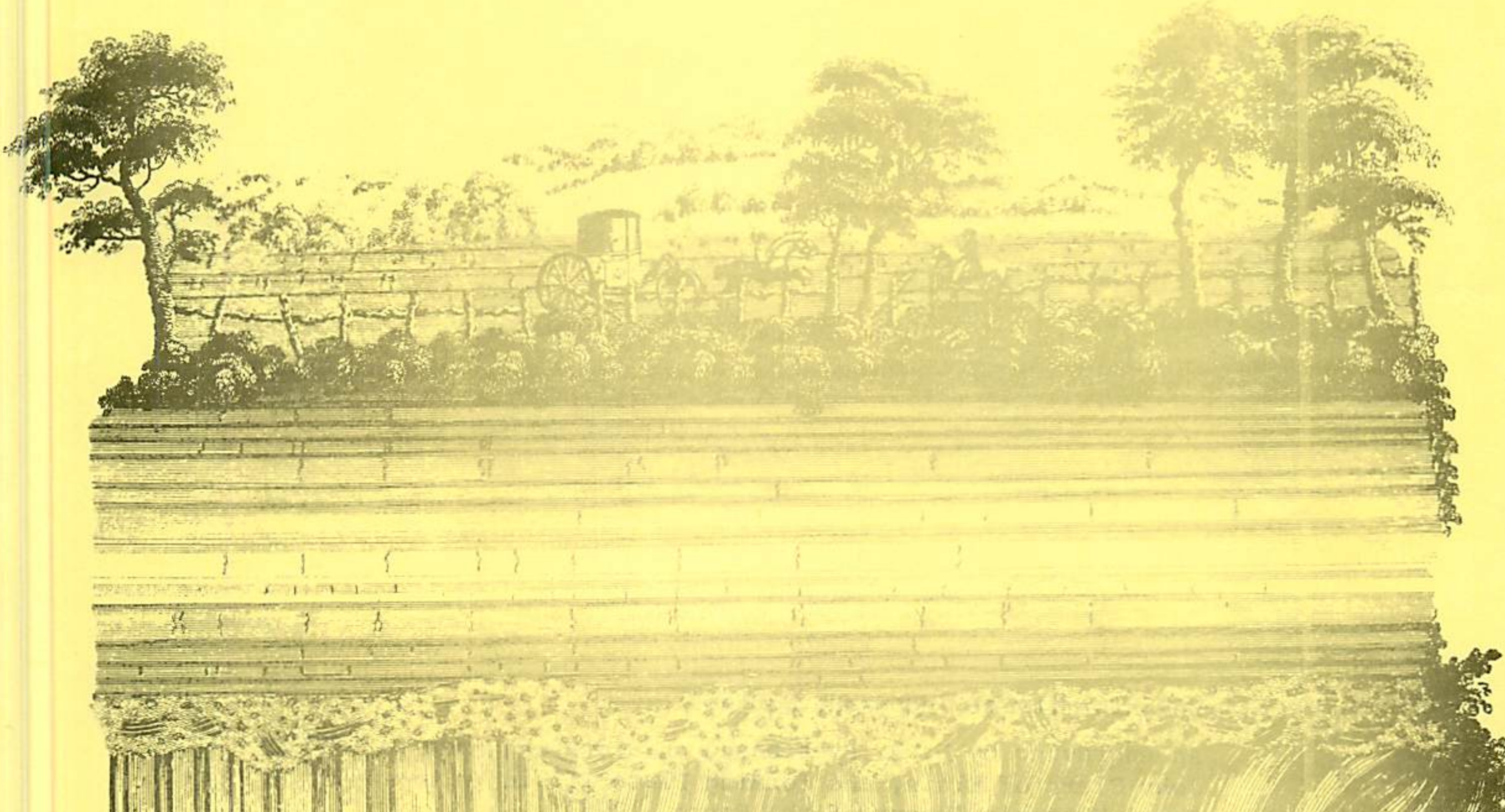
The Edinburgh Geologist



November 1978

Unconformity at Jedburgh, Borders

An engraving by D. B. Fyet based on a drawing made in 1787 by John Clerk of Eldin, and forming Plate III in Volume I of James Hutton's Theory of the Earth, 1795.

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PROFESSOR HEDDLE - A LEGENDARY MINERALOGIST

Professor Matthew Forster Heddle was born in 1828 and died, at St Andrews, in 1897.

On both sides he came from old Orkney families. He was reared at Melsetter, Hoy, in the Orkneys, on a property purchased by his father Robert in 1818 on his return from Senegal, West Africa where he had amassed a fortune in gold as a merchant trader.

As both of his parents had died by the time Heddle was 14, he, along with his brother Robert and two sisters, were placed under the charge of three curators who were responsible for them.

Heddle was schooled in Edinburgh, first at Edinburgh Academy and then at Merchiston Castle where there are records of him in the years 1842-1844. 'It was at this stage of his career that he seems to have begun to develop that propensity for collecting which became his dominant characteristic in after-life', (Goodchild, 1897, q.v.). He collected first shells, then botanical material and finally, following a traumatic day when his herbarium was dropped accidentally into a river and totally destroyed, he started to collect stones.

Heddle entered the University of Edinburgh at the age of 16 as a medical student. At the conclusion of his medical course he went to Germany to study Chemistry and Mineralogy, going first to Clausthal and then to Freiberg. He returned to Edinburgh and graduated M.D. in 1851 taking as his graduation thesis 'The Ores of the Metals' (a copy of which is in the Library of the Royal Scottish Museum).

Leaving University, Heddle became a poorly paid doctor working in and around the Grassmarket. He discovered that the practice of medicine had few charms for him and he began looking for an escape from medicine. This came in 1856 when he was lucky enough to become assistant to the Professor of Chemistry at St. Andrews (Professor Connell) on the understanding that when Connell retired he would succeed him, which he did in 1862. To celebrate his new job, Heddle chartered a boat and went to the Faroes where he succeeded in obtaining an extensive collection of Zeolites. He also got married.

By this time and in spite of his training to become a doctor, Heddle's knowledge of mineralogy must have been extensive for only two years later he revised and virtually re-edited the final text for the celebrated work on British mineralogy - 'Manual of the Mineralogy of Great Britain and Ireland' by Greg and Lettsom, 1858.

It was during his tenure in the Chemistry Department at St. Andrews (1856-1884) that Heddle achieved most of his active mineralogical work. Indeed his period as Professor of Chemistry was really a camouflage under which Heddle pursued his interest in mineralogical science. It was also during this time that most of the renowned Heddle Collection of Scottish Minerals was collected. Teaching terms were short in those days, only six consecutive months in the year, which left Heddle from April till September to get on with the task of collecting minerals.

Every summer Heddle, alone or with friends, roamed over the length and breadth of Scotland. Heddle described his exploits briefly in a letter to a former Director of the R.S.M. His letter reads:

> 'Scotland has been searched from the lighthouse rock of Burra Voe in Unst to the lighthouse on the Mull of Cantyre - From the Hanseman Rock on the Aberdeenshire coast over every peak of the Grampian Ridge to St. Kilda and the Flannan Islands. Every wrinkle of the shore was walked, where accessible from Aberdour to Burghead - from Thurso to Rhiconich.
>
> Of the 409 peaks in Scotland over 3,000 feet in height, 357 were ascended, carrying a 14lb hammer and a 4lb side hammer, with the single exception of Ben Nevis, which was never honoured with one above 10lbs in weight.
>
> Every one of the old limestone quarries whose site could be determined was searched or more or less opened up anew.
>
> Some 10 summers were devoted to yacht exploitation during which almost every island and rock of the west coast was landed on and to some extent examined.'

Much of Heddle's collecting, it may be noted, was done at a time when there were few Ordnance Survey maps in existence. Nor was travel easy in those far off days - and accommodation at night was not always assured.

Heddle wrote many mineralogical papers based on specimens collected and analysed by himself. These were mainly published in the Transactions of the Royal Society of Edinburgh between 1876-1897, and also in the Mineralogical Magazine from its beginning in 1897. For some of his researches into Scottish minerals Heddle was awarded the Keith Medal from the Royal Society of Edinburgh, while the Mineralogical Society (of which he was a founder member) made him President of the Society. He was also at one time President of the Geological Society of Edinburgh during which office he played a major part in influencing the government's decision to establish a Geological Survey Office in Edinburgh.

His most famous work, however, is his two volume 'The Mineralogy of Scotland', published in 1901. Although Heddle had completed most of the text before his death it remained for an officer of the Geological Survey of Scotland (J. G. Goodchild who was stationed in the Royal Scottish Museum) to edit the work for publication. Heddle's mineralogy is still a valuable work of reference and in some ways it can never be superseded. Indeed the work has become a bible for thousands of lapidarists and mineral collectors who belong to 'rockhound' clubs and societies throughout the United Kingdom. Mention of Heddle or mention of data from Heddle's Mineralogy adorns the pages of almost every monthly publication of the rockhounders magazines 'Gems' and 'Gemcraft'. Indeed Heddle has become a legendary - almost a cult figure, to many collectors who try to follow in his footsteps or act like he did.

Heddle dearly wished to leave his collection of minerals to the University of St. Andrews. That University's officials however procrastinated so long over the provision of adequate space and furnishings (cabinets) to house the collection, that Heddle finally turned to the Royal Scottish Museum to where (after considerable negotiations) his collection came to rest.

In recent years Heddle's collection has been rehoused in fine new storage cupboards and a selection of his minerals is on display. This display is arranged on a regional basis instead of the former and less popular systematic manner of elements, oxides, sulphides and so on. About one half of Heddle's renowned agate collection is on display - at the repeated request of dozens of lapidary and mineral clubs.

Work continues on the Heddle Collection. Hundreds of specimens have been rechecked by optics, x-rays and microprobe. Specimens of minerals new to Scotland since Heddle's time have occasionally been added to the collection, but alas much remains to be done before the collections can boast of having samples of every mineral species in Scotland.

In Heddle's day about 205 mineral species were recorded from Scotland. Today the figure is 370. The present writer and his colleague Dr. Alec Livingstone, hope to publish in a year or so a completely updated list of minerals known to occur in Scotland. This list will record name, formula, crystal [illegible] and the nature of the occurrence as described in the first or earliest known reference to the mineral.

In the 150th year after Heddle's birth it can be confidently stated that many minerals new to Scotland (some perhaps new to mineralogy) will be found over the next decade or two. That some of these will be found by amateur mineralogists as well as professional mineralogists, petrologists or field geologists, is emphasized by the fact that three minerals new to Scotland, discovered in material supplied by an amateur collector, are being studied in the department of geology, R.S.M.

In coming to the end of this thumbnail sketch of our greatest mineralogist, Heddle himself, would I think nod his approval when I gently remind our gallant field geologists, when collecting their rocks, to spare a few moments to search for signs of (small amounts) of mineral unknowns or oddities that may be lurking nearby.

Finally I should point out that accounts of Heddle are rare, indeed there is only one of significance. It is that written by J. G. Goodchild and published in the Transactions of the Geological Society of Edinburgh, vol. 7, pages 317-327. The present writer has been collecting data on Heddle for a possible future publication. I would welcome hearing from anyone who possesses or knows of any original information of any kind about Heddle.

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RAF ICELAND EXPEDITION 1978

Geological Report

The Royal Scottish Museum's (RSM) Icelandic collections go back to the earliest days of the museum's existence. In 1815, a specimen of Chalcedony from Iceland, "said to be the finest in Europe" was purchased and today graces a case in the museum's mineral hall.

Over the years, the geological collection has increased with Zeolites in 1890, Iceland Spar in 1928, Ash from Surtsey in 1964 and Prase from Oxnadal in 1969. Although the RSM therefore has many specimens from Iceland it has no true representative collection of Icelandic material with good localities. This is a sad omission by one of Iceland's nearest neighbours, since Scotland, in the remnants of its Thulean geological episode shares a common heritage of mutual interest.

An expedition to the Myvatn area provided a unique opportunity to study recent volcanic activity and the subsequent processes of erosion which are normally muted by time and mantled by vegetation in areas of Scotland with an older volcanic origin.

I was very pleased, therefore, to accept the invitation to join the expedition as a geologist.

No person who professes even a passing interest in geology can stand on a mountain top in Iceland, looking out over that beautiful tortured landscape without feeling that they have stepped back through time to a continent in the making. The awesome powers of the natural processes are all around making the changes wrought by man seem like transient scratches. To study geology under such conditions is a pleasure as well as a privilege.

In retrospect, I see that my proposed study programme would have occupied several geologists for years. The scale and inaccessibility of parts of Iceland are difficult to appreciate for those used to travel and conditions in other parts of Europe. Only by the outstanding efforts of members of the Rocky Road 4-Wheel Drive Club* was I able to examine so many important sites.[1]

Our route north from Reykjavik up the west coast was mainly through the typical basalt landscape. There was much evidence of recent weathering including some massive landslip features. An example of a structure forming at present was a rather fine alluvial fan on Aesusradafjall running down towards the Svarta river near Artun Farm, SE of Blonduos, where we made our overnight stop on the way to Myvatn.

On arrival at Myvatn a base camp was set up and I made a preliminary choice of possible sites in the area which could be visited over the next week. The initial field excursion was to the lava fields NW of Krafla. The Icelandic government is constructing a geothermal power plant at Krafla, and we visited the manager on site to obtain more recent information about the area. He pointed out that there had been an eruption subsequent to that reported by Bjornsson et al., 1975.

The 1975 flow was visited first and an examination of the outflow area was undertaken before we moved off northwards towards the 1977 flow. This flow occurred from the same longitudinal fissure some 3km further north.

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* from the American forces base at Keflavik in South Iceland

1 they acted as chaffeurs and guides to the expedition over country which at first sight seemed impossible to drive over and also took an active part in all expedition activities

The eruption took place on 27 April, 1977 and covered an area of 0.8 sq km to a depth of up to 3 metres. The lava is similar to that of the 1975 eruption and is highly vesicular.

Specimens were collected from both flows and from the 1977 flow several "lava roses", small circular structures, were gathered. They occurred towards the edge of prominent fast flowing lava streams, and bore a certain resemblance to foam patches sometimes observed on fast flowing turbulent water. They were only lightly, or sometimes not at all, attached to the surface of the lava and must have been forced up through an already cooling crust with a rapid circular motion to harden almost immediately on the surface.

At a point midway between the northern outflow of the 1975 eruption and the 1977 eruption, two very distinct lava lake shore lines were observed around a knoll. These distinctive features in the 1729 lavas were some 1.5 and 2.5 metres above the ultimate level of the solidified lava.

Next day a small party went to examine Hverfjall to the East of Myvatn. This is a ring wall crater with an estimated age of 2,500 years. There is a very mixed bag of ejected material on the crater walls which would seem very liable to erosion. Although there was evidence of an outwash area around the foot of the crater wall, it seemed an extremely small amount for 2,500 years of weathering of a very friable material. This lends some credit to the low rain fall levels recorded for the Myvatn area and suggests that these levels may have been the norm for an extended period. There was some evidence of wind erosion and tearing in the internal wall of the west side due to movements along the main fault lines.

On the summit of the Hverfjall the party divided into two, one group moving by vehicle along the track to the foot of the crater Ludent, the other group going east on foot via Strandarholt studying the vegetation and erosion features on the way. Especially interesting were a fine series of wind ripples in the black lava sand on the western slopes of Dagmalaholl. The older crater of Ludent is not a perfect isolated feature like that of Hverfjall and has in fact a slightly lower and more rounded outline. However, the sheer size of the crater is astounding. This feature with i . subsidiary craters breaching the main wall rim has been compared with craters on the moon. Return to the base camp was by the crater row at Ludentsborgir. Several photographs were taken of a strange stalactitic lava flow which had formed a cave-like feature.

A longer but worthwhile road journey was made to the waterfall, Detifoss, on the Jokulsa river. Although the height is less at 44m than some other

Icelandic falls, the volume of water is tremendous, estimated at 193 tons/sec at peak periods. The falls are caused by flow over two relatively thick and hard lava flows which show prismatic columns in certain parts of the canyon walls below the falls. Spray from the fall rises as a dense, misty cloud to fall on the canyon walls and descend again as rivulets cascading down into the turmoil at the base of the falls.

Letting a handful of water drain from the palm of the hand showed the black sand which is carried in suspension by the river. The amount of material transported to the sea each year by this agency must be enormous.

A search for dreikanter in the lava desert south of Detifoss was rewarding and also showed the same blast effect of the wind when carrying the black lava sand. From the abraded surfaces of larger boulders, it was established that the prevailing high velocity winds which pick up the material to carry out this sand blasting operation were from the south or south-west. This is not however a suitable criterion for establishing the overall direction of the prevailing wind as other factors may reduce the effect of north winds eg. snow on the ground or wind with rain.

The mountain of Hlidarfjall, north of Myvatn is the result of the subglacial protrusion of a highly viscous acid lava called Rhyolite. Because of its very different nature, we visited the mountain to examine the rock and collect a specimen for comparison with the much more common basalt lavas.

The rock proved to be very variable in nature, much of it being very friable, and badly weathered. Near the summit at the south end of the ridge, some obsidian (black volcanic glass) was found. We now journeyed 6km further north to a shallow unnamed lake, where Cassiope tetragona was in full flower beneath a small semi-permanent snow field. As always, we were on the look out for stone polygons or stripes but none were observed although several areas looked suitable.

The first part of our last working day was used up by climbing Vindbelgjarfjall to the west of Myvatn. A typical basaltic tuff breccia volcano of subglacial origin, this mountain shows some intense weathering of the predominant rock matrix as well as some interesting flow banded rock showing vesicle layers. A specimen of this material was taken for future study.

In the afternoon, the group moved to the Solfatara area of Hverarond, east of Namafjall to examine the boiling mud pools and crystal deposition around the fumaroles.

In retrospect, the geological study in the Myvatn area achieved three things;

1. I gained up to date field knowledge of volcanic and seismic activity which will be of long term use to the RSM.
2. A series of photographs was taken showing geological processes and features. These will be catalogued and used for teaching and reference.
3. A small but well localitated collection of representative specimens illustrating the geological history of the Myvatn area will be added to the collections of the RSM.

Thanks are due to many people in Iceland including;

1. The Director of the Natural History Museum, Reykjavik for helpful discussion and advice.
2. The Manager of the Krafla Power Station for directions and information.
3. Hjortur Tryggvason for recent unpublished information.
4. National Research Council of Iceland for permission to collect specimens for the RSM.
5. Kristjan Saemundsson for pointing out my more glaring errors of fact.

Bill Baird

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Current rifting episode in Northern Iceland. Nature. 266, 318-322.

VINTAGE ASSYNT '78

During May, members of the Edinburgh Geological Society descended on Elphin in the Assynt District of Sutherland for a week of fascinating geology, beautiful scenery and some adventurous cooking. 'Base camp' this year for what is successfully catching on as an annual event was perhaps not as palacial as Kinloch Castle (few buildings could be) but nevertheless proved an ideal centre. It was in fact the village school which last saw proper service in the 1950's but is now run by Highland Regional Council as a field centre suitable for education and recreation. Fully equipped with electricity, water, kitchen and washing facilities, it is as good if not better than the average Highland youth hostel.

For our catering needs, the daunting task of providing for a party of about 25 was undertaken by an ad hoc committee who efficiently procured the goods and supervised cooking and washing rotas. This fairly divided the work load amongst the party, allowed for a diversity of cooking styles and scope for worthwhile critical appraisal of the cuisiniers. The entire party returned home in good health. The only problems encountered were an excess of bread loaves (compulsory with each course) and a surfeit of bacon (half a surfeit would have sufficed).

Sleeping quarters, except for campers, were of a bunk dormitory style, conducive to the relation of late night stories and witicisms. The resultant cackles of laughter could often be heard long into the night mingling with the whirring wing beat of the snipe. The single bathroom (plus a couple of outside loos) did cause traffic chaos at peak times (the Society's President took to showering outdoors)but generally things ran very smoothly.

Geological Setting

1. Introduction

A line of major dislocation, known as the Moine Thrust, running from Durness to south east Skye divides the North West Highlands into two geologically distinctive areas. West of this line a series of Lower and Upper Torridonian and Cambrian sediments rest unconformably on an ancient metamorphic basement of Lewisian rock. The 'unmoved' portion of this region, known as the Foreland, passes eastwards into a structurally intricate area, the Belt of Complication (or the 'disturbed' region) which, in turn, is bounded in the east by the Moine Thrust. The Belt exposes gently inclined crustal dislocations (thrusts) which have had the effect of superimposing thrust slices (or nappes) of older strata on younger. East of the Moine Thrust there occur a series of crystalline metasedimentary rocks, the Moine Schists. Recent age dating has shown that the latter were probably deposited somewhat earlier than the Lower Torridonian and metamorphosed before the deposition of the Cambrian.

The formations comprising the foreland are summarised in Table 1.

2. Scenery

One of the most impressive features of the North West Highlands, and

TABLE 1

Period and Formation	Environment of deposition	Characteristic Rock
CAMBRIAN		
Sailmhor Group	clear water limestones	massive, crystalline, grey dolomites
Eilean Dubh Group		fine grained, white limestones and dolomites
Grudaidh Group		dark grey limestones and dolomites with Salterella (conical fossil tubes)
Serpulite Grit		upper dolomitic grit with numerous vertical worm burrows (of Scolithus linearis) and Salterella; lower massive gritty quartzite with sporadic Salterella
Fucoid Beds	fine grained calcareous muds deposited in deep waters	dark blue shales and bands of gritty dolomite showing rusty weathering; rocks contain flattened worm casts (originally mistaken for seaweeds or fucoids) and trilobites (Olenellus)
Upper Quartzite ('pipe-rock')	shallow shoreline sediments derived from a land mass to the north west	fine grained, grey quartzite with reddened vertical worm burrows of Scolithus
Lower or Basal Quartzite		false bedded gritty quartzites composed of quartz and feldspar; the latter gives a pinkish appearance to the rock; a basal pebbly grit

UNCONFORMITY

Following a gentle westward tilting of torridonian strata, prolonged marine erosion produced an almost level platform on which Cambrian sediments were deposited. Over wide areas the Torridonian was completely removed, so that the Cambrian Basal Quartzite now rests directly on the Lewisian basement.

TORRIDONIAN

Upper (Torridon) Group consisting of the Aultbea, Applecross and Diabaig Formations	semi-arid conditions; mainly fluvial sedimentation	red current-bedded arkoses and conglomerates with dreikanter pebbles; locally grey marine shales at base

INTER-TORRIDONIAN UNCONFORMITY

A period of uplift and erosion succeeded the deposition of the Lower Torridonian

Lower (Stoer) Group	fluvial and lacustrine deposition; local volcanic activity	red arkoses, sandstones and siltstones; mudflows and breccias

UNCONFORMITY

Prolonged erosion of crystalline basement produced an undulating and irregular surface on which the Torridonian was deposited.

LEWISIAN

Gneisses, mainly of igneous aspect, highly metamorphosed (Scourian Orogeny) and later intruded by basic and ultrabasic dykes (Scourie Dykes) North of Loch Laxford and elsewhere renewed metamorphism (Laxfordian Orogeny) affected gneisses and dykes.

in particular the Assynt District, is the geological control of topography. In other words, the scenery reflects the geology.

The present day landscape of Assynt has formed as the result of prolonged late-Mesozoic and Tertiary erosion and was further modified by the Pleistocene glaciation. Where the Lewisian is exposed, a rough, hummocky, poorly drained, peat covered 'basement' terrain is characteristic. Above this irregular basement, remnant pedestals of Torridonian have been eroded into north-west trending mountain ridges (nunataks during glaciation) which dominate the panorama. Examples include Quinag (2653 ft), Beinn Garbh (1769 ft), Canisp (2779 ft), Suilven (2399 ft) and Cul Mor (2786 ft). Except for Suilven, all the mountains are capped by Cambrian quartzite which dips to the south-east. Post Cambrian porphyry sills are found on Beinn Garbh, Canisp and Suilven.

In general, the Torridonian sandstones and arkoses may be recognised by their brown colour, their blocky nature and strongly developed vertical joints, particularly well displayed in corries and sea cliffs. Cambrian strata also produce a distinctive land surface. The white quartzites can often be distinguished from considerable distances, the Fucoid beds have a characteristic rusty weathering and the limestones not only produce impressive cliffs and caves but are also responsible for particularly fertile soils. The Moine, in contrast, is characterised by comparatively uninteresting boggy ground and smooth topped hills.

3. The Belt of Complication (even for professional geologists!)

In Assynt, because of a wide embayment of the outcrop of the Moine Thrust, the Belt of Complication forms an expansive zone, up to 8 miles across in which gently inclined thrusts are exposed. Three major overlapping thrusts, active in post-Cambrian times, are recognised. They are from west to east the Glencoul Thrust (the lowest), the Ben More Thrust and the Moine Thrust (the highest). The Glencoul Thrust has been responsible for the westward movement of a great slice of Lewisian gneiss and overlying Cambrian sediments over Cambrian strata. Similarly, the Ben More Thrust has superimposed Lewisian gneiss and overlying Torridonian and Cambrian strata over Cambrian. This is particularly well seen during an ascent of Conival (3234 ft) and Ben More Assynt (3273 ft) from Inchnadamph). The most powerful of the dislocations, the Moine Thrust has moved crystalline Moine schists from the east over Cambrian and pre-Cambrian rocks. The Moine Thrust has in places cut out the lower nappes, and at some localities such as Knockan Cliff (NC 190195) the Belt of Complication is apparently reduced to a thickness of only a few feet.

Within the Belt other features in addition to the major dislocations may be noted. Immediately below the great thrusts there occurs a 'Zone of Imbrication' where Cambrian strata are repeated again and again by minor reversed faults acting in the same westerly direction. The base of this zone is referred to as the 'Sole'. Folding and inversion of strata has occurred in association with the Ben More and Glencoul Thrusts and shearing of rock which forms the base of the thrust slices is ubiquitous. Along the lines of dislocation, mylonite is often developed. This flinty looking, fine grained, thinly banded rock is the product of grinding and crushing processes which preceded the formation of the clean-cut thrusts.

4. Post-Cambrian Intrusions - some exotic petrological goodies

In addition to sills of porphyry and felsite, there are two alkaline igneous complexes around Loch Borrolan (265105) and Loch Ailsh (315110). The range of chemistry of the rocks within the Loch Borrolan mass is considerable with rocks varying from quartz syenites to nepheline syenites together with basic and ultrabasic types. The genesis of this unusual suite of alkaline rocks has been variously ascribed to assimilation of limestone and gravity differentiation but there is no evidence of direct country rock assimilation (eg. there are no xenoliths of Cambrian limestone within the complex).

The Excursions

May 21

Members of the party arrived at various times during the afternoon and evening, some having stopped just south of Elphin to see the Moine Thrust at Knockan Cliff (pp 36 - 39, Assynt Guide). A short discussion of the proposed itineraries took place after dinner.

May 22 Day 1 A Gentle Introduction (pp 25 - 28, 39 - 41, Assynt Guide)

'Cool, dull with low cloud' turned out to be fairly discriptive of the whole week's weather. But the rain was minimal and the low temperatures made walking less exhausting.

Cars were taken to Skiag Bridge (235244) where the Cambrian Succession, and in particular a fine development of 'pipe-rock' is exposed. Road cuttings on the road to Lochinver between (230245) and (210252) reveal the Torridonian - Lewisian unconformity and this together with basic and ultrabasic dykes (Scourie Dykes) on the north shore of Loch Assynt were examined during the morning.

After paying homage to Peach and Horne at their memorial at Inchnadamph (where we stopped for lunch) the party split. The energetic climbed Beinn an Fhuarain (258157) to examine a klippe (outlier) of the Ben More nappe. The ascent also had the effect of sorting out the unfit from the grossly unfit. The remainder of the party walked directly from the Inchnadamph road up to the caves at Allt nan Uamh (269170) where they waited for the 'athletic' ones to rendezvous. The caves are formed in the Eilean Dubh limestone beneath the Ben More Thrust plane and some have extensive passages. The bones of reindeer, bears, northern lynx and lemming have been found in former days. Traces of human habitation have also been noted but the party reckoned they were better off at Elphin whereupon they returned.

May 23 Day 2 Some Foreland Geology

Members drove to Drumbeg (123327) in a convoy which must have shaken motorists travelling in the opposite direction. Some dubious 'sedimentary' structures in a Lewisian ultrabasic intrusion (Bowes, Wright and Park, 1964) were examined before the party moved to Stoer Bay where some proper sedimentary structures in Torridonian sediments are to be seen. The deposits on the north side of Stoer Bay (041284) to (030285) belong to the Stoer (=Lower) Group of the Torridonian (Stewart, 1975) and are composed of fanglomerates, playa and fluvial sandstones and lake siltstones. Impressive fossil mud flow deposits with embedded fragments of contemporary lava and Lewisian gneiss were also seen. At Clachtoll (035274) the party examined a basal Torridonian breccia (fossilised scree) perched on the original Lewisian palaeoslope.

May 24 Day 3 Complications (pp 29 - 32, 63 - 65, Assynt Guide)

The party walked along the south shore of Loch Glencoul from the Kylesku road firstly over Torridonian and then the Imbricate Zone of repeated Cambrian strata. The overlying plane of the Glencoul Thrust could be easily picked out on the north side of the loch from changes in terrain and vegetation. On the south side, when the outcrop of the thrust plane was eventually encountered, it was a remarkably impressive sight - Lewisian basement on Cambrian sediments: an age difference of some 2000 million years, the wrong way up! At this point the party divided and those with extra energy proceeded south eastwards to climb the Stack of Glencoul (290286) and so see the effects of another major dislocation, the Moine Thrust. Below the summit of the Stack, which is composed of Moine Schists, there is a small thickness of Cambrian Pipe Rock. The latter has been mylonitised just below the thrust plane and the pipes are flattened and elongated.

May 25 Day 4 Geo-ornithology

The main object of the day was to visit Handa Island, north of Scourie. Members drove to Tarbet (165489) via the Kylesku Ferry (£1 return!), some stopping on the way to photograph some fine examples of Dryas octopetala near Skiag Bridge. A small motor boat transferred the party to the island where the time was spent viewing great quantities of sea birds including fulmars, bonxies (great skuas to the uninitiated), puffins, razorbills and kittiwakes to name but a few. The air traffic control of kittiwakes to and from a source of nesting material on the island was impressive as were the cliffs in which the birds nested. The island is composed entirely of Torridon Group sandstones and the cliffs on the northern and western extremities show a strongly developed vertical jointing pattern. In places these planes of weakness have been variously exploited by the sea to produce blow holes (gloups), inlets and stacks. On returning to Tarbet on the mainland, the boat failed to reach the jetty owing to a recession of the tide. But the boatman came to the rescue and carried most of the party ashore, though some declined this kind attention and waded ashore under their own steam. A Scourie dyke containing anthophyllite and magnesite at Loch an Daimh Mor (160428) was examined on the homeward journey (Bowes et al., 1964)

May 26 Day 5 An inter-syenotorridonian juxtaposition

The morning was spent in the Loch Borrolan area. A latent rock-hound instinct was detected in several members as they went 'hammer and tongs' for the 'best' specimen of borolanite (a melanite-nepheline-syenite) at an old quarry next to the Lairg road (287096). The limited exposure of vullinite (a granulitised igneous rock) fortunately failed to conjure up the same enthusiasm (in the burn below Loch a'Mheallain at (288100)), and hammers were restricted to fallen material of cromaltite (a biotite-melanite-pyroxenite) at (245113).

In the afternoon members visited Enard Bay (031146) off the Achiltibuie road. A fascinating shore section, described by Gracie and Stewart, 1967, included the inter-Torridonian unconformity between the Torridonian and Stoer Groups. Examination of this feature provoked animated discussion for and against its existence.

The evening saw a final discussion of the week's accomplishments. It was regretted that we failed to climb Ben More Assynt but the low cloud never once lifted. A delicious green pudding completed a most successful week of self-catering and a sale of uneaten (ie. uncooked) items raised a substantial sum which was shared out amongst the party - the mark of a truly successful excursion!

The enjoyment of this excursion was due in no small way to the wholehearted efforts of the following: in particular Mr and Mrs Hogarth and other members of the catering committee (Mr Brownlee, Mrs McMillan); Drs. Mykura, MacGregor, May and Rock for their geological expertise; and the rest of the party who so willingly undertook their stint of the chores and contributed to such a stimulating week.

Some Selected References

a) General Reading

Bailey, E.B. 1952. Geological Survey of Great Britain. Thomas Murby & Co (for a history of the Survey's research into the North West Highlands)

MacGregor, M., Phemister, J. and Johnson, M.R.W. 1972. Geological Excursion Guide to the Assynt District of Sutherland (3rd Edition) Edinburgh Geological Society

Phemister, J. 1960. The Northern Highlands (3rd Edition) Regional Guide, Geological Survey

Stewart, A.D. 1975. Torridonian rocks of western Scotland in Geological Society, Special Report No. 6: Precambrian

b) Papers on specific aspects

Bowes, D.R., Wright, A.E. and Park, R.G. 1964. Layered intrusive rocks in the Lewisian of the North-West Highlands of Scotland. Q. J. geol. Soc. Lond. 120 pp 153-192

Gracie, A.J. and Stewart, A.D. 1967. Torridonian Sediments at Euard Bay, Ross-shire. Scott. J. Geol. 3, pp 181-194

c) Maps

Topo. 1" Sheet 9 Cape Wrath; Sheet 13 Loch Inver and Loch Assynt
Topo. 1:50,000 Sheet 15 Loch Assynt
Geol. 1" Assynt District, parts of Sheets 107, 108, 101, 102.

Andrew A. McMillan

The following postscript to his lecture was received from the Clough medalist, Professor Basil King;

ODE TO THE BAIKAL RIFT

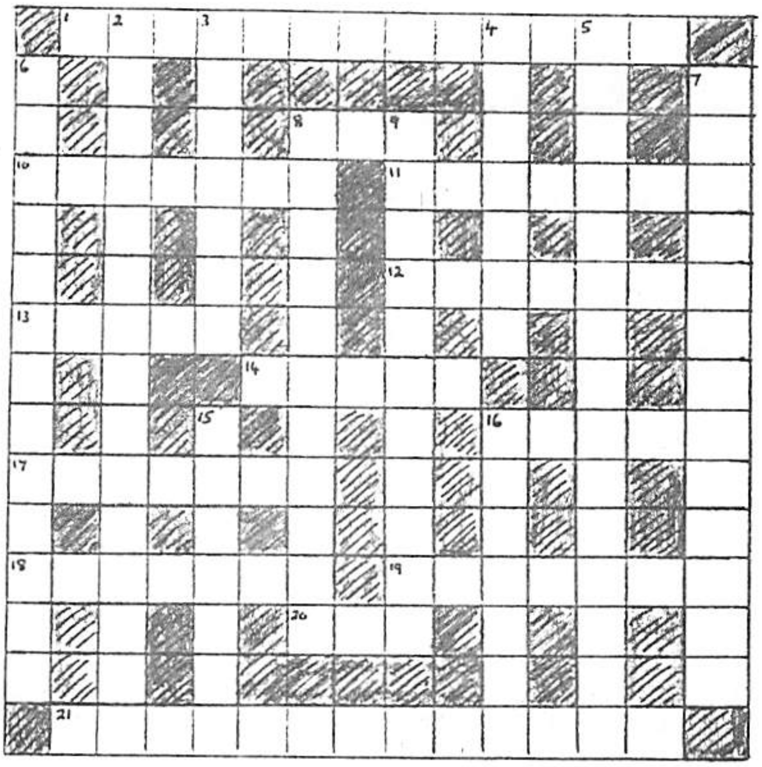
O Baikalian Rift in the heart of Siberia
you're in no way inferior
To the rifts that developed elsewhere;
You're so far from the oceans,
You show no plate motions
To give you false notions
And yet you're undoubtedly there.

You show crustal convulsions, but no triple
junctions,
And your course follows archaic trends;
There's been no occasion
Of mantle invasion
Though, by seismic persuasion,
You yet could make future amends.

O Baikalian Rift, with continent drift,
You could widen with greatest of ease:
A gulf of salt water
Along the right quarter
Is something that ought to
Please Russians as well as Chinese.

B. C. King

Geological Crossword No. 2



ACROSS

1 Unable to adapt? (13 letters)
8 Pillar-like plug (3)
10 "In virtues nothing .... could surpass her,
Save thine 'incomparable' oil, Macassar!" (Byron) (7)
11 E'en-tide is best occasion to look for this mineral (7)
12 Window on the crystal world (7)
13 We sat on the spoil (5)
14 "I had lockt my heart in a case .' ....,
And pinn'd it wi' a siller pin." (Scottish ballad) (1,4)
16 A crystallographic qualification (5)
17 Lumpy (7)
18 Ordnance Survey lost in isostatic adjustment - keeps quiet about it! (2,5)
19 A gin cocktail follows East African valley (7)
20 Earlier event (3)
21 Make concrete again (13)

DOWN

2 Modern building material of ruddy complexion? (3,3,9)
3 Very variable silicate found in the riot (7)
4 A Canadian consort with oil wealth (7)
5 Slices of Precambrian controversy in north west Highlands (8,7)
6 Big gorse bushes I'll see in Northumberland (5,4,4)
7 Look at fit lumberjack (3,4 6)
8 Sulphide of silver and antimony (11)
9 Jaundiced and mixed up French rock yields pigment (6,5)
15 Prometheus was pierced by more than one, according to Shelley (7)
16 Cigarette remains of an American autumn (3,4)

Solution to Geological Crossword No. 1

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J U N I O R   M E M B E R S !

Do you think the Edinburgh Geological Society does enough for You?

Are the annual programmes of lectures and excursions just your cup of tea; or would you like to see a small number of additional activities arranged just for you? These might include lectures similar to the annual schools' lecture, film shows, field trips in and around Edinburgh, or anything else you can think of.

If you have any ideas on the subject, jot them down on a postcard, not forgetting to let us know what time of day, week and year would be most suitable for such activities, and send it to:

Either

Mrs C. L. Thompson,
c/o Royal Scottish Museum,
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EH1 1JF

or

Mr S. K. Monro,
Institute of Geological Sciences,
Murchison House,
West Mains Road,
EDINBURGH,
EH9 3LA.

REVIEW - G. Y. Craig, D. B. McIntyre and C. D. Waterston. 1978. James Hutton's Theory of the Earth: The Lost Drawings. Scottish Academic Press. £75

1978 is proving to be a bumper year in Edinburgh, particularly so for anyone interested in geology and its historical development. Although the 250th anniversary of the birth of James Hutton occurred two years ago and the present publication was planned for 'early 1977', the ensuing delays have become a blessing in disguise. Its appearance only in July of this year has meant that it could be studied in close proximity to the exhibition of John Clerk of Eldin etchings and drawings at the Steigal Gallery during the Festival, to the various Robert Adam exhibitions in the city and now to the splendid display, The Discovery of Scotland, mounted in the New Wing of the National Gallery of Scotland, an appreciation of Scottish scenery through two centuries of painting.

What becomes increasingly clear from all this is that the origins of geological mapping in Scotland, the emergence of what Martin Rudwick, drawing largely on that somewhat neglected book, Prints and Visual Communication by William Ivins, has called 'a visual language for geology,' go back certainly to the middle of the eighteenth century. In 1746, a young English artist, Paul Sandby, was appointed official draughtsman to the military survey of the Highlands then about to commence. Sandby came to know Robert Adam and his brother-in-law, John Clerk of Eldin, whose 250th anniversaries this year's exhibitions celebrate. Sandby seems to have been the main influence in John Clerk of Eldin's development as a topographical artist.

Geologists know that their business is to observe and record their discoveries, but these are not necessarily confined to the Earth itself. Charles Waterston's discovery (ie. recognition of the scientific importance of) in 1968 of the so-called 'Lost Drawings', many by John Clerk of Eldin, has led, 10 years later, to the present work. Beautifully printed and sumptuously presented as a large folio of facsimile drawings containing a separate volume of text, the three intrepid authors deserve the highest praise. Of course, this could not have been accomplished without the involvement of many other people. Almost totally free from errors, the work will stand as a monument to the skill of those fine printers, W. S. Cowell Ltd. of Ipswich. The world of learning will everlastingly be in debt to Gordon Craig as editor and to Douglas Grant, the publisher, for bringing the whole work to fruition. Because of its size, the folio measuring 83 x 33.5 cm., librarians will probably have to place it with the atlases. But that is where it belongs.

The 62 pages of text, containing 42 figures, begins with a brief statement of Hutton's life and times and then deals briefly also with the fate of the Theory of the Earth and the drawings. It is an interesting story, not, of course, yet complete. Who knows, even now, where the remaining manuscript may be lurking, waiting to be discovered and published. This part contains a most useful list of all the 70 drawings in the original folio that came to light in 1968. There then follow brief sketches of all the characters known to have been associated with Hutton, especially on his geological excursions. A wealth of biographical and other information is given and the portraits of the principals (seven in all) stand out with an unusual clarity reproduced in sepia. Finally, and most important, the last chapter contains a chronological arrangement of the excursions undertaken by Hutton and his friends between about 1785 and 1788 through Scotland and to the Isle of Man, together with illustrations of the drawings produced. Wisely, the authors only draw brief conclusions, allowing the drawings themselves to speak from the printed page. One extra pleasing feature of the volume of text is the brief technical note on all the materials, equipment and methods used.

The 27 facsimile drawings (one, of Salisbury Crags, in 3 parts) in the folio do indeed speak for themselves. The two by Sir James Hall of the famous unconformity at Siccar Point and of folds near Siccar Point, stand in marked contrast to the highly developed style of John Clerk of Eldin. As drawings, those of Hall really show no advance on those of, say, John Strachey published in 1725 and known to William Smith. John Clerk of Eldin's drawings range in scale from detailed plans and sections, those of Arran being especially fine. His ability to combine the detail of topography and geology in plan and section, is especially clear.

Probably, relatively few people will be prepared to pay the price for the complete work. It is to be hoped that some, at least, of the finer facsimiles will become available for purchase as separate prints. Framed and mounted on the wall, they would forever remind us of our heritage.

Norman E. Butcher

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THE NEXT ISSUE of the Edinburgh Geologist will be published in March 1979. Will anyone planning to contribute to it please get in touch with me in early February to give me time to plan the issue.

My thanks to all the present contributors who have made this a very good issue.

Editor

NEW POSTCARDS

The experimental work of H. M. Cadell on mountain building is shown in two new postcards made from the original photographs supplied by Mr. W. A. Cadell. These are available at 5p each from - Ian Bunyan

REVIEW - GEOLOGY by Andrew McLeish, Blackie & Son Ltd. (1978) 138pp. £2.95

Authors of school books on geology, of which there are now several, generally emphasise the point that the science of geology has a strong inter-relationship with other sciences. Andrew McLeish goes further and says that because of this, 'geology is an admirable subject for both able and less able pupils'. I am inclined to agree with this, and I see his new book having a rosy future as the teaching of this admirable subject in schools upwards.

'Geology' covers the requirements of the various United Kingdom CSE, O-level and O Grade syllabuses. It does this in seven Units (why he uses Units rather than Chapters, the author does not say): Planet Earth, Earth Chemistry, shaping the Earth's surface, Earth Physics, The Moving Earth, Earth History (including a section on the geological history of the British Isles) and Earth Resources. Some of these titles are directly related to more familiar school subjects - Earth Chemistry, for instance, which covers the field of rocks and minerals. This approach immediately provides a framework in which the student is at home. One of the greatest achievements of the author, however, is that he has made the text easy to follow despite having to concentrate geology into 136 pages. Sentences are inevitably short and to the point, but continuity is not lost. Key works are in bold print, which allows the book to be used as a kind of dictionary if the reader so wishes. Indeed, the concise nature of the book generates a useful summary for students for revision purposes. The block line diagrams (164 in all) and the tables are simple and informative (although I think figure 7.14, 'Metallogenic provinces in western Europe. Deposits of tin minerals are found in two well-marked belts' - in which two broad grey bands cross the map of Europe, leaves a little too much to the imagination). Also, black and white photographs (76 of them) have been used to good effect to embellish many points. An extremely useful feature, one might say essential for a school text, is the integration into the text of several simple laboratory experiments to illustrate various geological processes. I shall delight in trying some of these myself, as I am sure every student will too.

Questions about the experiments are posed, to bring out the relevance of the experiment to real-life geology, and some hints given as to the correct answers to the questions. Under the same umbrella of useful, even essential, is the distinction that McLeish makes between fact and theory. It is reassuring that even at the early stage of CSE or O Grade the student is asked to, 'Find out what theories are and how they are used in science' (p 49).

This book is, then, a good teaching aid from the point of view of both teacher and taught; but here lies the clue to the successful use of the book. It is one that the student needs to be guided through so that each point can be elaborated upon. Frequently in elementary geology, the student cannot "see the wood for the trees" because it is necessary for him to absorb an enormous amount of factual information on rocks, minerals and fossils etc. This information needs to be considered in a broader context. 'Geology' is not a book that a student working on his own could successfully use. Perhaps this is inevitable in a course text book, but it may place limitations on its use.

In a field where there is very little room for innovation in new text books, Andrew McLeish has produced a book that adequately meets its remit in a style that will appeal to many. I strongly recommend school teachers to consider it for their courses. It is not a book for reading at leisure, however.

Roger A. Scrutton

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PROCEEDINGS OF THE GEOLOGISTS' ASSOCIATION

We have been offered the chance to buy some back numbers of the Proceedings (from Vol. 86 and 87) at a reduced price.

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