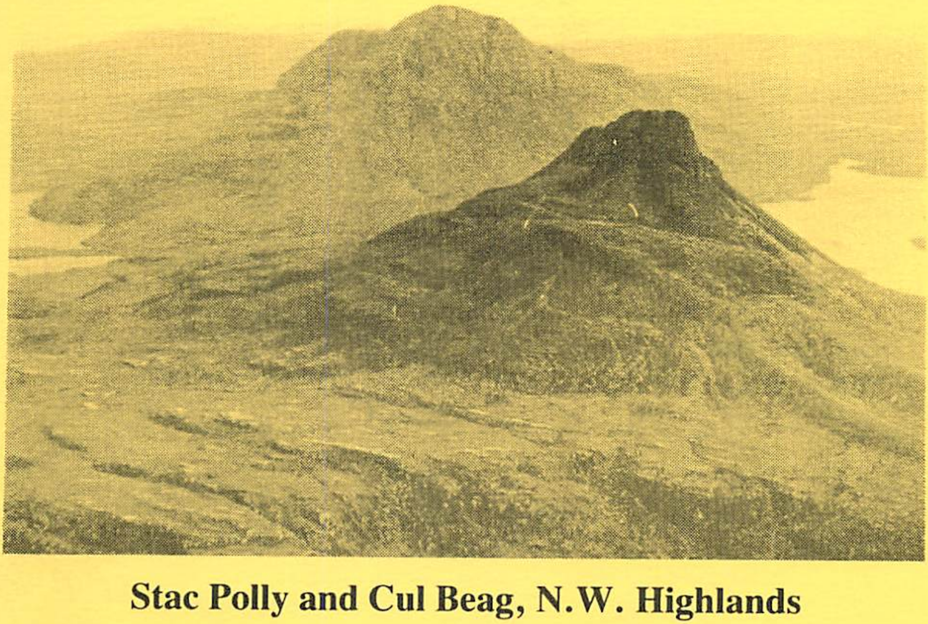
The Edinburgh Geologist

No. 25 Spring 1991



Stac Polly and Cul Beag, N.W. Highlands

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Cover Illustration

Stac Polly and Cul Beag, N.W. Highlands. Relict mountains of Torridonian sandstone resting unconformably on an irregular basement of Lewisian gneiss; viewed from the south east. BGS photograph D2422, reproduced by permission of the Director, British Geological Survey, NERC copyright reserved.

Published by
The Edinburgh Geological Society
c/o Murchison House
West Mains Road
Edinburgh EH9 3LA

ISSN 0265-7244
Price £1.50 net

Printed by Drummond Street Reprographics Unit.
Typeset by Drummond Street Reprographics Unit.

Editorial

Issue 25 of the Edinburgh Geologist will, I hope, provide articles to cater for a wide variety of the members' interests. The topics covered range from a report on the sixth meeting of the European Geological Societies which took place in Lisbon during last October, written by John Lovell, to a report on the British Schools Exploring Societies expedition to the Kluane wildlife sanctuary in the Yukon by David Edwards. The latter deals with the dating of Quaternary landforms and processes by the study of intercalated ash deposits produced by the eruption of Mount Bona, a volcano close to the border between Canada and Alaska.

The volcanic theme is continued in a report by Mike Browne of a lecture given at the Royal Museum of Scotland on the Volcanoes of the Andes by Professor R. Sparks of Bristol University.

Members who are intrigued by historical aspects of the development of geology and by the role played by the EGS should read the articles on the Societies written and photographic archives by David Land and William Harper and the review, by Bill Baird, of the recently published book entitled The Highlands Controversy written by David Oldroyd. Two further reviews by Bob Cheeney and Scott Johnstone of books dealing with Highland geology are also included.

Poets are advised to fortify themselves before trying to emulate the deathless prose of Bill Baird and Andrew McMillan inspired by the society's long excursion to Rhum. I wonder if the Orkney excursion will provide similar material to be included in the next issue!

Clive Auton

April 1991

Report on the 6th Meeting of the European Geological Societies, Lisbon, Portugal.

John Lovell,
British Geological Survey

The sixth meeting of the European Geological Societies (MEGS 6) took place in Lisbon, Portugal from 2-4 October 1990, as part of the celebration of the 50th anniversary of the Geological Society of Portugal. Its theme was 'The Atlantic and its relation to Europe', and the meeting was originally planned to last from 29 September until 7 October allowing field excursions to be held both before and after the lecture sessions. Unfortunately, owing to the organizers' failure to organize, these trips were all cancelled at a very late stage, leaving those of us who had purchased APEX air tickets with a few days to kill in Lisbon. This was no great hardship except for difficulties in arranging accommodation because it was a Portuguese holiday weekend. Private field- and sight-seeing trips were quickly organized by the intrepid Caledonian party. The weather was pleasant throughout, with temperatures in the mid- to upper 20s, and with only one rainy day, during which the bus driver contrived to soak numerous participants by driving fast through a deep puddle, causing a waterspout to enter the bus through a poorly sealed door.

The Conference

The sessions were held in the splendid Gulbenkian Foundation, a purpose-built library and conference/concert centre which also houses a museum and cafeteria. It is one of several such institutions financed by the oil billionaire Calouste Gulbenkian who, although of Armenian extraction and a British subject, lived for some time in Portugal. Total attendance was apparently 90 people, primarily from Spain and Portugal, but with some from eastern Europe, although where most of them were I can't imagine, as there were rarely more than about 40 in any of the sessions.

Twenty two papers on topics associated with the meeting's theme were presented, together with an equal number of posters. Many of the papers were in French (the meeting's second official language), which caused much head scratching amongst our party, especially since the French as spoken by Spaniards and Portuguese is heavily accented, and a very long way removed from 'la plume de ma tante' stuff of our schooldays.

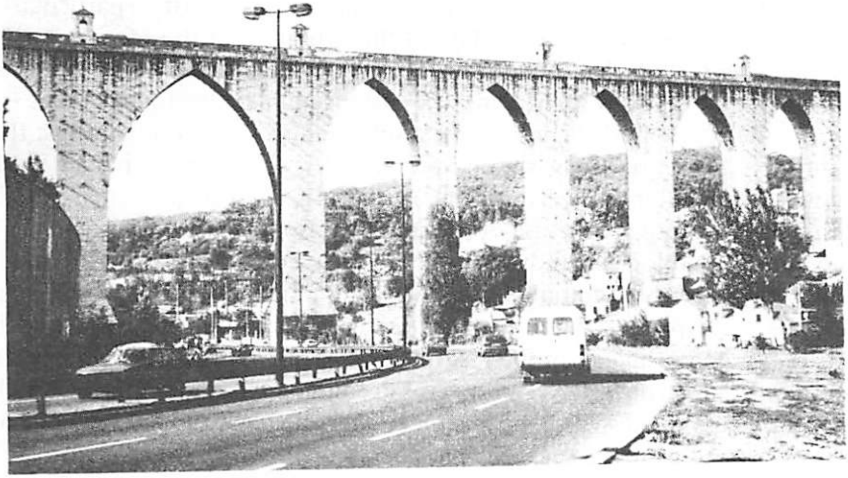

Figure 1. Aqueduct of Aguas Livres, completed in 1748 and still in use. It survived the great 1755 earthquake.

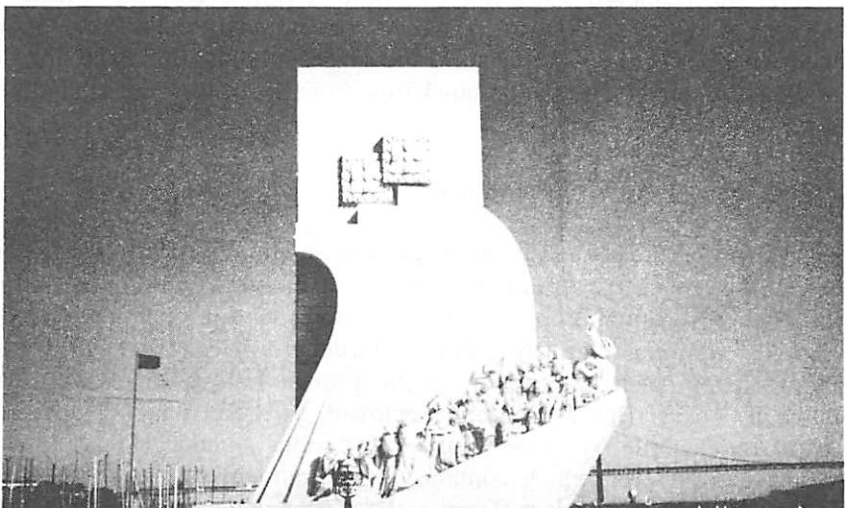

Figure 2. Monument to the Discoveries, on the Belem seafront, incorporating statues of Prince Henry the Navigator and other explorers. Tagus Suspension Bridge in background.

Most papers described Portuguese, Spanish and French palaeontological and stratigraphic work in the Iberian peninsula and north Africa particularly directed towards the understanding of the evolution of the Mesozoic and Tertiary basins of that area. This theme was extended back into the Palaeozoic by Andrew McMillan, who, after suitable adjustments to his tie for the photographer's benefit, gave a splendid presentation, with just the right mixture of erudition, wit and pretty slides. Some of the papers were relevant to similar projects current in the UK, two in particular which described respectively the use of detrital K-feldspars in provenance studies and a sedimentological study in an urban area were of particular interest. Some discussion was initiated, along basin and urban geology lines, and surprise was expressed that montmorillonites in the Lisbon area appeared to cause no geotechnical problems on expansion. The former scientific isolation of much of eastern Europe was exemplified in a presentation which spoke of geosynclines; we hope that meetings such as MEGS will continue to promote and encourage scientific glasnost.

A little comic relief was unwittingly provided by one presenter who insisted on standing directly in front of his slides, so that the subject matter, illegible anyway, was rendered invisible too; a note of controversy was added by another who cast doubts on the conventional palaeogeographic reconstructions of the Atlantic area, and suggested that Greenland arrived at its present position in double-quick time from the tropics. Certainly food for thought there.

Accompanying Person's Programme

A social programme for accompanying persons had been arranged. This consisted of coach trips round Lisbon and its environs, and a visit to the Gulbenkian Museum. Visitors to this museum found it imaginatively laid out, and containing relatively few but exquisite examples of many art forms ranging from Ancient Egyptian to the French Impressionists and Art Nouveau. These trips were greatly enjoyed, as there is much to see in Lisbon, for example St George's Castle; the famous aqueduct (Figure 1); the Belem seafront area which contains the Monument to the Discoveries (Figure 2) and the Belem Tower; the Tagus Bridge; and numerous museums, palaces and churches.

Lisbon itself is a pleasant city, and contains on the higher ground a mixture of medieval housing with narrow cobbled streets. The city centre consists chiefly of 18th century boulevards, parks and civic buildings, the result of a reconstruction programme by the Marquis of Pombal after the great 1755 earthquake, fire and tsunami, which devastated the lower-lying parts of the city. Lisbon also has its fair share of shanty towns and concrete monstrosities, and in common with many cities is being rapidly choked by the motor car. Other memorable features are the *azulejos* (blue and white painted tiles - very decorative, and generally portraying classical or maritime scenes), and the use of small limestone cubes to produce decorative mosaic pavements and squares. These mosaics frequently represent waves and ships, a particularly fine example is found at the base of the Monument to the Discoveries on the seafront at Belem, and is best seen from the summit of that monument.

Social Programme

A port tasting reception was arranged for all participants, followed by a pleasant meal and entertainment in an *Adega Tipica* - a restaurant at which the *fado*, traditional Portuguese songs of destiny, was performed. The *fado* is pompously described in the Oxford Companion to Music as 'essentially café or tavern entertainment, and as such enjoyed for hours by the lower class of Portuguese – whilst a good deal looked down upon by the more educated classes'. This may well be so, but our table was blessed with the presence of an educated Portuguese who took pains to describe the differences between the *fado* of Lisbon and that of Coimbra, and who obviously enjoyed the singing, the more so as the night wore on.

The evening reception took place in the 18th century Lisbon Town Hall. After having a glass of port and making polite conversation for about an hour, the party began to wonder when the Lord Provost of Lisbon or some other civic dignitary would appear. Even the entry of the Queen of Sheba would have been welcomed! Interrogation of the organizers revealed that no such delights were in store, and that we had been invited merely to view the room from the balcony of which the declaration of the Portuguese Republic was made on October 4, 1910! It was certainly an impressive and beautiful room, but after a quick final viewing, the party retired en masse to find a convenient restaurant.

The Field Trips

The field trips were originally intended to show participants the volcanics of the Azores, and the Mesozoic basins and shear tectonics of parts of western and central Portugal, but, as mentioned before, they were all cancelled. The

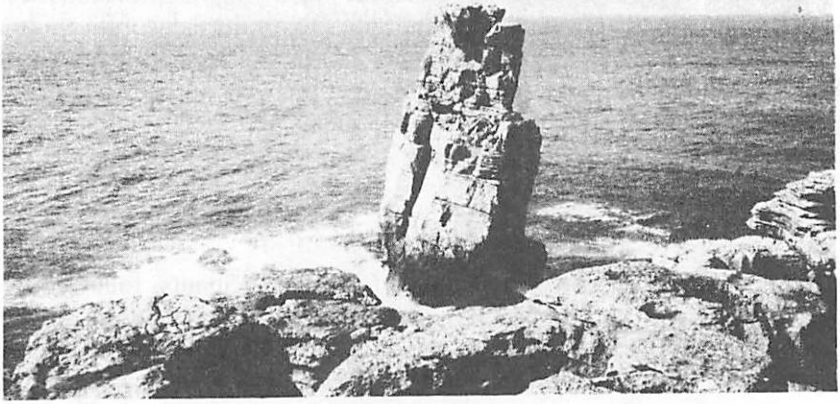

Figure 3. Sea stack consisting of limestones towards the top of the Peniche carbonate fan sequence. Note karsted cliff top in foreground.

Figure 4. Examination of massive fossiliferous limestones just below base of Peniche carbonate fan sequence.

excuse given was insufficient numbers, but this was seen as nonsense by the Edinburgh party of sixteen good men (and women) and true, all keen to see some geology, so the free days were filled by small private field trips organized on the initiative of BGS and Edinburgh Geological Society members. The trips were arranged with some assistance in the form of maps and guidance from the Geological Survey of Portugal and postgrads from the Old University of Lisbon, who were obviously embarrassed by the organizers' failures.

The first trip was led by Carla Kullberg, a postgrad from the Old University of Lisbon. A fleet of jeeps drove to the Sintra area, about 20 miles or so west of Lisbon. Here the relationships between the Sintra Granite and the surrounding sediments were examined. The granite itself is of late Cretaceous (Alpine) age, and its intrusion is thought to be associated with the rotation of Iberia. The granite was seen to be leucocratic, but containing younger, much darker dioritic and epidotic bodies; these are probably ring complexes or cone sheets. Several of these bodies were seen in an offshore exposure a few miles west of Sintra at Cabo da Roca, a high and very exposed headland and the most westerly point on mainland Europe (illuminated certificates to that effect were purchased by most). Here the granite's contact with the surrounding Cretaceous sediments was observed to be a thrust to the north, but vertical to the south.

The next day, a smaller party drove to Peniche in a hire car and the coastal section from Peniche (about 50 miles N of Lisbon) southwards to Ericeira was examined (Figures 3 & 4). The cliffs on the northern part of the Peniche peninsula revealed a small volcanic vent which contained fragments of gneissic material as well as country rock. Southward-dipping massive and more thinly-bedded limestones of the Peniche carbonate submarine fan sequence (Touarcian-Aalenian) described by Wright & Wilson (1984) were examined. Particularly striking features were the heavily karsted cliff tops seen all round the peninsula, and indeed, farther south around Sintra on succeeding field trips. The party then followed the coast southwards to examine the middle Cretaceous sediments. A third day trip followed the coast from Cascais, west of Lisbon, to Capo da Roca and Sintra, and repeated the examination of that area. The lower and middle Cretaceous limestones and mudstones are well exposed all round the coast, and once again the karst features were observed.

The town of Sintra is well worth visiting for its Royal Palace, the summer home of the kings of Portugal, dating in parts from the 14th century, and containing many interesting rooms and art treasures. It is also celebrated for its excellent tea and cake shops, quickly smelt out by the expert noses of certain members of the party well practised in this art. Overlooking, and considerably higher than the town is the Moorish Castle which splendidly utilises the natural contours of the granite and dates from the 8th or 9th century; and the Pena Palace, a grotesquely overdone 19th century folly visible on its hilltop site for miles around.

Summary

MEGS 6 took place despite the efforts of the organizers. The several months prior to the meeting were characterised by a complete lack of any response to letters, telexes and other requests for information, with a result that the Edinburgh party arrived in Lisbon not knowing when (or indeed if!) the conference would take place. Only the vaguest time was given for the start, the cafeteria was not pointed out to participants, and many papers were inexplicably withdrawn, but the most exasperating failure was the cancellation of the field trips. Vasco da Gama and the other great navigators would have been saddened by this shambles.

Despite the irritations however, the Edinburgh party enjoyed the conference and self-organized trips. Old friendships were renewed, many new contacts made and the links between European geological societies strengthened. We look forward to MEGS 7 in Paris.

References

WRIGHT, V. P. & WILSON, R. C. L., 1984. A carbonate submarine-fan sequence from the Jurassic of Portugal, *Journal of Sedimentary Petrology*, Vol. 5, p. 394-412.

Returning to the fold:
Some personal thoughts from a born again geologist

J.M. Johnstone

July 1970. MacEwan Hall, Edinburgh.
To my utter amazement, and I suspect to that of many of my friends, the University of Edinburgh awarded me a BSc with honours in Geology. A brief flirtation with the thought of further study had gone and so it was good-bye to state funding and the perceived allure of 'research students' to young lady undergraduates. Fortunately, I'd taken the precaution of obtaining a post with a large Scottish bank, never really intending to pursue a career in geology. Apparently I was not alone in this view on a career change as I discovered when I telephoned my Director of Studies, a very polite palaeontologist, to explain my plans and request a reference. 'Jolly good idea' was the response! Perhaps I shouldn't have found his goniatites so funny. No matter. I was off. Released.

Over the following fifteen years, my life continued happily with no thoughts whatsoever of geology. My parents eventually accepted that not everyone in banking required a geology degree and my sole contact with the thing was confined to an occasional drink with an old university chum. Then it happened!

While browsing in a London bookshop, I came across it. The second edition of the 'Geology of Scotland'. In true Thatcherite fashion I produced my credit card and made an impulse buy. Twenty-four hours later, I was totally hooked. I felt I could personally relate to the authors. Strange, I'd never felt that way when they'd been teaching me! G.Y Craig; always looked so dapper, even on field trips. J.P.B. Lovell; the songs he taught me have regaled numerous rugby clubs. M.R.W. Johnson; still on about cleavages. E.K. Walton ... P. McL.D.Duff .. To my amazement, it all seemed so much more comprehensible than it had so many years earlier. Or was my mind playing tricks on me? Had I been trying to improve my bridge when the Moine Thrust was being explained? And how things had moved on as well. Where had the Iapetus Ocean been when I was a boy? Surely I would have remembered such a beautiful name. Or had I been trying to improve my snooker when the dear old Iapetus was under discussion?

By now both my credit card and the shelves in my study were under strain as more and more books were added to the gem that had reawakened my interest. How much more easy is it is to read these tomes when no one expects it of you. And I was actually learning. I'm afraid the same cannot be said of my field ability. For example, there I was happily explaining away a chunk of volcanic rock to my daughters when my wife pointed out it was actually concrete! And she can't even spell geology! Messrs. Cox and Upton no doubt will mutter that some things never change.

But why should a grown man become so besotted by a subject that appears so dull to the uninitiated? I'm not alone however. I recently met a beautiful lady auditor who was a born again geologist and Wilf, the barman in the Windows of the World in Manhattan, loves talking on the subject. But why? Black Holes are fascinating. Interest rate risk management is intriguing. But geology really is something else. I think I know why. It's ten per cent nostalgia. I have very fond memories of my student days in the late sixties and often wonder if geology is taught in the same way. I mean, do they still play French cricket in Irish peat bogs? My early concerns on this matter were dispelled when I learned that a former undergraduate colleague and now a respected lecturer at Glasgow, intended to teach his students how to juggle. It's wonderful. I didn't even know he could juggle.

It's ten per cent frustration and regret. Not so much on my part for having ignored my true love for fifteen years but rather for not realising what was going on around me during my undergraduate days. The worthy Professor Hallam describes the sixties as a time of revolution in the earth sciences (we happy amateurs are allowed to read of such things) and of course, it was. Plate techtonics had arrived and the teaching staff were really pushing out the boundaries of imagination. I, however, failed to recognise this and completely missed it. A former lecturer at Edinburgh at that time explained it rather succinctly at a recent reunion. He'd been trying to impart knowledge whereas the students had been too busy trying to pass exams.

The remaining eighty per cent is the uncertainty and potential for controversy. How many geologists do you know who don't thrive on a good old argument, be the subject geological or otherwise? The history of the subject is littered with rip-roaring squabbles and disagreements. How dare you suggest Arthur's Seat is volcanic! Natural selection! Humbug. Continental Drift! What nonsense. It would seem to me that the beautiful simplicity of the principles of plate techtonics (well it seems simple enough when I'm sitting in bed reading about it) pretty well kills off potential arguments on the macro scale for the moment but presumably we can live in hope that someone will come along soon and upset the applecart. There must be potential somewhere. What exactly is going on in continental interiors and does it sit neatly with sea floor spreading? Will chaos theory erode and possibly kill our cherished quantum mechanics. What does morphic resonance do for evolution? Will anyone famous every publicly recant?

Of course we amateurs rely exclusively on the professionals to provide the fuels for controversy so go to it ladies and gentlemen and give me something mega to argue about when next I see Wilf. Or should I go and see that beautiful young auditor...?

'Hugh Miller' is alive and living in Cromarty

Scott Johnstone

On 23rd June 1990 'Hugh Miller', with a large retinue, went in procession through the town of Cromarty, from the School Hall to his birthplace cottage. Included in his immediate 'tail' was his granddaughter (brought up in Australia but returned to marry a local farmer), the Earl of Moray, Mr Lester Borley, Director National Trust for Scotland (NTS) and several notables of the District and Community Councils.

At the cottage, which had been closed for re-furbishment, Mr Borley passed the keys to the Earl who formally re-opened the house and admitted 'Hugh' to his former abode.

The Cromarty folk are very aware of the debt owed to Hugh Miller (and the NTS) in rendering their attractively preserved town a major tourist attraction.

A 'Hugh Miller Day' recognised the centenary of the occasion when the Cottage passed into community ownership as a memorial of their famous son. The town was 'en fete' and many folk were in period costume (as available – some regalia apparently dating to the earlier part of the 18th Century!). Various stalls and booths catered for craft, food and fun and a full programme of entertainment was provided.

The NTS, of course, now cares for the cottage and the presence of the Earl recalled the occasion when his father presented the keys to that organisation.

'Hugh Miller', (Figure 1) portrayed by the local baker, was suitably provided with an unkempt hairpiece but apart from that bore a strong facial resemblance to the original, a circumstance not lost on the more ribald members of the crowd of onlookers. Perhaps he was more jovial than one would imagine from the formal portraits available but no doubt Hugh had his moments.

My presence at the festivities was as the only known geologist on NTS Council, despite the fact that the Old Red Sandstone is hardly my speciality.

Figure 1. The Earl of Moray, 'Hugh Miller' and Mr Finlayson (convener, Ross and Cromarty DC).

Nevertheless I could not help noticing recent sedimentation in progress. At about 9.30 am (arriving from Edinburgh after a 6.00 am start) I found the road descending the hill into Cromarty inches deep in red sand and seed potatoes washed out from adjacent fields by a horrendous overnight rainstorm. The Cromarty Firth was red for many yards offshore as spuds and sand formed a recent accumulation.

Fossil fish and chips? What would Hugh have made of that?

Tephrochronology in the Kluane region of the Yukon territory, Canada

David Edwards
Edinburgh University

Introduction

In the summer of 1990 I was fortunate enough to be taken on as a geomorphology leader on the British Schools Exploring Society's six-week expedition to the Kluane wildlife sanctuary, Yukon territory, Canada. Looking for a meaningful project to occupy the six students I would be allocated for the three week science phase, Dr Andrew Dugmore of the Edinburgh University Geography Department suggested that I look at the little studied White River Ash deposits.

White River Ash

Approximately 1250 years B.P. (Lerbekmo et al., 1975) a volcano now known as Mt. Bona (about 17 miles west of the Alaska/Canada border), erupted 6 cubic miles of volcanic material (Figure 1). Westerly winds spread the ejecta 500 miles eastwards into the Yukon territory of north-west Canada, depositing it as a single primary layer only about 1 cm thick in the area visited during the expedition. An earlier eruption, dated at 1887 BP, produced a northern lobe of ejecta. The volcanic ashes (tephra) are collectively named the White River Ash, after a river near the source vent. Several studies have examined the composition of the tephra, and its concentration, (Lerbekmo & Campbell, 1969; Stuiver et al., 1964) but the purpose of this study was to identify the deposit in the field and use it as a tool to analyse geomorphological processes that have developed since its deposition.

The ash is unmistakeable when seen in the field being a light grey/white gritty band. A lightweight field microscope showed it to be comprised of distinctive glassy, angular fragments about 0.1-0.2 mm in size.

The study area

The study area is located in the Kluane Wildlife Sanctuary, in the Yukon

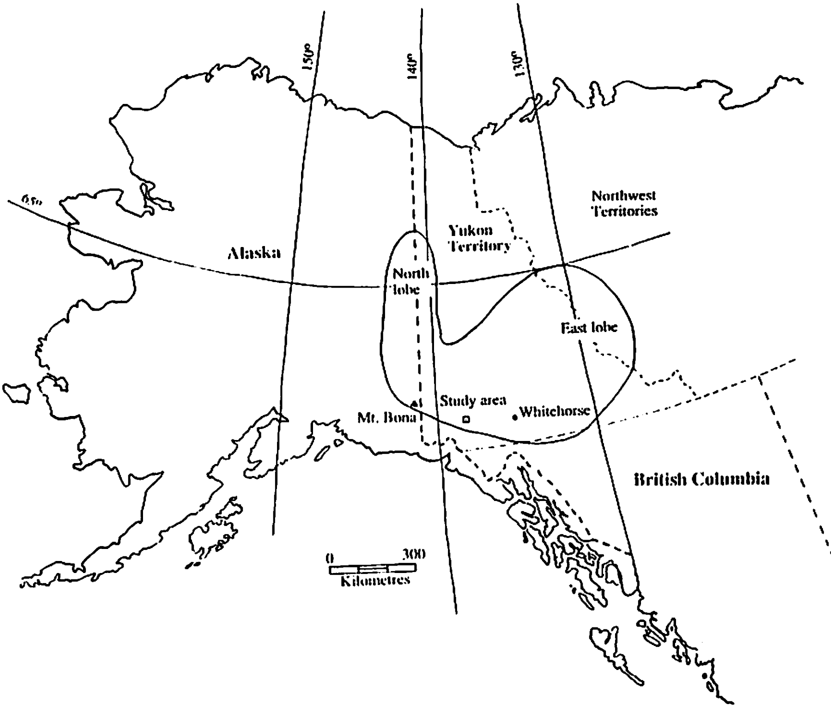

Figure 1. The limit of noticable deposits of the White River Ash.

territory of north west Canada. The Alaska Highway afforded the closest ingress by road, and from there walking led to the foot of the St. Elias mountains, at latitude 60° 55'N, longitude 138° 16'W.

The Kluane area has low rainfall (typically less than 20 inches per year), being in the rain shadow of the St. Elias mountains to the west. High winds do, however, occur. Winter temperatures fall to less than -5°C, and the average annual temperature of Whitehorse, the state capital about 115 miles to the east, is –1.3°C.

The low, vegetated foothills of the Front Ranges of the St. Elias mountains give way to bare, rocky mountainsides mantled with scree. Weathering in this area is intense: all the rocks are rotten (regardless of lithology), and gaudy chemical weathering stripes cloak the ground. There is certainly no shortage of fine weathering products and angular stones. These products seem to form the parent material of the lower, vegetated hill slopes, where stone circles and polygons abound. Hill cover appears to be a veneer of clay- and scrub-bound colluvium up to 2 m thick.

Grass is very rare on the hills in the district, tending to form occasional 'oases'. The normal vegetation is dense, high, willow scrub in well drained areas, or heathery scrub and arctic willow everywhere else. The normal hill soil is very clay and stone rich and is extremely hard to dig. There is evidence everywhere of small slope failures (e.g. 'tears' in vegetation cover, and solifluction terracing). Soil drainage is generally poor, and it is suspected that downslope movement is primarily due to a combination of low winter temperatures and high pore water pressure in the spring when winter snow melts. Frost heave, solifluction and water pressure are assumed to be the main moving agents.

Methodology

Digging in such densely vegetated and/or stony soil is hard work but taking note of natural exposures saved energy and led to the discovery of the two sites to be described here; sites 'L' and 'H'. Other unproductive areas were also logged to try and define the useful limits of the ash. The entrances of gopher burrows were routinely examined, as they often showed White River Ash in the excavated material.

Description of Sites

Site 'L'

The site is at 1290 m above sea level, near the foot of a south-west facing slope (Figure 2). The average slope angle is 18° . Above the site, the slope reaches a maximum height of about 1360 m above sea level. A sandy landslide track, with rafts of vegetation, marks the failure of a part of the lower hillside.

The landslide left two back walls 2 m high, approximately 12 m apart. The most northerly one provided an excellent section for minimal effort. The other showed interesting folding of the ash layer but was not conducive to consistent logging.

The northern section showed that the ash layer was present as up to five

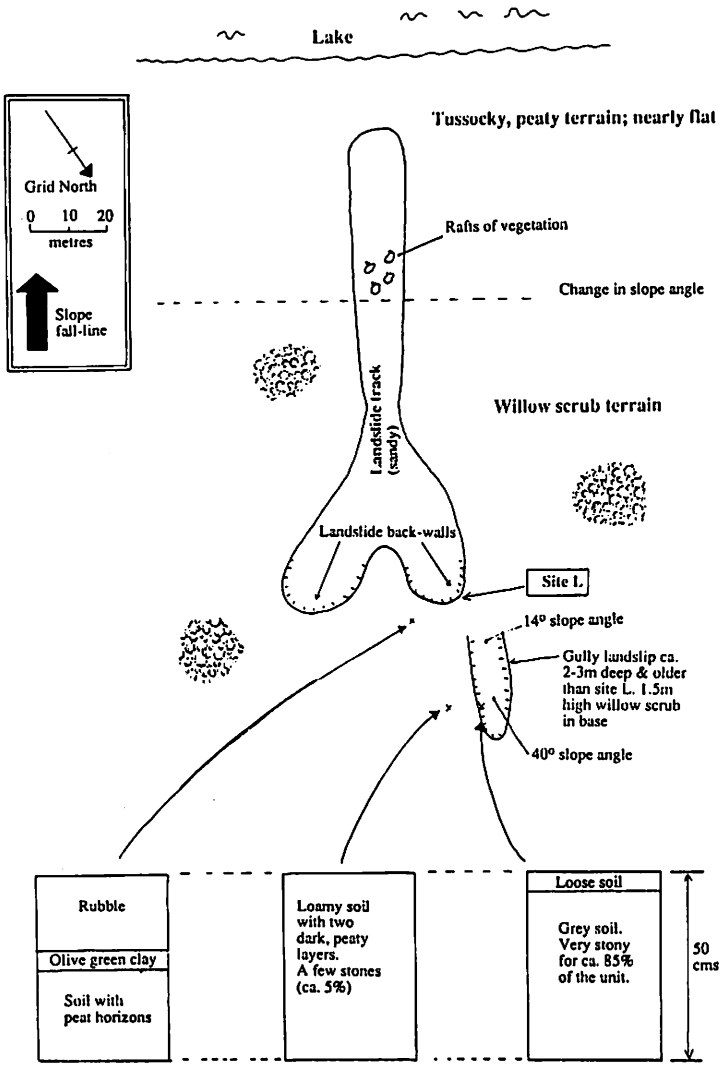

Figure 2. Plan view of site L and generalised soil profiles.

separate horizons (Figure 3). The repetition of the ash layer with associated peat/old vegetation horizons, clearly showed that the slope had slipped repeatedly over the last 1250 years, allowing thin layers of ash and soil to slip down from higher up the slope. The whole sequence was capped by an overthrust slide of basal regolith. Control holes were dug around the exposure which further confirmed the unstable, mobile nature of the slope, shown by the wide diversity of soil horizons encountered and the fact that older horizons often overlie layers of younger material.

It is thought that the basal regolith layer is the zone of weakness for slope failure. The landslide scar below this site, and the regolith zone above the site, have a sandy matrix which binds less well than other horizons.

Site 'H'

Site H (Figure 4) is a grassy hollow on a hillside. It is at the foot of a north-easterly facing slope (1340 m above sea level), just above a level flood-plain. The average slope angle is 14°.

The hollow was examined by means of two trenches dug at right angles to each other, the longer running down the fall line of the slope. A very striking difference in ash attitude was seen between the longitudinal (fall-line) ash profile (Figure 5), and the transverse profile (Figure 6). The longitudinal profile showed a remarkable parallelism between ground surface and the ash layer, while the tranverse trench showed a very uneven ash horizon. The ash infilled hollows in the soil, and was also banked up against stones on their upslope side; clear evidence of secondary deposition. As the transverse trench was extended towards the heathery, flanking, hillside, the ash layer became disrupted and faulted, probably due to solifluction and landslip processes.

Discussion

At Site H the ash layer shows great variation in its depth of burial, extent, thickness, and aspect in relation to the present ground surface. Its intermittent preservation at this site is probably due to erosion by surface water which would preferentially erode where the flow was more concentrated (in rills, for example). Aeolian transport would probably not show such preferential erosion on such a small scale. It it interesting to note that this difference would not show up in a profile parallel to the fall-line, but

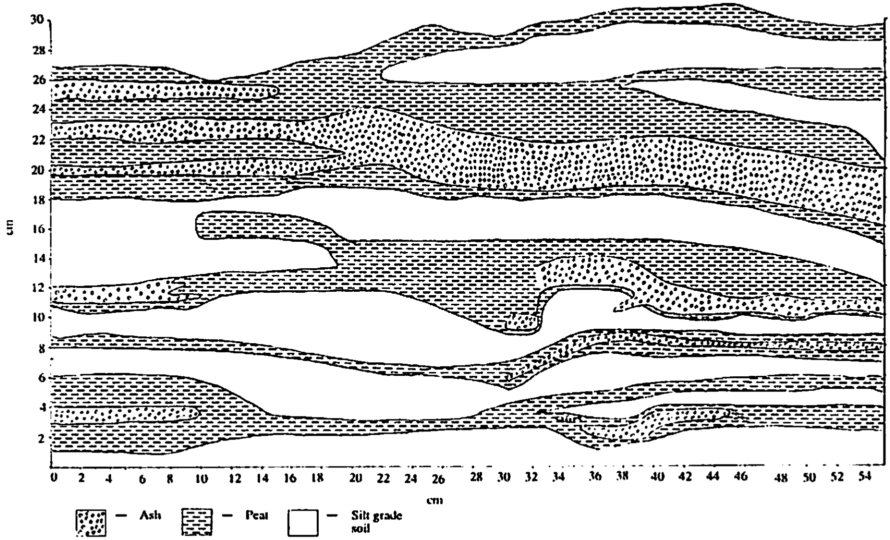

Figure 3. Detail of ash, peat and silt layering from the foot of the backwall of site L.

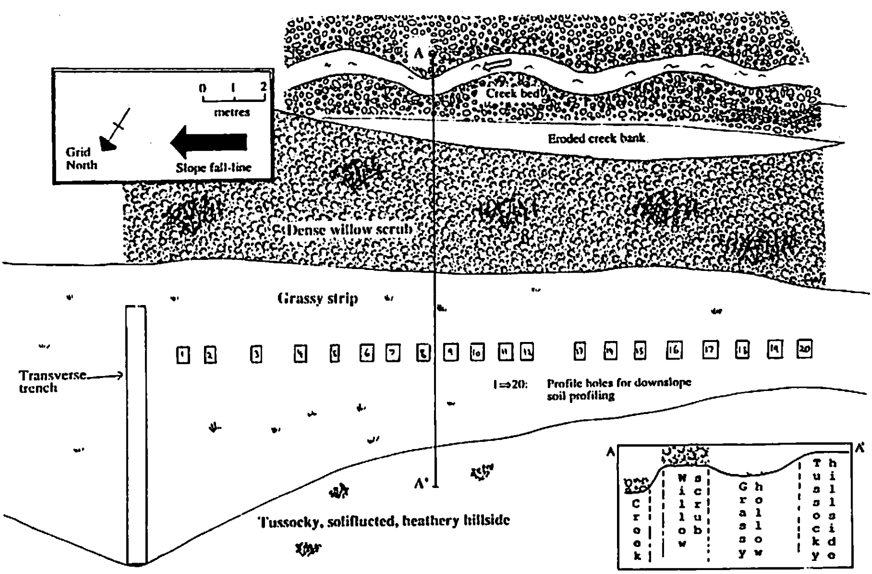

Figure 4. Plan view of site H. The ash was first seen in the creek bank. Vertical section A-A′ (inset) gives height relationships of zones.

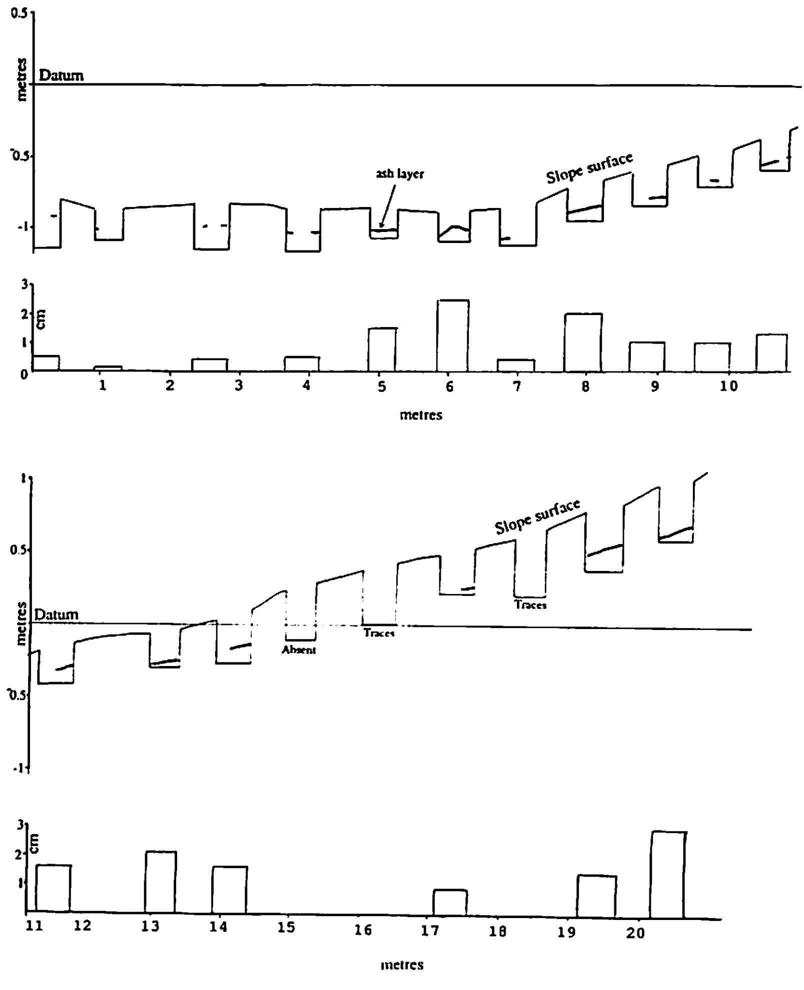

Figure 5. Site H. Fall-line sub-surface soil profile showing the White River Ash layer; thickness of ash shown in histrograms.

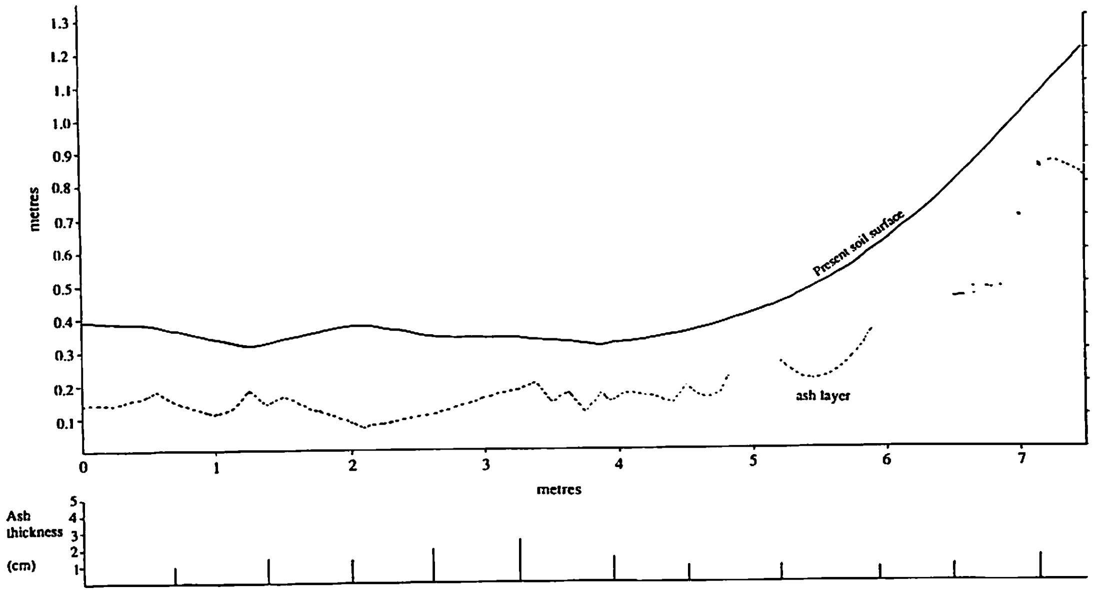

Figure 6. Site H. Sub-surface soil profile in the transverse trench showing the White River Ash layer; ash thicknesses shown below.

only a section 'across the grain' and is consistent with this study's findings. The sharp boundary of the ash layer with the overlying soil, implies that the ash did not seriously affect the ecology of the area.

At Site H, ash may have been transported down the hill and accumulated in front of stones until a 'ramp' formed, sufficient to allow the ash to override the obstacle and be deposited in its lee. Alternatively, we could be seeing a combination of primary deposition plus later 'bolstering' by secondary deposition. In some instances the lack of ash on the top of the rocks would seem to confirm that we are not seeing a primary drape, although if ash had been present it would have been very easy to remove, being neither protected by the rocks, nor pushed up against them.

The soil above the ash has obviously been deposited by slope wash, although this did not remove the ash immediately after its deposition. Rainfall is low, and it is suggested that the rills into which the ash fell (and sometimes filled) may have been caused by the spring run-off from melting snow. That the ash itself was not washed away during the following year shows that vegetation had a chance to stabilise the material, although the gaps in the ash layer may be caused by rills formed by the next phase of snow melt. Aeolian processes may have helped concentrate the ash, and the soil which has accumulated above it: loess and windblown silt horizons have been logged in the area (Denton & Stuiver, 1967). Slope wash accumulation on this slope appears to be of the order of 0.2 mm per year on average.

It would have been quite easy to recognise that the slope on which Site L is located was unstable and prone to sliding without the ash layer being present. However, the complicated reworking shown in Figure 3 would have been hard to deduce without the delineation afforded by the ash.

Above 4400 feet the ash is rarely found. Snow melt, frost heave, solifluction, and a paucity of flat or slightly concave ground, all combine to lessen the chances of the ash layer being preserved. Ash was occasionally found at greater elevations, however, (notably in soil that had been exposed by a bear digging for ground squirrels) but only as individual grains incorporated in the soil, not as a distinct horizon that could be used for deductive purposes.

On the high ground the hill slopes are very active; landslides, frost heave, and solifluction obliterate any indication that the ash once laid there.

On the lower ground, conditions for favourable ash preservation seem to be flat ground or gentle slopes, but not areas of active deposition e.g. floodplains, or areas where strong aeolian processes operate.

Samples of ash and associated soil horizons were brought back to Edinburgh for analysis and dating. A chronological framework will be established when laboratory work on the samples is completed. A more detailed paper is in preparation.

This study, on the very margin of the deposits, showed that tephrochronology is a valid aid to study of geomorphological processes in this area.

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Acknowledgements

Financial support provided by the Edinburgh Geological Society, the Weir Fund, the Geologists Association, and the Edinburgh University Student Travel Fund, made the study possible. Dr Andrew Dugmore provided inspiration and valued advice.

Volcanoes of the Andes: Report on a lecture given by Professor R.S.J. Sparks

Mike Browne
British Geological Survey, Edinburgh

A superbly illustrated lecture on volcanoes in the Chilean and Argentine Andes was given by Professor Sparks (Bristol University) at the Royal Museum of Scotland on November 1st 1990. In his talk, which closed with an extract from a video of two recent eruptions of Lonquimay, he discussed three distinct geomorphological associations.

Association 1: South of Santiago

There are active volcanoes such as Lonquimay (38.37°S, 71.58°W) with summits about 3000 m high, spaced at regular intervals c. 40-60 km apart with recent lava flows at least 11 km long. These young active volcanoes all formed within the last 18,000 years since the last glacial period. A large volume (approximately 50 km^3) of andesitic magma is involved with each volcano. There is a lot of erosion, mainly glacial of somewhat older volcanic structures. Valley glaciers are still present. The most recent eruption of Lonquimay produced blocky lava (little 'red hot' magma is seen in the crater) and the lavas are slow moving (less than 10 km/year). Volcanic gases consist mainly of steam but also include chlorine and fluorine which poison animals and plants. Lonquimay was mildly active in 1933 with some scoria ejected while an eruption of Llaima took place about 40 km to the south south-west. A bigger eruption in 1889 produced lava as well. The recent eruption lasted from December 25th 1988 to January 25th 1990 producing lava and scoria.

Association 2: North of Santiago

Above the Atacama desert there are many closely spaced obvious classic volcanic peaks on top of the high Andean plateau (the Altiplano) with summits which are generally over 5000 m high. History of activity extends back many million years and only one volcano is active. This is the little known Lascar volcano (23.37°S, 67.73°W). There is little erosion as it is a desert area and therefore volcanic cones are still 'intact' and give a false impression of there being far more volcanic activity here than in area 1.

Some thinnish pyroclastic flow deposits are present within the successions (30 m thick spread over say 20 km). Lascar had been quiet in historic times but has been mildly active since the very minor eruption of September 16th 1986. Little would have been known of this eruption, one of the few recorded in the central Andes, in the absence of remote-sensed data.

Association 3: Large Caldera

The Cerro Galan Caldera (67°W, 26°S) was spotted from Landsat imagery in 1976. It is about 35 km in diameter with considerable valley (canyon) dissection within the caldera. Immense volumes of dacitic magma have been erupted. About seven thick ignimbrites form a sequence recognised within and outside the caldera. The caldera was formed by ground collapse after removal of underlying magma with continuing eruption of magma producing the 2 km thick unit forming the mountainous area now present in its centre. The caldera is on the same scale as that of the Yellowstone National Park in the USA (tourists take note). The ignimbritic flows (deposits of pyroclastic flows) are very thick and of great geographical extent. The size of eruption which produced the latest two million years old caldera must have greatly exceeded the biggest historic volcanic event at Tambora in 1815 (eastern Indonesia). The associated ignimbrite is 30-200 m thick and extends in all directions from the crater for 100 km. The ash fall probably affected most of the continent and is over two metres thick 200 km away from the caldera.

Questions

Q. What makes an andesitic volcano so explosive?

Steve Sparks explained how oceanic crust moves away from the 'hot' oceanic ridge cooling as it moves and becoming hydrated by hydrothermal circulation of seawater. At the 'cold' continental margin it sinks beneath the continental crust, also picking up oceanic water and moving deep into the mantle. With increasing pressure the water (and other volatiles) come out (the rock dehydrates) and migrate upwards into the overlying mantle. The addition of small amounts of water reduces the melting temperature of the mantle forming hydrous magmas. The magma migrates upwards into and through the continental crust and at the surface the contained water and volatiles come out of solution to form bubbles in a viscous magma. The pressure generated by the expansion of the gasses causes the violent explosive volcanicity.

Q. Do the eruptions have any effect on global climate?

This is controversial. However historic eruptions have altered global climate for short periods of about 2 years.

Q. What is the composition of the gasses?

The composition of the gases from the Lonquimay volcano are greater than 90% H_2O, with some CO_2 and sulphurous gases and halogens (F, Cl). Other eruptions e.g. many African volcanoes, have more CO_2.

Q. What governs the speed of lava flows, is it temperature or composition?

Speed of flow is a function of viscocity which is mostly controlled by composition. Magma behaves like a polymer. The higher the percentage of SiO_2 the more polymer chains are formed and therefore the greater the viscosity.

Q. Was there much loss of human life at Lonquimay?

There was no loss of human life in the two active eruptions known, but many cattle died due to fluorine and chlorine poisoning. Evacuation of humans was reasonably efficient and effective.

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Descriptions of the eruption of Lonquimay may be found in the following Scientific Event Alert Network (SEAN) bulletins:-

SEAN Bulletin, 1988. 13, 12, 2-8
1989. 14, 2, 12-15
1989. 14, 3, 10-12 (also Lascar; 12)
1989. 14, 4, 6-7
1989. 14, 6, 11-13 (also Lascar; 13)
1989. 14, 8, 14
1989. 14, 9, 6-8
1989. 14, 11, 12-14 (also Lascar; 14-16)
1989. 14, 12, 14-15 (also Lascar; 15)
1990. 15, 1, 10-11 (also Lascar; 11)
1990. 15, 3, 15-16 (also Lascar; 15)
1990. 15, 4, 11-13 (also Lascar; 11-12)

Description of the eruption of Lascar only may be found in:-
SEAN Bulletin, 1990. 15, 2, 7-8

Strange Earth, No. 11 : Maleficent Lakes of the Camerouns

W.J. Baird
Royal Museum of Scotland

The country of Cameroun [Cameroon] lies in West Equatorial Africa. More than 30 crater lakes occur in the volcanic region of its north western province Grassfields area. These lakes have a reputation of being either good or bad in the legends of the local people. Until recently, these beliefs were regarded by European observers as simply the fanciful superstitions of primitive tribesmen. Then on 15th August 1984 the 96 metre deep Lake Monoun [Manoun] released a lethal gas burst which killed 37 people. Witnesses of the event reported a whitish, smoke-like cloud, drifting with the wind near the lake. People and animals within the cloud collapsed and died. Survivors reported a strange smell described by one as 'sulfurous like a car battery acid'.

On August 21st 1986, a loud rumbling noise from Lake Nyos (Figure 1) was followed by the ebullition of a ghostly column of vapour which poured over the edge of the lake into the valleys below. In the villages of Lower Nyos, Cha, Subum and Fang the deadly effects of this gas cloud killed 1700 people. As at Monoun other animals caught within the cloud also died, including 3,000 cattle and creatures as small as ants. Again, witnesses who survived the gas described a strong smell, like the overpowering smell of rotten eggs, indicating at least traces of hydrogen sulphide. However it seems that people caught in, or travelling through the gas cloud were asphyxiated, almost certainly from carbon dioxide poisoning.

Where did these vast quantities of carbon dioxide and other gases come from and how did they escape? The answer may lie in the curious layering of the water in the lakes. The lower levels are anoxic, saturated with siderite and retaining a large amount of carbon dioxide in the water [as a balance of both carbonic acid HCO_3 and carbon dioxide CO_2]. It is thought that the build up of these substances in the lower levels of the lakes has been taking place for a long time, perhaps thousands of years, possibly from volcanic fissures in the lake beds. If this theory is correct, then the waters in the depths of the lakes were in a precarious state of chemical and physical balance. They were in effect time bombs merely awaiting activation of a trigger, which could have been a small earthquake or a landslide from the side of the lake disturbing

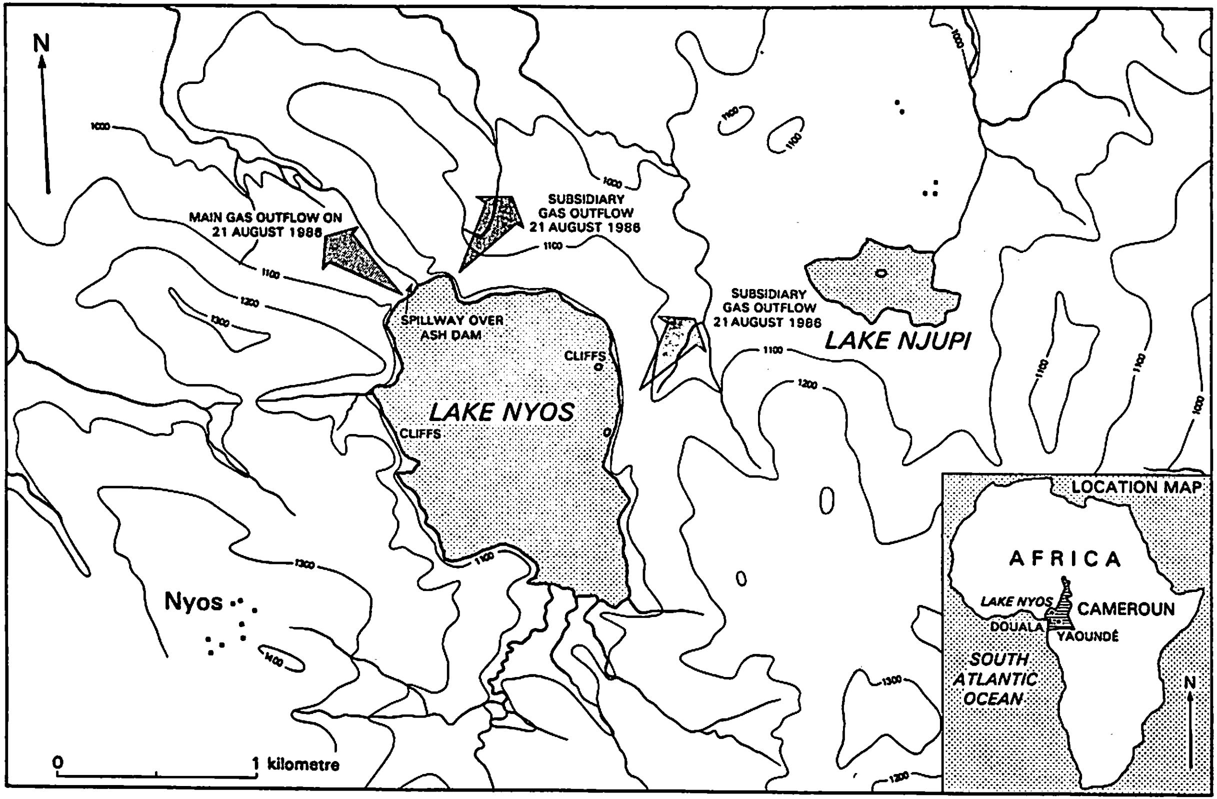

Figure 1. Locality map of the Lake Nyos area Cameroun, showing directions of gas flows during the gas release disaster of August 1986; modified after Walker, Redmayne and Browitt. Reproduced by permission of the director, BGS.

the heavily mineralised and stratified bottom layers. This would have caused a reaction to take place between the siderite and carbonic acid in the water producing ferric hydroxide and carbon dioxide. Another factor that could have added to the already unstable situation within the lake waters was that carbon dioxide is more soluble in cold water than in warm. Therefore any disturbance which mixed layers of warmer water with cooler water, already heavily charged with carbon dioxide, would lead to a reaction producing a discharge of gas.

Whatever the reason, once the reaction had started it spread rapidly throughout the waters of the lake, causing a gas burst at the surface. The burst caused a surging wave of water up to 5 m high in Lake Monoun and 80 m in Lake Nyos but the main cause of the catastrophe at both sites was the release of gas. The volume of gas released from Lake Nyos is estimated to have been about a billion cubic metres.

Perhaps the most serious implication to arise from a study of these incidents is that other lakes in Africa, both in Cameroun and elsewhere, have the potential for such lethal outbursts, but because of their greater size and depth, on an even more terrible scale.

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The Society's Written Archive

David Land

As one of the earliest Scottish scientific societies, our society has a long and distinguished history of which we can rightly be proud. The materials for this history are comprised in our archive which is now in the safe keeping of the Special Collections of the University of Edinburgh library in George Square. Maybe the word archive conjures up an image of dusty boring papers, but to those with a sense of history the image becomes one of a priceless mine of information.

We are fortunate in having a complete set of minute books from the very first founding meeting to date. There are nine volumes of Council minutes from 1867 to 1982 and fourteen volumes of Meetings minutes from 1834 to 1982. This excellent set of minute books is unfortunately not complemented by any correspondence files prior to 1934. This is doubly disappointing in that not only is the corpus of letters irrevocably lost but the particular and immediate details of events and decisions which letters convey are also lost. We therefore have to rely for the first century on the minutes which tend to be brief ('the matter was considered and it was decided..') and almost inevitably give a somewhat edited version of discussions. I recall some advice given to me when I became a minutes secretary: 'Don't write what the members said, but what you think they think they would have said if they did think'. No Society secretary has ever taken this advice literally, and reading the minutes it is obvious that they are careful records of proceedings.

Correspondence files from 1934 to 1950 are concerned almost wholly with the Centenary celebrations of 1934 and with the administration of the Clough Fund. From 1950 onwards we have general correspondence files on all the wide variety of topics which reflect the extensive interests of the Society.

Printed material in the archive includes Billets from 1879 to date (except for 1944 to 1952), membership Rolls from 1870 and various editions of the Laws from 1845. There are five volumes of Teasurer's account books covering 1873 to 1947. A large ledger-type register of members extends from 1868 to 1926, and there are membership secretary's files for 1950 to 1980.

The very first minute, recording the beginning of the Society, is worth quoting from Minute Book 1, a rather tired-looking 6 x 4 inch paperbacked notebook: "Edinburgh, 4 December 1834. At a special meeting of the Mineralogical Class held in Mr Robertson's Tavern, Milnes Square [Close], present Messrs Dun, Forrest, Laidlaw, Castle, Jamieson, Porteous, Moir, Jeffery, Brodie, James Muir and Peter Muir. Mr Dun having been called to take the chair, it was resolved that a geological society be formed for discussion and mutual instruction, to meet in Mr Rose's house, no 2 Drummond Street'. John Castle was chosen as president and James Brodie secretary.

It is rather odd that Alexander Rose, in whose house they decided to meet, was not present at this historic meeting, though he succeeded John Castle as president within a few months. The new society quickly got down to business: it was resolved that the first meeting should be four days later, on 8th December 1834, and that the topic for discussion would be 'to examine the evidence for Arthur's Seat being of volcanic origin'. This was also the topic for the society's first field excursion on 4th June of the following year. (See Dr Waterston's article in the Edinburgh Geologist no 18). Today we take the volcanic origin for granted, but 157 years ago this was still a matter for debate. Even today the rocks of Arthur's Seat pose problems for solution.

There is a considerable body of papers in the archive in connection with the Centenary celebrations in 1934. Of particular interest are illuminated addresses from other scientific societies. The most splendid is a blue and gold parchment from the Royal Dublin Society. The one from the Academy of Sciences of the Institute of France is bound with green silk ribbon and runs to four pages of delightful flowery French. After invoking the spirit of our patron saint James Hutton, it concludes: 'Ce qui comptera toujours dans l'Histoire de la Géologie, c'est l'example de la Société d'Edimbourg, c'est ce qu'elle a su accomplir et un petit siècle, c'est la méthode de ses entraîneurs, c'est par-dessus tout l'amour de la nature, l'amour de la Terre d'Ecosse, qu'elle a allumé et entretenu de si ardente façon au coeur de tous ses membres, et qui donne à vos confrères étrangers reconnaissants, l'assurance tranquille des grands jour réservés à la Géologie écossaise'.

This may be (rather freely) translated: 'What will always count in the history of geology is the example of the Geological Society of Edinburgh, what it has accomplished in one short century, the principles guiding it, above all the love of nature and of Scotland which is kindled and ardently sustained in the hearts of its members, and which give to its grateful overseas colleagues firm confidence in an assured future for Scottish geology'.

The society's archive may be freely consulted by anyone on application to the University librarian in charge of Special Collections. All the society asks is that the source should be duly acknowledged in any publication. From time to time more material will be added, so maintaining the value of the archive as the prime source for the history of our society.

In addition to the printed and written archive described above, the Society also possesses a collection of photographs which is curated and looked after by Mr W. Harper who describes it in the next article.

The Society's archive collection of photographs

William Harper

Unlike the printed and written archive described by David Land, photographs of Society activities from 1834 to 1984 are practically non-existent, but some group and portrait photographs have survived, the most interesting being:

> Photograph of Alexander Rose (1781-1860), our second President and effective Founder of the Society.
>
> Dr John Horne and Dr Benjamin Neave Peach, photographed at Inchnadamph Hotel during an excursion from the B.A. meeting at Dundee in 1912.
>
> Edinburgh Geological Society Centenary 1934 group photograph of Society office bearers including Sir John S. Flett, FRS, President and Professor Edward B. Bailey, FRS.
>
> Portrait photograph of Charles W. Peach (1800-1886).
>
> Portrait photograph of James Peddie Falkner, SSC, President of the Society from 1862 to 1863.

About seven years ago the Council decided to encourage the introduction of a photographic record of field excursions and of formal occasions involving the Society.

The exhibition 'Geology serves the Nation' in the Royal Scottish Museum was the first event to be covered in detail in an excellent set of photographs by Tom Bain (Geological Survey photographer). The opening of the Festival exhibition 'Geological maps of the World' on 11th August 1986 by Dr John McKay, Lord Provost of Edinburgh was a significant event, again recorded by Tom Bain.

Photographs taken by Society members since 1984 form the basis of an ongoing collection illustrating the many and varied sites of geological interest visited during field excursions. In general the photographs relate to the social aspects of excursions; they are not intended to form a scientific record.

In the longer term it is hoped that photographs of Society activites contributed by the members themselves will supplement the printed and written archive material by providing an illustrated record of people, places and events.

To ensure continuation of the record, members are invited to submit prints of photographs taken on field excursions for inclusion in the Photographic Archive Album. The subject matter should be of general interest to Society members. Most photographs will include people, and print quality should be good enough to permit recognition of at least some of the individuals depicted.

Snippets

Mike Cotterill
Portland House, Freshwater, Isle of Wight

(1) Volcanic Melody

Modern science gives an unexpected insight into the successful secrets of a famous Italian family of stringed instrument makers. Transmission electron microscopy of small samples taken from a maple wood cello, made near Cremona in 1711 by Antonio Stradivari, has revealed a hard layer only 50 microns thick, applied before the varnish just to improve acoustics. Peter Edwards at Cambridge University has shown by chemical analysis, using the high energy electrons in EDAX (energy dispersive X-ray spectroscopy), that this secret ingredient was pozzolana volcanic ash from Cremona. It was probably mixed with water and egg white, and applied as a paste.

Source: New Scientist 24/3/88

(2) Just Fool's Gold?

Once denigrated because its brassy yellow colour could be mistaken for gold, the sulphide mineral Pyrite (FeS_2) derived from anaerobic sedimentary facies, provided real wealth to some early British industrial chemists. They used it to produce Copperas or 'Green Vitriol' ($FeSO_4$ $7H_20$), the crystalline ferrous sulphate which could be calcined for making somewhat impure Sulphuric Acid. This was in great demand for many commercial processes like dissolving dyestuffs, making other acids (nitric and hydrochloric) and pickling metal goods. Exports of Copperas were so large that it became known as 'Green English'. London was a leading market in the 17th and 18th centuries, and most of the pyrite came from southern England, especially from organic-rich Jurassic shales (notably Black Ven Marls), Lower Cretaceous deltaic and shallow marine deposits (Wealden and Lower Greensand), and Eocene clays (Bagshot and Bracklesham Beds). Where these cropped out along the coasts of Dorset, Hampshire, the Isle of Wight, Essex and Kent, collectors were employed to gather nodules washed out by erosion of the cliffs. Copperas works operated at Bournemouth, Brownsea near Poole, and Deptford, London. Despite losing some markets to the higher purity Vitriol produced by burning imported Sicilian volcanic sulphur (Brimstone) further Copperas works opened in the late 18th century in N.E. England at Hartley, Walker and Denton, and obtained Carboniferous pyrite from the rapidly growing coal mining industry.

Pyrite ore was spread over impervious outdoor platforms, where it oxidised spontaneously under the action of water and bacteria. For a year or longer, percolating rainwater absorbed the products, and was collected into lead vats. When sufficient was available, scrap-iron purchased from city scavangers was added, and the solution boiled until supersaturated. Copperas works lost their early pre-eminence as different technology for producing sulphuric acid directly by burning imported Brimstone improved quickly after 1740. Though largely abandoned in early nineteenth century Britain, pyrite was reintroduced after 1840 using a new roasting process, when politics made sulphur imports unreliable.

Iron is an essential element in living organisms, and iron sulphide is produced in sediments by anaerobic bacteria like *Desulphovibrio* which obtain energy by reducing the iron sulphate in organic detritus to iron sulphide. Pyrite oxidises readily on exposure to air. The heat generated this way caused spontaneous combustion of coal heaps on London's Puddle Wharf in the 16th century, and of pyrite stored in leaking sheds at Ealand, Yorkshire (1664) and Whitstable, Kent (1693). Spontaneous combustion at cliff-falls produced a famous tourist attraction, the so-called 'Lyme Volcano' of 1908. Similar incidents had occurred earlier in Dorset, at Charmouth (1751), in the Kimmeridge Clay of Holworth Cliff (1826-9), and at Golden Cap cliff (1890).

Sources: Dictionarium Rusticum (1704)
G.M. Davies. The Dorset Coast (1935)

(3) Critical Uranium

Like every element heavier than Helium, all Uranium on Earth probably originated by fusion nucleosynthesis in large stars whose ultimate explosion as supernovae provided the dust from which the solar system condensed. Atoms of fissile elements, those elements which split spontaneously and release energy, begin to split at random times from the instant they are formed. They provide the Earth's internal heat. Each such element has a characteristic 'half-life': despite the random time at which any particular atom splits, the length of time taken for half of all atoms of that element to have completed their splitting can be found precisely. It is a natural constant. Different fissile elements thus decline as energy sources at different rates.

There are two natural fissile Uranium isotopes, and they occur mixed in what is believed to be the same ratio throughout the Solar System at any given point in time. Currently this is 7.20 atoms of U^{235} to every 1000 of U^{238}. In 1972 H. Bouzigues observed only 7.17 to 1000 in the ore obtained for French nuclear reactors from an open-case mine at Oklo, near Franceville, in S.E. Gabon, N.W. Africa. This puzzle led to detailed investigations which revealed that the ore vein had been enriched in a distinctive suite of nuclear-fission products. These could only have been formed by a natural nuclear reactor that had operated deep underground.

Geologists deduced the probable sequence of events leading to this apparently unique event. In the Precambrian anoxic (oxygen-absent) atmosphere, Uranium disseminated in small quantities throughout igneous rocks was eroded at the ground surface over a broad watershed. It was insoluble and accumulated in streams as heavy metal placer deposits. With the evolution of photosynthetic algae, over 2000 Ma ago, Oxygen entered the stream water and oxidized the accumulated Uranium into soluble compounds. Tributaries flushed these into a river, leading to a delta where sediment accumulated over a subsiding granitic basement. Above ripple marked sandstones, organic rich sands and oozes gave anoxic conditions where Uranium was reduced to an insoluble form and deposited at a concentration of 5000 ppm by weight.

Later tectonic movements steeply tilted and fractured the deeply buried sediments. Groundwater then percolated and remobilized some Uranium, before depositing it in seams of almost pure Uranium oxide, locally 1 m thick. Even in deposits of this size and purity, a chain reaction of induced fission would only occur if the high speed neutrons expelled by randomly splitting atoms were sufficiently slowed down ('moderated') to let them be easily absorbed into the nucleus of other atoms, causing those also to split and to supply yet more neutrons. Although U^{238} can absorb high speed neutrons, and thereby split, its fission does not release neutrons. Only U^{235} could generate the reaction.

At Oklo, the hydrogen atoms in groundwater molecules acted as the essential 'moderator', absorbing collision energy to slow down neutrons from fissioning Uranium U^{235} nuclei. At lease 10 parts in 1000 of the Uranium had to be U^{235} for the chain-reaction to occur.

The formation of the ore-body and operation of the six reactor sites found at Oklo has been dated at 1700 to 1900 Ma. Because U^{235} and U^{238} have different natural decay rates (half lives of 710 Ma and 4,500 Ma. respectively), there was at that time a suitably higher ratio than today of the essential U^{235} (30000 ppm). Negative feedback restricted power output, since excessive heat dissipated the water 'modulator' as steam, quenching the chain-reaction. The reactors may have remained active for over 0.1 Ma. and consumed about 6 tons of U^{235}, of which a third came from induced fission of U^{238}.

Recent interest in Oklo has focused on the information it can provide regarding the underground movement of fission products, since this is relevant to the construction of nuclear-waste repositories.

Sources: Scientific American July 1976 Vol. 235
New Scientist 5 May 1990

(4) Geologist of Ancient Egypt

The oldest extant geological map in the world was plotted on a papyrus scroll 14 cm. wide and over 2 m long, by the scribe Amennakhte, for Egyptian pharoah Ramses IV in 1150 B.C. Though held in the museum of Turin since the last century, it was not checked in the field until 1989. In the Eastern Desert between the Nile Valley and Red Sea, J.A. Harrell and V.M. Brown, American geologists from the University of Toledo in Ohio, confirmed that the location, shape and colour of rock formations agree well with those depicted on the ancient map.

Sources: National Geographic Magazine November 1989
Dr S.G.J. Quirke, British Museum
(personal communication)

Rhum, 1990

Gathered together on Mallaig Pier,
Some weighed down by camping gear,
We all piled on MacBrayne's wee boat
To our surprise it stayed afloat.
Setting sail on flat calm seas
Destination – the Inner Hebrides.
Porpoises arrived in schools
Just to see Muriel's family jewels.
In Loch Scresort we were cast ashore
Marched up to Kinloch and banged on the door.
Some turned right at the camping site
Paradise for midges at fifty pence a night.
Now once again in Kinloch Castle
Without ado and not much hassle
Fairly installed in the stately pile
Where damp is rising all the while
Mine host he showed us bedrooms small
And toilets – well hardly any at all.
The bathroom queue is three miles long
And when you get there – what a pong.
Ceilings threaten to descend
Bringing meals to an untimely end.
Midges in the courtyard throng
As they hear the dinner gong.
Collapsing beds and banging doors
Disturb the gentle night-time snores.
Primeval gloom enshrouds the stairs
No light, no candles – no repairs.
Door handles are in short supply
They'll arrive on the boat by and by.
To the hills we soon set out
With our leader firm and slightly stout.
Sinclair strode up Coire Dubh
Followed by many, understood by few.
Ken Oakley scurried far and wide
Seeking exposures Emeleus tried to hide.
By Guirdil, Loch Long and the Dam

We tore along on bread and jam.
Harry spied on mating ducks
While others searched the skies for eagles.
We travelled far and hammered wide
The rocks had nary a place to hide.
Back to Kinloch by last light
Where the kitchen staff saw us right
Through soup and venison and crumble
You should have heard the tummies rumble.
Then down to the lab for a quick debrief
And a dash upstairs to clean your teeth.
Then into bed for refreshing sleep
Too tired to need non-existent sheep.
Unburdened of sore feet and heavy load
We'll dream of Harris and the Kinloch road.

Bill Baird & Andrew McMillan, 1990

Review: Highland Geology Trail

John L. Roberts
Strathtongue Press £4.95

This book follows a logical journey around the Highlands visiting and describing classic and/or informative geological exposures and viewpoints. The book is written with the assumption that it will be used by those with little, if any, geological knowledge who are interested in, 'but intimidated by', the subject. Twenty seven of the 116 pages are therefore used to provide an initial simple geological history of the Highlands and an explanation of geological terms.

John Roberts is, of course, well known to members of E.G.S. as an authority on Highland matters, a good excursion leader and a clear writer. His selection of localities is well done and, within the reviewer's experience, correctly treated. For those with a reasonable understanding of geology, such as visiting professionals or knowledgeable amateurs, the book would serve a useful purpose in providing a time-saving select list, especially as it does give good read-directions. The localities themselves, however, could do with more illustration.

As far as its intention to meet the needs of the non-geologically informed public are concerned, however, the book seems wide of the mark. Even the simplified geology at the beginning of the book is probably too much for the casual visitor, who is unlikely to have absorbed enough before trying to apply it to a local section or viewpoint. At any rate, to have the dedication to follow a Geological Trail presupposes enough serious interest to assume a basic understanding of the subject, in which case, much of the very simplified introductory section seems rather superfluous. Most of the 27 pages of introduction would have been put to better use by providing additional locality sketch maps or illustrative drawings.

Apart from the diagrams, the biggest deficiency in the book is that there are no indications in the text as to which topographic sheet or geological map the named localities lie within. Frequent references to Gaelic-named hills or places and the use of six-figure grid references presupposes that the requisite 1:50,000 topographic map at least is available to be consulted by the reader. While one is told in the Introduction that such maps are required, it would be useful to know the one to use in each case – unless one can afford complete coverage of the Highlands! Our own excursion guides supply this information without effort. Incidentally, in this same introductory section reference is made to the Ordnance Survey 1:100,000 map. This publication is not known to the Scottish offices of the Ordnance Survey. Try Bartholomews.

The recommended 10-mile Geological map again is hardly adequate either for topography or geology, without the provision of additional location maps and diagrams. The book could be used, however, as a useful adjunct to the BGS Regional Handbooks whose diagram maps would probably fill in the geological detail without the cost of purchasing individual Geological 50,000 sheets.

Despite these criticisms, many members of E.G.S. would find that as a handy reference for personal exploration, covering a broader field than the specialised field guide, this book would be worth the modest fiver asked for it.

Scott Johnstone

The Northern Highlands : A review of a recently published BGS handbook of British regional geology.

ISBN 0 11 884460 1, price £6.00.

Of the natural geological divisions of the United Kingdom, the Northern Highlands of Scotland, with their peaks, maritime inlets and islands, must rank amongst the best in terms of scenic attraction. No less regarded must be the geological attributes of the region: they provide unrivalled sources for scholarship and research, a fact recognised from reports of travel in the area as far back as the aftermath of the '45. The region has been, indeed, continues to be subjected to a diversity of ideas, expounded from a variety of backgrounds, national and international. From the earliest of accounts to the current literature, it is clear that geological concepts (and the techniques upon which they are based) have been forged, tested, shattered, discarded, resurrected, reconstituted, imported, exported, etc. etc. in an open air laboratory that constitutes a cherished national heritage.

The new, fourth edition of the handbook is a welcome and valued addition to the literature, to which it provides also a comprehensive introduction. Its publication follows an interval of nearly thirty years since J. Phemister's third edition, itself an easily recognisable descendant of the 1936 first edition. Over those three recent decades, the considerable ebb and flow of scientific and cultural changes have clearly rendered essential a fresh approach, and the authors have responded to the challenges in preparing a volume bearing the hallmark of authority, yet revealing with honesty the bounds of uncertainty that continue to limit our understanding of many facets of the region and of the mechanisms by which they were shaped.

At twice the length of its predecessor, it would be difficult to review the content of the new volume with any consistency in the space we have here, so we shall simply have to dip in. The geographical domain covers mainland Scotland north-west of the Great Glen, together with the Outer Hebrides, but excludes (or gives but scant attention to) Skye, Raasay, Rhum and the small isles, Coll, Tiree, Mull and the Ardnamurchan peninsula; for these latter, you must consult the companion volume 'The Tertiary Volcanic Districts'. Nevertheless, with 219 pages, 47 figures, 31 plates (5 in colour) and 503 entries in a 'selected' bibliography, I hope few would deny the continuing value of the handbook (7s. 0d. [35p] in 1960, for the 3rd edition;

2s. 6d. in 1948 for the 2nd edition; 1s. 6d. in 1936 for the 1st edition!).

To the west of the Moine Thrust Zone, the last thirty years have seen a concentration of effort expended with great reward on areas both of Lewisian and Torridonian (s.l.) rocks: geochemical, radiometric, mineralogical and structural studies on the former; stratigraphical, sedimentological and nanopalaeontological studies on the latter. The result is that our knowledge of the evolution of these rocks is now considerably enhanced and their position in the structural framework of the North Atlantic more clearly defined.

Within and close to the Moine Thrust Zone, the pace of activity has been more variable. What we now know to be a Cambro-Ordovician succession of sedimentary rocks has been studied in great detail from earliest times and new results are hard won. However, the structural complexities of the thrust zone itself continue to receive international attention and, although a considerable body of knowledge accumulates, the authors of the handbook are presented with the considerable problem of charting a balanced path through the wealth of interpretations, many of which are clearly mutually at variance. Here, as is the case amongst the Moine rocks that lie eastwards, we are still far from concensus on many aspects of the spatial and temporal positions of many of these rocks. The recent acquisition of geophysical data has added more than the third dimension to the debate!

With the focus of attention in the early years dominated by the complexities presented by the rocks of the far north west, the younger sedimentary formations, the Old Red Sandstone and the Mesozoic, appeared to suffer comparative neglect. This imbalance has now been restored and a more rounded introductory account of these rocks is now available, including some briefly presented results of offshore surveys amongst the Mesozoic basins of the Sea of the Hebrides and adjacent maritime areas. Brief as are these latter references, we must note with anticipation the Director's hope, expressed in the foreword, that material adding crucially to our knowledge of these larger parts of our continental-shelf domain will become available. In landward areas, we find also a more complete description of the Mesozoic rocks that skirt the Sutherland coast of the Moray Firth, prompted by the more-recently established hydrocarbon interests.

We should note also that, while the Nothern Highlands span the area that contains the oldest rocks in the UK, the area is also still seismically active and that the Pleistocene record contains evidence of substantial environmental changes. As our continuing adaptation to our environment places increasing demands on the finite resources of this, as well as other parts of our planet, and their supposed long-term stability, we need increasing re-assurance that we understand their evolution and the processes that continue to shape their development. Our Government has assumed responsibility for an area of continental shelf that far exceeds the landward extent that was included in the brief that formalised the activities of the nascent Geological Survey more than 150 years ago. Most fitting as is the present handbook as a memorial to its editor and as a most creditable achievement of its principal author, it is but a stepping stone towards an ever-retreating target.

Robert Cheeney

Review : The Highlands Controversy

David R. Oldroyd,
University of Chicago Press, 1990. £19.95 [paperback]

The Highlands Controversy is a work of considerable scholarship. The index, glossary and bibliography alone stretch to sixty pages and make this an invaluable source book for the whole subject of the history of geology of the Highland region and its protagonists. One may wonder why, with already large appendices, it should be necessary to include long and distracting footnotes. Many of these would have been better placed in the main reference section. The text, although occasionally inclined to wordiness, is still very readable and it is almost impossible to dip into this volume without finding oneself reading on for several pages beyond the intended span. The colour plates and line drawn maps are mostly excellent, but the black and white photographs are poorly reproduced. Some of the many text figures showing original sections are also badly reproduced and at too small a scale. Dr Oldroyd could perhaps have been better served by the graphics section of the University of Chicago Press.

This book is not without its misconceptions, one of which being, that it does not always view events within the context of their time. For example, during the Victorian period a junior employee [Peach] was indebted for his education to a previous director of the survey Geological Survey [Murchison]. Murchison's views were still those held by the then present director [Geekie], and it would be most unlikely that Peach would contradict, certainly publicly, those opinions. It was simply not the done thing, however confident Peach might have been in his own judgement that he was correct and his seniors wrong.

Oldroyd's attribution of motives to Murchison and Geekie in the support of the Murchisonian interpretation of the structure of the North West Highlands is initially balanced and muted. However, later in the book he becomes more and more caught up in the controversy, his support of Nicol more vehement and his railing against the supposed machinations of Murchison and Geekie more strident. Eventually he becomes so involved in their world that he even records (for our interest) when Nicol is definitely 'not mentioned' in one of Murchison's letters. The favouring of one character against another in this way is not strictly relevant to the argument but certainly Oldroyd's taking of sides in the controversy makes for a very readable text.

Apart from disappointment with the photographic reproduction, I have in general only small criticisms of this book. It contains a wealth of detail about the personalities behind the well known names of the 19th century geological scene and is an excellent source of reference, both to the geological fieldwork of the time, and the controversy behind the scenes.

W.J. Baird

The Edinburgh Geologist
No. 25 Spring 1991

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ISSN 0265-7244