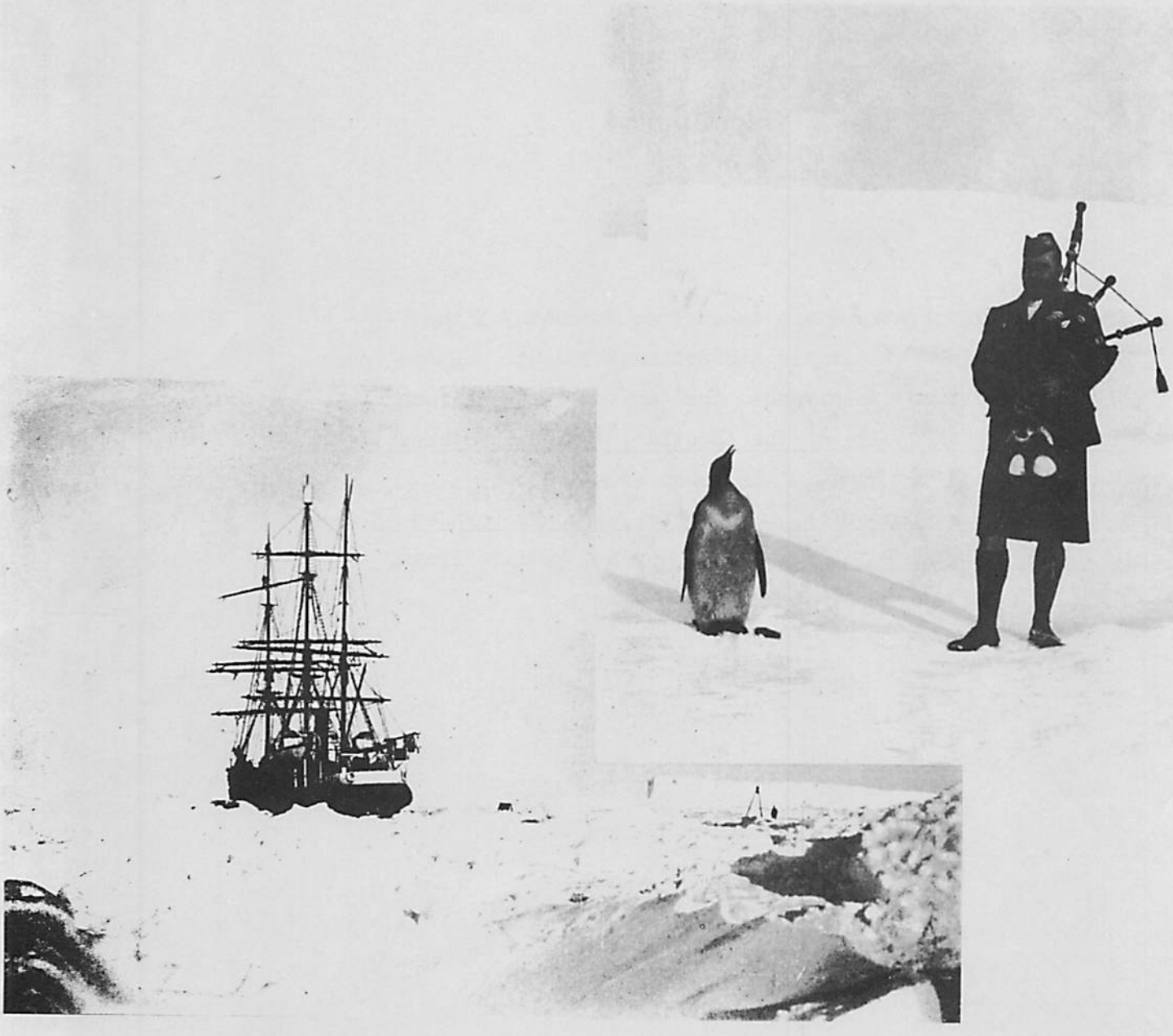
The Edinburgh Geologist



November 1979

The cover illustrations are taken from accounts of the Scottish National Antarctic Expedition, 1902-04. Photographs of the Expedition steam yacht, the 'Scotia', may be found in The Scientific Results of the 'Scotia', 1902-04, Volumes II-VII. The 'Piper and the Penguin' is taken from A Naturalist at the Poles. The Life, Work and Voyages of Dr W S Bruce, the Polar Explorer. by R N Rudmose Brown, 1923, 316 pp.

EDITORIAL

It is amazing how quickly November comes round each year and, with it, the task of preparing the first of the session's Edinburgh Geologist. This time we are very pleased to report a fine response to requests for articles: in fact we already have one or two contributions for the next issue, which is certainly a record! By mentioning this healthy state of affairs we hope members will not feel released from the essential but (we trust) pleasurable job of producing material and generating new ideas for the magazine. We would also appreciate some 'feedback', literary or otherwise and preferably constructive!

The caption competition is a new venture which could be repeated if further suitable illustrations can be found - any volunteers? We do hope you will indulge your imaginations and have a go at composing captions as we are looking forward to reading the entries! The best caption(s) will, of course, appear in the next issue.

The next Edinburgh Geologist is scheduled for February/March 1980 and contributions should reach us, please, by the end of January at the latest.

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RECEPTION

This year's Reception will be held in IGS, Murchison House, West Mains Road, Edinburgh on Friday, 7th December at 7.30 pm. Buffet, bar and entertainment will be provided. Tickets (£3, exclusive of bar) may be obtained from Mr E F P Nickless, Mr S K Monro or Mrs Margaret Sutherland of IGS, Murchison House. Telephone 667 1000.

THE MYTHICAL GRAPTOLITES OF THE SOUTH ORKNEY ISLANDS

Ian W D Dalziel
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"Our small green ship doubled Cape Dundas and slipped into its anchorage in Scotia Bay leaving Cape Burn Murdoch to port and the towering mass of Ailsa Craig well to starboard. The low field stone walls of Omond House could be seen just above the pebble beach beneath the dark bulk of Mount Alan Ramsay." Extract from a novel set around the Firth of Clyde? No, an extract from the diary of a field geologist working in the South Orkney Islands. The diary and field notes for the work on Laurie Island on whose southern coast Scotia Bay is located abound in Scottish place names: Pirie Peninsula, Cape Geddes, Ferguson Peninsula, Fraser Point, Macintosh Cove, Buchanan Point, Murray Islands, Buchan Bay and Mackenzie Peninsula are all there, together with others reflecting the heritage of the first surveyors of the island. Even more personal thoughts are obviously behind the naming of Cape Mabel and Shiela Cove!

The South Orkney Islands are located approximately five hundred miles east of the tip of the Antarctic Peninsula and the South Shetland Islands (Fig. 1). The names of the two groups of islands are derived not only from the fact that Scots seafarers were involved in their discovery, but also from the fact that their locations at 61° south latitude (South Orkneys) and 63° south (South Shetlands) roughly correspond to those of their northern hemisphere counterparts.

The South Orkney Islands were discovered in December 1821 jointly by Captain Powell of Great Britain and Captain Nathaniel Palmer of the United States, in the course of a voyage of exploration for sealing grounds additional to those recently discovered in the South Shetland Islands. The islands were

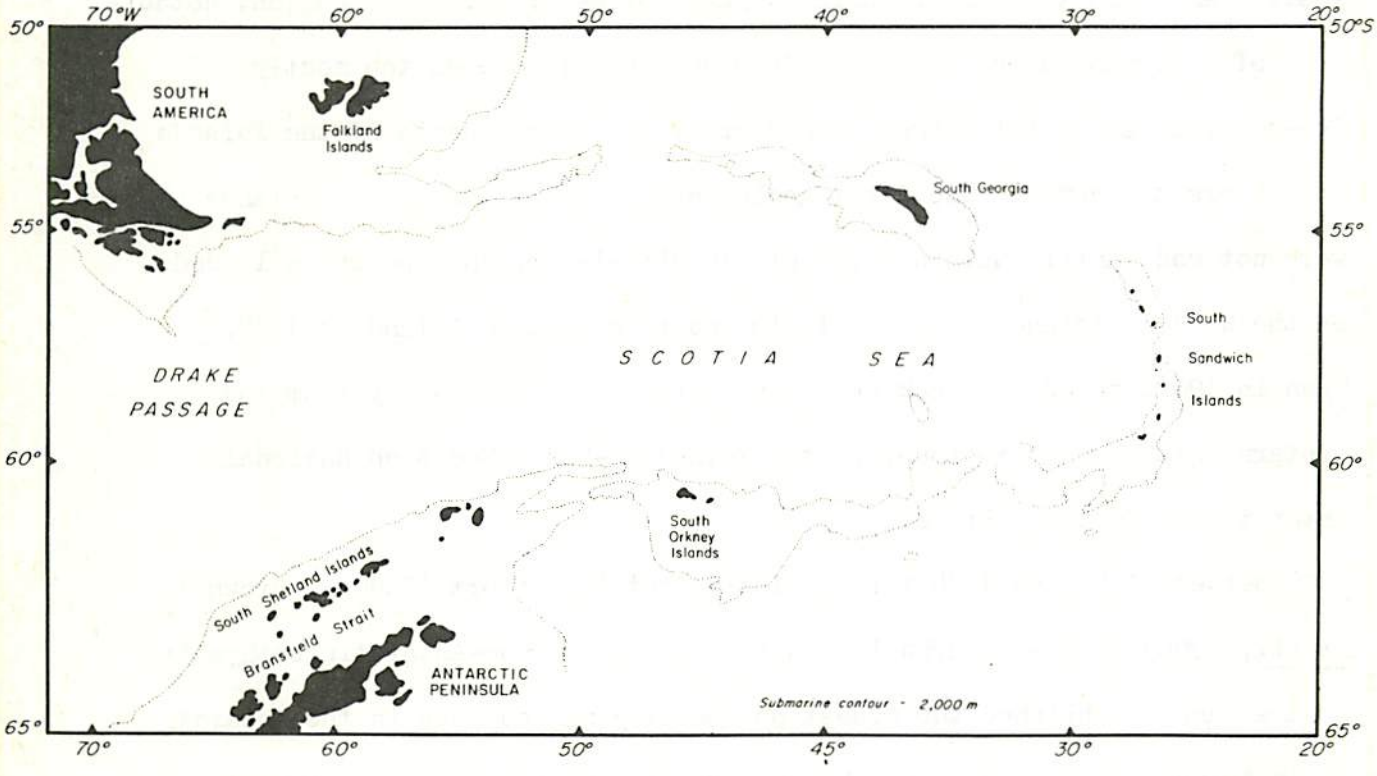

Fig. 1. Geographic and bathymetric setting of the South Orkney Islands.

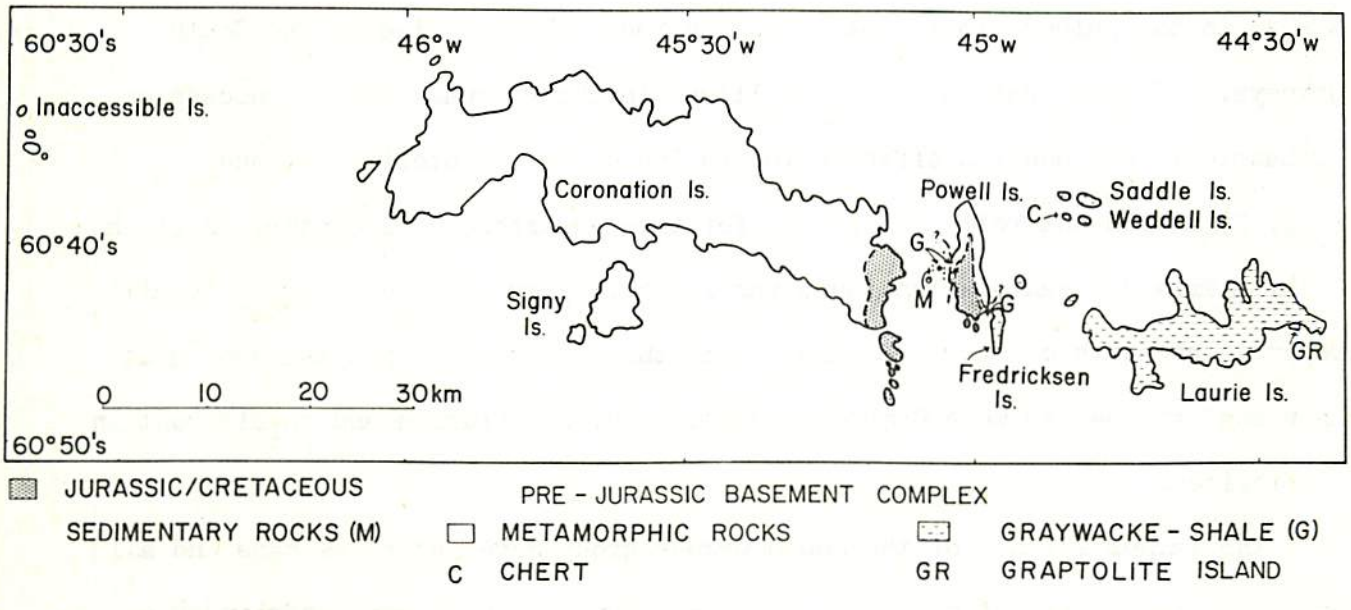

Fig. 2. Geography and geology of the South Orkney Islands.

visited again in the 1820's during voyages of geographic exploration, notably that of Scotsman James Weddell in 1823 when he discovered the mostly ice-covered, and still largely unexplored, sea to the south of the islands that bears his name. The first geological observations in the islands were not made until Captain M Dumont d'Urville's French expedition landed on the Weddell Islands (Fig. 2) to the north of Laurie Island in 1838. Then in 1902, the first rock specimens were collected, mainly from the eastern islands of the group, by the Edinburgh-based Scottish National Antarctic Expedition (Pirie, 1905).

Between 1902 and 1904 this strictly Scottish effort (Rudmose Brown et al., 1906) made a remarkable contribution to circum-Antarctic bathymetric studies and established the oldest permanently manned base in the Antarctic. The original Scottish base was handed over to the Argentine government in 1904 and has been in continuous use ever since as the meteorological station "Orcadas". Sad to report, however, is the fact that the members of the expedition, as well as some well known figures who studied material that was returned to Scotland, apparently erred badly (if understandably, given the times) in the paleontologic dating of the rocks they studied in the South Orkneys. Identification of "graptolites" in the graywacke-shale succession of Laurie Island and its offshore islets including 'Graptolite' Island (Fig. 2) misled Antarctic geologists for three-quarters of a century until in 1978, a Triassic radiolarian fauna was found in chert collected from a small rocky islet north of Laurie Island. But then every good Scottish geologist knew that graywackes were Cambrian, Ordovician, or Silurian and should contain graptolites!

The larger islands of the South Orkney group have major ice caps and all are inhabited by almost countless penguins, some of which were befriended by the Scottish National Expedition, and some eaten. The group consists of two

major islands, Coronation in the west and Laurie in the east (Fig. 2). Together with the Inaccessible Islands and Signy Island, Coronation is underlain by a metamorphic complex. Laurie Island, and its offshore islands, principally Fredriksen Island, the Saddle Islands and the Weddell Islands are composed of a sequence of graywacke and shale. The Scottish expedition made its base on Laurie Island, in the field stone-built bothy known as Omond House whose walls are still standing. On the southern coast of the island, in Scotia Bay where the expedition's brig the steam yacht Scotia was forced to winter when beset by icebergs, is situated a prominent sea stack, named Ailsa Craig by the homesick Scots. Although it does look like the real McCoy it would not yield very good curling stones since it is formed of horizontally layered graywackes that are indistinguishable from the good honest Southern Upland Paleozoic graywackes I used to have so much difficulty identifying in the first year laboratory at the Grant Institute in Edinburgh!

In some ways, therefore, it is not surprising that organic remains discovered in these sedimentary rocks a few miles east of Ailsa Craig should have been reported to be graptolites by no lesser authorities than Dr Ben Peach of the Geological Survey of Scotland and by Dr Gertrude Elles of the Sedgwick Museum when Dr W S Bruce, the leader of the Scottish National Antarctic Expedition, and Dr J Harvey Pirie, its geologist, brought the remains back to Surgeons Hall (Pirie, 1905).

The idea that Lower Paleozoic rocks, lithologically similar to those in the Southern Uplands of Scotland, existed in the South Orkney Islands persisted for approximately fifty years. The eastern (or "greater") part of the Antarctic continent was widely recognized as a Precambrian shield long before the 1950's, and Paleozoic fossils had been found in various parts of the Transantarctic Mountains and West Antarctica, so their reported presence in the South Orkneys raised no eyebrows.

While there was, therefore, no real reason to doubt the presence of a Lower Paleozoic graptolite fauna in one of the sub-Antarctic islands, Dr Raymond J Adie of the British Antarctic Survey asked other British and American geologists, including graptolite expert Dr Isles Strachan of the University of Birmingham, to examine the specimens collected by the Scottish expedition. The conclusion was that the organic remains, rather than representing original graptolites and their commonly associated phyllocarid crustaceans, are in fact indeterminate and rather non-descript plant fragments (Adie, 1957).

There the matter rested for some twenty years until the 1977 cruise of the US National Science Foundation's Research Vessel Hero (Dalziel et al., 1977). Hero was named after the small vessel in which Captain Nathaniel Palmer of Stonington, Connecticut, co-discoverer with Captain Powell of the South Orkneys, had earlier sighted the Antarctic continent. On board the present-day Hero my colleagues from the Ohio State University, the British Antarctic Survey, and I discovered a small rocky islet between the Weddell Islands and the Saddle Islands that consists entirely of bedded chert (Fig. 2). Dr David Jones of the US Geological Survey in Menlo Park, California, was able to extract Triassic radiolaria and a Permo-Triassic conodont from specimens of chert we recovered. Together with accumulating evidence that the lithological correlatives of the South Orkneys' graywackes in Antarctica are Triassic (Thomson, M R A, 1975; Edwards, in press), this discovery seems to cast a still deeper shadow on the interpretation of Dr Elles, reported by Dr Peach, that the organic remains brought back by the Scottish expedition are Lower Paleozoic graptolites. We did in fact revisit Graptolite Island in the course of the 1977 Hero cruise but were unable to find any organic material in the rocks. The island is only about one half mile in diameter, a few tens of

feet high, and it is the nesting bastion of a considerable number of rather aggressive and very dirty "chinstrap" penguins. This makes fossil hunting an extremely messy business!

Present evidence does indicate that the "graptolites" of Graptolite Island were most probably the product of wishful thinking. The recent discovery of the Triassic radiolarian and conodont fauna is in keeping with the graywacke-shale sequence of the South Orkney Islands representing, in classical terms, a fragment of Alex du Toit's "Samfrau geosyncline" deformed in the early Mesozoic during what is known as the "Gondwanian orogeny". In plate tectonic terms this means the South Orkneys were part of an early Mesozoic subduction complex along the margin of Gondwanaland prior to the break-up of the supercontinent (Dalziel, in press).

Despite the doubt over the "graptolites" and the fact that the handing over of Omond House to the Argentines was a factor contributing to the present very confused South Atlantic political situation, the Scottish National Antarctic Expedition was nonetheless a considerable success. The maps the group made by sledging around Laurie Island, though understandably inaccurate by modern standards, are still in use. The bathymetric work led to the first recognition of the submarine Scotia Ridge between South America and Antarctica (Fig. 1). For the first time the scientific world was given a basic knowledge of the geologic composition and structure of the eastern South Orkney Islands. Finally, the expedition was able to penetrate further into the Weddell Sea than any other expedition for over half a century, discovering the part of the east Antarctic shield along the margin of the Weddell Sea. This coast they named Coats' Land in recognition of the expedition's chief sponsors, members of the family that founded the still-thriving Paisley company, J & P Coats Ltd.

The one sad note on the expedition was the death of the Chief Engineer of the Scotia. Alan Ramsay died in the South Orkneys from an illness he concealed before departure in order not to let his leader and comrades down. They buried him on the side of the island "nearest to home" beneath the peak that bears his own name and although still far from home, he lies amongst many places bearing names that would be familiar to him and that are likely to remain unchanged for a long time. Even Graptolite Island will retain its name as one of historical significance despite the uncertainty that now clouds its origin.

REFERENCES

Adie, R. J., 1957. The petrology of Graham Land: III. Metamorphic rocks of the Trinity Peninsula Series: Falkland Islands Dependencies Survey Sci. Rept., No. 20, 26 p.

Dalziel, I. W. D., in press. The pre-Jurassic history of the Scotia Arc: a review and progress report, In, Craddock, C., ed., Proc. SCAR-IUGS Symposium on Antarctic Geology and Geophysics, Madison, Wisconsin, August 1977, University of Wisconsin Press.

Dalziel, I. W. D., Elliot, D. H., Thomson, J. W., Thomson, M. R. A., Wells, N. A., and Zinsmeister, W. J., 1977. Geologic studies in the South Orkney Islands: R/V Hero Cruise 77-1, January 1977: Ant. Jour. of United States, v. XII, p. 98-101.

Edwards, C. W., in press. Further paleontological evidence of Triassic sedimentation in West Antarctica, In, Craddock, C., ed., Proc. SCAR-IUGS Symposium on Antarctic Geology and Geophysics, Madison, Wisconsin, August 1977, University of Wisconsin Press.

Pirie, J. H. H., 1905. On the graptolite-bearing rocks of the South Orkneys: Proc. Roy. Soc. Edinburgh, v. 25, p. 463-470.

Rudmose Brown, R. N., Mossman, R. C., and J. H. H. Pirie, 1906. The voyage of the "Scotia": Edinburgh, Blackwood, 366 p.

Thomson, M. R. A., 1975. Fossils from the South Orkney Islands: II. Matthews Island: Brit. Ant. Survey Bull., No. 40, p. 75-79.

du Toit, A. L., 1937. Our Wandering Continents, Oliver and Boyd, Edinburgh, 366 p.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE: A PERSONAL VIEW OF THE MEETING IN EDINBURGH, SEPTEMBER 1979

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Department of Geological Sciences
University of Birmingham

The annual BA meetings have changed quite a bit over the last few years. The proceedings now take place from Monday to Friday instead of Wednesday to Wednesday which means that whole-day field trips at the weekend are no longer possible although this year there was a day geology excursion on the Monday, before the Inaugural Meeting. Another change is that there are more "themes" for days and half-days, and on the whole the meetings are less 'bitty'. As a fairly regular attender at the annual meetings, I have found that in recent years the Section C programme (geology) has kept me fully occupied and I have not felt the need to explore other Sections as I used to.

There were of course a considerable number of differences between the 1951 and 1979 meetings in Edinburgh apart from the two already mentioned, as well as many similarities. In both, the Civic Reception was held in the Royal Scottish Museum and also in 1951 the Section C committee met in the Heriot-Watt building in Chambers Street although the University of Edinburgh was then the host. The Inaugural Meeting for 1979 in the McEwan Hall was

not as colourful as in 1951 (in the same hall) when it was customary for many of the audience to wear academic dress as well as those in the official processions.

The first lecture of the geology section always used to be an account of the local geology (given in 1951 by Robert Campbell) but this was made up for this year by having the first day devoted to the Midland Valley as a rift structure. Six speakers (3 from the IGS) discussed the history of the area from Lower Palaeozoic to post-Carboniferous times and many of the problems of interpreting the structure as a rift-valley were aired. It was interesting to hear differing views and to be told that there were still unanswered questions. Many scientific talks and papers today give the impression that the final word is being said.

The same frankness in acknowledging our imperfect state of knowledge came again on the second day when the Presidential Address by Professor W S Pitcher set the scene for the morning on granites. Although not a petrologist, I was able to follow the discussion which covered the modern ideas in a most stimulating way and pointed out the topics which looked like the promising lines of further research. I now know what some of my colleagues in Birmingham are talking about!

Thursday morning was devoted to the northern North Sea. Part of it was geophysical and related to oil exploration but Dr N G T Fannin closed the session with an account of Quaternary deposits and potential geological hazards which opened up a completely new field of interest to me. The afternoon was spent looking at and hearing about a number of exhibits of both local and other work, which unfortunately attracted a rather small audience. There was a capacity audience however later for a Young Scientists talk by Dr L B Halstead on "Hunting for dinosaurs" which was a fascinating account of adventures in Nigeria trying to collect fossil vertebrates while fighting political intrigue.

The last morning was also well attended as the subject of disposal of radioactive waste is a current winner. I am afraid that I took the morning off to go round the bookshops as Edinburgh is still better supplied with these than Birmingham although the second-hand area is poor compared with 30 years ago.

It was most unfortunate that the central BA planners decided to give free tickets for the Tuesday evening Tattoo to participants without letting the section know in time to arrange another evening for the visit to Murchison House (IGS) which had to be cancelled. I was fortunately able to make alternative arrangements for a BA regular to see the new premises. As a result, I did not go on the afternoon field trip to Arthur's Seat which was the third and last excursion of the section programme. This contrasts sharply with 1951 when there were excursions most afternoons as well as two per day on Saturday and Sunday. Perhaps with the greater mobility of people nowadays there is less need for local excursions. There is certainly less demand for them although it is always good to be shown over a piece of ground by someone who really knows the area.

The last function to be mentioned is the Section Dinner which attracted about 25 people this year, including one student so that the age range was from about 20 to over 80. My diary for 1951 simply notes that the dinner was held at the Royal British (this year's was at the Royal Scot) and I have no recollection of the number attending. The Dinner is, however, one of the enjoyable events of the BA meeting and I hope next year at Salford to see some of the same faces again.

A TASTE OF BANFFSHIRE-ABERDEENSHIRE ROCK

Alexander Mackie

"By zigzag paths and juts of pointed rock"
(Tennyson, "Idylls of the King")

The September week-end excursion to the Banffshire and Aberdeenshire coasts was another very successful one, due to the excellent leadership of Drs May and Mykura, and to the smooth running arrangements, organised by our indefatigable excursions secretary, Mr Hogarth. We were favoured, on the whole, with splendid weather quite different from the Killinian type, experienced by some of us three years ago. A great deal of complicated geology was lucidly explained, and we were introduced to the mykurated ideas of time and distance!

Our headquarters were at Macduff, and 29 participated, which is probably a record for a week-end excursion. Macduff is a busy fishing port, but in former times the famous "Walls (wells) o' Tarlair", just a little east of the town, and discovered in 1770, were alleged to have health-giving properties. William Alexander, in his "Johnny Gibb of Gushetneuk" describes how Johnny and his wife set out for their annual visit to Macduff to take the waters "renowned for their restorative and invigorating virtues". That was in 1839, but the wells have since disappeared, except for the well-house on the left hand side as the swimming-pool is approached from Macduff.

Banff, on the other side of the River Deveron, had a grammar school in 1544, and the present Banff Academy, founded in 1786, is its successor. Duff House, built in 1725-40 to William Adam's designs, is a fine building, situated near the Deveron Bridge. It was the seat of the Duke of Fife, who married Edward the Seventh's daughter, the Princess Royal.

Most of us travelled from Edinburgh on the Saturday morning and arrived in time for the start of the excursion at 1.30 pm at New Aberdour foreshore

on the Aberdeenshire coast about 11 miles east of Macduff. The main part of the excursion consisted in the study of the Dalradian rocks, which are very well exposed on the Banffshire and Aberdeenshire coasts, and range from low grade to high grade metamorphism.

Saturday, 15 September

The outstanding features of the New Aberdour foreshore were the ?Lower Old Red flood-plain deposits and the Dalradian (Rosehearty Beds)/Old Red Sandstone unconformity. The Dalradian rocks are very much folded, and at Quarry Head, about 1½ miles east from our starting point, almost a text-book example of an anticline was seen.

Sunday, 16 September

In the morning the Portsoy shore section was examined as far as the swimming-pool. The several Lower Dalradian rock types and the mélange in which masses of rock are enclosed in a matrix are well exhibited. Limestones, pelites, quartzites, and black schists with metamorphosed gabbro, serpentine, and anorthosite intrusions are well exposed. A conspicuous feature is the spur of mullioned quartzite. Nearby is the exposure of anorthosite, which Professor H H Read (Geologists' Association Guides, No. 31, p. 7) suggests may be a tectonic 'pip'. Between the quartzite cliff and the swimming-pool is the serpentine rock, extending from the famous quarry (Portsoy Marble). The quarry has not been worked for many years. Incidentally the serpentine, used for the pillars of the great hall in the Palace of Versailles, was quarried here and was given to Louis XIV as a present by Charles II.

In the afternoon we proceeded eastwards to Links Bay and to Cowhythe Head. The latter is composed of highly deformed micaceous gneiss.

Our next stop was at Cullykhan Bay on the Banffshire-Aberdeenshire boundary. The rocks were examined as far as Pennan Bay. An angular unconformity between Lower Old Red Sandstone braided river sandstones and

Middle Old Red Sandstone slate-breccia (alluvial fan deposit) was distinctly seen. Just as the village of Pennan came in sight, our leaders had a slight difference of opinion as to whether a fault existed or not. This altercation added a little innocent merriment to the proceedings. On the return journey a call was made at Gardenstown, where the Lower Old Red Sandstone floodplain deposits grade upwards into braided river sandstones, the latter showing well developed trough cross bedding. At the south-west corner of Gamrie Bay the Lower Old Red Sandstone was seen faulted against the Dalradian (Macduff Slates).

Monday, 17 September

The morning was spent on the Macduff shore section east of the town, where low grade metamorphism of greywackes and slates of the Upper Dalradian were examined. There were excellent examples showing the relationship of folding to cleavage. There is an interesting boulder bed in the greywacke just west of the swimming-pool. The boulders vary in size and some are as much as 3 feet in diameter. It is suggested that the boulders may have been transported by floating ice. At the swimming-pool and in the next few bays to the east greywackes, grits, and slates are exposed. Some very interesting sedimentary structures were demonstrated.

After packed lunch the party proceeded on the homeward journey. However, two stops were made, first at Bin Quarry, 3 miles north-west of Huntly, to examine the Huntly Gabbro, the conspicuous feature of which being the rhythmic banding which was subsequently overturned by the final Caledonian folding. The second stop was made at the famous chert locality, just about a mile west of Rhynie. Unfortunately the main exposure is now buried, but a few specimens were collected. The Rhynie Cherts, resulting from a silicified peat bed, were discovered by Dr W Mackie (no relation of the writer of this article) of Elgin. They were further examined by R Kidson and W H Long (Trans. Roy. Soc. Edinb., 1917-21, 51, 761-84; 52, 603-28, 643-80, 831-54,

855-902) in great detail and described with excellent illustrations. Plants of early Old Red Sandstone age have been so well preserved in the cherts, that it has been possible to study the detailed structure of the plants.

Here ended this intensive, instructive, and most enjoyable week-end, and as Shakespeare would say,

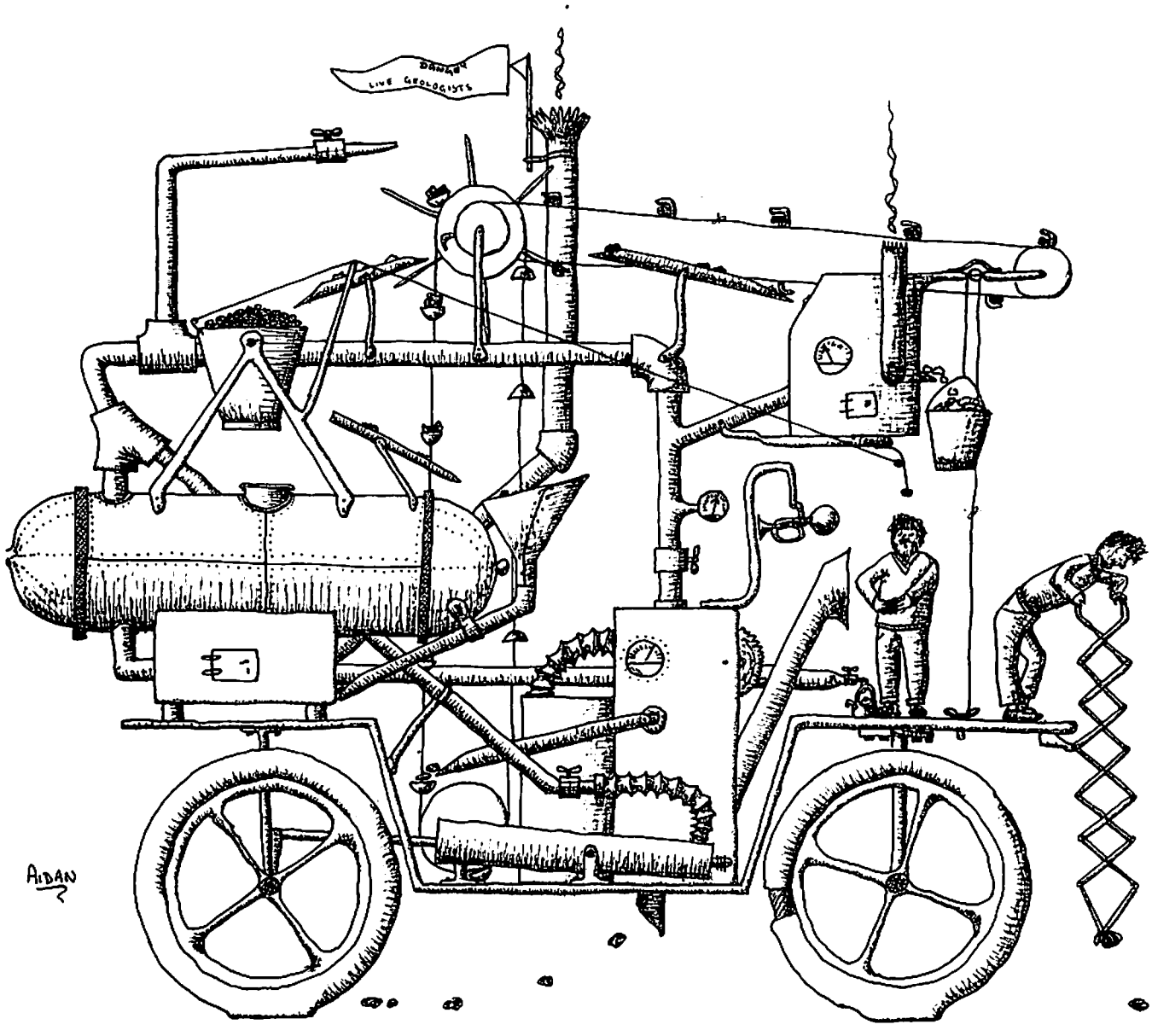
"Sermons in stones and good in every thing" ("As You Like It").

LATEST PUBLICATION NOW AVAILABLE

The Society's Excursion Guide to the Assynt District of Sutherland by Macgregor and Phemister has been edited and revised by Dr M R W Johnson and Dr I Parsons. The new 76 page guide contains a summary of the geology of the main structural units and details of 8 excursions. There is also a road log and glossary of place names. The guide contains 4 coloured geological maps and 15 black and white maps etc. It costs £1.33 to members and is available from the Publications Sales Officer, Ian Bunyan at the Royal Scottish Museum, Chambers Street, Edinburgh EH1 1JF. POSTAGE EXTRA. Please make cheques out to 'Edinburgh Geological Society'.

A GEOLOGICAL REVOLUTION - INTRODUCING A NEW AGE

INTO FIELD GEOLOGY .. ..



CAPTION COMPETITION

A PRIZE copy of the new Assynt Guide is offered to the reader who in the opinion of the Editors composes the best short caption for the above.

Entries, please to the Editors by Friday, 21 December 1979.

SAMPLING AT SEA WITH IGS

Dan Evans

"What kind of work do you do?"
"I'm a marine geologist"
"Hm, that must be very interesting, do you spend time at sea with your work?"
"Yes, I spend a couple of months a year at sea"
"Now that must be really exciting, I'd love to spend some time away from it all at sea. It must be great!"
"Yes, I enjoy going to sea, it's a pleasant break from office routine, but in fact it's actually very boring most of the time"

Such is a typical introductory conversation for members of the Institute of Geological Sciences' (IGS) Continental Shelf Northern Unit based at Murchison House, Edinburgh.

Well, how would you like to spend a fortnight in the high summer cruising blissfully on an azure sea under a golden sun, and get paid for it? The catch is that around Scotland the weather is very rarely warm and sunny, the sea is often rough, the accommodation less than luxurious and the vistas very tedious (i.e. nothing but sea). We also have to work fairly strenuous around-the-clock shifts during a geological sampling survey programme. Seabed sampling is only one of three types of cruises from which information is gathered about offshore geology; the others concern geophysics (which is the first survey to be carried out in an area) and drilling (to depths of up to 300 m below seabed).

A summer sampling survey of some three months duration is normally divided into legs of two or three weeks, which are separated by port calls of about 36 hours. During port calls most of the IGS crew is exchanged and a great deal of work normally has to be done repairing equipment, unloading samples and restocking stores. At this time the ship takes on oil and water as well as vast quantities of food for the coming leg. When all preparations

are complete the ship unromantically moves from the quayside without the aid of streamers and ticker tape and heads for the sampling area.

Assuming that the weather is favourable, work continues around-the-clock aboard the ship. To do this there are separate day and night shifts working a basic 12 hour day each, although the working time is usually much longer. The day shift is made up of five IGS staff, each of whom has distinct responsibilities. The Chief Scientist is responsible for the running of all IGS aspects of the cruise and although on call throughout the 24 hours, mainly acts as the day-geologist. The technician is also continuously on call, for although it is during the day that his expertise is mainly required equipment may, and often does, break down during the night. In the laboratory (often a euphemism) is the day-lab man who looks after the curation and storage of the samples. Also in the lab is an engineering geologist who helps on deck and carries out on-the-spot geo-technical tests on the samples recovered. The final member of the day shift is the day-navigator who stays permanently in his ivory tower on the bridge away from the cold, the damp and the muck of the working deck. His job is to note and plot the positions of all sample stations and he is responsible for the shipboard map collection and for all drafting and clerical work related to the survey.

The most important sampling tool on these cruises is the vibrocorer, which can penetrate 6 metres into drift sediments. This is done with a 6 metre steel barrel, topped with a heavy vibrating motor, and held upright in a tripod frame. To use the equipment it is necessary to lay anchors, an operation which can only be carried out during daylight by the ship's Captain. Consequently vibrocoring must start as soon after first light as is practicable (i.e. when you can persuade the Captain to get out of his bed) and anchoring normally begins about 0600 hours, at which time the night shift rudely but gleefully wake the day shift, who stumble sleepily to their tasks.

Laying a spread of three anchors takes just over 30 minutes, and once it has been established that the anchors are holding the vessel in position, the vibrocorer is lowered gently to the seabed. The vibrating motor is then switched on and while the technician gets increasingly hungry keeping a watch on the progress of the corer, the rest tuck into breakfast.

The corer takes about half an hour to penetrate the full distance into the sediment, after which the motor is switched off and the shift take their stations on deck to haul the corer in, while the technician goes to get his long awaited, but now cold, breakfast. Once the corer is on deck and recovery of sediment is confirmed, the ship's crew begin lifting the anchors while the barrel is removed from the frame and carried to a bench for removal of the core. This is not always an easy operation, for six metres of sediment inside a wet, greasy, mud-smeared steel barrel weighing over 2 hundred-weight, is difficult to carry across a slippery, swaying deck. The core is retained inside a stiff plastic liner which slips inside the outer barrel, and the liner with the enclosed sediment must now be pulled out from the steel barrel. Once this is achieved, and it can take considerable time and effort, the core is cut up into metre lengths, examined and described by the geologist, tested by the engineer and finally capped, sealed and stored. Meantime, the barrel is washed and re-loaded with fresh liner tubing, then put back into the vibrocorer frame ready for the next station.

While the core is removed and examined the ship lifts anchors and starts steaming to the next location. The sites of vibrocorer samples are usually pre-determined so that they are optimally placed in respect to the anticipated geology and the position of geophysical lines previously run in the area. The resulting vibrocore coverage is roughly on a six mile grid. The positions are all plotted on board ship to allow shipboard assessment of progress and in addition the navigational and geological data are noted on forms which, at the end of the cruise, will be punched for input into a computer data bank.

The complete vibrocoring operation including steaming and anchoring is a lengthy process and usually only six sites can be completed in a day extending from 6 am to 9 pm or later. In areas of solid rock outcrop a similar pattern of work is followed, but a rock drill is used instead of a vibrocorer.

The only real relief from the dirt on the deck and the monotony of the programme is provided by the meals which become a high spot of the day, so that good catering is very important in maintaining high morale. It would also be very pleasant to have some attractive scenery to relieve the monotony but in the North Sea there is only the sparse industrial seascape of the oil fields, and most of the time nothing but a flat horizon and the odd ship. Contact with the office is maintained by making routine radio telephone link calls three times a week. Personal calls can also be made provided you don't mind both the very high cost and everyone else in the North Sea hearing your conversation, although the latter is not too big a problem for those of us who speak Welsh!

Limitations on work owing to bad weather depend to some extent on the vessel used and the degree of shelter to be found in the working area, but generally a ship cannot lay a three anchor spread in wind conditions above Force 5. In such cases vibrocoring cannot be carried out and so sampling methods which are generally used during the night are employed until conditions become too rough for any work at all (by which time part of the team may be 'hors de combat' anyway).

In contrast to the day shift, the night shift consists of only three members, a navigator, a night geologist and a laboratory curator, the latter often being a geochemist who prepares samples for subsequent geochemical analysis. They normally start work after the evening meal (which is taken at about 5 pm) and help the day shift with the vibrocoring until the latter gratefully wander off to bed when the last samples have been stored and the vibrocorer made ready to be put in the water first thing next morning. The

work of the night shift is then to collect dredge and grab samples and gravity core at nominated stations which complement the distribution of vibrocore sample points. A grab takes a small sample of the seabed at one point, while the dredge is dragged along the bottom for about five minutes. Grab samples are also taken at all vibrocore stations, usually while the motor is vibrating. The gravity corer is a barrel topped by half a ton of lead which is allowed to "free fall" into the seabed.

In addition to their sampling chores, staff on the night shift also have to cook their own midnight meal, the delights of which depend a great deal on the state of the sea and their stomachs. Although occasionally lifted by a magnificent dawn or the near midnight sun of Shetland latitudes, night shifts tend to be particularly tedious. However they are always improved by having the pleasure (both actual and anticipated) of waking the day shift in the early morning so that yet another day's sampling can begin. After breakfast the night workers retire to their bunks hoping that they will get a decent day's sleep despite the clanging and banging of winches, machinery and men.

Given average weather, over a hundred stations are occupied in a fortnight, of which up to 40 will be vibrocore sites. At the end of the leg when the existing IGS crew hand over to new staff, plenty of cheerful chatter is exchanged concerning recent events in the office - conditions during the last leg, and, most important, the quality of the ship's cuisine.

But the work related to the geological study of the area is only at an early stage. The collected samples, test results and descriptions are curated and interpreted, and go towards the production of track charts, bathymetry, surface sediment, drift and solid geology maps on the scale of 1:100,000 (which is the working scale of IGS offshore maps). These maps provide considerable service as they may be examined in discussion with the area geologist by those interested in the offshore geology of Scotland. Such

groups include oil companies, certifying authorities, site investigation firms and sand and gravel companies. The data on 1:100,000 maps will subsequently be summarised at a scale of 1:250,000 for publication, and three versions (seabed sediments and bathymetry, Quaternary geology and solid geology) are produced for each area as the final products of the survey programme.

REVIEW

INVERTEBRATE PALAEONTOLOGY AND EVOLUTION by E N K Clarkson

George Allen & Unwin. 336 pages, 164 line drawings and 23 photographs. (£15.00 hardback and £7.95 paperback)

The book comprises: Part 1, General Palaeontological Concepts 1. Principles of palaeontology (21 pages), 2. Theory of evolution (12), 3. Origin and early diversification of metazoans (10). Part 2, Invertebrate Phyla 4. Sponges, archaeocyatha and stromatoporoids (11), 5. Cnidarians (35), 6. Bryozoans (10), 7. Brachiopods (32), 8. Molluscs (52), 9. Echinoderms (49), 10. Graptolites (20), 11. Arthropods (44), Exceptional faunas (7), Systematic index (6) and General index (8).

In the preface the author explains his purpose in writing this book; that is for the undergraduate reading Geology or Earth Science, a group he recognizes as of varied backgrounds, many of limited biological training. Since palaeontology is a subject involving the study of "the remains of once-living organisms (including the tracks and trails that they made) it is also in part a zoological subject".

In the light of these remarks Clarkson has set out in the short first part of his book the concepts that are essential to the study of any group of fossils, whether a whole fauna, or a single phylum or class. The section covers preservation of fossils, divisions of palaeontology, systematics, growth, trace fossils and behaviour, within the chapter headings above. Terms are set in bold type when introduced and defined and link well with the excellent index.