note that these are not individual readers but groups that may be numbered in hundreds) as well as several large consortial customers in China and South America. GSW is also moving to a new platform hosted by Silverchair.

These developments are all likely to have a positive impact on SJG but it is important to recognize that Publishing is itself evolving. As noted, there is already a migration from print to online with concurrent rapid increases in the speed of production. Larger publishing houses, including GSL, are moving from sales of single Journals to distribution of bundles of titles. This is particularly important when Libraries are faced with flat or declining budgets, and purchasing models are evolving. Apart from the proliferation of new, online only, journals that charge authors for publication, there are concerns about piracy and illegal hosting of materials for which the host has no legal title. Another recent development has been the appearance of Preprint Servers where there could be a grey area between legitimately posted papers from authors and material in the process of publication by other bona fide publishers. This may be resolved in new data protection legislation. Finally, there is the issue of who "owns" data. Grant awarding bodies now place a variety of restrictions on how, when and what material can be published. This is resulting in a proliferation of licences and mandates with no common principle as to how data should be treated.

These issues are not unique to SJG but form the common environment that all Journals must face. Our immediate issue is in the low rate of submissions. Recent changes mean that we

have new figures on the Editorial Board and new ideas on how to address this key issue, and we will be working with GSL to develop plans to strengthen the journal. We hope to see the results of some of these in the coming year.

Colin Braithwaite

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Publication Report session

The bookshop continues to be a popular part of lecture nights and nearly £150s worth of sales were made by the end of 2016.As of January 2017 I was unable to carry out the duties of bookshop officer and my place was taken by Bob Diamond, several months earlier than he had expected. He has my sincere thanks for stepping in and taking over at such short notice. The online sales, mainly of Madeira Guides, continue unabated and 24 books were sold by mail by the end of June 2017. Bob has now taken over all aspects of managing the bookshop and I am sure it is safe in his hands and will continue to be a very successful aspect of lecture nights.

Mina Cummings/Bob Diamond

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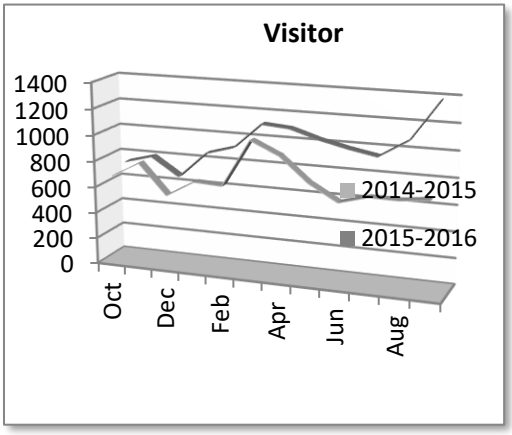
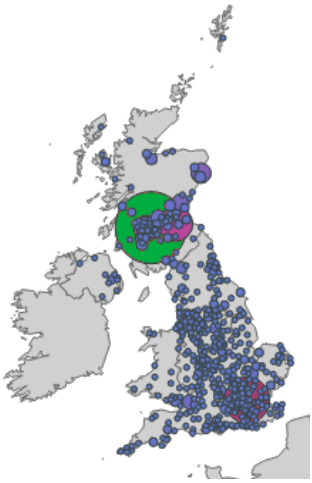
Website Report

Session 159 was a period of consolidation for the website. The Lectures and Excursions sections continued to be used to publicise the society's activities to members and non-members alike. Thanks to the efforts of the society's honorary archivist Margaret Anderson, the Archive section was expanded to include a new set of extracts from the society's proceedings for significant anniversary years (150 years ago to 25 years ago at 25year intervals). This page is well worth exploring for the insight it gives into the society's past activities and for the wealth of fascinating historical material it contains. Another page that also features new content is the Society Presidents page (in the About Us section). This page contains a list of all the society's former presidents, and the plan is eventually to have a link from each president's name to biographical details about them. During the session, biographical information was added for several presidents. Again, this page is well worth exploring, to learn about some of the fascinating people, both famous and less well known, who have served as president.

The traffic to the website has increased steadily since the website was launched in January 2011. In Session 159 there were 20274 visits to the site, an increase of 75% over the total for the previous session (11590). The number of visitors, as opposed to visits, was 16515, an increase of 86% over the previous session's total (8867). The chart shows the number of visitors each month for Sessions 159 (2016-2017) and 158 (2015-2016).



The increase in visits reflects increased traffic both from the UK and from abroad. The number of visits from the UK increased from 7664 in Session 158 to 8436. Outside the UK, the three most productive countries were the Philippines with 3443 visits (762 in the previous session), the USA with 2328 (948) and India with 1417 (229). Within the UK, Scotland accounted for 5115 visits (4373 in Session 158), England for 3117 (2880), Wales for 123 (103) and Northern Ireland for 72 (79).



The map shows the amount of traffic from cities within the UK. Glasgow was the most productive city, with 2251 visits (1728 in the previous session), followed by London with 962 (970) and Edinburgh with 519 (503).

The most popular part of the website was the Local Rocks section, with the Rock-forming Minerals page accounting for a massive 22.1% of pageviews, followed by the Metamorphic Rocks page (5.2%) the Scottish Fossils page (3.0%) and the Local Rocks home page (2.6%). Other popular pages were the website's Home page (12.4%), the Lectures page (2.3%) and the Excursions page (2.0%). By far the most productive source of traffic to the website was Google, which was responsible for 15074 visits (7293 in the previous session), but the next most productive was direct logons to the website, which produced 3151 (2153) visits. Bing produced 490 (416) visits and Yahoo 136 (154). The majority of the remaining visits resulted from referrals from other websites. The most productive source of referrals was Facebook (124 this session compared to 46 last session), followed by the campsies.co.uk website (96 compared to 80), the Edinburgh Geological Society website (56 compared to 104) and Wikipedia (50 compared to 4).

Because of some issues with the society's old Facebook page, a new page has been constructed; the title of the new page is "GSG Geological Society of Glasgow". A slow start to this page was expected because the only way to contact the followers of the old page (those who "like" the page) was to post a message on that page to promote the new page. As before, some of our posts have been more popular than others. The post on the display of Cononish gold at the Hunterian attracted over 650 visitors to the page and the fake news story in the Herald about a tyrannosaur having been found on the Isle of Skye drew 340 visitors. With over 1,750 visitors over three months, the page is doing well. If you have a Facebook account, or use other social media, please "like" and share any society posts that you find particularly interesting.

A similar story applies to the society's Twitter account, and a new account has had to be created; its name is @GeolSocGlasgow. If you have a Twitter account, please follow us and retweet any of our tweets that you like.

There is also a Wikipedia article about the society. However, as far as we know, this article was not created by a society member. (Wikipedia editors can be anonymous, and the creator of this article is.) It originally contained some inaccuracies and out of date information, but I have managed to edit the article to correct these errors and add some additional material. I envisage that we will continue to expand and enhance the Wikipedia article.

As Webmaster, I am responsible for the day-to-day running of the website. In this task I am assisted by three society members who join me in the website working group. Neil Clark (Web Consultant) assists with the development of the site and looks after the society's Facebook page. Maggie McCallum takes care of the Geoconservation section of the site and Maggie Donnelly chairs the working group. I am grateful to all three for their continuing 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 2016-2017

SGG:- 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. SGG has one new member, Matthew Staitis.

Leaflets/Booklets/Geology walks:- SGG leaflets continue to be distributed. Where copies are scarce, laminated copies have been dispersed in appropriate outlets. No Campsie Glen leaflets are left but work is in progress to revise the leaflet in order to reprint. There are no Balmaha leaflets left. Ardmore Point leaflets are very low. 1000 copies of Dumbarton Rock leaflets have been printed this year and are particularly popular with Dumbarton Castle and Balloch Information Centre. Good progress is being made with the Glasgow Necropolis leaflet. Margaret Greene led a successful walk on 16th September 2107, with 18 participants, as part of the program for Glasgow Doors Open. SGG continue to work on linking sites of interest to the SGG part of the GSG website and investigating linking leaflets to mobile phone apps.

Strathclyde Councils:- SGG continue to work with Councils of East Dunbartonshire, West Dunbartonshire, South Ayrshire, Inverclyde, Renfrewshire, 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. SGG volunteered to type up more than 30 hand written site assessment sheets for Paul Carter and Mike Browne who had done the assessments. These were duly passed to the Biodiversity Officer of North Lanarkshire Council to be incorporated in their LDP. MG, Chair of SGG, has commented on the Main Issues Report, South Lanarkshire, which includes 12 sites assessed by BGS, and also on the Inverclyde Main Issues Report, recommending six sites suggested by Chris Burton as geodiversity SINCs.

Scottish Geodiversity Forum:- Scottish Geodiversity Forum (SGF) is promoting EarthCaches in Scotland. SGG are interested in helping to promote this too, with particular interest in some work done already, concerning the Glasgow Necropolis. SGF is organising a Geoheritage Festival in October 2017 and several SGG members will be leading geology walks. MG continues to attend appropriate meetings and to encourage additional signatories to the Charter. MG has obtained agreement from the Clyde & Avon Valley Landscape Partnership to sign up to the Scottish Geodiversity Charter. Glasgow City Council has signed up to the revised Scottish Geodiversity Charter.

East Dunbartonshire held a symposium on Friday 8th September 2017 at Mugdock Country Park, entitled Dunbartonshire's Biodiversity and Green Network: Past, Present and Future. Two SGG members attended and Dr. Iain Allison wrote a comprehensive report for circulation to SGG members. At this symposium Angus Miller, chair of Scottish Geodiversity Forum and Councillor Jim Gibbons, Convener of Place, neighbourhoods and Corporate Assets, signed the revised Geodiversity Charter. SGG intend to make a contribution, to the cost of the fee of £35, to SGG members who wish to attend the Charter launch at Dynamic Earth in Edinburgh on 16th November, 2017.

Fossil Grove:- David Webster who is a Trustee of Fossil Grove and also a SGG member is keeping the SGG informed of any developments regarding Fossil Grove. SGG organised events for children and adults at FG in conjunction with Glasgow Doors Open on 16th September 2017. Iain Allison and David Webster have written an excursion guide to FG quarry which is now available for purchase. A revised version of the SGG leaflet is being printed. One volunteer, Allison Drummond, from SGG has been liaising with the visitors to FG over several Sundays, finding out what they think of the fossils and the condition they are kept in. Positive for the fossils and negative for the conditions.

Margaret Greene

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Geodiversity: Argyll and the Islands Report

GAI members have worked on three of the 51 Best Places locations, and all three of them are now included in the list. James Westland submitted two sites – Staffa and Iona – while Alastair Fleming submitted the Luing and Atlantic Islands site. In addition, in Argyll, David Webster has contributed the Islay site, but not connected with GAI. However, the Luing and Atlantic Islands site overlaps with the Islay site as both include reference to the Garvellachs – fortunately the submissions seem mutually supportive! GAI originally suggested a long list of 10 sites, so with four sites in the final list GAI feel well represented! The next step may be to produce local leaflets/booklets for each site. We would also mention the existence of John Sedgwick's private publication of the Geology of Seil and Easdale, which gives an excellent introduction to the geology of the Slate Islands.

Alastair Fleming

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Proceedings editor's report

The session 158 proceedings were slightly longer than usual due mainly to the excellent photographs provided by the trip reporters. As is now our normal practice the full text of the proceedings has been made available on the website and the trip reports are available individually with all photos reproduced in their original colours. My thanks to all those who

wrote reports and provided the photos and as always to Bill Gray for uploading everything to the web.

Mina Cummings

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Treasurer's report

The Income/Expenditure Account and the Balance Sheet are shown below. These have been checked and signed off by Ian Anderson, Independent Examiner.

Notes to the Financial Statements

1. Membership subscriptions have settles down following a fairly recent increase in fees.
2. Gift Aid continues to make a substantial contribution to our funds. We continue to encourage members to sign Gift Aid forms for us.
3. We have been unable to progress on the Conico-Phillips prize which had been awarded to the most outstanding candidates in the Scottish Higher Exam. This exam is now withdrawn and we seek alternative use for this fund.
4. Following the death of Dr. Brian Bluck we had taken custody of the residue of his research fund to finance nineteen annual prizes of £500 to the best final year student and have paid the first of these.
5. During the course of the year Bob Diamond took over as Publications officer. He has rationalised the stock list by a devaluation of inactive stock which offsets a useful surplus. We have received, from Edinburgh, payment for two years sales of Moine Guides. Stocks are now almost depleted and are written off.
6. Losses on two unpopular Saturday Excursions were almost compensated by a surplus on the others.
7. Weekend excursions remain popular and returned a modest surplus.
8. We now enter the last of three years at an agreed rate for Room Hire from the University which will require renegotiation for next year.
9. Other costs of meetings are slightly reduced.
10. Postage of our proceedings was increased due to an increase in their weight.
11. A significant increase in costs of the Newsletter after losing access to a University printer is now largely rectified.
12. We sponsored one student to attend an expedition to Islay.
13. We paid last year's overlooked subscription to *Paleontology* of £250 in addition to this years of £260.
14. We returned a surplus of £1,506.39.
15. We have undertaken a significant reorganisation of our investments and established an Endowment Fund consisting of investments now held by a broker with the intention of drawing dividends to be used for our charitable purposes whilst, hopefully, maintaining their real value. See separate sheet for a summary.

Balance Sheet

THE GEOLOGICAL SOCIETY OF GLASGOW

Income and Expenditure Account for year ending 30th September 2017

			Session 159 2016 - 2017		Session 158 2015 - 2016	
Income						
1. Subscriptions						
Received during year			7332.42		7277	
Deduct paid in advance this year			-324.32		-242	
Add received in advance last year			241.67	7,249.77	92	7127
2. Investment Income						
Dividends			636.25		600	
National Savings			142.79	779.04	160	760
3. Gift aid				1,299.67		1196
4. Publications	In house	net surplus	422.59		414	
		Stock devaluation	-421.51		Reval'n 113	
	Moine Guide	Revenue	250.36		14	
		Stock sold/devalued	-131.25	120.19	0	541
7. Saturday excursions		net deficit		-37.78		-6
8. Week end excursions	Lochaber 1	net surplus	10.40			0
	Lochaber 2	net surplus	22.30			
	Antrim	net surplus	81.15	113.85		27
9. Donations (coffee collections & personal)				327.55		227
Total income				**9,852.29**	Omitting Brian Bluck	**9874**
Expenditure						
1. Meetings incl speakers expenses, etc			633.40		1009	
Room Hire			3639.00	4,272.40	3699	4707
2. Publication and postage of Proceedings				768.88		492
3. Strathclyde Geoconservation				200.00		0
4. Sponsorship				500.00		0
4. Library and Down to Earth				725.00		215
5. Affiliation fees				90.00		90
6. Insurance				202.72		198
7. Website	Maintenance		360.00		360	
	Upgrade		79.18	439.18	62	422
8. Admin costs - postage, stationery, etc						
Hon Secretary expenses(Newsletter)			707.56		218	
Stationary			3.00			
Membership Secretary			430.38		553	
Treasurer			6.78	1,147.72	55	826
Total expenditure				**8,345.90**	Omitting Brian Bluck	**6956**
Surplus				**1,506.39**	Surplus	**2919**

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THE GEOLOGICAL SOCIETY OF GLASGOW

Balance Sheet as at 30th September 2017

		Session 159 2016 - 2017		Session 158 2014 - 2015	
Members' Funds					
Balance as at 30/09/2016		**69,532.15**			
Add revaluation of Investments		8,050.14			
Add Surplus for the year		1,506.39		Surplus **2919**	
Common Fund as at 30th September 2017			**79,088.68**		
Restricted Funds	TN George fund		380.00		380
	Brian Bluck fund at 30/9/16	9,000.00			
	less prize 2017	500.00	8,500.00		9000
	Conoco-Phillips fund		1,350.00		1350
Total Funds			**89,318.68**		
Represented by					
Current assets					
Cash at Bank					
Royal Bank of Scotland		10,579.21		15542	
National Savings Income Bond		12,000.00		12000	
National Savings Investment Account		4,008.49	26,587.70	3866	19408
Cash in hand					
Publications/Proceedings officer, Mina Cummings		-305.94		124	
Publications Officer, Bob Diamond		22.36		0	
Treasurer		-164.43		-57	
Saturday excursions officer		189.22			
WE Excursion sec/past Vice president		347.82	89.03	267	1143
Stock of Publications	In house		3,008.27		3473
	Moine Guide(remaining stock devalued)		0.00		131
Deposits paid in advance for Raasay Excursion 2018			1,474.50		
Hotels paid in advance for speakers			143.00		
Endowment Fund			59,040.50		See note
	Total Assets		**90,343.00**		
LESS LIABILITIES					
Subscriptions paid in advance			324.32		241
Deposits held in advance for Raasay Excursion 2018			700.00		
	Total Liabilities		**1,024.32**		
Net assets			**89,318.68**		**80262**

The financial statements were approved on 15/11/2017 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

Income & Expenditure

Steady increase in membership fees and gift aid.
True return on book sales masked by necessary revaluation of stock.
Deficit on two unpopular Saturday excursions almost recouped by the remainder.
Weekend excursions popular with modest surplus.
Meetings cost rather less than last year.
Proceedings; increase in printing (27%) and postage (102%) costs due to increased weight.
Sponsorship at £500 to Remote Scotland Expedition below target.
Library paid subscription to Paleontology for both last year and this.
Newsletter; a significant increase in costs after losing access to university printer now largely rectified.
We returned a useful surplus of £1,506.39p.

Investments

At the start of the year we held two investments in our own name and other investments with financial advisors who informed us during the year that it was no longer viable to meet current financial regulations for small accounts and they wished to close ours. An Investment Committee was convened and with Council approval reorganised investments in funds of their choice to be managed without advice by a new broker and to be held in an Endowment Fund. The objective is that these should as nearly as possible maintain their real value whilst yielding improved dividends identified as being principally for our charitable purposes.

Holding at 30/9/16

£30,000 invested with Spiers & Jeffrey at June 2014	
J P Morgan Higher Income Fund (611.94)	
M&G Charifund (660)	
Conservative Balance Sheet valuation of above at 30/9/16	£44,000

Realised during year

Sale of Spiers & Jeffrey holding	£39,525.86	
Sale of J P Morgan 611.94 units	£ 3,483.78	
Market value of M&G 660 units at 30/9/17	£10,638.94	£53,648.58
Appreciation against Balance Sheet valuation at 30/9/16		£ 9,648.58

Transfer from Members Fund to Endowment Fund

Invested with Redmayne Bently holding	£44,404.00	
Invested with M&G Charifund (further 310.03 units)	£ 5,000.00	
Transfer of M&G Charifund (660units) valued at 30/9/17	£10,638.94	£60,638.94

Value of Endowment Fund at 30/9/17

Valuation of Redmayne Bently holding	£43,404.00	
Valuation of M&G (970.03 units)	£15,636.50	£59,040.50
Initial depreciation of Endowment Fund		£ 1598.44
Net appreciation against Balance Sheet valuation at 30/9/16		£ 8,050.14

Ben Brown

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Meetings Secretary's Report

Our first lecture of the session on the ***13th October 2016*** was given by **Dr. Rachel Wood,** who is Professor of Carbonate Geoscience at the University of Edinburgh. Her talk was entitled ***'The great dying: what happened 250 million years ago?'*** At this time the Earth saw the greatest mass extinction known, where over 90% of all marine life disappeared. She showed evidence from the continuous carbonate successions in the Middle East and discussed the role that extensive volcanic eruptions may have played in altering the ocean chemistry. She drew analogies with what is happening in our seas today.

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On the ***10th November*** we went underground with **Dr. Ian Fairchild**, Professor of Geosystems at the University of Birmingham who gave a talk on ***'Cave deposits (speleothems) as archives of past environments and climates'.*** He introduced Quaternary palaeoclimate and followed this by a discussion of how caves function and the manner of formation of speleothems. Then he considered the many properties that speleothems display that may be modified depending on an interaction of climate with the cave and karst system and gave a concise description of how Uranium-Thorium radiometric dating can be combined with counting of annual layers. Finally, he used some case examples as illustrations of the varied ways in which past climates and environments have been brought to life by studying the underworld.

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In a change to the original programme, **Dr. Tony Fallick** from the Scottish Universities Environmental Research Centre in East Kilbride gave a talk on ***'Planet Earth's mid-life crisis: carbon isotopes, concretions and the "Great Oxidation Event"'*** after the brief AGM on the ***10th December***. Around 2.2 billion years ago, the Earth experienced a series of dramatic upheavals which accompanied the transition from a reducing to an oxidising ocean and atmosphere system. The global carbon cycle was perturbed to an extent unparalleled

before or since. From concretions in sediments, he showed evidence that the manner in which organic matter is remineralised underwent radical change. However, in a nod to the 'Gaia' hypothesis the exact sequence of events leading to this "greatest pollution event of all time" (a phrase coined by James Lovelock) is not yet clear. The interplay of the records of oxidised carbon (as carbonate) and reduced carbon (as organic matter) is especially problematic. He explained that recent drilling in Arctic Russia has produced a marvelous new archive of 3.6 km of drillcore with which these and other issues are being addressed.

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Into **2017** and on the ***14th January*** **Dr. Stephen Brusatte**, who is the Chancellor's Fellow at the University of Edinburgh addressed the Society on ***'Scotland's Jurassic Park: The Isle of Skye and New Fossil Discoveries by the PalAlba Group'.*** Steve told us that you can find dinosaurs in Scotland which are important on an international scale. The Isle of Skye is one of the few places in the world that preserves fossils of dinosaurs, crocodiles, lizards, turtles, and even tiny mammals from the middle part of the Jurassic Period, about 170 million years ago. He described the fieldwork that the PalAlba team - a collaborative group of Scottish palaeontologists - has been conducting on Skye and explained the importance of the fossils and described a remarkable dinosaur tracksite left by colossal long-necked dinosaurs moving through an ancient lagoon.

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On the ***9th February*** **Dr. Diarmud Campbell**, who is the Chief Geologist (Scotland) at the British Geological Survey in Edinburgh gave us a talk entitled ***'Making better use of the ground beneath our cities: Glasgow has shown it helps to ASK'.*** He explained that knowledge of the subsurface is a vital element in delivering successful construction and regeneration projects — yet poor understanding of ground conditions is widely recognised across the UK and Europe as the largest single cause of project delay, as well as overspending. To help address this, the British Geological Survey (BGS) has, through its Clyde-Urban Super-Project (CUSP), developed highly visual, and easy to use, city-scale 3D subsurface models and other geoscience datasets (geochemistry, groundwater, engineering geology etc.) in the Glasgow area. These have been providing new insights into Glasgow's complex superficial deposits and bedrock, the impacts of its industrial legacy, and opportunities for harnessing heat energy that lies beneath the city.

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On the ***9th March*** **Dr. Derek Fabel,** from the Scottish Universities Environment Research Centre, addressed us on ***'Extremely rare isotope metrology'***. He took us behind the scenes at SUERC to illustrate the complexity and effort involved in making these types of measurements. He explained that precise and accurate measurement of isotopes in minerals and rocks is key to understanding the Earth. Radiometric dating is the principal source of information about the absolute age of rocks and other geological features, or the age of the

Earth itself, and together with stratigraphic principles, has been fundamental in establishing the geological time scale. He concluded that radiocarbon and surface exposure dating rely on being able to measure the abundance of extremely rare radioisotopes in the sample material using a technique called accelerator mass spectrometry.

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The last lecture of the session on the ***20th April*** was given by **Professor John Parnell** of the University of Aberdeen on ***'An Alternative Fossil Record: Evidence for a Deep Biosphere in Scotland's Past'.*** He told us that the story of life on Earth is largely subsurface, and only since the evolution of land plants in the last 10% of Earth's history has the locus of biomass shifted to the planetary surface. He went on to describe examples from Scotland which yield a range of evidence such as organic biomarker evidence for subsurface biodegradation; isotopic evidence for microbial colonization in the subsurface; metal concentrations in red beds attributed to bacteria; and preservation of microbial filaments in fracture-fill vein minerals. He concluded by putting them in the wider context of planetary habitats.

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Members' Night on the ***11th May*** rounded off Session 159 in the usual fashion with several short presentations by members of the Society. These were Joan Walsh: "Identification of Scottish Slates", Simon Cuthbert: "Conserving Nature's Stage - Geodiversity for the bewildered.", Margaret Greene: "Geodiversity" and David Jarman: "The Romanian Carpathians - Range destruction by rock slope failure."

David Webster

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Excursions Secretaries Reports

Day Excursion Secretary's Report

The day excursions program started on June 3rd with our joint excursion with the Edinburgh Geological society. This year it was our turn to organise the event and I opted for a trip to the Fintry Hills with a walk to and along Kilewnan Burn continuing to the top of Dunmore, then downhill to Fintry quarry. The excursion was followed by a very sociable high tea at the Fintry Sports and Recreation Club, in company with our Edinburgh colleagues. Our

leader on the day was Dr. Con Gillen and my sincere thanks to him for coping with such a large party. There were 13 participants from GSG.

The next excursion was on 10th June to view the abandoned lead workings above Tyndrum and then to visit four sites in Glen Orchy in the afternoon. Our leader was Dr. Iain Allison and we had 10 participants.

Following last year's successful visit to the Glasgow Museums Resource Centre in Darnley, we arranged a further visit on 24th June. The 12 participants made their own way to the centre. Many thanks to Ann Ainsworth for her excellent presentation of the intriguing exhibits that are not usually on public display.

The third field trip was on 22nd July to visit sites in the Comrie area. We started with a visit to the Earthquake House just outside the town where we were given an excellent talk by Chris Palmer who looks after the equipment on behalf of the BGS. We then took a walk along Glen Lednock to see the De'il's Cauldron waterfall where the River Lednock has incised a rock-cut gorge. We then indulged in some democracy and chose to return next year to view the Comrie pluton rather than rushing the day, so one of next year's excursions is already arranged! Many thanks to Dr. Simon Cuthbert for his enthusiastic explanations to the 21 participants.

Dr. Con Gillan was kind enough to offer to lead two excursions this year so on 29th July we met him in Little Glen Shee to examine Dalradian rocks. There were 19 participants on this trip.

Our final day field trip on 19th August was to Southerness on the Solway Coast on an excursion very ably led by Dr. Chris Burton. This was our only coastal excursion this year and offered the 20 participants a chance to examine the Kirkbean Outlier.

As ever, could I 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. Due to lower participation than expected on the first two trips, and my unwillingness to charge extra for poor attendance to locations chosen by me, the Society lost money overall this year. Your Council is discussing the charging structure for next year's trips.

Roy Bryce

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Residential Excursion Secretary's Report

Two residential excursions took place this session. The first was to Lochaber which took place from Fri 21st to Mon 24th Sept 2017; and was repeated over the weekend of Fri 5th to Mon 8th May 2017. It was led by Jim Blair, Chairman of Lochaber Geopark Association. Thirty-four members showed interest in the excursion to and so it was decided to have two weekend trips with, in the event, 16 members on the first and 17 on the second. Both went very well with good weather, excellent geology and scenery.

The second excursion was to Causeway Coast of Antrim, which ran from Fri 8th to Mon 11th Sept 2017 and was led by Dr. Fiona Meade. This trip also went very well with 16 participants, fairly good weather and again excellent geology and scenery.

On all three, travel was by private cars and volunteers were 'persuaded' to write a half day report, providing 6/7 reports for each trip.

Maggie Donnelly

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Chris Burton, Librarian
An appreciation

As Assistant Librarians, we have between us been privileged to assist Chris for twelve of his forty-four years as the Librarian of the Geological Society of Glasgow, and we can vouch for the outstanding service that he has provided for members of the Society, as well as for the students and staff of the School of Geographical and Earth Sciences who use the Library.

We have witnessed his dedication, and his regular reorganising of material, which ensures that information is always accessible and relevant. He has also catalogued several major donations from renowned geologist colleagues.

Over the years, the Library has had to be squeezed into the smaller and smaller spaces allocated by the University. A painful aspect of this shrinking space is that it is sometimes necessary to dispose of books. On the other hand, books have on occasion had to be rescued: one tale that Chris tells is that, on hearing of yet another 'rationalisation' by the Department, he rushed to the rescue, ending up in the depths of a skip, from which he removed many an irreplaceable volume.

A remarkable and valued resource for users of the Library has been access to Chris's expert knowledge, which he willingly shares with unfailing courtesy and generosity; and if he does not have an immediate answer to a query, he will know where to find the

appropriate book, map or memoir. We are very grateful that this resource will still be available to us in future, as Chris has expressed himself willing to continue to be present in the Library when it is open from 6.45pm until 7.25pm each Society Lecture evening.

Assistant Librarians Seonaid Leishman (Sessions 148-155)
and Margaret Anderson (from Session 156)

Excursion Reports

Residential Excursions :-

Lochaber 1st trip **Fri 21 April – Mon 24 April 2017**

16 participants

Fri 21 April, am

Report by Maggie Donnelly

We met in the car park beside the Ballachulish tourist information centre, around noon on a fine morning, and drove 2 km west to St John's church, NN 065 587, on the shores of Loch Leven, where we planned to locate the Ballachulish Slide, one of a number of 'slides' found in the west central Grampian Highlands. A 'slide' is now interpreted as a syn–sedimentary low angled fault which occurred in a basin prior to the opening of the Iapetus Ocean. Later, as the ocean closed and the land masses collided, this fault was reversed – the rocks came back up, but not as far as they had gone down, with the result that the stratigraphy indicates a normal fault but the sense of shear indicates a reverse fault. This Slide occurs within the Appin Group; the rocks exposed consist of the lower Leven Schists, the Appin Transition Formation and the base of the Appin Quartzite. All have been folded into a major recumbent nappe – the Ballachulish Syncline.

We walked about 200 m NW, crossing the road and making our way down to a small inlet beside a peninsula, and an exposure of phyllitic graphitic pelites with thin semipelite beds, NN 0669 5869, – the upper Ballachulish Slate Formation. This youngs to the southeast into the Appin Transition Formation and then into the basal Appin Quartzite, all of which lie on what was originally the upper limb of the Ballachulish Syncline. At the northwestern end of this peninsula there are thin beds of gritty quartzite, of the Appin Transition Formation. The bedding in the Slate and its penetrative schistosity strike northeast and dip steeply northwest, with the two planar surfaces having axial planar to tight folds which plunge steeply to the southwest. There is a marked stretching lineation (pyrite blebs and mica) pitching down the dip of the schistosity; the latter is folded by minor tight folds which plunge subvertically, with a mainly 'Z' geometry and an axial-planar crenulation cleavage.

The group then scrambled up and over the steep grassy bank (fighting through bushes and trees!) to the next inlet where, about 50 m to the southeast, NN 0665 5875, the rocks are black phyllitic pelites, with a more variable strike than previously, and more beds of gritty quartzite, up to 70 cm thick, towards the northwest. These are Appin

Transition beds and again the penetrative schistosity is almost parallel to the bedding. They end at a NE-trending, 4 m-thick microdiorite dyke. Between this dyke and a second 5 m-thick dyke, there is a 10 m-thick unit of yellow-weathered, grey metacarbonate rock interbanded with millimetre- to centimetre-thick beds of dark semipelite – typical of the Ballachulish Limestone Formation. These NE-striking beds are locally strongly folded by steeply plunging minor folds displaying both 'S' and 'Z' geometries. The Ballachulish Slide occurs at the junction of the metalimestone with this western dyke, NN 0663 5882, and a few centimetres of platy quartzose schist outcrop over a distance of about 1 m to the west of it. The latter is interpreted as a slither of the basal facies of the Leven Schists, which occur over the remainder of the peninsula to the west of the dyke. The Leven Schists consist of quartz-rich psammite interbedded on a centimetre scale with ribs of semipelite; no way-up criteria have been established. One well-exposed minor fold has a plunge of 40° to the north-east and an 'S' geometry, but otherwise there are no well-developed minor structures.

Looking north-east along the Ballachulish Slide (black line).
Maggie Donnelly

The Ballachulish Limestone Formation lies in the core of the syncline and the Leven Schists on the upper limb – hence the 'S' geometry; both have been brought in by tectonic movement.

Satisfied that we had achieved our aim, we returned to the cars and, with time against us, eating our lunch on the way!! We crossed the Ballachulish Bridge and stopped for a short time to take in the view across Lochs Linnhe and Leven to the Ballachulish Igneous Complex and the Pap of Glencoe. We then went into the old slate quarry on the north side for a good look round, before continuing to the Corran ferry. Although a brief sail it was beautiful and the scenery was magnificent. Once across we drove rapidly but carefully to the Silica Mine at Lochaline – our appointment there was for 4.30 pm.

Friday 21st April, pm
Report by Margaret Greene

Visit to Lochaline Silica Mine

The white sandstone at the mouth of Lochaline has been quarried for building since the 19th century but it was only at the outbreak of the Second World War when the supply of imported sand was cut off that the mine was opened. In 1940 Charles Tennants & Co of London leased the mineral rights from Ardtornish Estate and production was managed by Charles Tennants & Co of Glasgow. The original manager and mine workers were recruited from the Ballachulish slate quarry. Tilcon took over the lease for the mine in 1972, then in 2001 Tarmac took over management and subsequently closed it in 2008. However it was reopened in 2012 by the present owner Lochaline Quartz Sand Ltd which is a joint enterprise between an Italian mining company, Minerali Industriali, and NSG/Pilkington, the glass manufacturers.

We gathered at the mine office to be given a short introduction to the mine by Veronique, the office manager, who also checked we all had the requisite high viz jackets, hard hats, and most importantly, torches. The mine produces very high quality silica sand with very little impurities. The sand is from the early Cretaceous, Greensand group, which is so named due to the greenish tinge due to the presence of glauconite. Above the level of the sandstone is a thick layer of Palaeogene lavas from the Mull igneous complex. There are two grades of sand produced by the quarry; LQS85 and LQS500. The numbers indicate the amount in ppm of iron. The higher level of iron content produces a slightly greenish tinge in the glass

The sand mine is the only underground mine in Britain and is mined in the room and pillar system. It is estimated that there is approx. 14 years of extractible sand left in the mine.

Once the introductions and safety information were issued we were led to the quarry by Diego, the mine manager, with Veronique taking up the rear. The entrance to the quarry is a large opening in the hillside – big enough for the enormous trucks which transport the sand out of the tunnel. We were led in with explanations on the height and width as well as the size of the pillars which are left to hold up the roof. The sand is drilled and blasted, then transported to the surface by trucks. There is a daily check on the air quality; there are a number of entrances as there are at least 14 miles of tunnels. Water also gathers in the mine and this is used in the washing process. The mine is crossed by faults and one of the reasons that the previous mining company closed was the presence of a large fault which meant a change in direction and depth of the sandstone.

When he considered we were deep enough into the tunnel Diego suggested we all turned off our torches to experience the total darkness which exists in the mine – quite an eerie experience.

Once we returned to daylight Diego introduced us to all the processes which crushed and washed the sand. It was screened through mesh to ensure only the finest grains got though. The crushing machinery has recently been replaced and this has improved the production and profitability considerably. The sand is finally directed through spirals where the last of the impurities are removed.

Examining the silica sand drying under cover. *Jim Martin*

The sand is constantly tested to ensure it is of the right quality, either LQS85 or LQS500. Diego has had constructed large covered sites, where the sand is stored before it is loaded into the boats which pull up at the adjacent pier. These covers have ensured that the sand is dry for transfer into the boats. Diego has improved the quality and production of the sand tremendously by his innovations and as such has kept his rivals at bay.

Saturday 21st April, am

Report by Muriel Alexander

After an enjoyable breakfast we gathered at the Strontian Hotel, sorted out transport and set off northwards towards the hills, following the road through the Ariundle Oak Woods behind Strontian. Our objective was to explore the Strontian mines. Our first stop was at an area where we could inspect outcrops of granitic country rock, identifying the pink and white feldspars and hornblende along with darker xenoliths, perhaps of a basaltic origin.

On driving further up through the forest we next made a stop near the demolished Bellsgrove Lodge where we noted a water adit draining the mines, and a settling pond in use when the barite was mined for a few years in the 1980's. The road now opened out onto bare hillside and from our exposed parking place we could look across and slightly up the valley to see much evidence of mining on the hillside and, in the distance, the abandoned buildings of several of the mine workings. Close to our parking place we found a very old mineshaft through the granite and could trace the evidence of the mining from there across the hillside to the buildings and beyond.

Mining in the area started in the 18th Century and was initially based totally based on galena (lead ore) with other minerals such as sphalerite (zinc ore) being identified later. However, profitability was poor and many companies opened their mining activities only to collapse after a short period of time. The mineral strontianite, from which the element was isolated, was also found in the veins and named after the local village. Barite also in

the veins was originally put onto the spoil heaps but was more recently found to be useful in North Sea Oil drilling and thus was mined from 1983 for a limited period of time.

We then set off to walk up to the mines identifying the deep, now collapsed shafts and adits of the 18th Century mines. We moved on to the more recent strontian/barite mine which was opencast, but since 1986 was no longer in use. It was wide and sloped quite steeply downwards to an old adit at the end. Here we identified many examples of galena, sphalerite and barite of the vein, cutting through the granitic rock and were able to pick up some good samples. After a short beak we crossed over to the yard where the remains of the processing plant stood and which was now littered with discarded rusted equipment. At the back of the yard an adit with railway lines running into it led straight into the hill, but it was now totally collapsed.

Having enjoyed exploring the mines it was now time to return to the cars and head to the seaside for the afternoon.

The more recent opencast strontian/barite mine.
Maggie Donnelly

Saturday 21st April, pm
Report by Maggie Donnelly

In early afternoon we drove east along the A861 and turned southwest along the B8943 coastal road, parking at a farm near Kilmalieu, NM 897 558. We were now standing on a raised beach, one of several in the area, created during and since the end of the last ice age. We were close to the centre line of the Great Glen Fault, active since 450 Ma with initial sinistral movement of about 200 – 300 km between 430 and 400 Ma, followed by later dextral movement of 25 – 30 km, post-Devonian. Note, however, that different sources provide different displacement distances.

Prevented from crossing the intervening field by a large herd of cattle, we took the long way round on the coastal path to the southern end of the bay and onto the flat rocks below a high cliff face. Beneath our feet were metamorphic rocks of the Loch Eil Group, the youngest group of the Moine Supergroup – psammite (metamorphosed sandstone) and semipelite (metamorphosed mudstone). There was a sizeable intrusion of granite pegmatite, emplaced via a fault. Continuing across the rocks to the cliff, Rubha na h'Earba, NM 908 555, we could see a distinct change – on top of part of the Moine was a large lithified deposit of angular pebbles and cobbles. This was the Basal Devonian Conglomerate, deposited during flash floods in a desert environment.

The unconformity between Moine rocks and Lower Basal Devonian Conglomerate. *Maggie Donnelly*

At its base was a significant unconformity, lying at a steep angle up the slope – quite spectacular! We spent time examining this and the fallen rocks while taking photos. Further along the grassy and rocky shore to the south, up dip towards younger rocks, it could be seen that the depositional environment had become less energetic with time as the clasts in the conglomerate became progressively smaller and finer.

We were informed that the coarse basal sediments were derived from the Moine rocks to the north (the Northern Highland terrane) while the finer sediments at the top came from the Dalradian rocks to the south (the Grampian Terrane).

By now the ground was getting very rough, and at least one member dropped out, to sit on the rocks and take in the view. Soon the weather deteriorated and so a number of others turned back to the sandy beach, leaving a few to continue along the Lower Devonian rocks. Their persistence was rewarded when they successfully found a lamprophyre dyke of the Ardgour swarm, Permo-Carboniferous, 300 to 290 Ma. Back at the cars we continued southwest along the raised beach and up through the valley, (a challenging road!) with abundant glacial features, via Kingairloch. When we reached the A861 some of us turned towards Lochaline and took the road west towards Drimnin for about 5 miles. On the right hand side of the road beyond Funary was an obvious wall of rock about 20 feet high with a large hole through it. We stopped for a closer look. This was a Palaeogene dyke, known as the "Wishing Stone" – its horizontal columns could clearly be seen and some had fallen out creating the hole; we took lots of photos. Returning past Lochaline we parked beside a large road cut through an outcrop of dark

olivine dolerite. Several pale green olivine crystals were found both in the rock face and in the loose material lying about. Finally, we made our way back to the hotel.

Sunday 22nd April, am & pm

Report by Maggie Donnelly

On a sunny morning, we drove east from the hotel on the A861 for about a mile and parked beside the beautiful shores of Loch Sunart. Making our way down onto the pebbly beach we came to an outcrop of Strontian granite with a number of 'dark patches' throughout, very similar to the exposure we had seen at our first stop on Saturday. As yet there is no definitive interpretation for these. They may be xenoliths, or perhaps small basic intrusions; their edges are ill-defined suggesting partial melting, and all are aligned in a north-south direction. We continued on for three or four miles, following the road towards Lochaline until, rounding a bend, our leader pulled over in a space at the roadside. We walked back a few paces to a huge quarry previously hidden by the bend and made our way in. As usual, everyone was thinking to themselves 'What **am** I looking at?' We were faced with an immense black outcrop and it took a minute for us to realise that we were staring at a series of huge dykes, all side by side with no intervening country rock, such that some of them looked like composite dykes. The granite, with large red feldspar crystals, into which they had been intruded, could be seen on either side of the quarry. We tried to count them and all came up with a different answer! There must have been about eight or ten. These dykes may be at least in part lamprophyre and, although their exact age is uncertain, are thought to be part of the Ardgour Dyke Swarm, *ca* 290 Ma. They may represent intrusions associated with the movement of the Great Glen Fault. We had great fun looking about for samples of 'dyke/granite contact'.

Our group in the amazing dyke quarry. *Maggie Donnelly*

Driving on, we arrived at the Rahoy junction where we examined an unconformity between Permian red sandstone and the underlying Moine schist, sparkling with abundant Muscovite in the sunshine. We then walked a short distance up a forest track cut into Jurassic limestone pavement containing *Gryphea* fossils. These are the Broadford Beds, deposited with the Pabay Shales, and have been protected from erosion by the overlying Tertiary flood basalts. This is a protected site – no hammering and its location is generally not publicised for its own preservation. A roadside cutting further on contained rocks also protected by the Tertiary lavas – the Stornoway Formation. They are dark red thermal Triassic and Permian sandstones and nodular limestones and are composed of a mix of poorly sorted clasts. In some places they appeared unstructured while in others large-scale crossbedding could be discerned.

We arrived at the Ardtornish Estate and walked a little way along the coastal track to have lunch beside the beach – and in the drizzle! – before continuing to the "Fossil Burn" on the east shore of Lochaline.

In the burn we found hard Jurassic limestone pavement, abundant with fossils in its bed, on its banks and on its many scattered boulders. By now we were walking along the base of huge 'Morvern lava' cliffs, and beside basaltic boulders which had tumbled down the slope. Many of these had clearly polygonal shapes and had obviously originated as basalt columns on the hill above.

Basaltic boulders with clearly polygonal shapes.
Maggie Donnelly

Finally, we came to the path up to "Tennyson's waterfall" which flows over basalt terraces. The hardy and intrepid members of our party set off and completed the climb; the less adventurous decided to avoid this challenge and had a leisurely stroll back to the cars. After we had all returned we headed back to the hotel for dinner and a well-earned rest.

Monday 24th April, am
Report by Jim & Lynne Martin

Twelve of us boarded the 10:00 Corran Ferry and met our leader and Breach (handsome Border terrier) at the Holly Tree Hotel Kentallen. After coffee, we crossed the busy A828 and ascended the Malcolm Shepherd Way to the viewpoint where Lochaber

Geopark information panel gives a comprehensive description of the geological aspects of the location and its environs.
Panel 22 can be viewed on the following web page:
http://lochabergeopark.org.uk/explore-lochaber/rock-routes/

The surrounding rocks are Kentallenite. They are creamy coloured with a rough texture due to their olivine crystals having been weathered out. Kentallenite is a course grained igneous rock "of unusual chemical composition. It is rare to find pyroxene and olivine, rich in magnesium, in a rock with large amounts of potassium feldspar". A nearby erratic was determined to be an explosive breccia displaying fragments with flow patterns evidenced by streaked vesicles.

reference

1. Excursion Leader's Handout – Dr. Con Gillen.
2. GCR Dalradian volume, PGA, vol. 124, no. 1-2, 2013.
3. Trewin, Nigel (Ed.). (2002). *The Geology of Scotland, 4th edition, pp 443-5.* The Geological Society.

Lochaber 2nd trip **Fri 5 May – Mon 8 May 2017**

16 participants

Friday 5th May, pm
Report by Maggie Donnelly

Our party gathered, under wall-to-wall blue skies, beside the Ballachulish tourist information centre at 11.45 am, and had time for a visit to the South Ballachulish Slate Quarry which cuts into a large deposit of the Ballachulish Slate Formation (graphitic pelite). Originally laid down as a very fine-grained mud, around 800 million years ago, this underwent low grade metamorphism during the Grampian Orogeny (peak ~ 470 Ma), converting the mud into slate, with a bluish hue due to the presence of iron and sulphur.

Established in 1692, the Ballachulish Slate Quarry thrived during the 18th Century, producing many of the slate roof tiles for surrounding areas as well as those for Edinburgh and Glasgow. In 1845, the quarry supplied 26 million slates. However, much of the quarried slate was of poor quality due to the presence of small quantities of iron pyrite which weathered rapidly in the Scottish climate and increased the porosity of the tiles. The quarry employed many of the villagers and had a major impact on their lives. All were affected directly or indirectly by its activities, with the intermittent deafening explosions and the continual drilling, hammering and chiselling by both machine and man. There were also two long running disputes over medical care between the management and the workers, before the quarry eventually closed in 1955.

A short and interesting walk takes the visitor round the quarry, with interpretation boards on its history, the people, the nature and versatility of Ballachulish Slate, as well as an excellent interpretation of the geology of the area (Lochaber Geopark Association). There are good views of the exposed quarry faces with complex, almost vertical bedding planes, sub-parallel to the slaty cleavage planes; the rock faces are cut by basalt dykes and quartz veins, and we had fun looking for samples of pyrites.

We then drove 2 km west to St John's church, NN 065 587, on the shores of Loch Leven, in order to see the Ballachulish Slide

. For a description of the locality and geology of this shore section with the Slide, see the first report for **'Lochaber, Fri 21 April – Mon 24 April 2017'.**

Having accomplished this, we returned to the cars and had a brief lunch break in the parking area before crossing the Ballachulish Bridge. We stopped for a short time to take in the views across Lochs Linnhe and Leven of the Ballachulish Igneous Complex and the Pap of Glencoe, as well as to examine the old slate quarry on the north side before continuing to the Corran ferry. On this second occasion the cloudless skies and sunshine made the sail even more magnificent than on the first. Once across, we drove to Strontian where we parked a few cars, and continued on to the Silica Mine at Lochaline – again our appointment was for 4.30 pm.

Reference

https://www.wildlochaber.com/glencoe/geology/ballachulish-slate-quarry.

Friday 5th May, pm
Report by Bob Diamond

Lochaline Silica Mine

During Friday afternoon we were given the opportunity to visit the Lochaline Silica Mine, which is owned by Lochaline Quartz Sand Ltd, a joint venture between an Italian mining company and the owners of Pilkington Glass. This is the only silica sand mine in Britain, and the purity (particularly the very low iron concentration) of the sand makes it ideal for high quality glassmaking. We were privileged to be able to walk a short way down one of the main adits which was high enough to accommodate a substantial dumper truck, accompanied by three very knowledgeable mine employees. The silica is mined using the room and post system. After blasting, the sandstone is taken to the surface where it is crushed, screened and washed. We were also able to see how the mine water is pumped to the surface to be used in the washing process, making this a very environmentally friendly system. The sand is then put into ships via a conveyor belt system, and taken directly to Runcorn

The mine exploits a seam of almost pure silica (99.8%) which is up to 12 m thick in places. The sand was deposited in Cretaceous times (*ca*. 93 Ma) in a shallow tropical sea close to the shore. As a result of repeated reworking by tides and storms, the deposit was sorted until it became almost pure quartz sand. The sand overlies Jurassic shales and limestones and is capped by the later Mull basalt flows. As a consequence, the top layer of the sand has become very hard, and this makes it a perfect roofing material for the mine. Only the middle 5 m is mined.

An Archimedes Screw used to lift the sand and water slurry.
Jim Martin

The sandstone was first mentioned at the end of the 19th century but it was not actually mined until the outbreak of War in 1940 when high quality silica was needed for periscope lenses and gun sights. Nowadays most of the output is used for Pilkington's Optiwhite glass, an extra clear float glass with very high light transmission.

It was a pleasure to visit this site which is not only geologically special, but has played an important part in the modern industrial history of Lochaber.

Saturday 6th May, am
Report by Joyce Stewart

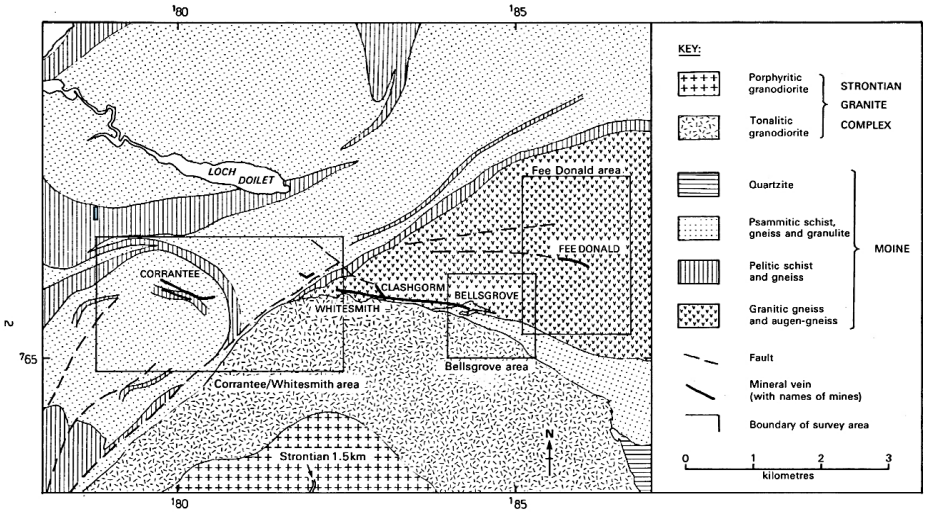
After a hearty breakfast we all met in the carpark including our guide Jim Blair at the Strontian hotel in the village of Strontian (Gaelic for "Point of the Fairies") to car share. It was an ideal day with a cloudless blue sky.

We drove north to the Ariundle Forest road, and saw Glacial drift with locally derived materials. Further up the road, we had a lively discussion on exposures of the granite with xenoliths. One theory was that a dyke was trying to intrude into a crystal mush – this was discounted. Other theories were that it was a stream of xenoliths as the magma moves or maybe a crystal mush on the move.

The edges are clean and this hints that it is some form of xenolith, possibly a xenolith stream in the process of being absorbed back into the magma? The xenoliths seem to be aligned, stretched or streaked out or a mixture of both. See the picture and decide for yourself. Further on, there were angular inclusions which looked more xenolith-like. After this we moved on to see granodiorite with lenses.

Our next stop was at Bellsgrove mine where we saw the settling pond which was used in the 1980's when mining baryte for North Sea oil drilling mud. The water from the settling pond then run off into Strontian River. The mining stopped in 1990 when the company went bankrupt. The opencast baryte mining practically obliterated the old lead/zinc mines.

Jim told us the history of the mines. In 1720 Sir Alexander Murray of Stanhope bought the Ardnamurchan estate and starting mining in 1722. The lead ore vein complex goes on for about 8 km across the hillside. After the Napoleonic wars there was less demand for lead and the mines went through various hands without much success. Silver was a by-product of the lead mining and out of 300 – 400 tonnes of lead around 40lbs of silver was extracted. We saw the entrance to 60 – 70 ft. deep shafts which are not safe to go down. We then had a safety talk for overhanging faces in the Whitesmith quarry. The quarry faces were Argyle Granite Gneiss and we saw cockscomb baryte. We saw the veins of calcite following the faulting. After a busy and enjoyable morning, we stopped to have our lunch at the quarry before continuing on to the next location.



British Geological Survey; Mineral Reconnaissance Programme Report, No. 85 Geophysical surveys near Strontian (page 2), Highland Region; Director, Geological Society; Authored by G.S. Kimbell (1986)

Saturday May 6, pm: Rubha na h'Earba
Report by Bill Gray

This afternoon's walk took place in sunny conditions with a gentle east breeze. We parked at a farm near Kilmalieu at the northeast end of the Morvern peninsula (NM 897 558). This locality lies on the southern boundary of the Northern Highland terrane, which is separated from the Grampian terrane by the Great Glen Fault. The plan was to walk round the bay to the headland of Rubha na h'Earba to the east and to examine the metamorphic rocks of the Moine Supergroup and the sedimentary rocks of a Devonian outlier on the way.

Walking towards Loch Linnhe and the start of the excursion.
The headland of Rubha na h'Earba lies beyond the sandy bank in the bay. *Bill Gray*

We started by inspecting a wave-cut platform at the beach near the path. Jim explained that this area was near the centre line of the Great Glen Fault, which has been active since 450 Ma and along which there has been a displacement of between 200 and 2000 km. (According to the account in *The Geology of Scotland*, 4th edition, 2002, there was a sinistral displacement of probably no more than 200-300 km between 430 and 400 Ma and a later post-Devonian dextral displacement of 25-30 km along the fault.) The platform on which we were standing was composed of metamorphic rocks belonging to the youngest group of the Moine Supergroup, the Loch Eil Group. The rock types were psammite (metamorphosed sandstone) and semipelite (metamorphosed mudstone) and there was a prominent fault intrusion of granite pegmatite.

Jim standing on a platform of psammite and semipelite with a granite pegmatite in foreground. *Bill Gray*

We now walked further round the bay towards Rubha na h'Earba, which is a Devonian outlier in the Moine. At the unconformity between the Moine and the Devonian (NM 908 555), the rock type changed from psammite/semipelite (Moine) to angular breccia (Devonian), which was deposited during a flash flood in a desert environment. The time gap represented by the unconformity is of the order of 450 Ma, as the Moine sedimentation finished at around 870 Ma and the Devonian period started at around 420 Ma.

As we walked along the shore, which alternated between grassy sward and bare rock, the breccia became progressively finer in texture. As we were walking along the direction of dip towards younger rocks (southwards), this indicated that the environment of deposition had become less energetic with time. Jim explained that the coarse basal sediments were derived from the Moine rocks of the Northern Highland terrane on the northwest side of the Great Glen Fault while the finer sediments at the top of the succession were derived from the Dalradian rocks of the Grampian terrane on the southeast

side of the fault. We passed a Palaeogene dyke on our way to the point of the headland (NM 910 553), where we had a refreshment break on the shore. While enjoying the sunny sheltered location, we could, with the help of binoculars, see seals and cormorants on the small island of Sgeir nan Gillean. We were still on Lower Devonian rocks, but after our break we searched for members of the Ardgour lamprophyre dyke swarm, which dates from 300 to 290 Ma (Carboniferous-Permian). While looking for the dykes, we saw an exposure of tufa limestone, precipitated by evaporation from water percolating through the rocks. With Jim's help we eventually found one of the lamprophyre dykes, which ran parallel to the shoreline before turning through a right angle into the sea.

We now made our way back to the cars and drove back to the Strontian Hotel along the raised beach via Kingairloch. On the descent to Loch Sunart we stopped at a viewpoint with a wonderful panoramic view north to the Ariundle mine and beyond, and took the opportunity to capture a group photo.

Geology field days don't get much better than this.

Course angular breccia at base of the Devonian outcrop.
The lens cap is 52 mm in diameter
Bill Gray

Jim indicating the position of the lamprophyre dyke at Rubha na h'Earba
Bill Gray

Group photo. *Bill Gray*

Sun 7th May, am & pm
Report by Walter Semple

Day 3 allowed us to view the three dominant rock types of Morvern: the underlying Moine schist, the Strontian granite and the extensive Mull flood lavas spreading far into Morvern, and protecting the pre-existing rocks from erosion.

Our guide, Jim Blair, took us to the granite on the north shore of Loch Sunart, east of Strontian, near the cattle grid. He pointed out xenoliths in the granite all aligned in the same north-south direction. They resembled aligned xenoliths in the granite about 2 miles north of Strontian which we had seen on day 2. He challenged us to explain these features. We moved on to Stop 2 which took place at a quarry on the west side of the road south to Lochaline. The Strontian granite in the quarry featured large red feldspar crystals giving it an attractive appearance. Intruded into the granite were multiple dykes, thought perhaps to be associated with the Ardgour dyke swarm. The age of these dykes is not settled beyond doubt. They may be at least partly lamprophyre, and may represent intrusions associated with the movement of the Great Glen fault over long geological periods.

Stop 3 took place at the Rahoy junction where Jim Blair showed us a roadside unconformity between Permian red sandstone and the underlying Moine schist, sparkling with Muscovite in the sunshine, and demonstrating the variety of rocks to be seen in the area. Stop 4 took us a short way up a forest track whose excavation had revealed Jurassic limestone pavement bearing *Gryphea* fossils. Protected from erosion by the Tertiary flood basalts, these are the Broadford Beds deposited with the Pabay Shales. Stop 5 at a roadside cutting revealed further rocks protected by the Tertiary lavas. These are known as the Stornoway formation. They are composed of thermal Triassic sandstone and nodular limestone formed in the Triassic and Permian periods. The appearance was that of an unstructured set of dark red rocks containing miscellaneous poorly sorted clasts.

New collective term – a “hat” of geologists.

Having lunch in the sun on the bank of the River Aline.

Alison Grant

Stop 6 took us through the Ardtornish Estate to the "Fossil Burn" on the East shore of Lochaline. Here was exposed hard Jurassic limestone pavement with liberal examples of fossils on the limestone boulders lying amongst the basaltic rocks which had tumbled down the burn. The next stage was to walk up the hill to "Tennyson's waterfall" flowing over a basalt terrace. The volume of water passing over the waterfall had suffered from the wonderful dry and sunny West Highland May weather which we were much enjoying.

Stop 7 was in a large road cutting on top of the Mull lavas high above the western Lochaline. Searching for olivine crystals in the volcanic rocks produced good success. The final stop 8 took us again to the West Shore of Lochaline where we found many Jurassic fossils which had survived thanks to the protection of the Tertiary lavas. They included *Gryphea*, *Pentacrinus* and Ammonites.

Monday 8th May, am
Report by Eve Gilmour

Those of us who had stayed to participate for Monday morning’s excursion went back over the Corran ferry and assembled at the Holly Tree pub in Kentallen. We went down to the shore to be shown wave worn vertical beds of the Dalradian country rock with an intrusion of a granodiorite and were introduced to the Kentallen intrusion. This is a member of the Duror of Appin cluster of appinitic diorite intrusions. Kentallen is the type locality of ‘Kentallenite’, a melanocratic, olivine monzonite. The rocks post-date the deformation and metamorphism of the Dalradian country rocks, and probably pre-date emplacement of the Ballachulish granite pluton.

We then followed the No 7 cycle path for a short distance where a Lochaber Geopark information board gives a good view Loch Linnhe (part of the Great Glen fault) and the geologic scenery of the Kentallen intrusion, the Ballachulish complex and Dalradian country rocks. We could also examine the Kentallenite in more detail, looking

for phenocrysts of olivine and augite. There is also an igneous breccia boulder near the board, an erratic from Glen Coe.

Our group beside the Kentallen information board. *Maggie Donnelly*

A short walk along the shore led to a shore side site which exposes an actual junction of the Kentallenite Metamorphic Aureole with the country rocks. The junction is very clear, even to those of us who have more to learn. A nearby exposure of Kentallenite has a coating of cordierite, which has weathered with a distinctive honeycomb pattern.

Back at the Holly Tree Jim Blair was thanked for excellent leadership, showing the depth and breadth of knowledge which he shared with us with enthusiasm – an excellent few days.

Additional attractions in Lochaber, May 2017

It was early May, and the sun shone in an almost cloudless sky for the full four days of our trip to Sunart and Morvern. As well as the fascinating geology, Lochaber had many other natural history attractions, especially the early spring woodland flowers and the spring bird song. Just behind the Strontian Hotel lies a stretch of community woodland, with Scottish bluebells, cuckooflower, celandine and pink purslane covering the forest floor. Past the village, another short woodland walk follows the Strontian River up the east bank, crossing the river then joining the Ariundle road back to the village. The light foliage of the ancient oak trees, famous in the Sunart area, gave a dabbled shade to a carpet of wood anemone, studded with cuckooflower and dog violet. From both sides of the hill up to the lead mines, cuckoos were calling repeatedly.

We picked up the call of the cuckoo again the following day on our excursion into Morvern, calling across the sheltered glen as we made our way south to Loch Aline. Here oak woods were replaced with ancient birch groves, fresh in bright green leaves. On a delightful walk along the east shore of the loch towards the sound of Mull, a pair of ravens croaked above the craggy horizon. Near the Fossil Burn, the steep grassy banks leading down to the lochside were covered with thousands of primroses, interspersed with

dog violet. The more shaded banks were covered with delicate carpets of bluebells, and everywhere the cuckooflower. In the warm afternoon sunshine, pairs of small white, green-veined white and orange-tipped butterflies visited them. The warmth of the afternoon also brought out the coconut scent of the gorse.
Swallows darted across the shores of the loch, the occasional goldfinch perched on roadside bushes, and on the crags high above Loch Linnhe on our final day, a pair of stonechat watched our scrutiny of the Kentallenite along the cycle path above Kentallen. We did not spot the white-tailed eagles or golden eagle which are known to frequent the Morvern area, but we came home with lots of memories of a beautiful spring visit to Lochaber.

Anne Gray

Causeway Coast **Fri 8th Sept – Mon 8th Sept 2017** **Leader: Fiona Meade**

Friday 8th Sept
Reporter: *Maggie Donnelly*

Cushendun

Nine of us travelled to Coleraine on Thursday where we stayed in the Premier Inn. On a sunny but showery Friday morning we drove north to the coast and visited the ruins of Dunluce Castle perched on the edge of basalt cliffs, before driving on to the northeast coast and Cushendun, near the Glens of Antrim. Here we met the rest of the group at 1.30 pm. By now the rain was serious so we took refuge in a local café for lunch before the sixteen of us plus Fiona and her friend Paul set out north along the shore to the far end of the bay where we found ourselves facing metamorphic rocks of schist and metabasites – the Glendun Formation, the top and final formation of the Dalradian Southern Highland Group and part of the Dalradian 'Antrim Inlier'. It consisted of grey and green tinged schists, with a number of large and well-formed pink crystals of (surprisingly!) albite, conspicuous in some bands. Their pink colouration, we were told, was the result of weathering. The many other crystals present included chlorite, biotite and tourmaline. There were a number of sheets of a distinctive porphyry – the Cushendun Granodiorite. It was pinkish brown and contained large oligoclase crystals showing zoning (reflecting different stages of growth) in a quartz-rich, fine grained groundmass. There were coarsely crystalline pegmatites, formed in the closing stages of slow granite cooling when albite crystals more than 2.5cm long were able to grow. The original pebbly and sandy sediments of the schists were deposited as turbidites prior to *ca* 595 Ma. Towards the end of this period, dolerite dykes were intruded into the lithified sediments, and then during the Grampian orogeny of the Ordovician Period, the collision of a continental margin across the island arc of the Tyrone Igneous Complex folded, deeply buried and metamorphosed the Dalradian rocks.

The area is famous partly because it was an essential part of a serious academic controversy about the origins of albite schists. The original view, argued by Bailey and

McCallien in 1934, was that the schists merely reflected the chemical composition of the original sediments, probably albite-rich muds, altered during metamorphism. However, in 1942 Doris Reynolds took a radically different view and proposed that hot fluids percolated the quartz-rich rocks during metamorphism and introduced sodium (essential for albite formation), potassium and possibly iron. Reynold's work was a fundamental contribution to the understanding of these rocks worldwide, making this a vital reference site in international geology and one of international importance – it *should* be designated and fully protected.

We walked back along the shore and coastal path to the south end of the bay (the rain had gone off) where there were huge cliffs right down to the path. They were made of an extremely coarse conglomerate – the 'Cushendun Puddingstone' or Conglomerate of the Cushendun Formation. In Antrim its thin basal layer is rich in schists but higher up the succession, where we stood, it comprised cobbles and large pebbles of mostly quartzite derived from the NW. The matrix was a lithic arenite with single cycle detritus of minor quartz and abundant fragments of welded tuff, schist and quartzite. It was **very** similar in appearance to the Basal Lower Devonian Red Sandstone of the Midland Valley, of which it is a continuation. We took time to examine it – all the clasts were very rounded, indicating a polycyclic history, and some were sheared. Further along, the cliffs extended across the path and down to the sea but two gaping holes appeared in front of us – the first of the 'Cushendun Caves'.

The caves of Cushendun became internationally famous when they featured in the hit fantasy drama 'Game of Thrones', attracting tourists worldwide, who probably would not have known that these caves have their own fascinating story.

We entered the right-hand one and followed the tunnel for some distance to the end where it opened up into a large cave. There was an exit, fenced off for safety and security, but beyond this the path continued through thick vegetation to the 'Cave House'. An historical 18th century residence it was once magnificent, but is now a shell and requires total restoration or demolition. Nicholas de la Cherois Crommelin lived here during the middle years of the 19th century and in 1903, Crommelin's grand-daughter Constance married John Masefield – the "poet of the sea". At one time it was home to the Sisters of Mercy and is undoubtedly one of the most secluded of retreats, best seen from sea or air.

We returned and entered the second tunnel. Its roof was low allowing us a close-up of the conglomerate. It terminated at an exit onto a small beach where the cliffs were low and overhanging – again a close-up view.

Bedding and cross-bedding. *M Donnelly*

In the cliff walls some bedding and cross-bedding were distinguishable.

Bedding and cross-bedding. *M Donnelly*

We returned to the cars and on our way home via the beautiful Glens of Antrim we stopped at the mysterious 'vanishing lake' of Loughareema. The bedrock is limestone and at times the water finds its way down through small cracks, leaving an empty patch on the surface!! At other times the cracks get blocked and the lake 'appears'!! It was there for us!!

References

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2. Cushendun Caves & Cave House.
http://www.irishnews.com/lifestyle/property/movein/2017/06/22/news/cave-story-invites-you-along-for-a-poetic-adventure-in-cushendun-1063859/.

Saturday 9th Sept, am
Report: *Isabel Collins*

Ballintoy Harbour

On leaving our accommodation in Coleraine we drove across a lava plateau. Obscured as it was by the last of the morning's rain, the topography appeared slightly stepped indicating the various terminations of the lava flows. Fiona explained later that these are the lavas of the Antrim lava field and they are part of the North Atlantic Igneous Province which relates to the Iceland plume and the opening of the North Atlantic. We learned that there are two lava fields in Antrim, known as the Upper and Lower Basalts. Coleraine is situated on the younger Upper Basalts and as we drove to Ballintoy we gradually came down sequence, passing through the inter-basaltic layer. This layer is marked by what is called a laterite, formed in a wet tropical environment, essentially eroding and chemically weathering the surface of the lavas into a red soil over a period of about 1-2 million years between the two phases of lava eruption. It is during this period that a small localised eruption of basalt formed the Giants Causeway, known as the Causeway Tholeiites. The basalts we were to see at Ballintoy were mainly the older Lower Basalts and the Causeway Tholeiites.

On arriving at Ballintoy harbour car park we discovered that it was situated in a redundant chalk quarry. The creation of the harbour itself was a direct result of the need to transport local stone from mining and quarrying. We later came across the remnants of old

lime kilns which were used to burn the chalk for the production of agricultural lime that was exported along with dolerite setts for road construction on an industrial scale. Leaving Ballintoy harbour car park we headed westwards along the coastal path towards White Park Bay. The coastline itself was very dramatic with a series of islands, skerries, rock arches and sea stacks. Most of the exposed rock on the shoreline consisted of metamorphosed chalk, known as the Ulster White Limestone Formation. The chalk itself was laid down in marine conditions during the Cretaceous and was later covered with and metamorphosed by the molten lava of the Palaeogene. As a result of being buried under several kilometres of basalt the chalk here is physically hard and cemented. Following the formation of the Lower Basalts there was a period of quiescence in which the laterite was formed before the Upper Basalts were extruded. Underneath the Cretaceous chalk are Jurassic rocks which unfortunately, due to timings, we did not get to examine, as they were to be found in the tidal zone. We stopped at various localities along the way looking at the interactions of the lavas and chalks along the coastline.

Fig. 1. Former Sea Cave caused by erosion along fault breccias formed along the Ballintoy Fault
A Geological Excursion Guide to the Causeway Coast by Paul Lyle

Our first stop was to the nearby raised sea cave (Fig. 1) close to the car park. This was one of the many indicators that we were to come across on the shoreline, that the area was raised due to isostatic rebound following the last ice age. It was also the first place where we saw evidence of a line of weakness in the area. Fiona confirmed there was Tertiary faulting, and outlined the Ballintoy Fault running parallel to the coast which forms part of the larger Portbradden Fault. An estimated 100 m has moved downwards, north of the break in the earth's crust, resulting in the Upper Basalts here lowering down to the level of the Cretaceous chalks at sea level.

When the North Atlantic was opening the area would have experienced rifting and movement on faults which suggests that rather than being a single line of weakness here, there may have been several faults forming a fault zone, and the movement has left the chalk in the sea cave with a fractured and brecciated appearance (Fig. 3).

Fig. 3.
Joyce Stewart

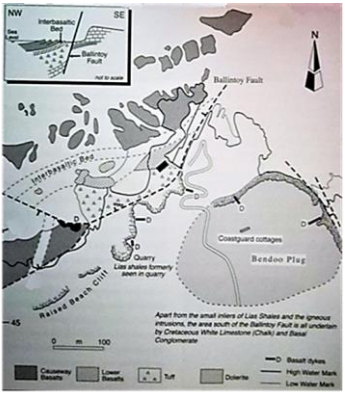


Fig. 2. Geological map of Ballintoy Harbour
A Geological Excursion Guide to the Causeway Coast by Paul Lyle

This fault boundary filled with the Causeway Tholeiites north of the faults (Fig. 2). The chalk was characterised by having quite obvious flint nodules which also appear to have been crushed by the faulting (Fig. 3).

Fig 2. Geological map of Ballintoy Harbour. A Geological Excursion Guide to the Causeway Coast. *Paul Lyle*

Beside the cottages we got up close to Tertiary volcanic rocks. We first had a look at the laterite with the younger basalt flow on top (Fig. 4). As the lava flow cools the vesicles left behind by the escaping gasses are filled with secondary minerals called amygdales, such as calcite, quartz, chlorite or one of the zeolites. Typically, the Antrim basalts are quite amygdaloidal. These amygdales are a useful tool telling us about the thickness of the basalt pile and the fluids that passed through it at a later time.

Fig. 4.
Joyce Stewart

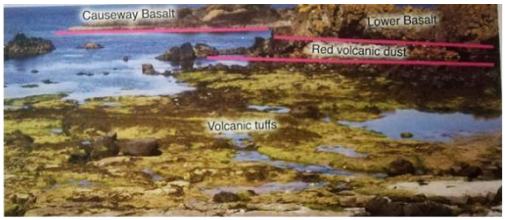


Fig. 5. Lower Basalts underlain by red volcanic dust and with Causeway Basalts to Seaward
A Geological Excursion Guide to the Causeway Coast by Paul Lyle

We were standing on two beds of volcanic tuff (Fig. 5). The first bed nearest the laterite was pale green volcanic tuff and the next a darker basaltic tuff. This volcanic ash would have been ejected by a nearby explosive vent, the likely source being the vents just at the next headland at Carrick-a-Rede and Kinbane Head.

We stood right on the fault line at the harbour with black rocks on one side and white rocks on the other. A similar scenario was to be found at White Park Bay.

There were further examples of this fault breccia viewed as we walked along the raised beach where the fault planes had a different orientation than before. Again the action of the sea emphasised the fault and you could see the fractures and stresses the whole way through the rock. The chalk formed at the bottom of the sea bed following the gradual accumulation of calcium rich shells, mainly cocoliths.

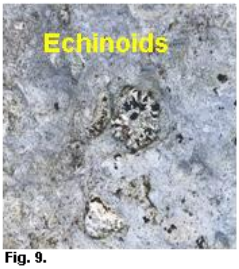


Fig. 9.
Joyce Stewart

Continuing along the coast where the chalk is not so brecciated, you can identify some fossils in the chalk, Echinoids (a kind of sea urchin), Fig. 9 and belemnites (bullet shaped fossils, essentially the core of a squid type creature).

Fig. 11.
Joyce Stewart

There were also numerous horizons of flint nodules to be found within the chalk (Fig. 11). It is thought that flint forms in pockets in the sediment as a result of siliciclastic input from silica rich organisms such as the spicules of sponges. The flint nodules are typically elongate round or tabular but they can be found in larger more cylindrical shapes called paramoudra flints. With the combination of the cave systems and the abundance of flint, this area was popular in Neolithic times. There are signs along this coastline of early human habitation by Neolithic people in the form of so called axe factories, producing knapped flint and axe heads.

Fig. 12.
Joyce Stewart

We came across another section of raised beach with sea stacks and sea arches on our way to White Park Bay where there were clear signs of instability. The bedding in the chalk cliffs at this point was much more apparent and essentially, we were not far away from the base of the chalk sequence. The whole slope is characterised by rotational slumps, landslips off the edge of the cliffs. This is a function of sea erosion but there is also a geological reason. The underlying Jurassic is a Liassic or Lias known as the Waterloo Mudstone Formation. This mud and clay forms a slip surface and so the chalk cliffs are moving into the sea forming stacks. As we walked further there was a freshwater stream (with delicious watercress growing all around) emerging from the base of the chalk as the water could not pass through the underlying impermeable clays. The exposed chalk here had a larger grain size and the lower beds contained fragments of rock and pebbles. These course grained beds are referred to as Conglomerates, which formed as a result of flooding of the Jurassic surface by the sea in the Cretaceous. Regrettably, because of the tide, we did not make it around the headland to the Jurassic rocks. Incidentally, the last picture (Fig. 12) shows our view from the grass verge where we sat and ate our lunch while looking onto Elephant Island, before returning to Ballintoy car park with our excellent guide Fiona.

Saturday 9th Sept, pm

Report: *Joyce Stewart*

Bendaloo Pug and Portrush Sill

Fig 1. Path to Bendaloo Plug

We started the afternoon excursion walking up to a lime kiln above Ballintoy harbour. There are lots of lime kilns in the area due to the large-scale mining of the chalk. There was a stunning view from the top. No wonder the Antrim coast is designated an area of outstanding natural beauty.

Above the kiln, Fiona showed us a basalt dyke intruding into the chalk. The chalk is the remains of microscopic algae in the sea around 100 million years ago and the basalt formed by volcanic eruptions about 60 million years ago.

Fig 2. Dolerite dyke intruding chalk

We went on to see where the chalk exhibits a fractured appearance which is known as breccia. We saw flints in the chalk in layers, some of which were linear and in other parts not so linear.

We followed the path east of the harbour to the beach with the dolerite Bendoo plug which pushed up through the chalk and is cylindrical in aspect and about 350m in diameter. When the hot magma comes into contact with the colder rock it is called intruding.

The rock often becomes hardened with the heat and discolours the contact rock. This is known as contact or thermal metamorphism. As the changes at the contact between the dolerite Bendoo plug and the chalk are slight, the zone of metamorphism is only a few centimetres wide. This shows that it was not a long lasting intrusion and not a major feeder for the Antrim lavas. The erosion from the sea has left the harder dolerite plug and eroded the softer chalk rock leaving not much chalk showing on the shore until you go back to the cliff edge. We searched for small belemnite fossils in the chalk; there were very little samples available to see. We then walked back to the cars to drive to Portrush.

Fig3. Bendoo Plug Erosion

Fig. 4. Chalk erosion

Unfortunately the dry weather did not last – it started raining at Portrush. Fiona informed us of the two schools of thought on the origin of igneous rocks – one Neptunists, who thought that these rocks were crystallisation from seawater. The other, known as Plutonists, thought that the rocks were the crystallisation, or solidification of molten material. At first the Neptunists were winning due to the appearance of fossils in what they thought was basaltic rock led by Reverent William Richardson in the late 18th century.

By the early 19th Century it was discovered that the Reverend Richardson had mistaken the Lias rocks with ammonite fossils for Basalt. He had not noticed the contact between the Lias rock and the coarser dolerite and the sill.

The Portrush sill extends offshore and forms a chain of islands called the Skerries. The sill is formed from a coarse dolerite intruding into Lias mudstone (part of the lower Jurassic period) which was baked by the hot magma into a hard dark fine grained brittle rock known as hornfels. There are many ammonite fossils found in the baked Lias mudstone. These Jurassic rocks are identified by the appearance of a specific species of ammonite known as *Psiloceras Planorbis*. In 2014 geo-vandalism occurred and sixteen rocks believed to contain samples of the ammonite fossils were stolen from the Portrush Sill nature reserve, spoiling the site for future generations.

After a very enjoyable full day with our excellent leader Fiona we drove back to our hotels to get ready for our dinner at Elliott's Bistro.

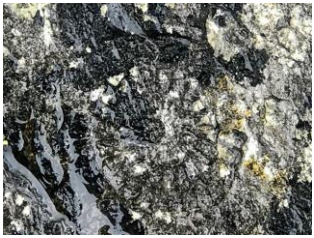


Fig. 5. Ammonite fossil in the Jurassic mudstone.

Sunday 10th Sept, am
Reporter: *Anne Gray*

Giant's Causeway

Under Fiona's expert guidance, we had been travelling up the geological time scale from the Dalradian schists at Cushendun, to the Cretaceous limestone cliffs along the northern coast. Today we reached the Paleogene with the Giant's Causeway. The Causeway consists of tens of thousands of basalt columnar blocks, some still intact in the hillside and rising 10 to 25 metres high, some truncated to stepping stone level and reaching out in a vast tapering pattern into the sea and towards the Scottish coast. Under the aegis of the National Trust, the site has World Heritage Status, both for its outstanding natural beauty and geological significance. These tholeiite blocks were formed at the time of the opening of the Atlantic, between 60 and 55 million years ago. Following an initial pulse of relatively thin basaltic lavas which make up the Lower Basaltic formation, the Causeway lavas were a short-lived and highly regional extrusion which poured into a deep river valley that became blocked allowing the lava to become deep and to cool more slowly, forming tall columns in the typical 6 sided formation. A second pulse of thinner layers of lava then capped these tholeiites and preserved them, creating the spectacle we enjoy today.

On the 15 minute walk down from the interpretive centre to the shore, Fiona pointed out several features: the presence of a red laterite layer above the lower basalt, in testament to the subtropical conditions that pertained for Northern Ireland 60 Ma.

Fiona points out onion weathering, Giant's Causeway *Bill Gray*

Also indicative of weathering were the examples of onion weathering in some of the blocks. Through the Giant's Gate we assembled at the foot of a wall of 8 metre high columns and examined their vertical jointing, and horizontal joints that formed ball-and-socket patterns. We were then free to wander across the stepping stones in the footsteps of the giants of old.

We gathered again to walk up the scenic path to the Organ, a bank of 20 metre high columns capped with entablature; this foliage-like topping Fiona explained as having formed from the flow of river water over the lava and cooling it faster, resulting in much smaller and irregular columns. Further up this path we encountered an impressively wide bed of laterite, bright red and with much coloured markings, the most famous of these being the Giant's Eye. The pale colours form by reduction of the iron in the laterite. Its thickness indicates a long period of weathering before the upper basalt was laid down. As we turned the corner, more columnar formations on the far side of the bay were visible. Very tall columns, these were interesting in that they displayed horizontal joints two-thirds

of the way up the columns, where the cooling from top-down had met the cooling from the base upwards. As well as numerous photos of geological significance, we were treated to wonderful scenic views of the Antrim coastline. We then returned, some by the courtesy bus, some by rock steps in the hillside, to coffees and lunches at the café.

Group Photo Giant's Causeway *Bill Gray*

The Organ Colonnade and Entablature *Bill Gray*

Sunday 9th Sept, pm

Reporter: *Seonaid Leishman*

White Rock Beach

After the hustle and bustle of The Giant's Causeway it was good to drive to the car park above White Rocks Bay and descend to a beautiful sandy beach almost empty apart from a few surfers and dog walkers. The sand by the way is not local; it must be 'imported' by tidal action. We were standing beneath magnificent cliffs of the White Limestone Formation. These are in fact Northern Ireland's very own White Cliffs of Upper Cretaceous chalk similar to the White Cliffs of Dover. The chalk is a pelagic limestone formed from protozoa (cocoliths and foraminifera) in shallow water. It contains bands of flint – precipitation of silica in the calcareous ooze which may be caused by water depth change. The conchoidal fracture of flint means it was treasured as a cutting tool and weapon. Before we investigated further Fiona pointed out the major unconformity exposed on the roadside far above us. It is stark and obvious – the black Lower Basalt Formation undulating on top of the White Limestone Formation. This is the earliest evidence of explosive volcanism at the base of the Antrim lava.

On the beach we were to discover the inner workings of this explosive volcanism, but first we worked out why this chalk is so very hard. It had been 'cooked' as it lay buried under many layers of molten magma and is therefore hornfelsed. It is still pretty pure and can be used in medicine as well as industry.

The volcanic mechanism comprised magma rising via dykes which eventually met water on the carst chalk landscape. The explosion produced tuff and a zone of destruction which was then infilled with chalk boulders and basalt agglomerate. As we wandered along the cliffs, in and out of weathered chalk arches we saw examples of all stages. Some of the flint accretions were shattered, others pink coloured because of iron from the lava.

A dyke intruded into the limestone cliffs *Seonaid Leishman*

It was disconcerting to be fossil hunting in this scene of desolation! In the pristine chalk, folk found evidence of Belemnites, Echinoid spines and brachiopods including *Rhynchonella*. Near to the vents even the fossils showed evidence of destruction!

Remains of the huge vent on the beach *Seonaid Leishman*

Fossil hunting! *Seonaid Leishman*

Mon 11th Sept
Reporter: *M Donnelly*

Carrack-a-Rede Rope Bridge

Our final morning started off showery and blustery with bits of sun and blue sky coming and going. The plan was to visit and cross over the Rope Bridge. However we were greeted in the car park of the Inn by Fiona who told us that we were unlikely to get across as the wind was too strong. We set off regardless, east along the north coastal Ballycastle road, taking a narrow road signposted to Larry Bane just past Ballintoy, and down towards the coast. This was steep and curvy – quite a challenge – but took us to the car park and café about halfway down the cliff. Here the wind was strong and gusty, 40 mph; the Rope Bridge was indeed closed so, as ever, we had a brief respite in the café before heading along the coastal path at the edge of steep cliffs. We walked past the huge Knocksoghy Sill with its towering columns of dolerite and its disused quarry at the base. This is the only sill in Antrim intruded into the basalt, part of which probably forms Sheep Island offshore. We stopped from time to time to take in the view – Sheep Island looked beautiful and mystical in the occasional sunbeam. The path took us to the top of a ***very*** long flight of steep wooden steps down the face of the cliff and we started the descent. The gusts of wind were **very** strong and at times we had to hold on tightly to the wooden railing to prevent becoming airborne!!

Halfway down there was an open area with an information board and a marvellous view of Carrick-a-Rede, the bay with its immense cliffs and the wild blue sea whose breakers were crashing against the coast. Then we were off again on the second stage down to the bridge. Its entrance was barred by a sturdy steel gate and guarded by a friendly 'National Trust lady'; we could look over and see a **very** steep ladder of about fifteen steps leading right to the bridge.

The Rope Bridge *M Donnelly*

At about 600 m in diameter, Carrick-a-Rede Island and the surrounding land are the remains of the most extensive explosive volcano in Antrim, erupting at the start of the igneous activity about 60 Ma. The main vent is just adjacent onshore and extends to the rocks under the bridge, both on and off the island. It consists of agglomerate of basalt blocks up to 3 m in diameter in a matrix of volcanic ash with a few fragments of chalk and Lias clay country rock. The ash has hollows and cavities suggesting the presence of finely ground soluble limestone. Further afield the agglomerate is of basalt, chalk and Lias clay

fragments and all of this was blown out of the volcano during the initial explosive phase. In its later phase, dolerite sills were intruded, one of which forms the cliffs on the east side of the island.

While we were down at this entrance we had the opportunity to examine the agglomerate closely on the hill slope, as well as that on the island from a distance. We also had an excellent view of the tall columns of the dolerite sill on the east of the island.

Sheep Island *M Donnelly*

We then made our back up the massive flight of steps and to the car park, where Fiona was presented with a token of our appreciation for a marvellous weekend, for all the experience and knowledge which she had shared with us, and for taking us to little known sites which we should never had found by ourselves.

References

1. Our Leader's itinerary
2. **Lyle, P.** *A Geological Excursion Guide to the Causeway Coast. Northern Ireland Environment Agency, Department of the Environment. Third Edition, 2014.*

Day Excursions

Dunbeg, Kilewnan Burn and Dunmore from Fintry

The Glasgow contingent arrived by coach at the Fintry Sports Club which provides all facilities, which included coffees for some of us while we waited for the Edinburgh members to arrive.
Con Gillen was to be our leader. He and Mike Browne produced the recent Guide to the Geology of the Stirling Area, which includes this excursion. In addition we were privileged to be joined by Peter Craig – no one knows the area better! In 2011 he made a major contribution to the Campsie Fells Strategic Review – 37 suggested sites and 7 geo-trails. Perhaps one of these days the Review will be actioned……

Today we were to follow a trail above Fintry and study vents, pipes, plugs, sills and the relationship of the base of the volcanic sequence to the underlying Ballagan Beds.

By taking the old quarry road south of the village through the Fintry woods we came to our first exposure. (But the last in the Guide - it is a late phase in the Linear Vent System). The ringing tone when the rock was hammered gave the clue. This is phonolite trachyte, a late stage evolution in the Clyde Plateau Volcanic Formation, extruded through sediments laid down in tropical conditions. It is rare, but can also be seen at Dumbarton Rock. Trapairn Law is true phonolite.

Once through the woods we walked East along the wall to Dunbeg, a volcanic plug intruded through the Clyde Sandstone Formation which is exposed just south of the wall. The vent was infilled with breccia formed by explosive gases. After these had escaped there were mini 'squirts' of lava through the sandstone.

We then climbed gently south west in the direction of Dunmore and got a good view of the lavas on the North side of the Campsies. They gently dip to the east and are separated by large ash flows giving the classic stepped profile. These step/trap lava flows could have been up to1000 years apart therefore laterite could form.

Trap formation

Dunmore is part of this major vent system which includes Dumbarton Rock, Garnock, the Gavachan system, perhaps also Endrick. (Dumgoyne, Dunfoyne etc. form the later and last of the linear vent systems.) Further up towards the main lavas is supposed to be a Covenanters' meeting place, "Covenanters' Hole". The 'hole' was formed by one of many landslips along this face.

So far so good for weather. However, the forecast had NOT been great, and with spits of rain forming we decided to huddle amongst some gorse bushes for lunch before donning the necessary wet weather gear and clambering down towards, and sometimes into, the Kilewnan Burn.

Here we discovered some good exposures of Ballagan Formation – dolostone and cementstone.

Ballagan Beds

These formed in a period of evaporation in shallow salty water therefore little evidence of life. We would appear to be at the top of the Formation which shows red/green weathering. Peter Craig's work on this section shows that this is conformable with the younger Clyde Sandstone Formation –which we discovered further upstream.

The next exposure was another volcanic vent. Here the tuffs and agglomerate contain charcoal, evidence of plant life on the contemporary land surface**.**

Photovent in Kilewnan Burn

At this point the excursion continued uphill towards Dunmore and I decided to bail out – mainly because it looked as though the weather forecast had been correct…..

This photograph of the columnar basalt at the top is courtesy of Will Frampton, one of the folk who braved the full-on thunder, lightning and torrential rain. The change in orientation of the columns shows the trumpet-like nature of the intrusion. Vertical in the middle and sloping towards the edges.

columnar jointed basalt

The members of the Group who had avoided the hill climb and storm had to put up with having tea and cake in the Fintry Sports Club while awaiting the arrival of their VERY wet friends! The Club's facilities and friendly staff ensured that everyone was soon comfortably seated for a very pleasant high tea. At each table there was much chat and sharing of past geological experiences – and promises of meeting up at the next Joint Excursion. Con and Peter were warmly thanked for their generous sharing of expertise, with the hope of more discoveries to come. Once again Roy had organised us all in his calm and efficient way!

Tyndrum & Glen Orchy: 10 June 2017

Leader: Iain Allison 9 participants

Report by: *Bill Gray*

In today's excursion we visited rocks in the Central Highlands Terrane belonging to the Dalradian Supergroup. The sediments forming these rocks were deposited as mainly marine sands, silts, muds and calcareous sediments during the Neoproterozoic and early Palaeozoic eras and the rocks were deformed and metamorphosed during the Mid-Ordovician Grampian Orogeny. The Dalradian Supergroup is divided into the *Grampian, Appin, Argyll and Southern Highland groups*. The excursion was split into two parts: in the morning we looked at the workings of the old Tyndrum lead mine and in the afternoon we visited several localities in the classic Glen Orchy/Beinn Udlaidh area.

The coach carrying our small but enthusiastic group arrived at the Green Wellie car park in Tyndrum at 11:00 and we disembarked into an unseasonal drizzle. We followed a marked path SSW from the road and went through the underpass under the railway, turned right to follow the path beside the railway and then left to follow a stream and climb the hill towards the workings of the lead mine (grid reference NN 321 305). Before we started the climb, Iain gave a short talk to set the scene. He explained that the mineral veins occur in fractures associated with the NE-SW Tyndrum-Glen Fyne fault, a late Caledonian sinistral strike-slip fault which has placed middle Dalradian Argyll Group rocks east of the fault against lower Dalradian Grampian Group rocks to the west. The Argyll Group comprises various types of sedimentary rocks – sandstones, shales and limestones – now metamorphosed, while the Grampian Group consists of meta-sandstones (psammites). The Grampian Group rocks behave in a very competent manner compared to the Argyll Group rocks when subjected to

fault movements and so have been intensively fractured to produce extensive open cavities into which the mineralising fluids flowed and precipitated the vein systems.
The mineralisation consists mainly of vein quartz (but also a little chert) with sphalerite (zinc sulphide) and galena (lead sulphide). Other minerals that may be found are chalcopyrite, pyrite, barite and calcite. The mineralisation is thought to have occurred less than 1 km below the surface during the Lower Carboniferous (~360 Ma), just before the Campsie lavas were extruded and around the same time as the big Irish Pb-Zn deposits were formed. The mine produced 20,000 tonnes of ore at >30% Pb+Zn and was worked from 1741 to 1929.

The party at the spoil heap near one of the shafts of the Tyndrum lead mine. *Bill Gray*

We climbed to one of the lower shafts, which was fenced off for safety reasons. The first part of the climb was alongside the stream, with spoil on either side, and the last part was over a more concentrated spoil heap. Most of the spoil was quartz and calcite (the calcite was precipitated from the mineralising fluids just like the quartz), but we found one or two specimens of galena and several specimens of sphalerite and barite. On the way back we stopped to look at tailings pond and waste dumps at the site of the former processing plant.

We returned to the coach at the Green Wellie for our picnic lunch before setting off for the afternoon session in Glen Orchy.
The Glen Orchy-Beinn Udlaidh area has been extensively studied by Tanner and Thomas (2010) and shows large flat-lying fold nappes refolded into an open dome, the Orchy Dome. The rocks involved in the section that we studied are the Meall Garbh Psammite of the (lower) Grampian Group and the overlying Beinn Udlaidh Quartzite and Coire Daimh Pelite of the Appin Group. Although these rocks have been deformed and metamorphosed, in places original sedimentary structures may be observed and are important in interpreting the regional structure.
Treagus (2009) describes a geological excursion from south to north through the southern part of Glen Orchy. We travelled through the entire length of the glen in the coach along the B8074 but went from north to south, along the east bank of the River Orchy. We stopped at four localities, of which the first two were not described by Treagus, but the second two were. This itinerary provided a traverse across the Beinn Udlaidh Syncline from the lower, right-way-up, limb to the upper, inverted, limb. (Although the Beinn Udlaidh fold has younger rocks at the centre and is therefore a *syncline*, it is actually slightly inverted, and so is an *antiform*). The weather steadily improved throughout the day and the sun broke through at the last locality.

Locality 1 (NN 278 367). This stop was beside a bridge across a stream entering the River Orchy at Invergaunan. This locality was in the Meall Garbh Psammitic Formation of the Grampian Group, and the rocks on the banks of the Orchy could be seen to have a dipping fabric, which was a tectonic rather than a sedimentary feature. We didn't linger long here as the local midges had discovered our presence!

Locality 2 (NN 266 356). Easan Dhuba waterfall.

At this locality we had the chance to examine the Meall Garbh Psammitic Formation more closely. The dip was to the NW and the rock showed compositional variation, with a fining-up structure, indicating that it was the right way up. (We were still on the lower limb of the Beinn Udlaidh Syncline.) An outcrop on the opposite bank of the Orchy displayed no layering. This was a volcanic vent filled with a quartz breccia.

The Meall Garbh Psammitic Formation at Locality 2. The rocks dip away from the camera, to the NW. *Bill Gray*

Locality 3 (NN 248 330) (Locality 2 in Treagus (2009)). This was our longest stop and we walked along the river bank northwards on a gravel track to examine and discuss the rocks. We were now in the Beinn Udlaidh Quartzite (elsewhere the Glen Coe quartzite; Lochaber subgroup of the Appin Group), still in the lower, right-way-up, limb of the syncline but nearer the axial plane. We saw some blocks of quartzite displaying cross-bedding in the river and eventually reached an exposure of quartzite on the river bank that displayed a beautiful pattern of flat-lying minor *asymmetric* folds. (An asymmetric fold has an S- or a Z- shape.)

Although these were minor folds, they were actually fairly large (see the picture). This locality provided an ideal opportunity for a consideration and discussion of *vergence*, a concept which allows the direction of the axial plane of a major fold to be determined from the structure of the minor folds within it. Iain gave us a wonderful explanation of the concept with the aid of a whiteboard and coloured pens.

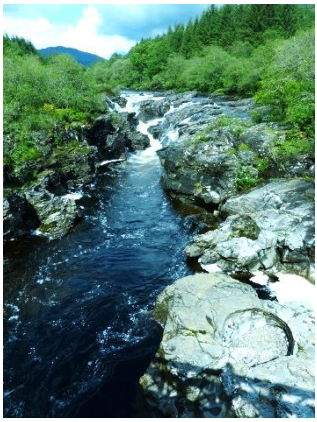
Iain describing the asymmetric folds and explaining vergence at Locality 3. *Bill Gray*

We determined that the vergence of these folds was to the south and so the axial plane of the antiform (syncline) to which the folds belonged was to the south. The structure here is termed "fold mullions" and is an excellent example with trains of folds with rounded parallel hinges.

Locality 4 (NN 243 322). Iron Bridge and Falls of Orchy. (Locality 1 in Treagus (2009)). Our last stop was at the Iron Bridge over the River Orchy, just south of the Falls of Orchy. The sun had now emerged and we enjoyed glorious weather for the end of the excursion. From the bridge we looked north and could see that the rocks in the river bed were darker than those we had seen previously. These were from the Coire Daimh Pelite Formation (elsewhere the Leven Schist), which lies immediately above the Beinn Udlaidh Quartzite. The beds were dipping to the south-west and were marked by numerous large potholes.

We walked about 200 metres down the road to the south, past an artificial salmon leap to a point where we had access to a prominent exposure in the river bed. This rock was lighter in colour than the pelite and in fact we were back in the Beinn Udlaidh Quartzite.

We had crossed the core of the Beinn Udlaidh Syncline and were now on its upper, inverted, limb. The quartzite displayed flat-lying minor asymmetric folds similar to those we had seen at Locality 3, but this time the vergence was to the north, confirming that we had indeed crossed the axial plane of the syncline. However, persuasive sedimentary structures to determine the way-up were lacking.



Looking north from the Iron Bridge towards the Falls of Orchy at Locality 4. The rocks belong to the Coire Daimh Pelite Formation. A large pothole can be seen in the foreground. *Bill Gray*

We returned to the coach at around 4:15 pm, after a most enjoyable day exploring the geology of the Tyndrum and Glen Orchy area. We were full of admiration for the effort that Thomas and Tanner must have put into the task of mapping the area and for the skill that they had applied in working out its geological structure. Some of us even had a discussion about vergence on the journey back to Glasgow!

References

Tanner P.W.G. & Thomas P.R. 2010. Major nappe-like D2 folds in the Dalradian rocks of the Beinnn Udlaigh area, Central Highlands, Scotland. *Earth and Environmental Science Transactions of the Royal Society of Edinburgh*, **100**, 1-19.

Treagus, J. 2009. Excursion D: Glen Orchy. *In* Treagus. *The Dalradian of Scotland*. The Geologists' Association, London, 47-50.

Saturday 24th June. Glasgow Museums Resource Centre

Leader: Ann Ainsworth Participants 15

This morning excursion is a guided tour of the Glasgow Museums Resource Centre at 200 Woodhead Road, South Nitshill Industrial Estate, Glasgow G53 7NN. You will need to arrange your own transport. The centre is about 5 minutes' walk from Nitshill railway station. Museum staff will be showing us some of the many items in the geology collection which are not on public display. Because of restricted space within the building, numbers will be limited to 15 but, in the event of higher demand,
a further trip will be offered on another occasion.

We are shown some of the Centre's 'special' specimens. *Hugh Leishman*

Saturday 22nd July. Comrie including Highland Boundary Fault and Earthquake House

Leader: Dr Simon Cuthbert

Comrie lies on the Highland Boundary Fault and has been called the "Shakin' Town" because of the frequent seismic activity there, especially during the 19th century. Our visit will focus mainly on the geology in the Grampian block immediately to the north of the fault where we will explore beautifully exposed examples of contact metamorphic changes to the Dalradian Aberfoyle slate adjacent to a late Caledonian diorite intrusion, the Comrie Pluton at Craig More.

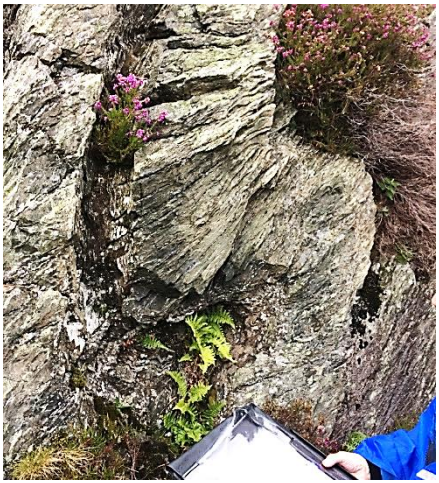
We will visit the famous "Earthquake House" by The Ross, just west of the town and see an early example of a seismometer. In the afternoon we will take a walk from Comrie along Glen Lednock to see the De'il's Cauldron waterfall where the River Lednock has incised a rock-cut gorge, and finally return to the Comrie pluton to examine the igneous rocks themselves and their contact relations with the country-rocks. Comrie has some excellent opportunities for cake, and if we are not too long delayed on the rocks we may wish to explore these too! The trip will involve a few km of variably rough and boggy walking, sometimes quite steep for short intervals.

The 'Earthquake House', erected by BGS in the mid 1860's. *Katerina Braun*

Little Glen Shee Sat 29th July 2017
Leader: Dr Con Gillen
Reporter: Maggie Donnelly

We travelled by coach up the A9 and turned NE just north of Dunblane onto the A822 to Crieff where we stopped for a short break. Continuing east on the A85 we soon turned north again and then east onto the B8063, through Glen Almond. On the left, near Drumharrow Cottages [NO 0220 3080] and the signpost for Little Glen Shee, we followed a single track minor road for about 5 km, to the track up the glen [NN 9870 3410]. Here we parked in a space beside a sharp bend in the road and met our leader. We all then walked along a good track west past Little Glen Shee farm steading, until we came to a large boulder by the track painted (now faint) with "No dogs" [NN 9792 3447]. On the right hand side of the valley, the exposure [NN 9792 3453] was a 50 m-long, west-facing low cliff about 50 m up the bracken and heather-covered slope. Our group scrambled up for a closer look.

We were in the 'Birnam Grits', on the steep limb of the Highland Border Downbend and the inverted limb of the Tay Nappe, and folds of interbedded pale-greenish grey metasiltstones and graded metasandstones could clearly be seen. There were sparsely preserved ripple cross-laminations; the folds had a spaced pressure-solution cleavage in the sandy layers which bent to a fan shape around the nose, and a slaty cleavage in the more-micaceous lithologies. These were high-level F_1 folds and they verged to the NW. The grading was picked out by the refraction of cleavage towards the fold axial plane with decreasing grain size. Younging directions, determined from normal grading and possible cross-bedding, showed that the beds were inverted and that the folds were downward facing.



The pressure-solution cleavage fans were asymmetric about the fold axial planes, with the cleavage on the southern limbs of synforms generally closer to the fold axial plane than that on the northern limbs. On these southern limbs, original bedding laminations between the cleavage planes were commonly up to 80° oblique to the gross bedding and within some sandy beds the pressure-solution cleavage was folded. This was a truly amazing locality and having taken numerous photos we set off for the next one.

Close up of spaced cleavage curving and fanning round

Vicky Scott

We drove to Bankfoot and followed the B867 (the old A9) north towards Dunkeld (having lunch *enroute*!!). 300 m before the junction with the new A9, we parked on the left-hand side of the road where a public footpath went under the railway [NO 0410 4045]. Following this path for about 50 m we took a footpath on the left signposted to Birnam Hill. Another 50 m [NO 0403 4049] further on, there was an overgrown track on the right leading to a small disused quarry in which there was an antiformal closure of 'Birnam Grits', again on the steep limb of the downbend and the inverted limb of the Tay Nappe. Here, it seems, large pyrite cubes can be found in the beds of greenish – and bluish – grey slaty metamudstones. However, our leader had decided against this locality as it had been very wet and muddy a few days earlier. Instead we continued a short distance north uphill and walked out into a huge quarry [NO 0378 4052], with a great black face of the 'Birnam Slates' staring back at us…….and it was dry underfoot!!!! A large antiform/syncline pair could be distinguished in the rock face, and again the folds in this locality are high-level F_1 folds. There was abundant loose material on the ground which we quickly fell to investigating, finding tiny folds and minerals such as copper pyrites, galena and barites. The former was expected, but not the latter two – perhaps there had been a quartz vein now quarried out, or they may have been exotic, brought in rubble to floor the quarry. We then approached close to the wall and found slaty cleavage and evidence of bedding. Eventually we made our way back to the coach.

Driving north from Birnam Hill we joined the A9 and passed Little Dunkeld before turning to the left [NO 0138 4230], at the signpost for The Hermitage, and parked in one of the two large car parks. We set off along the path south-westwards by the river, and quickly met a stream of guests returning from a wedding in Ossian's Hall (National Trust) – at the hall we met the bride and bridegroom having photos taken!! We continued beyond the first right-angled bend upstream and gingerly made our way down onto the large and quite slippery(!) flat exposure in the Dunkeld Grit Formation [NO 0078 4178] on the north bank. These rocks were also within the steep limb of the Highland Border Downbend, and now

only 800 m SE of its hinge. The metamorphic grade is higher than at Birnam Hill; the cleaved metasiltstones were phyllitic with a high percentage of muscovite and D_2 deformation was well developed locally with tight folding of the first pressure-solution cleavage (S_1). Thick composite sandy (psammitic) units were interbedded with mixed sandy and muddy (pelitic) units but convincing graded bedding has not been found, so that the structural facing cannot be demonstrated. Crossing the flat surface, we could see the relationship between F_1 and F_2, but it was difficult to identify the bedding in places. At the NE end of the rock pavement, below a low vertical face, S_1, a 0.5 to 1.0 cm spaced striping (tiny cleavage) in the metasandstone changes its orientation relative to bedding across the exposure. This indicated the presence of a fold – an F_1 synform. All the F_2 folds of S_1 verged towards the NW and had steep axial planes generally orientated close to bedding. Bedding here is also difficult to see, but can be detected by the absence of S_1 striping in more-pelitic beds. These beds carry a crenulation cleavage that dips at around 45° to the NW and is probably related to the downbend.

We returned to the car park and thanked our leader, Dr Con Gillen, for providing such an excellent day and an adventure in which we were shown aspects of geology seldom seen and which are truly fascinating.

Reference

Excursion Handout.

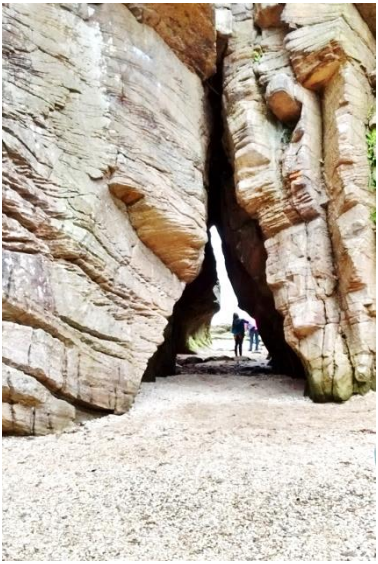
GEOLOGY OF THE STIRLING AREA. An Excursion Guide. Browne, M.A.E.,& Gillen, C., (eds)
Edinburgh Geological Society 2015

Saturday 19th August. Solway Coast - Southerness to Powillimount

Leader: Dr. Chris Burton

The coastal section from Southerness to Powillimount within the Kirkbean Outlier forms part of the northern margin of the Solway-Northumbrian Basin which lies between the Southern Uplands to the north and the Lake District to the south. The northern margin of the basin is locally formed by the North Solway Fault, the basin itself being an extensional basin active during the Early Carboniferous (Dinantian). Synsedimentary faulting, downthrowing to the south, combined with cyclical sea-level changes to produce a wide range of sediments from open, shallow marine limestones and Mudrocks to floodplain sandstones, silts and coals as the basin-fill developed.

Faunas and floras responded to these changing conditions, and the excursion will track these responses and their resulting ecologies, as well as the various sedimentary structures to be seen, and also the tectonic structures imposed on the basin during the Late Carboniferous.
Circa 2 km of easy coastal walking



The Thirl Stane" – a 10 m high stack of the Thirlstane Sandstone Member (fluvial channel sand) with a natural arch.
Lower Carboniferous. *Seonaid Leishman.*

Intimations

Miss Evelyn Crawford; Died December 2016 member since session 140
Dr. Ian MacDonald; Died 17th March 2017 member since session 120

Norman Edward Butcher of Edinburgh. Geologist, educator and historian passed away peacefully on Sunday 23rd April 2017 at the Western General Hospital.
Dr. Butcher was born in Chichester 1928, educated at Maidstone, Sheffield and Oxford (Queen's College) and taught at Reading University and at the Open University in Scotland from its inception.
He was an Igneous petrologist, a member of Min Soc.GB & I; . and of G Soc. London, Ed. G Soc.
Awarded the Prestwich Medal, the Collins Medal and the Clough Medal
(member of GSG since session 116)

Our group in the amazing dyke quarry. *Maggie Donnelly*

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