NEWS

LETTERS
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ARTICLES

SHOPFLOOR
Geology and Earth Science in the Primary School, Halley's Comet 1985-6, Age Relations of Major and Minor Features of the Donegal Granite, Names for the Order of Planets and Mohs' Scale, A Computer Program to Simulate Ripple Migration.

FIELDWORK
How Should We Assess Fieldwork in the New GCSE Geology Exam...

REVIEWS
Bath Stone, Geological Column Leaflet.

COMMENT
Top Down and Bottom Up.
ATG COUNCIL 1985-6

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NEW MEMBERS
Will existing members in neighbouring establishments please make new members welcome by making contact with them and offering advice where appropriate.

To October 1985
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YOXON, Mr Paul, Isle of Skye Field Centre, Beul-na-Mara, Broadford, Isle of Skye IV49 9AQ (Tel. 0471 2487) D. B. T.

THE SECRETARY’S REPORT 1984-5

The Association’s progress continues, not as quickly as it might, and certainly not as efficiently as it should. Our problems, both internal and external, continue to lead to frustrations; no sooner is one problem solved than another appears, and time spent mending broken links is time not spent progressing towards the future.

The prime problem remains one of manpower; a small number of people do very nearly all the Association’s work. This year we have existed with at least two key positions unfilled, and consequently increased workload for the rest. David Thompson has valiantly kept the Journal operating, with proof-reading carried out by the President and others. We have hopes now of help on the production side, and advertisements are recovering after an hiatus. If the Journal arrives late, however, has errors, does not contain the articles you would like to see, etc., members should consider their own positions, and certainly not point the finger of blame anywhere else.

Some costs for the Journal have risen sharply, and we need to increase subscription rates to keep ourselves solvent. We have had a number of years at the present rates, but if costs continue to climb, we may have to consider changes to the Journal.

Last year’s Conference at Leicester was quite well attended, and thoroughly enjoyed by all in excellent surroundings. Our thanks go to Dr. D Thurston and her helpers, and to the Leicester University Geology Department for making the weekend so profitable.

This year’s Conference at Lampeter, a primarily fieldwork-
orientated occasion, is booking well at the time of writing, with an encouraging number of faces new to Conference due to appear.

Council has met three times outside of Conference and transacted considerable business; of particular interest was the co-option of Mr. Geoff Cox of the Mineral Industry's Manpower and Careers Unit, who will be a tower of strength in years to come.

The ASE/ATG liaison group has been disbanded at the suggestion of the ASE.

The Association has put considerable effort into curriculum matters, as well as continuing to input into Examination Board and SEC work. Our SSCR work progresses as fast as possible, with a small team of reviewers analysing material of world-wide origins in terms of SSCR criteria. Tim Guy is on part-time secondment from teaching and is sponsored by the Association. He is producing a catalogue of these materials. Submissions of a definitive document to SSCR have to be made in a very short time.

We were very encouraged by the making available to SSCR of £5000 by a major oil company in order to further the work of SSCR in earth science. An ATG subcommittee considered two schemes which would utilise this money and submitted two proposals via SSCR - only for the donor to lay down further conditions, and to withdraw some of the money as a result.

The Secretary has been involved in a Royal Society Education Committee Working Group concerned with producing a scheme for coordinating science 11-16 across biology, chemistry, earth science and physics. Our task has been to write the earth science content of the core of the science curriculum proposal. My thanks are due to Chris King who helped draft a first submission and typed the result - yet another job to be done competently and in a rush. The haste continues with the time-costing of the content and the identification of both essential links and ‘opportunity links’ between the component sciences.

Steve Alcock retires as Treasurer, and deserves the Association’s highest praise and thanks for his work on our behalf over the years. The Treasurer’s work takes much concentration and care, both of which have been abundantly and willingly given. Di Thurston has put in a concentration and care, both of which have been abundantly and willingly given. Di Thurston has put in a

The balance sheets may be summarised as follows:

**INCOME**

<table>
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<tr>
<th>Year</th>
<th>Subscriptions</th>
<th>Promotions</th>
<th>Adverts</th>
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The balance for 1984/85 is £2,257.99.

The income of the Association has increased slightly this year due largely to the efforts of the Membership Secretary in collecting outstanding subscriptions.

The expenditure of the Association has increased by a considerable amount, most of which was due to increases in Journal costs.

If the ATG is to remain financially viable in the future, then an increase in subscription rates is required from September 1985; otherwise Journal costs will soon outstrip subscription income.

**CURRICULUM WORKING GROUP REPORT 1984 - 1985**

The calendar of demands on the working group have resembled that of a volcano this year. Fairly long periods of quiescence have been followed by unpredictably violent eruptions requiring an instant response from those involved. As yet, we have not been overwhelmed by the flow or fall appearing under other subject headings. Is this place important? I would suggest not. What is important is that geological material is included somewhere in the curriculum because it has a unique contribution to make. It is important that it is used, whenever appropriate, for its greatest potential. The criteria best fulfilled happen to be those which fall within science, but the name is irrelevant: good geology teaching never has been predominantly descriptive, and good teachers of geology fulfill these scientific criteria regardless of their own background 'label'. Our roles as teachers will have to change whatever our present 'subject' allegiances. The development of learning packages, and their availability at little cost, are administrative problems.

M. J. C.
of material although, at times, a few brave souls have had to make sacrifices. This has all made for an interesting life!

At the beginning of the year we had to respond to two DES publications, one on ‘AS’ levels, the other on the 5-16 curriculum. Our responses, generally welcoming the documents whilst making pleas on behalf of geology and earth science, were reported in the March issue of Geology Teaching.

Since then, our major concern has been our contribution to the coordinated science curriculum which is being developed by the Royal Society. We now have a commitment from the working party coordinating the syllabus that earth science shall have 1/7 (14%) of the teaching time both in core and non-core areas. This amounts to sixty-five 40-minute lessons over the two-year teaching period up to the 16+ GCSE examination. Our earth-science syllabus, which is now in its second draft, blends both traditional and modern approaches. No doubt it will receive considerable modification before reaching its final “coordinated” form.

We have begun, and are maintaining, a dialogue with the Scottish Education Office on the development of earth science/geology in Scotland. Some of our Scottish members are particularly concerned about the situation there.

In England and Wales, many of the working group members are involved in the ATG/SSCR working group which is making fairly steady progress towards the eventual publication of the catalogue of existing investigations in earth science, mainly for 11-16 year olds.

Undoubtedly the most significant developments in the field of the curriculum this year have been the recent publications of the DES document “Science 5-16: A Statement of Policy” and the GCSE “Criteria for Science”. Both apply to geology as a teaching subject and eventually they will require fairly drastic modification of geology syllabuses and teaching styles up to 16+. We are still digesting and considering these documents and a good deal of time at Conference in the working group meeting (Friday, 10.30pm) and the Open Forum (Saturday evening) will be given over to discussing them and their significance. Synopses of both documents were printed in the last edition of the Journal. We look forward to hearing the views of members on both these proposals.

At present, the working group consists of about 15 members. Some of these have greatly supported us with prompt, detailed replies to correspondence over the years, and others have given some very valuable responses on occasions. I thank you all for your contributions. I hope that you will continue to support us as the curriculum debate “hots up” and that more people will join us either at conference or afterwards.

A good deal of development work will be necessary before the earth-science contributions and modules of the future will be finalised. We, the ATG members, are the only people who must do the job! Please let us know if you are able to help, by writing to me at the address below.

Chris King, Altrincham Grammar School for Boys, Marlborough Road, Altrincham, Cheshire.

FIELDWORK GROUP REPORT 1984-5

Despite the economic climate of recent years, it is encouraging to note the continued enthusiasm of geology teachers for fieldwork. 1985 sees the first fieldwork-based Conference of the Association. We are very grateful to our guest excursion leaders who have contributed to the conference programme, but no less than six of our own members are also involved in leading or assisting with the Conference field excursions.

This year Graham Hall has taken over chairmanship of the Fieldwork Group from Robin Stevenson, and several interesting projects initiated during Robin’s term of office are continuing.

An index to geology field study guides is being prepared under the direction of Dr. John Gunner. It is hoped to complete and publish this work during the coming year. We would welcome help from members with specialist knowledge of different parts of the country in checking the entries for their areas.

The group is also continuing work on a fieldwork techniques and projects guide which will contain examples of the good use of geological sites with CSE, O-level and A-level groups. If you have developed a particularly successful visit or project with your students, perhaps you would consider submitting an article for the guide.

The ATG has recently lent its support to plans for the reopening of the Sygun copper mine in Snowdonia as a visitor centre and mining museum. The project is being opposed by the Snowdonia National Park Committee due to problems over car-parking regulations. The Association will be represented at a Public Enquiry to be held in Beddgelert in October. The fieldwork group would like to be informed of other instances where planning decisions could affect the interests of geology teachers.

The fieldwork group is hoping to organise occasional ATG fieldwork weekends. The first is proposed for the Spring of 1986, with the Lake District as a possible venue. Places would probably be limited to 30 persons. The weekend would be an opportunity to visit new sites, to discuss their use for teaching at different levels, and to practice new field-study techniques.

Graham Hall

CONFERENCE REPORT, LAMPETER 1985

It was a bold decision to hold the 1985 Conference at Lampeter and a sensible one to emphasise the fieldwork possibilities of the region as the main theme of the Conference. Over 140 members were attracted to this beautiful area, though a number, like myself, probably missed the opening lecture on the geology and geomorphology of South Wales as they were still finding their way along the rural byways of Wales and seeking the peace of mind which comes from spotting the first signpost for Lampeter. I am told that Professors Owen and Bowen, between them, delivered a splendidly illustrated lecture on their chosen topic. An international flavour was added to the proceedings when Prof. Mayer from Ohio State University described the developments and problems in earth science education as it is practised in American High Schools, usually to students in the 14 to 16 age group.
Courses are well developed and backed by some excellent textbooks - and there is even a shortage of earth science teachers in many parts of the United States. This talk was followed by meetings of various working groups until quite late in the evening.

There can be few Associations where many of those attending the Annual General Meeting do so in boots, but since the AGM at Lampeter immediately preceded the full day excursions on Saturday, most came to the meeting dressed for fieldwork. The formal business did not take very long to conduct, though it appears that the administrative work of the Association still rests on the shoulders of a small number of volunteers. The variety of field excursions on offer were all very worthwhile and I was fortunate to accompany Peter Hendry on a tour of some of the classic sites along the Pembrokeshire coast. White Sands Bay provided a great range of teaching opportunities at different levels with a great range of igneous and sedimentary rocks together with a number of interesting structural problems for students to solve.

Palaeontologists were well satisfied with their visit to Aberreiddy Bay with its rich pickings of Didymograptus murchisoni and other graptolites on the foreshore. Strumble Head displayed some excellent pillow lavas visible both in section and in plan view. We were surprised to see, on arrival, large numbers of people gazing out to sea through telescopes - apparently looking out for migrating birds rather than wondering what the palaeontologists were up to on the cliffs below!

Dinner was followed by two more lectures. Prof. Beaumont informed us of the various courses on offer in the Geography Department at Lampeter and of the research interests of its teaching faculty. After this Dr. John Phillips gave an address on 'Mineral Deposits in Wales'. The main substance of the lecture was an eloquent advocacy of the usefulness of Mohr's Circle in predicting the conditions of stress under which fault systems might develop.

After a whistle-stop tour around the exhibits, it was back to the main lecture theatre for the open forum, which had a certain air of déjà vu about it since most of the discussion centred on the future of geology in schools against a background of falling rolls and the squeeze on minority subjects, including geology. It emerged from the discussion that most GCSE geography syllabuses appear to be abandoning much of the traditional physical geography, although opportunities exist for including geological content in 11 to 14 science syllabuses where there is a lead from the geology specialist which will be accepted by his colleagues in other sciences. The lively discussion was formally terminated as closing time in the bar approached, though informal discussion of the issues raised continued for some time afterwards.

Sunday saw a further variety of field excursions on offer. The visit to Dolaucothi Gold Mine proved popular and those who went were able to enjoy a scramble through the muddy galleries of the mine, though I have not heard any reports of 'finds' of gold nuggets! I chose to visit the area around Llanwrtyd Wells in the company of Dr. John Davies. The Excursion was led with enthusiasm and energy. The area turned out to be one of great structural and lithological complexity and we had time to sample only a small part of it before returning to Llanwrtyd Wells to disperse for home. Dr. Davies earned our eternal gratitude by using his influence with the barmaid at the Neuadd Arms Hotel to allow us to slake our thirsts at an irregular hour.

Finally our thanks must go to Graham Hall and his team for all the hard work which was put into organising a most successful and enjoyable Conference.

Ian Ray, Cheadle Hulme School, Claremont Road, Cheadle Hulme, SK8 6EF.

NEW HMI FOR GEOLOGY

Members will be interested to learn of the appointment of W. J. (John) Rea as HMI for geology. The appointment is welcome news as it means that, for the first time in recent years, the inspectorate has a specialist geologist, who will be involved in the inspection of geology in schools and in further and higher education.

John Rea, who has been a member of the ATG since 1976, graduated with first class honours in geology and chemistry from Keele University in 1965 and subsequently took a D. Phil. at Oxford University. From 1969, he was lecturer in geology at the University College of Wales in Aberystwyth and in 1979 was appointed head of the department of Geology and Physical Sciences at Oxford Polytechnic. He served as Dean of the Faculty of Technology at the Polytechnic from 1982 to 1985. John Rea's research interests have been in igneous and metallogenic processes at destructive plate margins (the Andes, West Indies) and in geochemical prospecting in arid areas (Southern Africa). The latter work has involved many contacts with metal mining companies.

Although John's full time employment has all been within higher education, he has had a longstanding interest in school geology. He is a former chief examiner in A level geology for the WJEC and as honorary secretary of the Geological Society from 1981 to 1984 he coordinated much of the Society's work on geological education (see e.g. Geology Teaching 9, 4-8, 1984).

John Rea took up the post of HMI on 1 September 1985 and will be fully active with respect to geology from September 1986. Officers of the Association have already established contacts with the new geology HMI and we hope to see John at future ATG meetings.

D. B. T.

GEOLOGICAL EDUCATION IN SCOTLAND

Members will be interested to read of the latest letter from the Scottish Consultative Committee on the Curriculum to Chris King, Chairman of the Curriculum Working Group of ATG.

Dear Mr. King

I refer to your recent correspondence with Mr. Crawley of the Scottish Education Department. Mr. Crawley has also passed to me your letter of 20 October with 3 documents enclosed. In turn these documents are being passed to officers of the CCC who have responsibility for aspects of Geology/Earth Sciences.

You are already aware of the unfortunate circumstances which have delayed the implementation of proposals for reform of the secondary curriculum. Within the CCC's
present structure the Scottish Central Committees on Social Subjects and on Science share an interest in Geology/Earth Sciences. In practice the subject or aspects of the subject are most often taught by geographers and the SCC on Science has expressed reservations about the extent to which certain school Geology syllabuses contribute to its stated objectives of science education particularly in the areas of experimenting and problem solving.

At present as you will know the Scottish Examination Board offers syllabuses and examinations in Geology at the Ordinary Grade and more recently also at the Higher Grade. The CCC’s present advice to the Scottish Education Department and SEB is that Standard Grade Geology at General and Credit levels should, at a date yet to be determined, replace the Ordinary Grade syllabus. There are as yet no further proposals regarding Geology at Higher Grade although a general review of Higher and Post-Higher arrangements is under way. One option is that Higher Geology might be replaced by a progression of modules or short courses under the National Certificate arrangements of SCOTVEC as a means of enhancing the place of earth science in the curriculum.

Already aspects of earth science are included in proposals being considered for Geography at Standard Grade and together with other aspects already included as options within Standard Grade Science the arrangements appear adequately to meet the needs of all pupils who wish to undertake studies in this area of the curriculum.

Your Association’s interest and assistance is greatly appreciated.

Yours sincerely,
David R. McNicoll, Secretary, Consultative Committee on the Curriculum, Room 4/17 New St. Andrew’s House, Edinburgh, EH1 3SY. Telephone 031 556 8400 ext. 5181.
THE WORK OF THE SCHOOL CURRICULUM DEVELOPMENT COMMITTEE (SCDC)

Representatives of subject teaching associations were invited to a meeting at SCDC headquarters in London so that officials of SCDC could make themselves known and open up channels of communication with associations such as ATG. Eighteen subject-teaching associations were represented, together with several other non-subject-centred associations. The account which follows is a summary of what we learned.

When the work of the Schools Council was terminated about 18 months ago, two new bodies were set up to take on some of the roles of the Council. These were the Secondary Examinations Council (SEC; referred to in Pat Wilson's article in *Geology Teaching* 10(1) pp. 11-12) and the SCDC.

SCDC is funded partly by the Department of Education and Science and partly by the Local Education Authorities to the tune of £2 million at present (much less than the Schools Council budget!). It therefore has two 'masters' and thus has to walk a difficult political tightrope. It is also greatly constrained by the word 'development' in its title. Great stress was laid on the fact that the SCDC is not an advisory or policy-making body. Policy is made by the DES (now under Sir Keith Joseph) aided by her Majesty's Inspectorate, (the HMI) and the LEA's; SCDC's task is to identify needs and to initiate developments. (This is despite the fact that some of the development must take place before the policy can be formed!)

SCDC sees itself, therefore, as a catalyst, performing a coordinating and facilitating role with a national perspective. It attempts to play these roles in various ways as follows:

1. By the formation of working parties such as the recent Geology Unit, pp. 11-12) and the SCDC.

2. By the formation of the Teacher's Fund. It is thought that often the most worthwhile curriculum development takes place in schools and so the Teacher's Fund has been established to provide low-level funding to teachers working at local level. £150,000 was available in the first round of awards for which there were nearly 1400 applications. 258 of these were successful and of these 13% concerned environmental studies, 11% science and 9% technology. Awards ranged from £200 to £1000. A second round of applications has just closed and another £50,000 will be available in January. However, the January round will give priority to the following three areas: religious and moral education, the early years and special needs in mainstream schools.

You will see that earth science does not, and is not likely to, figure greatly in all these awards! SCDC staff have said however that since a large part of their total funds goes towards the funding of the Secondary Science Curriculum Review, it is unlikely that scientific areas of the curriculum will be designated priority areas in the near future. But SCDC is willing to consider all applications, so if a group of local teachers and/or a member of ATG have a proposal to offer they should submit an application as soon as possible.

3. SCDC have taken on some of the projects begun by Schools Council. By far the largest of these is SSCR but several other Schools Council projects are continuing such as the Industry Project (SCIP) or the History 13-16 Project. SCDC have also continued the publishing role of Schools Council in order to make available materials from those projects already in the pipeline as well as new projects.

4. SCDC have initiated several projects of their own including Arts in Schools, Primary Mathematics and the National Writing Project.

5. SCDC publishes an information magazine called 'Link' which is sent to all schools at the beginning of each term.

6. SCDC is keen to form and maintain links with the educational organisations including the subject associations, the teacher unions etc. The staff wish to keep themselves informed and to inform others of progress in the curriculum field. WE pass the message on.

C. H. J. K.

ARMAGH MUSEUM

With respect to Michael Bamlett’s article on “Geological Education through the Museum Service”, *Geology Teaching* 10(1) pp. 7-11 March 1985, Mr. Kenneth James, Senior Museum Assistant at the Ulster Museum, has kindly written to us to point out that the Regional Branch of the Ulster Museum is in Armagh and not Antrim (table 3, p. 9 first entry). He suggests that arrangements for research in the Armagh area are best made by contacting the Geology Department in the Ulster Museum in Belfast in the first instance.

D. B. T.

ATG Conference Bath 1986

The next ATG Conference will take place at Bath University, through the good offices of John Fisher, on September 12-14th. The format will be somewhat similar to previous years' conferences but will make full use of the locale and the great amount of geological experience which is available in the Avon area. Apart from this, there will be additional emphasis on geological education and GCSE curriculum-examination initiatives. Full details will appear with the March issue of *Geology Teaching*.

D. B. T.

LETTERS

Don't you teach them spelling any more?

Dear Editor,

Two printing errors crept into my recent article in "Geology Teaching" about why students come to Swansea. I certainly spell that metropolis of South Wales Maesteg, not Maestag, and I definitely spell definitely, definitely and not "definitly".

I definitely spell definitely, definitely!
I am increasingly appalled at the spelling used by our students. Even a very capable postgraduate came up with “caperbal” recently and in an undergraduate examination paper this year I found in the answers to a question on palaeobotany: “firns” - many times - and “the land surface was selficiently well forested”.

The ultimate horror came when the BBC repeatedly advertised one coming programme called “Seige” and another on the “Roll” of the police. Perhaps I’m old fashioned and the modern attitude is that it doesn’t matter. I would strongly favour making our language phonetic, especially as English rapidly seems to be becoming the world language, at least in science. A Dutchman recently told me that he gave his own language another 20 years. I dare not mention Welsh! But the bad spelling is usually not even phonetically accurate. To me it is just slovenly and seems to imply that the people who use it do not read or do not see the words they read.

Please be very careful in setting this letter Mr. Editor!

Yours sincerely,

Professor Derek Ager, Department of Geology, University College, Singleton Park, Swansea.

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"A level geology as an entry qualification for degree courses in the Geological Sciences - The views of CHPCGD"

Dear Editor

At a meeting on 21 November 1985 the Committee of Heads of Polytechnic and College Geology Departments (CHPCGD) adopted the following resolution:

1. Geology is a basic science with direct comparability to Biology, Chemistry, Mathematics and Physics.

2. Geology is an appropriate A-level subject for entry to geologically-based degree courses.

3. Geology is also an appropriate A-level subject for entry to degree courses in environmental sciences, geographical sciences and other science-based courses.

Members of the Committee reaffirmed its previous stance that:

a. they would regard A-level geology as a desirable qualification for their courses,

b. they regarded geology as an eminently suitable and desirable vehicle for science training in schools.

Yours faithfully,

Dr. W. E. G. Taylor, Secretary of the Committee of Heads of Polytechnic and College Geology Departments, Science Faculty, Luton College of Higher Education, Park Square, Luton, Beds.

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Red House Hotel
KESWICK, CUMBRIA, CA12 4QA.
Telephone: Keswick (0596) 72211

The Lake District has long been a favourite venue for field study groups of all ages with its beautiful scenery and unique geological, topographic and ecological features. The Red House Hotel, two miles out of Keswick on the slopes of the Skiddaw massif, is an ideal centre for field parties and we can offer them a welcome at various times of the year. The Hotel is set in 20 acres of woods and gardens and the 23 bedrooms (most with private bathroom) can cope with parties up to a maximum of around 50. Lecture and study facilities including projectors, large screen video, etc., are available and if required, we can help or advise on itineraries or visiting arrangements.

Catering is of a high standard and we can offer very competitive rates for parties. We can also invite staff to make a preview visit at special discount rates to inspect facilities and to discuss a possible visit.

Please write or telephone 0596 72211 for any further information from Mr & Mrs R.G. Bond.
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  Thrusted out overturned anticline,
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  Small anticline in slates,
  Kink band in alternating mudstones and siltstones,
  Similar folds in migmatic gneisses,
  ‘Z’ shaped parasitic fold,
  Concentric folds in Devonian slate.

- **INTRUSIVE IGNEOUS FIELD RELATIONSHIPS**
  by D Linnington and P Harrison
  £3.00 for 10 slides with notes (plus 25p p & p)
  Aplite intruding shales, Dolerite dyke in Moine Schist, Vent Agglomerate, Pitchstone sill in new red sandstone, Felsite dyke in Mona Schist, Aplitic dyke, Jointed granite. Columnar joining, Layered basic intrusion,
  Geological map of the Isle of Arran.

- **SEISMIC SECTIONS** by P. Harrison and Western Geophysical Company.
  £4.00 for 14 slides with notes and a seismic profile.
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- **ROCK TEXTURES IN THIN SECTION** by Neil Bowden
  Nine ‘split-image’ frames showing the following rocks in both plane polarized light and between crossed polar.
  1. Aeolian Sandstone
  2. Garnet Mica Schist
  3. Gabbro
  4. Gneiwacke
  5. Aplamellitite (Shap Granite)
  6. Chisostolic Slate
  7. Feldspathic Sandstone
  8. Amygdaloidal Andesite
  9. Crenulated Mica Schist

- **ASSOCIATION OF TEACHERS OF GEOLOGY TIE**
  £3.40 (plus 30p for p & p)
  Blue cloth tie with ATG motif.

- **PALAEOECOLOGY**, by Prof. D.V. Ager (reissue)
  £3.00 (plus 20p p + p)
  24 slides (as strips) with notes

- **LIFE ORIENTATIONS**
  Coral reefs, tree stumps, productids, burrowing bivalves, resting bivalve, Rudist colony.

- **DEATH ORIENTATIONS**
  parallel belemnites, random crinoid stems, overturned brachiopod, gossiping bivalves, separated mollusc shells, fossil ‘spirit-level’.

- **FOSSIL ASSOCIATIONS**
  brachiopod and coral, ammonites and worms, oysters and sponges, crinoid and gastropod, low diversity fauna, high diversity fauna.

- **TRACE FOSSILS (Mesozoic & Cenozoic)**: *Diplocraster*, *Thalassinoidea*, *Ophiomorpha*, *Rhizocorallium*, *Zoophycus*, browsing trails.

- **MODERN SEDIMENTARY ENVIRONMENTS 1.**
  (sedimentary environments of the Bahama Banks and the Arabian Gulf)
  by Roger Till and Chris Wilson
  £3.50 (plus 20p p + p)
  30 slides (as strips) with notes

- **BAHAMA BANKS – Oolite Facies** (including aerial views of sandbanks, and microphotographs of oolite grains). Mud & Pellet Mud Facies (aerial view of intertidal muds, microphotos). Oolites, Grapestone & Reefs (aerial views of oolite sandbanks encroaching over grapestone sediments, and of reef, microphotos).

- **ARABIAN GULF** – Algal sediments (aerial views of Sabkha environment, and examples of laminated sediments analogous to those in British Carboniferous, Rhaetic and Purbeck). Evaporites and Red Beds (this set shows modern sediments comparable to those that accumulated on the margins of the ‘Echstein Sea’ in the present North Sea in Permian times).

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  1. World Ocean Floor Panorama (1977) by Bruce C. Heezen and Marie Tharp, Lamont Doherty Geological Observatory, U.S.A. (Size approx. 60 cm x 90 cm).
  *This map alone retails at $20 in U.S.A.*
  2. Topography of the Oceans (1975) by T.E. Chase, Scripps Institution of Oceanography. (Size approx. 60 cm x 90 cm). Shows both oceans and continents at same contour interval.
  *Postage and packaging rates quoted for maps and charts despatched folded. Requests for despatch unfolded in map roll will be charged at £2 per despatch, irrespective of number of maps or charts. All orders £25 and over – p & p £1.50. All orders £100 and over post free.

Orders to: Fran Stratton, Geology Dept., Luton Sixth Form College, Badgers Hill Road, LUTON, Beds.

★ Official orders will be invoiced.
★ Cheques and postal orders made payable to A.T.G. Promotions Group.
The general background

Secondary science (11-16 years) is dominated by the disciplines of physics, chemistry and biology (DES 1979). In upper-school science the curriculum is determined by the demands of the examination syllabi, predominantly of these three subjects. In lower-school science there would seem to be greater freedom, but here too upper-school external requirements create a 'ripple effect' (Baxter 1981). This is partly because the teachers involved with the decision making and teaching of lower-school science are, in the main, the same teachers who take upper-school examination classes. They tend to be, therefore, specialists in physics, chemistry and biology. Whilst these teachers would expect to include elements of all three traditional disciplines in lower-school science, they would not normally expect to go beyond these boundaries. This is despite the many discussion documents which set down the broad aims and contexts for the science education of the future (DES 1979. ASE 1981).

The organisers of the Secondary Science Curriculum Review (1983) point out that few programmes extend beyond physics, chemistry and biology and that subjects such as earth science are generally limited to upper-school examination work, where they attract small groups. Geology is unlikely to become a mainstream science subject whilst it is excluded from lower-school science (Brown 1984).

A strong case has been made over the years, in this journal and elsewhere, for the inclusion of earth science in lower-school science, for example the argument put forward by the Schools Council Geology Curriculum Review Group (1977. 21-23). The arguments, however, are those of geologists, geology teachers, and traditional science teachers with an interest in geology. The majority of science teachers, who have no special academic background or interest in geology, who have no knowledge of the virtues of teaching earth science, would not normally consider it necessary or appropriate to include any earth science in lower-school science teaching.

If it could be shown to Local Authority Advisers, Heads of Science Departments and science teachers, that science concepts already taught in lower-school could be taught more effectively and easily through the inclusion of earth science topics, and that in fact such an inclusion clarified rather than confused the concept for the pupil, then science educators with no previous interest in geology or earth science might have to re-think their position.

First year science in tameside, greater manchester

In order to establish what was the nature of first-year science in Tameside, a questionnaire was distributed to the Heads of Science of 21 secondary schools in the authority in May 1983. The questions centred upon what was taught, how it was taught, why it was taught, and whether earth science played any part. 13 schools responded to the questionnaire, and a number of generalisations could be made from a study of these responses.

1. It is common practice for Heads of Department to set out a syllabus of work to be followed by teachers involved in first-year science. The way the work is taught by any teacher may vary, but the content does not.

2. The majority of schools base their work upon a published scheme, which is then modified by the Head of Department. A wide variety of schemes are in use including national schemes such as 'Science 2000', as well as authority produced and locally produced material.

3. Most schools do not make great use of text books in first-year science.

4. Earth science or geology teaching takes place in few secondary schools in Tameside at any level, only one responding school offered geology as an examination subject.

5. In the small number of schools that do include earth science in lower-school science topics, the component tended to be small and unadventurous, chiefly based upon soil and minerals.

6. Whilst no secondary schools teach separate sciences in the first year, there was an admission that the topics taught could easily be identified with the branch of science from which they originate; that is lower-school science is combined science rather than integrated science.

7. Over half the schools that responded described only one aim for first year science, associated either with learning practical skills or developing an enjoyment of the subject; two schools offered no aims at all.

8. The most popular topics included: Measurement, Air and Water; Classification; Solvents, Solutions and Separations; Heating and Burning.

Research into the possibility of including earth science in a traditional scheme

This article is a report of a research project undertaken in one school in Tameside in order to test the feasibility of including an earth science component in the traditional first year science scheme.

The hypothesis

The hypothesis put forward at the beginning of the research was: "It is advantageous for science teachers to include elements of earth science in lower-secondary science, in order to help children grasp concepts already taught in other ways, even when the teachers involved have no special interest, or academic background in, or knowledge of, earth science or geology."
The modification of a traditional science scheme

In order to test the hypothesis, research was conducted over two consecutive academic years, with first year science classes at Littlemoss High School for Boys, Droylsden, Tameside, Manchester. (The school intake of around 130 represents a wide ability range from a mixed social background, the major limitation being that is a boys' school.)

The first year science syllabus of internal origin was modified to include earth science topics in such a way that the basic science concepts already taught were reinforced in a different way than was usual. The modified work was presented to classes in high-achieving and middle-achieving bands; comparable classes of similar ability, which did not study the earth science topics, were used as controls. It was at first planned to present the work to a lower-achieving class, but no control class of comparable ability was available for this part of the research. Science teachers involved with lower-achieving groups did, however, use parts of the modified work in order that their own reactions could be judged.

The modified syllabus was introduced as a pilot scheme in the academic year 1981-2. A further modified scheme was used in the academic year 1982-3 with new first year classes. In each case tests of the understanding of concepts involved were issued to all four classes after a topic had been covered, so that comparisons of their achievements could be made.

<table>
<thead>
<tr>
<th>High-achieving band</th>
<th>test class taught scheme containing earth science, control class taught traditional scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle-achieving band</td>
<td>test class taught scheme containing earth science, control class taught traditional scheme</td>
</tr>
</tbody>
</table>

Fig. 1 Basic research model

The teachers involved did not have any earth science background or special interest. They had never taught geology or geological topics and would not normally have considered the inclusion of such topics in lower-school science under any circumstances.

Throughout the research the assumption was made that test and control classes were of similar ability in terms of academic achievement. This assumption was based upon the method used by the school, where pairs of classes were formed in the upper and middle band using the results of entrance tests in mathematics and English. The assumption was further checked by comparing end-of-year examination results in these subjects. It was found that in the second year of research the test class in the upper ability band had made slightly better progress in mathematics and English than had the control class through the academic year, a factor that had to be borne in mind when analysing the results of the science assessments.

Because of the nature of the research, the earth science work had to be closely related to the topics in the traditional scheme. All eight topics in the scheme lent themselves to the inclusion of an earth science component and only two topics, magnetism and light, were not used. Whilst the first year scheme for science at Littlemoss was unique, the research into the nature of work in the thirteen other Tameside schools had demonstrated that it was not a typical scheme.

In the first year at Littlemoss a large core of between 85% to 90% of teaching time was taken up with worksheets of the traditional science scheme. The remaining time was typically spent reinforcing concepts and facts contained therein, prior to the assessment of the pupils' achievement in each topic. The Head of Department agreed that the earth science work introduced could add up to 15% extra to the core scheme without overloading the pupils. This meant that earth science could, in effect, be used as an alternative method of concept enforcement with test classes for around 10% of the course, or 9 hours of a 90 hour total of first year science. The remainder of the allowance had to be set aside for the assessments issued to test and control classes.

The introduced earth science material was as far as possible self-explanatory and in a form which minimised the effects of variation in teaching method. The resultant earth-science work was incorporated into the chosen six topics in the form of one worksheet per topic. In addition an instrument of assessment was designed for each topic.

<table>
<thead>
<tr>
<th>Number code for Sheets</th>
<th>Details of Content</th>
<th>Topic in which the Sheets were Included</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1 GT1 G2 GT2 G3 GT3 G4 GT4 G5 GT5 G6 GT6</td>
<td>Structure of the Earth Metric Test Heat of the Earth Heat Test Giants Causeway Expansion Test Gravity in Water Gravity Test Making Mountains Pressure Test Plants from the Past Plants Test</td>
<td>Metric System Heat Transfer Expansion Forces Pressure Plant Biology</td>
</tr>
</tbody>
</table>

Table 1 Geological worksheets and assessment sheets
The earth science work in the modified scheme (the 'G' sheets) sought to develop an application of the basic science concepts. The test questions (on the 'GT' sheets) then assessed the degree to which this had helped the pupil in his understanding of the basic concept.

The questions on the 'GT' sheets could be divided into four categories, labelled A, B, C and D on the analysis model shown.

Fig. 2 Model to show the relationships between questions set on a particular topic

Question category A
This is the test of a concept common to both the traditional scheme and the earth-science work, and is the most important form of testing.

Question category B
This is the test of a concept specifically dealt with in the traditional scheme, but in the field of the earth-science work.

Question category C
This is the test of a concept specifically dealt with in the earth-science work, but in the field of the traditional scheme.

Question category D
This is the test of a concept not dealt with directly in either the traditional scheme or in the earth-science work, but in the field of both.

RESULTS AND ANALYSIS

Analysis of the four sets of class results, initially from the pilot scheme and then from the final scheme was carried out in order to determine:

1. if there was a significant difference between the marks obtained by the test class and the control class in the separate assessment categories A, B, C and D and in the overall total T, for the upper-ability first year band;

2. if there was a significant difference between the equivalent sets of marks for the middle-ability band.

3. if, on average, there was a significant difference between the marks obtained by the test classes and the marks obtained by the control classes.

4. if there was a significant difference between the mark comparisons across the two groups of the upper-ability band and those across the two groups of the middle-ability band.

The method of analysis used was based upon the two sample 't' tests (Fisher 1925), which proved satisfactory for the analysis of both positive and negative results and allowed all the data to be used even when classes were not of the same size. The analysis tested a 'null hypothesis', basically assuming that there were no differences between any two groups which could not have occurred merely by chance. With this type of hypothesis a difference was seen as statistically significant if its probability of occurring by chance was less than 1 in 20, or 5% (p<.05).

A program was written on the school computers which generated four values of 't', relating to each of the four points listed above. The program was used in turn for the results in test categories A, B, C and D and for the total, T, giving twenty values of 't' in all. In each case if the value of 't' printed out by the computer was greater than the value given in the statistical tables of 5% probability, then there was reasonable evidence of an effect. With the number of pupils involved, the relevant value for 't' was 1.98 or more. If the value of 't' was smaller than this then the observed effect may have been wholly due to chance. The sign of 't' was also important since a negative sign would indicate that the control class(es) had done better than the test class(es).

The results of the analysis for the second year of the research project are shown in Table 2.

In category A there is slight evidence from the first value of 't' that the test class in the high-ability band obtained better marks than the control class. However, the figure is not high enough to be regarded as important against the background of evidence that the test class in this band made better progress than the control class over the year.

In category B the values of 't' are all positive and are large enough to approach statistical significance in both ability bands, the value is even higher when the classes are averaged. This could be taken as quite good evidence that the earth-science component helped to enhance the achievement of the whole ability range in the traditional science work.

In category C the values of 't' are too small to be regarded as significant, but they are all positive, which indicates that the test classes obtained higher marks than the control classes, albeit not significantly higher marks.

In category D there is overwhelming evidence that the test class in the high-ability band obtained better results than the control class, there is less than 1% likelihood that this was due to chance. No such effect was found in the middle-ability band, but, when the classes are averaged, the overall
effect remains significant. It should be noted that the marks from this category only make a 10% contribution to the grand total T (see below), so its impact on the values of ‘t’ under that section is a limited one.

**Category T**, involving the grand totals, is weighted A - 40%, B - 30%, C - 20%, D - 10%, because of the number of questions in the assessments which fall into each category. The first value of ‘t’ in this section is significant, even after taking into account possible limitations in class comparability, evidence that the high-ability test class obtained better marks than the control. The second value of ‘t’ is not large, there is no strong evidence of a treatment effect in the middle-ability band. The third value of ‘t’ is significant at better than 5%, suggesting that there was overall benefit for the test classes when compared to their controls. The last value of ‘t’ shows that the difference between the performance of the two test classes in relation to their respective control classes, was not sufficiently great as to be of significance.

Overall, all but three of the values of ‘t’ relating to the tests were positive. Whilst the ‘t’ values for each of the categories are not conclusive, there is a cumulative effect in the grand totals. This can be taken to be a general indication that the inclusion of an earth-science component helped rather than hindered the teaching of basic science concepts.

### Table 2 Research Results

<table>
<thead>
<tr>
<th>Test Category</th>
<th>Score Difference Measured</th>
<th>Value of ‘t’</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>questions testing common concepts</td>
<td>high-ability groups, test v control</td>
<td>+1.34</td>
</tr>
<tr>
<td></td>
<td>middle-ability groups, test v control</td>
<td>-0.44</td>
</tr>
<tr>
<td></td>
<td>classes averaged, test v control</td>
<td>+0.61</td>
</tr>
<tr>
<td></td>
<td>difference between effects for high-ability and middle-ability bands</td>
<td>+1.25</td>
</tr>
<tr>
<td><strong>B</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>questions testing traditional concepts in earth science field</td>
<td>high-ability groups</td>
<td>+1.10</td>
</tr>
<tr>
<td></td>
<td>middle-ability groups</td>
<td>+1.53</td>
</tr>
<tr>
<td></td>
<td>classes averaged</td>
<td>+1.87</td>
</tr>
<tr>
<td></td>
<td>difference between effects for high-ability and middle-ability bands</td>
<td>-0.34</td>
</tr>
<tr>
<td><strong>C</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>questions testing earth science concepts in traditional field</td>
<td>high-ability groups</td>
<td>+0.79</td>
</tr>
<tr>
<td></td>
<td>middle-ability groups</td>
<td>+0.50</td>
</tr>
<tr>
<td></td>
<td>classes averaged</td>
<td>+0.91</td>
</tr>
<tr>
<td></td>
<td>difference between effects for high-ability and middle-ability bands</td>
<td>+0.18</td>
</tr>
<tr>
<td><strong>D</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>questions testing concepts not directly in either scheme</td>
<td>high-ability groups</td>
<td>+5.09*</td>
</tr>
<tr>
<td></td>
<td>middle-ability groups</td>
<td>-0.86</td>
</tr>
<tr>
<td></td>
<td>classes averaged</td>
<td>+2.90*</td>
</tr>
<tr>
<td></td>
<td>difference between effects for high-ability and middle-ability bands</td>
<td>+4.15*</td>
</tr>
<tr>
<td><strong>T</strong> Overall total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A - 40%</td>
<td>high-ability groups</td>
<td>+2.45*</td>
</tr>
<tr>
<td>B - 30%</td>
<td>middle-ability groups</td>
<td>+0.42</td>
</tr>
<tr>
<td>C - 20%</td>
<td>classes averaged</td>
<td>+2.00*</td>
</tr>
<tr>
<td>D - 10%</td>
<td>difference between effects for high-ability and middle-ability bands</td>
<td>+1.38</td>
</tr>
</tbody>
</table>

N.B. For statistical significance, \( p < 0.05 \), \( t \) must be greater than 1.98 – statistically significant

### The Reaction of Pupils and Teachers to the Revised Science Scheme

#### The pupils

It was considered useful to the research to obtain some feedback from the pupils at Littlemoss, as they can be regarded as consumers of the lower-school science scheme, either in its traditional or modified form. Second-year classes, who had taken part in the pilot research work whilst in their first year, were invited to respond to questionnaires which contained statements relating to the material contained in lower-school science, together with its aims, place and importance.

There was general support both for the traditional scheme and for its modification to include earth science, with no significant difference between the responses of the classes who had experienced the modified course and those who had not.

#### The teaching staff

The staff at Littlemoss who took part in the research work can also be regarded as consumers of lower-school science, since both the traditional and modified schemes were used by them in very much the same way as a published scheme is intended for use by its consumers.

A series of questions were drawn up in order that responses could be invited from those members of staff at Littlemoss who had been required to teach earth science to first-year
classes over the two year period of the research. The questions related to their attitude to earth science before and after its use, their attitudes to the place of earth science in lower-school science and the suitability or otherwise of the worksheets and assessment sheets used in the research. The questions were used as a basis for an informal discussion between the author and the members of staff, and they were then invited to express their views in written form.

The three members of staff involved were teachers of physics, chemistry and biology respectively. The chemistry teacher was also Head of the Science Department. Two of the staff, the physics and chemistry teachers, claimed that they were interested in the suggestion of the inclusion of earth science in their first-year work; however, the physics and biology teachers, in particular the latter, claimed to have experienced anxiety at the beginning of the course. The same two teachers felt that they needed to be able to refer to a geologist whilst the work was in progress (although in fact they did not). All three staff agreed that the earth-science component had been of marginal help in the teaching of basic science concepts, and cautiously accepted that the written tests had formed a valid instrument of assessment. The teachers agreed, with few reservations, that earth science should be written into the first-year syllabus in at least the quantity they had experienced, and that non-geologists could teach the work adequately. The biology teacher, who was originally the least interested of the three science teachers at the introduction of the new work, did see earth science in a new light by the end of the two years and as a result wished to see the concepts special to geology introduced in the first year. The physics and chemistry teachers both wished to see earth science in the course in a similar form to that encountered in the research, that is reinforcing concepts already found therein.

CONCLUSIONS AND RECOMMENDATIONS

The research demonstrated that even a cautious introduction of earth science into a first-year science scheme can produce positive results. In addition, the modification of the first-year science scheme at Littlemoss has gone some way towards demonstrating that aims more closely associated with inculcating an understanding of the processes of science rather than merely the content, such as problem solving, can be incorporated into traditional schemes by the use of earth science.

It has also established that once a science department which has not previously encountered the use of geology or earth science has embarked upon the teaching of a lower-school science course with an earth science component, the advantages are generally appreciated by staff and pupils alike.

Anyone wishing to conduct similar research in this field, would need to obviate a number of limitations that were placed upon this work.

1. The earth-science component contained no fieldwork, nor any concepts special to geology.
2. The ability range of the pupils involved with the work was around the top 70% of a comprehensive intake.
3. Littlemoss is a boys comprehensive school.
4. The total amount of earth science experienced by the test classes was only around 10%.

PROGRESS FOLLOWING THE FINISHING OF THE RESEARCH

Before this research began in September 1981, geology or earth science did not appear in any part of the curriculum at Littlemoss, other than as a limited amount of work in upper-school geography. From September 1984 aspects of earth science were retained for further development in lower-school science. In the third year geology now represents 25% of science for the top ability bands and geology has been added to the list of science options for the upper-school.

In Tameside as a whole, before September 1981, geology was taught in its own right by the geography departments of one or two schools only, and a small amount of earth science was taught as part of lower-school science in a number of schools as ‘soil studies’ and ‘mineral studies’. From September 1983 an Authority mode-three C.S.E. examination in Science containing an earth science module, began to be used by many Tameside schools. A series of meetings arranged by the Science Adviser as a response to the Secondary Science Curriculum Review Document (1983), held throughout 1984, included a consideration of earth science material, particularly with reference to the problem-solving approach in lower-school science.

Brown (1994, p16) sees progress for geology in schools as best achieved through its inclusion in lower-school integrated science. Based upon his experience over the last four years, the author would agree.

Acknowledgments

The author wishes to thank Mr. D. B. Thompson, the staff and pupils at Littlemoss School, and the Heads of Science in Tameside who assisted in the research.

References


THE PUPILS' WORKSHEETS

Worksheet G1. The Structure of the Earth

We think the Earth is made of layers (although we have never drilled a hole deep enough to know for sure). This
The Continental crust is around _______km thick
The Oceanic crust is around _______km thick
The Mantle is around _______km thick
The Outer Core is around _______km thick
The Inner Core is around _______km thick

(REMEMBER to change the figures above into kilometres)
The Earth weighs 6,000,000,000,000,000,000 kg
What would that be a) in grammes? ________
   b) in Tonnes? ________

Supposing we cut ourselves a square piece of ocean and crust...

What volume of water is this?

What volume of crust is this?

If each km³ of crust weighs 3,000,000,000 tonnes, what is the weight of crust here?__________

Gravity gives things weight by pulling them towards the centre of the Earth. Because of that, the nearer the centre we get, the heavier (or more dense) the rocks we would find: the core being very heavy (we think it is iron).

Two rocks (a) and (b) will be passed round the class, one is like the kind of rock the top of the crust is made of, the other is more like the bottom of the crust.

Try to work out which is which: Top__________
   Bottom__________

Worksheet G3. A Problem from Nature
In County Antrim and the Hebrides a very strange rock is found. It turns out to be quite a normal kind of lava.
(volcanic rock) called basalt (some will be passed round the class).

The strange thing is the shape. it is a little like this diagram with large columns forming steps down to the beach.

In the past people could not believe it was natural and called it the 'Giants' Causeway'!

So you try to solve this mystery of nature; here are two clues:

a. Remember this is volcanic rock so it began as a river of VERY hot liquid rock. (About 1,200° C)

b. It is now a much cooler solid, so use what you know about how things change as they cool.

Use the back of this sheet to write down your solution of the problem.

Worksheet G4. Gravity in Water

If a stone and a feather were dropped on the moon, they would hit the ground together. Here on the Earth, air gets in the way of the feather, so it takes longer. Water gets in the way of falling things even more if they are light, like a feather.

In front of you is a beaker of sand and gravel mixed up. If this was tipped into a beaker of water, do you think it will stay mixed?

After finding out complete the diagram below:

In your own words:

a) What happened? ____________________________________________

b) Why? ____________________________________________

The sorting out of large particles from small often happens on a large scale in nature. Here are some examples:

a. Rivers carry a large amount of sand, gravel and stones as they move along. When they meet the sea the movement of the water stops and the particles drop like this:

The fine material, taking longer to sink, is carried further out to sea.

b. What would happen to the above if severe rain storms on land gave the river more volume and power? ____________________________________________

c. Sometimes volcanoes throw everything from boulders to fine ash into the air. Finish this diagram below sea level.

Worksheet G5. Making Mountains

This involves both forces in solids and pressure in liquids.

Draw a second diagram at the side to show what you think will happen in each case:

a.

b.

Sometimes a rock structure like this is found:

This is as a result of forces. Draw below a diagram to show these layers of rock before this happened, add also arrows to show where the forces would have come from to do this.

A piece of rock will be handed round the class, notice how squashed and twisted the layers are. They began like this:
Introduction

The history of earth-science education in State University, John Dewey and the growing concern for geography course was perceived as decline, USA not appropriate for the expanding population entering high schools. According to an observer at the time, physical geography offered in the 9th grade was diluted college geology. Landforms, their genesis and evolution, were studied in great detail. Profiles of far away places the pupil could not visualise were made from topographical maps. Detailed but impractical studies of maps were often made. The home landscape, crying for recognition, went largely unnoticed. In the textbooks there was almost no reference to man’s relation to his environment and little about its effects on him, and when such material was included in the text, it was ignored by most teachers (Davis et al. 1950).

By the 1950s most schools had eliminated physical geography from the 9th grade curriculum. In many cases, a course in general science had been substituted. The exception was in the schools of New York State. There, operating under the guidance of the New York State Department of Education, the name of the course was changed to earth science and it continued to be offered as an elective along with biology and the other science courses. There was doubt among science teachers that physical geography would ever return to the high school as a separate course, except possibly in scattered instances or in certain special situations. On the other hand, many science educators saw the need and the opportunity for incorporating earth science into the programmes of science for general education all along the line (Holcombe, 1951). Thus, although the course had been eliminated in most schools, units on geology, astronomy, oceanography and meteorology were included in general science courses which had come into the curriculum in place of physical geography.

Early in 1963, the American Geological Institute, an organisation that represents the membership of the major geological societies, took a cue from events which were taking place in biology, chemistry and physics, and formed a steering committee to organise an attempt to develop a modern earth-science textbook. The writing conferences of the Earth Science Curriculum Project (ESCP), which subsequently received funding from the National Science Foundation, met in Boulder, Colorado in the summers of 1964 and 1965 in order to write a preliminary edition of a textbook which was then piloted in about 75 schools across the country. The final version of the text, *Investigating the Earth*, was published in 1967 (Heller et al. 1967). The attention of the ESCP committee then shifted to stimulating the offering of workshops and in-service institutes on the use of the ESCP text and laboratory programme. As a result of its influences, and the broad desire to improve science education in the post-sputnik era, many schools adopted

Worksheet 6. Plants from the Past

Six rocks will be passed around the class, some contain evidence of plants from the past, some do not.

Say below which is which:
1
2
3
4
5
6

Early plants did not make as much use of animals as modern plants do; why do you think this is?

Frank Fearn, Littlemoss High School, Cryer Street, Droylesden, Manchester, M35.

EARTH SCIENCE IN AMERICAN SCHOOLS

Introduction

Vic Mayer, Professor of Science Education at Ohio State University, follows up his talk to the Lampeter Conference 1985 with an explanation of the context in which the problems which he highlighted can be viewed.

Earth science can be defined as a course of study that includes information from geology, meteorology, oceanography and astronomy. Such a course is seldom taught in the schools of Great Britain but it has become very common in the United States. Geology, of the kind which is offered at the O-level and the A-level in English schools, is only occasionally taught in American high schools. The advent of the space age gave great impetus to the inclusion of earth-science content in the curricula of American public and private schools. Currently it is estimated that at least 50% of the students completing the 12 years of elementary and secondary schooling will have had a formal course in earth science or one of its included disciplines. The remaining students will have learned some content from the earth sciences from courses in general or integrated science.

The history of earth-science education in USA

The teaching of the content of earth science has had a long history in American schools. As far back as Benjamin Franklin’s academy, established in Philadelphia in 1751, the courses in natural philosophy included information on astronomy, geography, geology, meteorology and mineralogy. Public high schools (grades 9-12; age 15-18) began to develop in the early 19th Century, their curricula heavily influenced by those of the private academies. In 1892, the National Education Association established a Committee of Ten to study the curriculum of the high schools and to make recommendations regarding a desired pattern of subjects to be taught at that level. Their recommendations included a physical geography course taught at the 9th grade level (age 15). They also recommended that electives in astronomy and meteorology and geology or physiography be offered in the later years. The physical geography recommendation was widely accepted. In 1900 over 20 percent of the high school population was studying physical geography. In the 1920s and 1930s enrolment in those courses experienced a decline, in part because of the influence of educationalist John Dewey and the growing concern for social adjustment as a priority to be achieved in schools. The physical geography course was perceived as highly academic and not appropriate for the expanding population entering high schools. According to an observer at the time, physical geography offered in the 9th grade was diluted college geology. Landforms, their genesis and evolution, were studied in great detail. Profiles of far away places the pupil could not visualise were made from topographical maps. Detailed but impractical studies of maps were often made. The home landscape, crying for recognition, went largely unnoticed. In the textbooks there was almost no reference to man’s relation to his environment and little about its effects on him, and when such material was included in the text, it was ignored by most teachers (Davis et al. 1950).

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earth-science programmes, generally at the 8th or 9th grade (age 14-15). By 1972-3 there were over 1.2 million students, or about 6% of those enrolled in grades 9-12, taking earth-science and earth-science-related courses (Mayer, 1978). It is certain that many more students were taking earth science in lower grades, but such data were not available. More recent studies (Welch et al 1984) include data on grades 7-9 (age 13-15). These data indicate that enrolment has remained quite stable since 1976. In studies conducted in both 1976-7 and 1981-2 about 14% of the students in grades 7 through 9 were enrolled in an earth science course. This compares with about 15% in physical science, 20% in life science and 28% in general science. Enrolment in earth science has dropped at grades 10-12 from 4.4% to 3.7%, but gone up in astronomy, oceanography and geology. Apparently earth-science courses are holding their own in terms of enrolment despite some severe problems of teacher supply and funding.

The American school system

American schools are run quite differently from those in Great Britain. The ultimate authority in all matters relating to a school is the local board which consists of a small number of citizens elected to govern the schools. There are state laws that set minimum standards of curriculum and teacher preparation, but these are indeed minima. Each school hires a superintendent, a professional educator who actually runs the schools in his/her school district. There are no state or national examinations. In effect, what is taught in the classroom is almost entirely up to the teacher. Many districts will have curricular guides but seldom is there a means of insuring that teachers follow those guides. One might expect, then, a wide diversity in what is taught in earth science and in how it is taught. In fact this does not happen. What is surprising is the remarkable uniformity in the content of earth-science courses taught around the country. This is in part because most teachers closely follow a textbook and most textbooks are quite similar in content and format.

One of the most interesting and perhaps innovative efforts at curriculum reform was conducted during the mid-1970s. There was a great deal of concern on the part of some earth scientists for the lack of information concerning plate tectonics in school curricula. This was a theory just coming into its own. How could teachers keep their students abreast of this “breaking story”? The National Science Foundation funded the Crustal Evolution Project (Mayer and Stoever, 1978) to develop instructional materials that could be integrated into the existing earth-science courses. The project had six development centres co-ordinated through a national centre at the University of Oklahoma. Each centre was located in the vicinity of a research facility dealing with global geology projects such as the Lamont Doherty Geophysical Observatory in New York. Scientists assisted centre staff to identify topics from current research that were appropriate subjects for curricular materials. The centre director, versed in writing curriculum materials, worked with a local teacher and a scientist to develop the activity which was then tried in local schools. Of the 64 activities that were developed through this process, 32 were published by Ward’s Scientific Establishment in Rochester, New York, and are now available (see Thompson 1980 for details).

Problems of earth-science teaching in USA

Our earth-science programmes face several rather severe problems. The major one is the lack of qualified earth science teachers. After a brief surge of students coming into earth-science teacher-education programmes in the early 1970s, there was a gradual decline. There were years at my own institution when we did not enrol a single undergraduate in earth-science education. Over the past two years we have seen a slight increase; we now graduate three or four each year. This is a national problem. The state of Texas, where earth science is required by the state in 8th grade curricula, anticipates the shortfall of earth-science teachers this year to exceed 1,000. When principals find it difficult to hire qualified teachers in earth-science there is a tendency to drop the subject from the curriculum. If it is not dropped, it is taught by teachers who are poorly qualified. These may be biology teachers with little or no earth-science, or as is sometimes the case in the city of Columbus, Ohio, history teachers with maybe a course or two in geography.

Another problem, perhaps related to the first, is a decline in interest and achievement in science among school children. This is shared by earth-science. It can be imagined that poorly qualified teachers might find it difficult to interest students in earth-science and to foster their achievement. Also at fault are the materials that are used. The ESCP did have a dramatic effect upon the nature of earth-science textbooks. Most now reflect its influence. They tend to be highly academic and faithful to the science of the disciplines represented. There is little if anything that relates to how earth-science impacts on the lives of students. The importance of geology in finding oil, meteorology in predicting the weather, climate and the supply of food are seldom found in textbooks. Another, equally serious problem is the fact that textbook publishers, in order to maximise profit margins, must seek the widest possible market for each book published. Examples of features for illustration of concepts and processes are selected to represent the entire country, thus it is very unlikely that such features will be local and familiar to the student. They therefore find it difficult to relate to the content of the course. Also, in order to enhance marketability, the content must be such that it does not offend large special interest groups (such as the creationists) and the writing must be of a style that communicates to the broadest possible group of students. The result is that books are not written in a manner that holds the interest of students. These problems combine to produce courses that are boring to the student, providing him/her with little motivation for learning their content.

A national conference 1985

In order to address some of these problems the American Geological Institute, with support from the National Science Foundation, recently held a conference in Washington, D.C. Attending were several scientists, secondary school teachers, representatives from the petroleum industry, science educators and key people in state departments of education. They arrived at a series of recommendations which, if implemented, would help greatly to improve earth-science education. They deal with recruitment of students into earth-science education programmes, improvement of textbooks, development of guidelines for earth-science courses and national tests based on those guidelines, and the development of a national centre and several regional centres for earth-science education in order to assist in the development and dissemination of regionally focused instructional materials.

Conclusion

Earth science, under several guises has had a long history in American public and private schools. With the current attention being paid to improvement of education generally and science education in particular, earth-science should
receive renewed emphasis in the schools. We must hope that the Reagan Administration's emphasis on technology and the physical sciences will not divert support from those sciences, especially earth-science, which deal with complex natural systems. The public and its decision makers must have an understanding of those systems, to be able to predict what the use of various technologies will have upon them. Technology can enhance our lives, but if used unwisely can degrade our environment and even lead to the destruction of the essentials needed to maintain life on our planet. Hence earth-science remains an essential component of any public education system in the foreseeable future.

References

FUTURE EDUCATIONAL REQUIREMENTS FOR GEOLOGICAL SCIENTISTS

Roger Mason, a university lecturer, reflects upon the curricular discussions which have been going on in the Geological Sciences Department of University College as a result of the reorganisation of geology within London University. Discussion has focused on the medium-term future and, has been conducted in an atmosphere relating to the expansion rather than the restriction of courses (I). The optimistic tone of the article reflects this mood and provides a refreshing change from that normally related to the discussion of short-term problems.

Changes in approach

Geology encourages two particularly valuable aspects of intellectual training: it requires the development of skills of accurate observation of detail in the laboratory and the field and the precise recording of those observations in a thoroughly objective manner which discriminates observation from interpretation. These skills have an increasingly wide application in the modern world. Traditionally, geologists have been trained in patient observation of a qualitative and pictorial kind, especially when working in the field. Nowadays, this approach has been greatly extended by a wide range of quantitative techniques, both in the laboratory and the field.

The consequent theories about the Earth are increasingly framed in mathematical and physical terms. The tendency is even more marked in the inter-disciplinary sciences of geophysics and geochemistry. There has been a corresponding shift in the scientific method employed. The traditional method was inductive, with general conclusions emerging from the examination of large amounts of data. For example, a field study in structural geology would involve the preparation of a geological map, cross-sections (fig 1) and other types of diagrams, such as stereograms, from which the geologist would work out the structure of an area and its deformation history. By contrast there is a tendency for modern studies to be deductive or more precisely, dialectical. In a structural geological investigation, theories of plate motion might be combined with a knowledge of mechanical properties of rocks to predict the kinds of geological structures which might occur (fig 2), and the field survey would then be directed to


Professor Victor J. Mayer, Department of Educational Theory and Practice, Ohio State University, COLUMBUS, OHIO, OH43210, USA.
How will this affect degree courses?

What do these developments imply for the education of geological scientists? They will obviously need a much stronger background in all science, especially mathematics and physics. The use of increasingly elaborate equipment, especially in geophysics and geochemistry, will require not only manipulative skills but also a good understanding of atomic processes and the nature of the interactions of all kinds of electromagnetic radiation with matter. Already, university courses in the geological sciences devote much time to the quantitative application of the principles of physics and chemistry to geological processes, and a training in the use of computers is becoming an essential feature. These tendencies will continue and the familiar observational field-work element will probably gradually diminish, unless the B.Sc. course is extended to four years.

What will this mean for schools and colleges?

This poses problems for pre-university education. A general scientific qualification, including a level of numeracy well beyond present O-level standard, is obviously the ideal, and the widening of the syllabus beyond the present restrictive three A-levels would be very desirable. But for most branches of the geological sciences it seems likely that mathematics, physics or chemistry approaching present A-level standard will become essential pre-requisites. The exact syllabus content of these subjects is less important than the development of an understanding of principles, and the ability to work analytically.

However, I think it is likely that many potential applicants for degree courses in geological sciences will have studied a considerable amount of geology itself, and of geography, in their immediate pre-university education. This is because students are often introduced to the subject through the enthusiasm of a geography and/or geology teacher. Therefore we in the universities and polytechnics must frame our courses in such a way that students from this kind of educational background can go on to graduate in the geological sciences. While such students will have a harder start to the course than their classmates who have followed a physical sciences programme, those having a geological background can be expected to have the motivation for the subject to carry them through these difficulties. If they could have any kind of preparation before university, for
example by taking a one-year course in Additional Mathematics at O-level (or its future equivalents), it would help them.

**Summary**

In the future development of the mathematical and physical aspects of the geological sciences, the tradition of accurate, unbiased observation and precise recording will be preserved. It is more, not less, important when the recording is done electronically, and the results are processed by computer. It will remain essential to communicate scientific results clearly through the written and spoken word. Thus the future educational requirements for the geological sciences will be more exacting than they are at present, but the rewards in terms of an understanding of the Earth and its remarkable history will be correspondingly greater.

Dr. Roger Mason, Department of Geological Sciences, University College, Gower Street, London WC1E 6BT

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**SHOPFLOOR**

**GEOLOGY AND EARTH SCIENCE IN THE PRIMARY SCHOOL**

**Spaceship Earth on Zig-Zag course**

Back in July of 1986 I received a copy of a letter sent on to me by the President. It was a letter from a BBC producer which had reached the President via the Geological Society (Burlington House). The producer was asking for help and co-operation in making and promoting a programme on geology for primary schools. He also stated that some discussion had taken place with Dr. Alan Timms, Education Officer at the Geological Museum, South Kensington, concerning the programme and possible in-service courses associated with it. As convener of the Primary Group within ATG, I responded to the request offering help in general terms and publicity about the transmission dates in particular.

Following discussions over the Conference weekend, it became apparent that I should follow up the lead myself and investigate the project more thoroughly. Contact was made with the producer, Chris Ellis, who informed me that he would like me, not only to comment upon the script but to find a class of 9 or 10 year old children whom he could film actively engaged in appropriate geological investigations within the classroom and also outside in the neighbourhood. It was agreed that if I could find a suitable class of children in Sheffield, then Chris Ellis would be prepared to bring his production team and film the children in action.

Enquiries amongst LEA advisers enabled me to gain the support of Mrs. C. Jessop, Head Teacher of Ballifield Nursery, First and Middle School, situated on the south-eastern margin of Sheffield. A briefing meeting was held at the school in which all the issues were discussed with the Head Teacher and permission was obtained to proceed with the project. Two class teachers from the M2 unit would be directly involved as their children would be the ones undertaking the investigations both inside school and outside.

Chris Ellis was invited to Sheffield to visit the school, to assess the potential of the neighbourhood and to meet with myself, the Head Teacher, Mrs. L. Burton and Mr. N. Kingdom, the class teachers. Chris Ellis provided copies of the proposed script and outlined the range of investigations he would like carried out. Most of these were based upon "The Earth", a "Learning Through Science" package compiled by members of the ATG and the project team under the direction of Roy Richards and published by Macdonald (1983). Following the discussions, agreement was reached and a schedule devised for the class teachers to continue with their normal teaching programme, which coincided with an Earth Science topic currently being undertaken by Mrs. Burton's class. Additional materials and preparation would be required in order to meet the needs of the script. Geological materials, advice and guidance were provided for the class teachers by myself, whilst they prepared the workcards and assembled materials ready for the children to use in the classroom.

The introduction to geological materials was to be pressed through an examination of local buildings. The church and churchyard offered the greatest variety, together with the fronts of a few local shops. Workcards and recording sheets were prepared ready for the outdoor investigations. Permission to use the churchyard was obtained. Chris Ellis made a second visit to the school to check that all was prepared ready for the filming and to explain to the children what would be happening when the film crew arrived and subsequently how the programme would be put together. The production crew duly arrived as school opened on the Thursday morning and set about the task of filming the children capturing the excitement, enthusiasm and effort of different groups working through a circus of different experiments around the classroom. Filming was completed on the Friday by following the children around the churchyard as they were busily engaged in their investigations of, (i) the weathering of different rock types; (ii) the ability of different stones to be polished and (iii) the patterns of crystals exhibited by others. A few frames of local shop fronts and a Victorian water trough concluded the filming at the end of the half term.

The gist of the programme "Spaceship Earth", in the current "Zig-Zag" series on BBC2, follows the flight of the Earth as a spaceship, in its familiar orbit, and encourages the children to find out what the spaceship is made of, as it has lasted for so long. A conversation between travellers on board the spaceship links together a wealth of important geological concepts, illustrated by studio models and demonstrations, fascinating film sequences, rock specimens and experimental investigations completed by the 10 year-old children.

The programme will provide an ideal visual introduction for any primary school teacher who has an interest in getting involved in an Earth-Science topic and maybe lacks a little confidence in getting started. It shows that enthusiasm and common sense can lead to very exciting investigations and discoveries based upon local rock materials readily found within any neighbourhood. The sequential approach enables the children to understand some of the fundamental concepts upon which modern geological thinking is based. The programme will be transmitted on BBC2 as follows:-

February 10 (11.00-11.20); 12 (14.40-15.00) 1986
repeated February 17 (11.00-11.20); 19 (14.40-15.00) 1986
Discussions have already taken place with Dr. Timms (Geological Museum) about the possibility of promoting a teachers’ seminar before the transmission and to hold follow-up in-service courses after the event. Here, there is a great opportunity for ATG members to become more involved with their primary school colleagues in helping out with such in-service courses in different parts of the country. The opportunity to become involved with this project was greatly welcomed by the Primary Group and should provide a very good teaching resource to complement the Earth-Science package published earlier by Macdonald.

Whilst Halley’s Comet may be difficult to observe, I am sure “Spaceship Earth” will be much easier to watch as it follows its ZIG-ZAG course across the television screen.

Frank Spode, Department of Environmental Studies, City of Sheffield Polytechnic, Sheffield.

HALLEY’S COMET 1985-6
Some of your questions answered

Q. 1. How do I see Halley’s Comet?
   You will see it at night only. Binoculars will help greatly. Avoid direct illumination. Keep miles away from the glow of cities at night. Choose a clear moonless night. It may take many minutes to find the comet.

Q. 2. What does Halley’s Comet look like?
   It is a small object so look carefully. It is not bright and twinkling like a star. It is a small pointed fuzzy smudge of light. If observed for long enough (more than half an hour) its position will be seen to change.

Q. 3. When and where do I see Halley’s Comet?
   It was first seen on 16 October 1982 (through the Palomar 200 - inch telescope) more than 3 years from perihelion (and over 1 600 000 000 km - 11.04 AU away; 1 Astronomical Unit = Earth - Sun distance). In 1985 - in December (1-15) look in SW. In 1986 - in January (1-13) look low in SW. See the sky map (Fig. 1).

Q. 4. When is the final chance to see Halley’s Comet?
   25 April to 15 May; look low in S for rapidly fading comet. The above are best dates.

Q. 5. Where else is it possible to see Halley’s Comet?
   From 7 November 1985, and throughout 1986, daily every 40 minutes at ‘Once in a lifetime’ at the London Planetarium.

Q. 6. How many comets are there and where do they come from?
   Hundreds are known. It is believed there may be in the outer Solar System an Oort Cloud with many millions of comets. Halley’s Comet moves in an elliptical orbit that crosses the orbits of the planets. They are drawn in by the gravitational attraction of the Sun.

Q. 7. What is a comet made of?
   An ultraviolet emission scan (12 09 85) and a radio-wave analysis (12 08 85) each confirmed the presence in the nucleus of Halley’s Comet of water (as ice). Present also (c 25%) is ‘dust’ - small particles of silicate minerals. Other substances present include hydrogen. It has been described as ‘a dirty snowball’.

Q. 8. How big are comets?
   Halley’s Comet has a nucleus estimated at 9.4 km diameter, mass of 2 x 10^17 g (including ‘dust’). Only when close to the Sun does there appear a fuzzy ‘head’ or coma and a long (millions of km) tail, both formed by the effects of solar radiation. There may be two tails - the ion tail (of gas) and a dust tail. It is estimated that the comet during its current orbit approaching the Sun is losing 25 -100 000 tonnes of mass daily. The trail always points away from the Sun.

Q. 9. How far is Halley’s Comet from Earth?
   Halley’s Comet will have been at its nearest point (perigee) on 11 April 1986 (63 000 000 km). It will have been at perihelion (nearest point on its orbit to the Sun) on 9 February 1986 (89 000 000 km). At its furthest from Earth (beyond the orbit of Neptune) it is about 5 300 000 000 km away. It is believed the comet in AD 837 may have approached as close to Earth as about 6 000 000 km. Estimated distances of other comets include: Comet Lexell (1770) at about 2 200 000 km the nearest (the Moon is about 390 000 km away); Comet IRAS-Araki-Alcock in 1983 was 4 500 000 km away.

Q. 10. What is the velocity of a comet?
   Halley’s Comet moves at speeds of more than 190 000 kph (the velocity varies). Because of its great distance from us it appears hardly to move. As the Giotto space probe approached the comet their relative velocity will have been 68 kps.

Fig. 1 Sky map for December 1985, January 1986. This sky map covers both months, but at different times. In December it applies at 8pm. The comet should be visible in binoculars near Pegasus. In January the map is for 6pm, when the comet is brighter, but lower down. Moonlight interferes after the dates shown. (from National Astronomy Week).
Further explanations

1. Comets and Meteors

Meteors are swarms of dust particles in the orbits of comets. Two showers of meteors from Halley's Comet orbit occur annually when Earth enters the comet track (see Table 1); other comets create other meteor 'swarms'. Meteors become visible when they enter the Earth's atmosphere at speed and burn up (by friction).

<table>
<thead>
<tr>
<th>NAME</th>
<th>PEAK DATE</th>
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<tbody>
<tr>
<td>Eta Aquarid</td>
<td>4 May *</td>
</tr>
<tr>
<td>Perseid</td>
<td>13 Aug</td>
</tr>
<tr>
<td>Orionid</td>
<td>20 Oct</td>
</tr>
<tr>
<td>Leonid</td>
<td>17 Nov</td>
</tr>
<tr>
<td>Geminid</td>
<td>13 Dec</td>
</tr>
</tbody>
</table>

Table 1. Some Annual Meteor Showers (Reddy F. 1985)

2. Comets and collisions

Comets may have impacted onto the surface of the Moon; some of its craters may have this origin. Mars too may have experienced cometary collisions. It is believed that Earth may suffer such 'hits' once every few million years. The Tunguska event of 30 June 1908 may have been the impact of a fragment of Comet Encke onto an area of NE Siberia.

3. The age of a comet

Halley's Comet becomes visible every 76 years. It is estimated that it was 'captured' into its orbit about 76 x 2.300 years ago. It may be the age of the Solar System - about 4.5 x 10 years. It may orbit another 2 300 times (see Table 2).

4. Probes to Halley's Comet

VEGA; USSR - France, December 1984, twin probes, VEGA 1 closest - about 10 000 km - on 8 March 1986, VEGA 2 closest on 15 March 1986 (landing probes to Venus were launched from orbit in mid-June 1985).

GIOTTO; ESA (European Space Agency), July 1985, closest - 500 km - on 13 March 1986 passing at c68 kps (Dust in cometary coma likely to cause damage long before nearest approach).

SAKIGAKE (PIONEER): Japan, 8 January 1985, closest c 7 000 000 km

PLANET A - SUISEI: Japan, 19 August 1985. closest > 40 000 km - on 8 March 1986

ICE (International Comet Explorer): NASA, August 1978, flyby past Comet Giacobini - Zinner 11 September 1985, distant monitoring of Halley. The Challenger shuttle will also photograph the comet from space.

5. Halley's Comet

Named for Edmond Halley (1656-1742) - Astronomer Royal from 1720, who calculated that the comet of 1682 would return in 1759 (after his death). His prediction was correct and the comet was named. (See Table 2).

Table 2 Appearances of Halley's Comet

<table>
<thead>
<tr>
<th>Year</th>
<th>Date</th>
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<th>Date</th>
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<tbody>
<tr>
<td>BC</td>
<td>912</td>
<td>989</td>
<td>1066</td>
</tr>
<tr>
<td>239</td>
<td>30 Mar</td>
<td>5 Oct</td>
<td>23 Mar</td>
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<tr>
<td>163</td>
<td>2 Aug</td>
<td>11</td>
<td>5 Oct</td>
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<td>AD</td>
<td>1222</td>
<td>1 Oct</td>
<td>1301</td>
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<tr>
<td>66</td>
<td>26 Jan</td>
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<td>25 Sep</td>
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</tr>
<tr>
<td>837</td>
<td>27 Feb</td>
<td>986</td>
<td>9 Feb</td>
</tr>
</tbody>
</table>

Table 2 Appearances of Halley's Comet

End Pieces

"Of all the comets in the sky
There's none like Comet Halley
We see it with the naked eye
And periodically"

Turner, H. H. 1910

"Of all the comets in the sky
There's none like Comet Halley
We see it with the naked eye
But this time rather poorly"

Mason, J. 1985
References and Exhibits

Some recent books about comets

ARNOLD H D, 1985, Photographing Halley’s Comet, £1.75
BAILEY M, 1985, Halley’s Comet, £1.50
DOHERTY P, 1985, The arrival of Halley’s Comet, £4.95
HENBEST N, 1985, Halley’s Comet, A New Scientist Guide, £2.25
LANCASTER-BROWN P, 1985, Halley and his Comet, £10
MUIRDEN J, 1985, Observer’s Guide to Halley’s Comet, £2.95
REDDY F, 1985, Halley’s Comet, £7.95

AGE RELATIONS OF MAJOR AND MINOR FEATURES OF THE DONEGAL GRANITE

Adjacent to this piece is a schematic diagram, independent of scale, showing the various dykes and veins which cut the Donegal Granite.

Instructions

List in order all the geological events which are depicted in the diagram.

Reference


Mike Tuke, Department of Science, Cambridgeshire College of Arts and Technology, East Road, Cambridge, CB1 1PT.
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MNEMONICS FOR THE ORDER OF THE PLANETS & MOHS’ SCALE

As if to emphasise that his exchange teaching work in the USA did have some use (his words not mine - Editor), John Macadam sends us the following mnemonics in response to my request of March 1982; one picked up from NASA of all places! Does any member wish to add to these?

The Planets

My Very Energetic Mother Just Served Us Nine Pizzaspies.

Mohs’ Scale

A Tall Girl Called Flossie Appreciated Fellows Queueing To Cha-Cha-Cha Divinely.

John Macadam, Geology Department, Bodmin School, Bodmin, Cornwall.

A COMPUTER PROGRAM TO SIMULATE RIPPLE MIGRATION

Introduction

The computer program described below is for use with the 48k Sinclair Spectrum. The program illustrates how cross-stratification of different types is built up by the migration of ripples and dunes. As machine-specific graphics subroutines are contained within the program it would be difficult, although not impossible, to transfer it to other computers.

The background

The factors controlling ripple migration and the development of cross-stratification have been examined by many workers (e.g. Allen, 1971, 1982; Ashley et al, 1982; Harms et al, 1982). It has been shown that the factors include:

1. the characteristics of the ripple bedform, which are both time and space dependent. These characteristics are related to the properties of the current producing the bedforms and the grain size of the sediments;

2. the strength of the driving current which in turn controls the rate of bedload transport and the speed of ripple progress downcurrent. The current velocity also controls the amount of suspended sediment fallout allowed to settle onto the rippleform. This is especially important in the development of draped lamination (Ashley et al, 1982);

3. the overall rate of bed aggradation (i.e. the rate of sediment deposition relative to the rate of bed erosion).

In this simulation the rippleform characters (e.g. the ripple height and wavelength) are kept constant so as to simplify the analysis of cross-stratification development.

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In the program the development of erosional-stoss and depositional-stoss cross-stratification are related to the strength of the driving current, the rapidity of ripple movement, the rate of bedload supply, and the net rate of bed aggradation. The formation of draped lamination is linked to the relative immobility of ripples in the downcurrent direction, and the increased importance of suspended sediment fallout owing to a reduced current velocity and the concomitant decrease in bedload transport rate.

DEFINITIONS

| S | Stoss slope |
| C | Crest       |
| L | Lee slope   |
| T | Trough      |
| W | Wavelength  |
| H | Height      |
| RI | Ripple index (W/H) |
| RS | Ripple symmetry index (S/L) |

The program

After a short loading-screen program, called “Ripples”, the main simulation program starts by outlining a series of definitions (Fig. 1). This is followed by an animated introduction to the processes by which sediment may be added to the rippleform (Fig. 2).

a) VERTICAL SETTLING

b) HORIZONTAL INFLUX

Using variations in the controls outlined above, most of the program is concerned with illustrating the development of three different types of cross-stratification. Each one of the following is traced through a series of four time intervals to show the migration of the rippleforms and the resulting build up of the cross-stratification or cross-lamination:

1. draped, in-phase or rippleform ripple lamination (Fig. 3)
2. depositional-stoss or ripple-drift cross-lamination (Fig. 3)
3. erosional-stoss cross-lamination (Fig. 3).

At the termination of each example the factors controlling the development of that particular type of cross-stratification are outlined. A summary diagram (Fig. 3) is then drawn up of all the cross-stratification types considered in the program.

The final part of the program outlines the factors important in controlling the migration of ripples and the character of the cross-stratification generated.

Comments on the program

The program auto-runs after loading and the speed of execution of the simulation is determined by the user as numerous “pause points” are built into the program. This allows discussion periods to be interspersed with the material generated by the program. At many points in the program the user is offered the option of obtaining a hard copy printout of the screen contents. This option uses the “COPY” command of Spectrum Basic and so is usable with any ZX-compatible printer.

The simulation would be of greatest help and interest to sixth form students and first year undergraduates studying geology.

Copies of the program are available on request from the author at the address given below. A blank cassette tape should be enclosed with any request. Alternatively a listing may be obtained from the author.

References


Dr. P. J. C. Sutcliffe, School of Geological Sciences, Kingston Polytechnic, Penrhyn Road, Kingston upon Thames, Surrey, KT1 2EE.
FIELDWORK

HOW SHOULD WE ASSESS FIELDWORK IN THE NEW GCSE GEOLOGY EXAMINATION?

In this article Bill Groves, now a deputy headmaster but formerly a distinguished geology teacher and a survivor of many years of heated discussion in the subject and preparatory committees of JMB, puts his head above the parapet and risks, at this politically fraught period, being instantly shot to pieces for implicitly favouring the compulsory internal assessment of fieldwork. In so doing he introduces, with permission, some of the draft proposals of the Northern Examining Association and the Southern Examining Group in order that they may be widely discussed by members of ATG.

Introduction

One of the major features of the proposed GCSE examination is that at least 20% of the total marks should be given over to the assessment of experimental and other practical skills and abilities. The consortia of GCE and CSE boards are now putting together syllabuses, either in a draft form with a view to the first GCSE examinations in 1988, or as a Joint GCE O-level/CSE examination for 1987, which will presumably become the basis of the GCSE examination. The syllabus development groups that have prepared these documents consist of geology teachers who are in most cases experienced in examining at either CSE or Ordinary level. Many of them will hopefully be members of ATG. The indications so far are that the assessment of fieldwork will form a major part of the experimental and practical component. There is so much expertise and experience in our association with regard to teaching our subject in the field, and recognising our students' abilities, that it would be useful if some exchange of ideas could take place through the medium of this Journal.

Problems involved in the assessment of fieldwork

When I have mentioned assessing fieldwork skills to teachers of geology from comprehensive schools, the first, and quite understandable, reaction is one of trepidation. To take 15 or 20 pupils out to a local site of geological interest, to demonstrate and teach is one thing, but to allow the pupils to develop their own ideas, and to assess the skills shown by individuals, would pose problems of safety and control in what is often a dangerous environment. A pupil teacher ratio of 1 to 8 might be a reasonable one. Other problems, such as the difficulty of getting time for fieldwork in some schools, the lack of equipment and transport in others, lead many of us to be pessimistic about the practical component of GCSE. The time required for in-service training of teachers is an additional problem, not to mention the very tight schedule which puts the timing of the whole examination in question. However, whatever our views on the advent of GCSE might be, as geology teachers we should recognise that it has enabled groups of us to spend many hours discussing and putting together proposals for the content of new geology syllabuses in the 14 to 16 age range. Indeed, there can never have been so much discussion in syllabus development groups concerning our subject and the fruits of these discussions are now being published. Whether they lead to a GCSE examination in 1988 or not should not be uppermost in our mind at this moment; our professional associations can represent us on that point. What must concern us is how our subject is taught and examined in schools, and this we can influence both as an association and as individuals. We would be very foolish not to take up this opportunity.

Fieldwork is but a small part of the proposed syllabuses, but none of us would deny its importance in the teaching of our subject. The Northern Examining Association has produced a first draft of its proposed scheme of assessment of fieldwork. This document was circulated in the autumn of 1985 as part of NEA’s draft proposals for a GCSE geology syllabus. The Southern Examining Group’s draft was also distributed to schools during the autumn term. The two schemes could form a sound basis for further discussion.

THE SCHEMES PROPOSED BY THE NORTHERN AND SOUTHERN EXAMINING GROUPS

In the draft documents the NEA proposes that fieldwork assessment should be allocated 20% of the overall marks for GCSE Geology, the Southern Examining Group (SEG) proposes a weighting of 10%. In each case the assessment is to be carried out by the teacher; in the case of the NEA the assessment will then be externally moderated by a study of the pupils' fieldwork notebooks.

The Northern Group provides five (although one could view them as nine) aspects of fieldwork, whereas the Southern Group gives seven aspects. Both are as detailed below.

Allocation of marks within the NEA scheme

"The fieldwork of each candidate entered for GCSE Geology is to be assessed in the following areas of assessment, which will have the allocations of marks indicated.

A. Attitudes to fieldwork and safety: 0-5 marks.
B. Ability to work methodically and to organise work: 0-5 marks.
C. Ability to observe accurately and in a disciplined way and to propose further investigations: 0-10 marks.
D. Ability to use relevant tools and instruments and to measure in a quantitative way: 0-5 marks.
E. Ability to record information in field notebook (0-25):
   (1) Location of sites: 0-5 marks
   (2) Visual material: 0-5 marks
   (3) Recording and explanation of measurements: 0-5 marks
   (4) Description of a particular feature or features: 0-5 marks
   (5) Use of geological terms and general communication: 0-5 marks

Total mark for assessment of fieldwork: 50 marks."

135
Allocation of marks within the SEG scheme

“Seven aspects of fieldwork are to be assessed (the % weighting of each section is shown).

1. Observation of Geological Phenomena 20%
2. Record Geological Phenomena in an accurate and methodical way 20%
3. Perform Practical Techniques 10%
4. Recognise Specimens, Structures and Features 15%
5. Interpret the Observations made 15%
6. Develop appropriate Attitudes to Fieldwork 10%
7. Summarise work done in the field 10%

Each of the seven aspects is to be assessed on a four-point scale, a-d. The Criteria for Assessment are described in the notes that follow this introduction. The scale a-d in no way reflects the final grading of the examination.”

Possible fieldwork exercises

The NEA provides examples of the type of work which could be undertaken for fieldwork assessment:

“Candidates are to be assessed on their ability to describe and investigate specific features of geological interest at certain field locations. In detail the specific features to be described and investigated will vary according to the field locality. Examples of the type of exercise which can be assessed within the fieldwork component are given below; it is intended that the list of exercises be neither restrictive or exhaustive.

(a) Description of a sedimentary sequence in terms of thickness, dip and strike; description of the sediments in terms of grain size, grain shape and sorting.
(b) Description of sedimentary structures, e.g. ripples, current bedding, graded bedding.
(c) Finding and describing well-preserved fossils and drawing labelled diagrams.
(d) Describing the structure of a fold or a folded sequence of beds and measuring dips of limbs and strike of the axial plane.
(e) Describing a fault and measuring its throw (if possible) and the strike and dip of the fault plane; describing and measuring any related features, e.g. fault breccia.
(f) Describing and measuring the strike of joint planes. Recording a number of joint directions and plotting the information on a chart or base map.
(g) Describing and measuring cleavage planes and comparing them with axial planes of folds.
(h) Describing mineral veins and measuring their width, strike and dip. Identifying minerals in the field using simple tests (hardness, cleavage, colour, habit, reaction with acid, approximate relative density).
(i) Describing igneous rock types in terms of minerals, crystal size, shape of intrusion or extrusion. Describing simple textures included in the subject content of the syllabus.
(j) Describing igneous bodies (lava flows, sills, dykes) and measuring their thickness and dip. Describing how they were identified.
(k) Describing an igneous contact and measuring the width of marginal zones.
(l) Describing metamorphic rocks in terms of the minerals and structures included in the subject content of the syllabus.
(m) Describing the effect of geology on the scenery by associating rock outcrops with a broad annotated field sketch.
(n) Describing a small area where the natural resources of the crust are being or have been exploited, in terms of methods, uses of materials and social, economic and environmental considerations.”

The criteria upon which assessment is to be based

The two schemes differ quite considerably in their proposed methods of assessment. At a very basic level the NEA proposals involve a weighting for each specific area on a numerical scale from 1-5 or, in the area of observation, 1-10, whilst the SEG’s proposals require assessment on a four-point scale from a-d.

The proposals of the Southern Examining Group

Explanation of criteria for assessment of fieldwork

1. Observation of Geological Phenomena

Skill

“This is concerned with the extent to which the candidate is able to make sensible and relevant geological observations. It is a skill which is not easily mastered without thorough field teaching and only develops with time and field exposure. Consequently the observation skills a candidate has acquired must be judged by the amount of field exposure and hence assessment will vary with the stage of the course reached. Observation ability must not be confused with the candidate’s ability to record those observations, as this forms an entirely separate part of the assessment. As such it is an extremely difficult skill to assess, because it is not tangible, but rather is assessable orally by the teacher in the field. Such dialogue will be of use to the teacher in assessing other sections as outlined below. This assessment may be seen as a cumulative skill assessed at the latest possible time, but with due regard being paid to development throughout.

Assessment

a. sees all there is to see within the limits of the syllabus covered; is alert to features of geological significance and may seize upon and question about features not directly referred to
b. sees some of the features of geological significance at an exposure, and may question features directly referred to.

c. relies on seeing what he/she is directed to see, but once aware of the geological feature is able to carry out further observations independently; is able to transpose the concept beyond the immediate location.

d. relies on seeing what is pointed out; prefers to draw on the observations of others.

2. Record geological phenomena in an accurate and methodical way

Skill

This is concerned with the ability of the candidate to record geological information in a variety of forms, to the extent that an independent observer would be able, using the notation, to visit the location and identify those phenomena recorded.

The skill of recording relates to the selection and inclusion of items to fully illustrate the geology of the area under study, and the completeness of the presentation related to each phenomenon recorded. Recording may be in the form of annotated field sketches, written notes etc., appropriate to the feature being recorded, and should include reference to scale, location, orientation, etc., sufficient to allow it to be revisited and identified. Clarity, accuracy and a methodical analysis of the location are to be encouraged in the assessment but this must not be confused with artistic ability which is not part of the assessment.

The Examiners are aware that the field notebook is the physical expression of a number of elements which are not otherwise directly assessable, and therefore care must be taken to assess only the elements required above in this section.

Assessment

a. depicts information observed at each location methodically to provide a complete record of the site as is possible within the bounds of experience and instrumentation available.

b. provides a competent record of each site, documenting most of the data available in a methodical way.

c. the record provided for each site is incomplete, and that present shows evidence of mechanical need rather than geological significance; insufficient to enable the site to be identified independently.

d. shows limited ability at selection, clarity, accuracy and methodical analysis.

3. Perform practical techniques

Skill

This is concerned with the ability of the candidate to select and carry out basic geological field techniques. Such techniques are often limited due to a restricted range of instrumentation available to individual centres. Hence it is not possible to be too prescriptive as to what constitutes ‘basic’ geological techniques, but the following are suggested as an acceptable minimum:

1. familiarity with, and application of, a hand lens, a simple clinometer, directional compass and measuring tape.

2. safe, sensible conservation-minded use of a geological hammer.

It is obvious that some Centres will have much more available than this bare minimum and the Examiners would not wish in this case to limit the scope or initiative of such Centres, thus the assessment is not based on the quality of the instrumentation available, but on its geological applicability to field study in the hands of the candidates. Thus this section of assessment again relies in dialogue in order that the assessor is aware of why a technique is being applied rather than its mechanical application.

Assessment

a. is able to recognise the need for, and to apply, appropriate field techniques without guidance, and independently recognises the limits of the method, both in terms of instrumentation and operator.

b. selects and applies appropriate field techniques.

c. carries out field techniques in a mechanical fashion.

d. carries out the basic geological techniques with continuous guidance.

4. Recognise specimens, structures and features

Skill

This is the ability of the candidate to apply theoretical knowledge gained through classroom and/or field teaching to the recognition of discrete phenomena encountered in the field, i.e. a mineral specimen, a fault, etc., and to make a tentative conclusion based on first-hand evidence.

Field classifications for various phenomena are available and if use is made of these then some reference to them should be included in the field notebook together with the evidence available and the conclusions reached.

Care should be taken here not to confuse recognition with observation and interpretation which is to be assessed elsewhere.

Assessment

a. is able to recognise discrete phenomena in the field on the basis of the first-hand evidence submitted (this will demonstrate competence in observation, techniques and a three-dimensional view of the phenomenon).

b. able to recognise discrete phenomena but may require a little guidance in forming a conclusion.

c. needs considerable help and guidance to reach a conclusion.

d. relies completely on others to recognise phenomena.

5. Interpret the observations made

Skill

This is concerned with the ability of the candidate to synthesise the acquired information, and by inference to
suggest an acceptable interpretation of that information for the location or area under study. The basis for that interpretation should be in the field of 'the present is the key to the past', and should include reference to contemporary processes, and the relationship between those processes, topography and geology, thus linking the concepts of time and space within such interpretations.

Such interpretations by necessity draw upon theoretical knowledge of the subject and thus the level to which such interpretations can reach will be determined by the stage reached in the theoretical part of the course. Any assessment must take account of this.

**Assessment**

a. is able to relate his/her knowledge and understanding of basic geological concepts to the data gathered. He/she is able to suggest acceptable, though not necessarily correct, explanations on the basis of information gathered

b. requires limited stimuli in order to seed the basis for an acceptable explanation, but reaches a conclusion independently

c. requires guidance with each step in attempting to formulate a conclusion which would not otherwise be reached

d. is rarely able or willing to relate theory to the field data, and is therefore unable to offer an acceptable conclusion in spite of assistance

6. Develop appropriate attitudes toward fieldwork

**Skill**

This section is concerned with the development of a positive attitude to the subject, and in particular the field-based element of the subject, over the one or two year period of geological study. It is designed to encourage those candidates with an interest and enthusiasm for the work, rather than just following the course.

The intention is to encourage the candidate to work both independently, and as a member of a team; to work methodically through self-discipline; to become involved in planning, discussion and questioning; to be aware of the need for safety and to appreciate the value of the environment in which such work is taking place.

Attitudes and values being assessed here can change markedly over the duration of such a course, as candidates become aware of what the subject has to offer, and so assessment here is intended to be cumulative and not based on a single event.

**Assessment**

a. displays a positive attitude toward the environment, develops self-discipline and is willing to become involved, to learn, to listen and to act upon advice given

b. develops a positive attitude over the period of the course

c. interest and enthusiasm is largely mechanical

d. does fieldwork with reluctance and shows little concern for the environment

7. Summarise work done in the field

**Skill**

This section refers specifically to the follow-up work carried out in connection with the field investigations. It is the ability to understand the purpose of the fieldwork, together with the ability to tie together in summary form the work done, and to suggest other sources whereby the independent observer may be able to follow-up the area.

The summary should cover the objectives that were the basis of the field study and the extent to which those objectives were realised. It should contain a summary of the work covered together with any supplementary reports based, for example, on annotated photographs taken during the field study or laboratory work. Finally it should contain reference to other work published about the area, possibly in the form of a bibliography.

This section should not end up as a lengthy tome if care is taken to emphasise the weighting given to this section of the assessment, thereby pointing out to the candidates the importance of this compared with each of the other sections.

**Assessment**

a. produces a summary which indicates an understanding of the objectives for fieldwork; and a thorough resume of the available literature for subsequent follow-up work

b. produces an acceptable summary of the work covered and a basis for further study

c. produces a purely mechanical summary lacking in understanding, depth and detail

d. produces a summary which is little more than a list of contents”

**The proposals of the Northern Examining Association**

"In awarding marks for candidates’ fieldwork in each of the five areas of assessment listed… above, the teacher must apply the detailed marking scheme given below. The marking scheme gives a description of what a candidate must achieve in order to be awarded a given mark in each of the areas of assessment.

**A. Attitudes to fieldwork and safety (maximum 5 marks)**

5 marks: The candidate is always aware of the safety aspects of fieldwork and behaves in a responsible manner. S/he makes every effort to protect the environment and tries to avoid disturbing wildlife, damaging walls and fences, or interfering with equipment. S/he actively appreciates the importance of conservation while on geological sites, by using the hammer only when necessary and by collecting only from loose material.

4 marks: The candidate is aware of the attitudes and behaviour described above and generally works well, but at times can be distracted or can be thoughtless of the needs of others or of the environment. S/he follows instructions.
The candidate follows instructions and, although s/he does nothing that is dangerous or damaging, there is no highly-developed commitment or enthusiasm for practical work.

The candidate has a careless approach to fieldwork; although s/he is aware of the safety precautions and the need to protect the environment, s/he often chooses to ignore them. The candidate must be reminded frequently of how to behave and what to do. S/he has little respect for the geological environment.

The candidate is easily distracted and can be actively disruptive. S/he shows little sympathy for the environment and lets others do the work for him/her. At times the candidate can be a hazard to others.

The candidate does not take an active part in fieldwork on safety grounds.

Ability to work methodically and to organise work (maximum 5 marks)

The candidate requires no guidance in the field as to what has to be measured and observed. S/he records information in a logical way. S/he chooses the correct position for drawing field sketches. S/he always remembers to bring into the field the necessary equipment (i.e. the equipment which the teacher has instructed the candidate to bring). The candidate is able to allot the correct amount of time required for the completion of various tasks.

Although little guidance in the field is required, the candidate fails to cover and record all features with equal emphasis.

The candidate requires guidance and help in organising the sequence of procedures and in recording measurements; under guidance, however, the result is satisfactory.

The candidate must be guided constantly in order to achieve any useful results. The candidate often has to borrow writing or other equipment.

Even with guidance, the candidate cannot produce useful work. Results are not recorded or the candidate attempts to copy the material of others. The candidate rarely has all the necessary equipment.

The candidate will not try to organise work in the field. S/he has no equipment or field notebook.

Ability to observe accurately and in a disciplined way and to propose further observations (maximum 10 marks)

In the field the candidate quickly recognises the features of geological interest. S/he can point out and question unexpected features even though the significance of the find may not be known. S/he can propose where further observations might take place in order to test the validity of conclusions drawn. The candidate is able not only to recognise small-scale features of interest but also to comment accordingly upon the overall structure.

The candidate achieves a high standard of observation and can propose where further observations might take place; however s/he does not quite reach the perfection required for the award of 10 marks.

Observation is of a high standard and, although small-scale features are recognised, s/he often has difficulty in appreciating the overall structure. S/he can propose where further observations might take place in order to test the validity of conclusions drawn, but often after discussion with others rather than by personal initiative.

Observation is generally sound but is usually restricted to a particular, outstanding feature or features. S/he is capable at times of trying to confirm conclusions by means of further observations.

Observation is generally sound but is usually restricted to a particular outstanding feature or features; it is sometimes necessary for the candidate to be told what to look for. Only rarely is the candidate able to propose further observations in order to test the validity of conclusions drawn.

Although it is often necessary to tell the candidate where to look, s/he can recognise prominent features. In order to see detail, s/he must be told what to look for. Smaller, more subtle features are often missed.

When the candidate is told where to look and what to look for, s/he will recognise prominent features in most cases but normally fails to recognise detail. S/he is unlikely to propose any further observations to test the validity of conclusions drawn.

Even when told where to look, the candidate will normally miss the significance of many features. Once specific pieces of evidence have been pointed out, s/he can find other similar features but is unlikely to know how to test the validity of conclusions by further observation.

The candidate will see major features if they are pointed out in detail. Occasionally s/he can find similar features but does not know how to test the validity of conclusions by further observations.

The candidate often does not see features, even when they are pointed out. When the candidate does see evidence, s/he is unable to relate it to other features.

The candidate refuses to look.

Ability to use relevant tools and instruments and to measure in a quantitative way (maximum 5 marks)

Relevant tools are: hammer, chisel, hand lens, tape, clinometer and compass.

The candidate can use all equipment safely whi-
out guidance; all measurements are accurate. The candidate understands and can measure true dip, strike and true thickness.

4 marks: The candidate can use most of the relevant tools correctly but has difficulty in recognising true as opposed to apparent dip and in measuring strike.

3 marks: Although the candidate can use the hammer correctly, the hand lens and chisel often are not used when they should be. The candidate always needs guidance to complete accurate measurements with compass and clinometer but can use the tape accurately without guidance.

2 marks: The candidate can use the hammer with reasonable safety and effect. The distinction between true and apparent dip is not recognised and guidance is sometimes needed when true thickness is being measured.

1 mark: The candidate uses the hammer, but often in an indiscriminate and reckless way. S/she finds it difficult to use the tape accurately and cannot recognise true thickness.

0 mark: The candidate has not used any equipment for safety reasons or has refused to use any equipment.

E. Ability to record information in field notebook (maximum 25 marks)

(a) The field notebook should be written by the pupil in the field; it must not be a classroom-based project. The notebook may be improved subsequently. Any follow-up material which is included in the notebook when it is submitted to the teacher for assessment must be based on the fieldwork, e.g. annotated photographs and written interpretive accounts of the fieldwork. Credit must not be given for work which is not directly related to the fieldwork, e.g. material copied from published sources, or classroom essays, sketches and diagrams. Although pupils may have used duplicated hand-outs as help in compiling their notebooks or in carrying out fieldwork, such material should not be included in the notebook. Where, however, the teacher has prepared a base map or diagram for the pupils to complete in a complicated field area, the completed map, diagram etc. may be included in the notebook. Examples of such base material completed by the pupils are as follows:

(i) a base map for an awkwardly-shaped quarry on which pupils have plotted joint directions;

(ii) an outline of a large quarry face with a few prominent features marked, on which pupils have illustrated other features on the quarry face;

(iii) the outline of a complicated field sketch which pupils have annotated.

(b) Essential features of the field notebook are as follows.

(i) The record for each locality must be prefaced by a precise geographical location or a grid reference. Man-made sites must be fully explained in terms of social, economic and environmental considerations.

(ii) Visual material must be illustrated by a field sketch which must be clearly annotated to record important points and must contain scale, location and orientation.

(iii) Measurements must be recorded clearly and accurately in a form that is readily understood. Explanations of the purpose of such measurements should be clear.

(iv) The notebook must contain descriptions of specific features of geological interest at certain field locations.

(v) The pupil must use geological terminology and bring field exercises to a logical conclusion. The reader must be able to understand the text.

(c) The field notebook should be assessed on a six-point scale in each of the following areas of assessment.

(1) Location of sites

5 marks: All localities are clearly identified geographically by either name or map reference. Positions of adjacent, related localities are illustrated by sketch maps. If a locality is man-made, the reason for its position and any social, economic and environmental implications are fully explained.

4 marks: Sites generally are accurately located although some detail is missing.

3 marks: The candidate is not always accurate in locating sites and sometimes localities merge into each other. Although there is some reference to the social, economic and environmental implications of a site's position, they are not fully explained.

2 marks: The information about localities is sometimes misleading with mistaken names and/or incorrect map references.

1 mark: Some localities are not identified, often being introduced by vague statements such as “in the next quarry”. The social, economic and environmental implications of a site’s position are rarely, if ever, mentioned.

0 mark: None of the localities are identified.

(2) Visual material

5 marks: Visual material and field sketches are varied and well-annotated and contain scale, location and orientation.

4 marks: Generally the visual material is good although lacking in scale, location and/or orientation.

3 marks: Visual material is adequate but the candidate had to be prompted to draw some sketches; accuracy was often lacking.

2 marks: Many field sketches are missing or incomplete, although the candidate has some useful illustrative material.

1 mark: The candidate has made some attempt to produce illustrative material but the standard of it is poor.

0 mark: Illustrative material is missing or of such low standard that it is useless in explaining geological features.
(3) Recording and explanation of measurements

5 marks: Measurements are recorded clearly and accurately in a table or a chart. The purpose of such recordings is made quite clear.

4 marks: Measurements are recorded clearly and the applications are generally understood, but overall the standard of work is below that required for 5 marks.

3 marks: Measurements can be understood but greater clarity would help. The candidate is not always clear about the purpose of the measurements.

2 marks: Some measurements are very difficult to interpret. Some information is missing or inaccurate.

1 mark: The candidate has recorded some measurements but there is little evidence that their relevance is understood. Lack of clarity makes it difficult for the reader to understand them without oral explanation from the candidate.

0 mark: The only measurements recorded (if there are any) seem to bear no relation to anything else in the field notebook.

(4) Description of a particular feature or features

5 marks: Each description is clear and accurate with sketches or diagrams clearly related to the text. Measurements are recorded clearly. Each description as a whole indicates that the candidate has understood the significance of the geological feature concerned.

4 marks: Each description is good but, because it can be adversely criticised for its lack of clarity or understanding, cannot be awarded 5 marks.

3 marks: Parts of the description(s) are good while others are less clear. The candidate seems to have understood what the general aim was but has not coped with all the detail.

2 marks: Some of the description is missing or obviously not understood, but there is some reasonable work present.

1 mark: Description generally is poor and may be unfinished although the candidate shows some understanding of what s/he is trying to do.

0 mark: The description contains no useful geological information.

(5) Use of geological terms and communication

5 marks: Geological terminology is used freely and generally correctly; information is communicated accurately by means of the notebook.

4 marks: Geological terminology is used and most descriptions are drawn to a logical conclusion.

3 marks: Geological terminology, although used, is often mis-spelt or inaccurate. Some exercises are not brought to a logical conclusion.

2 marks: The candidate has avoided geological terminology wherever possible. The standard of written communication is such that the reader sometimes has difficulty in understanding what the candidate is trying to say.

1 mark: Virtually no geological terminology is used and some parts of the notebook cannot be understood.

0 mark: No part of the notebook can be understood.

The standards applied in the assessment of the fieldwork must be those which would apply at the end of the GCSE Geology course in an end-of-course examination, irrespective of when the fieldwork is assessed."

Are there other, equally valid ways of assessing fieldwork?

The two schemes detailed here are not the only ones available. The Midland Examining Group syllabus for the joint O-level/CSE examination of 1987, for example, also contains a detailed assessment scheme for fieldwork and follow-up/laboratory work. Many of us are already using systems of assessment for O-level and for CSE work. The differences between the various schemes immediately raise questions of emphasis:

* Should we assess the candidate in the field or through the field notebook?
* Should practical work be assessed beyond the traditional practical examination?
* Should we assess particular fieldwork skills or use a more subjective ‘global’ impression of a candidate’s abilities, attitudes and imagination?
* Why assess fieldwork at all?

We can, hopefully, respond to these syllabuses and proposals not only as individuals to the examination boards concerned but also through our journal, so that ATG Council has the benefit of our views when it needs to comment on these major syllabus developments.

W. Groves, Deputy Headmaster, The High Arcal School, High Arcal Drive, Sedgley, Dudley, West Midlands, DY3 1BP.

UNIVERSITY OF ABERDEEN
Residential Course 3rd - 9th May 1986
in Golspie, Sutherland
on
"The Geology of Northern Scotland"
Tutor: Dr. C. Gillen
Details from: D. Omand, Dept. of Adult Education & Extra-Mural Studies, Braal, Halkirk, Caithness KW12 6XE

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BATH STONE


This welcome slide pack illustrates the history and use of Bath Stone as building material from Ralph Allen onwards. He, by good marketing, so developed the use of Bath Stone from 1727. Views of Allen, his railway and mansion (built to advertise the potential of the stone) and the use of the stone in Georgian Bath, are all included. The further development of Bath Stone following the revolutions in canal (1810) and railway (1840s) systems are also well covered. The inclined planes then built to serve the new canal connections are shown on a map, but this does not take into account more recent scholarship like Pollard’s study of 1983 (Bristol Ind. Arch. Soc. Journal, 15, 13-19) which documents the Kingham Railway and Inclined Plane built by William Smith, the geologist, between 1810-12. Indeed this feature is not shown on the map.

Methods of working the stone underground and its transport to the surface right to the present time are also well covered in a series of evocative illustrations. One or two slides, however, could have been better focussed in the original or been better copied. Some local buildings in the Bath area made of Bath Stone or rubble are also included. This latter occurrence highlights the fact that Bath Stone was more widely used than is noted here, being much utilized in Bristol and farther afield.

If the descriptive notes could have been on occasion a little more detailed or scholarly, the slides are well produced in a stout folder, and the whole is recommended to all interested in Bath Stone and its long history. A museum is now being created from one of the major mines at Corsham which is also recommended to ATG members. Details are available from David Pollard, Director of Bath Stone Quarry Museum Trust, 1 High Street, Seend, Wilts.

Hugh Torrens, Geology Department, University of Keele, Staffs., ST5 5BG.

THE GEOLOGICAL COLUMN LEAFLET
MANCHESTER MUSEUM

Dr. R. M. C. (‘Michael’) Eagar of Manchester Museum has written to the Association to explain that a new sixth edition of this leaflet originally published in 1966, has been prepared and that it is available from the bookstall in the museum. The leaflet takes account of the fact that the Plate Tectonic hypothesis is greatly used to explain the evolution of plants and animals and the disposition of rocks of various ages throughout the geological succession preserved in the British Isles.

He writes that “as the geological sciences become more specialised I am increasingly indebted to the kindness of others for advice during the preparation of a new edition... Since it is impossible to find room for acknowledgement on the leaflet itself I ask if you will allow me to record the names of those who have been to some trouble on my account in helping me to bring the leaflet up to date for the sixth edition (1985). They are: Dr. P. Andrews, Prof. W. G. Challoner, Drs. J. W. Cowie, F. W. Dunning, D. Edwards, M. F. Giaessner, Mr. W. B. Harland, Drs. R. H. Johnson, W. S. McKerrow, S. Moorabth, R. Nicholson, C. J. Peat, J. E. Pollard, P. E. Seldon, N. J. Snelling, D. H. Tarling, Mr. D. B. Thompson, Drs. J. E. Treagus, J. Watson, R. Wooton, Prof. B. F. Windley and Prof. J. Zussman...... I am myself responsible for any errors which may be found in the leaflet.”

The leaflet has been bought in large numbers by members of the Association in the past and any enquiries for its availability and cost etc. should be made to The Manager, The Bookstall, Manchester Museum, University of Manchester, M13 9PL.

D. B. T.

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COMMENT

TOP DOWN AND BOTTOM UP

Since its inception as a separate school subject, largely in the 1950s, geology has been affected more than most subjects by syllabuses that have reflected the ethos and subdivision of studies that are common at university. This top-down approach to syllabus construction and revision has only recently been challenged as an appropriate way of providing courses for the majority of pupils who will leave school at 16. Led by the mathematicians, who have
espoused a bottom-up approach, the Cockcroft Principle has been offered for discussion.

It is not hard to see how a top-down approach has become established. In 1917-18 the matriculation boards of the universities were invited to rationalise the anarchy that had existed in the examinations field, wherein every small institution was setting its own entrance examination for school pupils. Since that year, when School Certificate and Higher School Certificate were established, the university examination boards have developed an enviable reputation for their integrity and administrative skill in developing their role with respect to the 25% most able students. Syllabus revision committees of the boards have been staffed by experienced university teachers, some of them with powerful personalities, used to getting their own way and often set in their academic and educational ways, and by a majority of school and college teachers in the mid-stream of their careers who had became successful in examination terms within the system over which they were now invited to preside. With rare exceptions, the syllabuses which they constructed at GCE O and A level reflected the subject disciplines common to university geology in the 1930s and 1940s when, in a Kuhnian sense, a period of 'normal' or 'orthodox' geological science prevailed, in which the subdisciplines were well known, and pure science was much more highly valued than applied science. It was tacitly accepted that what was good for the less than 10% of A and S level students who would go on to university was good for the 90% who would not: the selective function of assessment, for geology and for life generally, was as important as the formative educational one. By a process of 'watering down' the A level syllabus, or even allowing gross repetition between O and A level, ordinary level syllabuses were cobbled together without much educational rationale except that of gaining a paper passport of suitable standard. Often relatively mature sixth formers, forming c.33% of the candidates, took O level as a useful hurdle in going on to take A level one year later. In both O and A level syllabuses, sections of work clearly labelled mineralogy, crystallography, petrology, palaeontology, structural geology, stratigraphy etc. were to be found. Exceptions to this pattern were rare: the revised JMB O level syllabus for example was entitled 'Geology and Man' and in it an attempt was made to emphasise fieldwork, the rock cycle, a long section on resources, and man's responsibility for their wise use. There was even a section on the palaeontology of man - this being allowed only after deep heart searching over the educational opportunities - to do with the development of social skills and a personal philosophy - upon which geology might seize. Within even the most radically conceived syllabuses, however, it was possible for examiners, by their composition and selection of questions, to retain the emphases of long ago, some biases indeed being traditional to individual university departments. The relatively recent exercise to designate a less than 50% Common Core at A level merely emphasised the top-down approach, partly because the geological representatives sent by the boards were university people almost exclusively responsible for examining rather than curriculum development, partly because the lowest common denominators of existing syllabuses were inevitably sought and found. The only teacher representative was co-opted midway through the exercise. The resultant 'core' is thought by many to be nearer 80% than 50% of the whole.

With the coming of CSE in 1965 and the placing of control firmly in teachers' hands (no university personnel being allowed to sit on a committee except by invitation), the chance to fashion a totally different curriculum suited to the needs of the 99.9% middle-achieving children who would not go on to university but leave school at 15 (later 16), was nigh. In the event, the mode 1 CSE syllabuses and many mode 3 syllabuses - a mostly hidden garden of the curriculum - bear a decided resemblance to O level and A level syllabuses - or what is worse O and A level physical geography syllabuses - the latter a factor which betrays the background and interests of the teachers rather than the pupils. Perhaps this similarity was inevitable when CSE grade 1 was officially linked to the GCE grade scale and teachers of minority subjects had to make do with taking mixed-ability GCE O and CSE classes. In any case, in a stratified social system, secondary modern schools and stratified social system, secondary modern schools and their teachers had gained status by showing that they, too, could do the work normally associated with the higher level of educational endeavour; top-down was seen to work in strange but socially acceptable ways. Surely status should be gained by doing a job well at any level, and for doing it for soundly argued reasons.

A few CSE mode 3 syllabuses, and later some CEE syllabuses, took a bottom-up approach and emphasised the geology of the local area, local industry and local jobs. A few courses sought to cater for the needs of pupils and the enthusiasms of their teachers and their geological contacts, a notable example being a CEE syllabus centred on the geology of North Staffordshire composed by ATG's former treasurer. Bottom-up simulations and role-playing exercises are relatively rare in geology, however. In some areas CSE boards actively discouraged the presentation of mode 3 syllabuses, presumably because they were costly to administer and examine.

Paradoxically this general top-down fossilisation of school geology syllabuses took place at a time when university curricula were changing fairly dramatically after the geological sciences passed first through a period of incipient revolution (1945-62) and then a full Kuhnian revolution (1962-70) (see Hallam 1973), wherein the deepest beliefs, assumptions and practices of the profession were questioned and largely overthrown, sometimes only after considerable time-lag, as at Cambridge (see Muir-Wood 1985). As the Plate Tectonics Revolution ran its course, university syllabuses, illuminated by the bright shafts of the Open University, were relatively quick to respond. This was possible because in their essential elements they were 'mode 3' syllabuses, written (sometimes not even that) and assessed by the teachers in the light of local circumstances and enthusiasms, and moderated with wit and sympathetic insight by visiting external examiners. The system succeeds brilliantly whilst the samples of candidates are small. Despite showing many of the characteristics, therefore, of school syllabuses composed from the bottom-up, and despite steadily redressing the imbalance between pure and applied in many cases, the system nevertheless operates in a top-down way; the perceived needs of the top 10% - 20% high achievers who will go on to pure research are given greater priority than the 80% who plod through their degrees without showing great ability or enthusiasm for such matters.

Mention of the Open University is most apposite, for its staff were faced with new problems: how to motivate and interest customers who had long left the school system (and had often been branded failures); how to teach scientific method at a distance; c't how to package the practical elements of the course; how to teach in the open with as
many as two million viewers inspecting the results. Clearly much of what goes on behind normal classroom and laboratory doors would not bear such scrutiny. In solving their problems, they devised a system in which earth science contributed brilliantly at a very basic level to the Science Foundation Course and thereafter contained enough attractively packaged options, many involving very illuminating case studies and often of a very applied kind, to tempt customers notoriously suspect of their own abilities. This variant of the bottom-up approach has been generally judged a huge success.

Likewise Polytechnic and College of Higher Education Departments, faced with fewer resources and staff than universities, and having to subject themselves to peer review via CNAA and later the scrutiny of the National Advisory Board, sought to build courses on the most rational of educational criteria, being careful to incorporate a great many aspects of the new geology. Inevitably, in seeking parity with university courses, they were necessarily thinking top-down, but the courses are sufficiently distinctive and geared to the needs of the users - the engineering geology course at Portsmouth and many others for example - to be regarded as the products of bottom-up thinking.

Few of these relatively recent developments in Higher Education have rubbed off on board syllabuses used by schools and colleges but A level teachers often make very good use of the excellent Open University curriculum materials.

A strange contrast exists, however, in the way the various levels of these top-down systems are allowed to report their results. Universities, Polytechnics and Colleges of Higher Education always reward 95% of their protégés with at least a pass degree. Schools and colleges, however, pronounce only 70% of their A-level and 65% of their O and CSE students, a success. Clearly university teachers are better at their job and deserve their higher pay and status!

The advent of the GCSE has given geology teachers a new chance to rewrite the curriculum for the 98% who will leave school at 16 and who will not grace the portals of higher education. There is little however in the draft proposals which are now being circulated to suggest that new thinking has taken place. Apart from the WJEC proposals which are somewhat novel in places, there are copious draughts of the medicine as before. One would not believe that children are fascinated by extinct volcanoes, mines, caves, the fossil localities of their own area, by dinosaurs, earthquakes and other natural disasters seen daily on TV; that many raw materials form the basis of local industries that might provide them with lifelong jobs. One would not suspect that Plate Tectonics provides a theoretical framework of all-embracing potential; that geologists are pre-eminent the wealth producers of our industrial society, that North Sea Oil contributes £7 billion annually to the Exchequer, that raw materials contribute 20% of our industrial production, that our invisible earnings include a myriad of other services rendered by geologists.

Your editor tries to write all this during the festive season and it has been bottoms up most of the days of this week. Will it be bottom-up in geology from 1986 onwards? Will ATG’s Council and Curriculum Working Group give a lead? Will individual members, against frightening odds, muster enough energy to write their own syllabuses, suited to their own children and making the best of their own locale?

References
D. B. T.

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Contributions for the next issue of Geology teaching will be welcome, and should be sent to the Editor, D.B. Thompson, Department of Education, University of Keele, Staffs. ST5 5BG

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