Earth science conservation

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Earth science conservation is the journal of the Earth Science Division of the Nature Conservancy Council. Correspondence and comments should be addressed to Dr Des O'Halloran, The Editor, Earth Science Division, Nature Conservancy Council, Northminster House, Peterborough PE1 1UA. Telephone (0733) 40345.

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Earth science conservation – index for issues 1 to 23
Editorial

With the appearance of this issue we maintain our schedule of producing two issues of *Earth science conservation* per year. The new format adopted in the last issue has been generally welcomed by our readers, but we intend to keep up our attempts to further improve the presentation. Some readers criticised the closely-set typeface used in the text, and will, we hope, be relieved to see us adopting a less optically demanding version in this issue. We would also like to apologise for a number of mis-spellings which crept into some items included at a late stage in preparing the text, and which we failed to pick up at the proof stage. This was especially true of page 22 where, to my embarrassment as an igneous petrologist, the term igneous appeared in no less than three different spellings in the course of one line!

Turning to more serious considerations, *Earth science conservation* is, to the best of our knowledge, the only scientific journal in the world concerned solely with matters of geological conservation. As such it is a unique information source on the interface between earth science conservation on the one hand, and development and resource exploitation on the other. Hitherto it has not been easy for readers to trace the evolution of specific case histories and other recurring themes through successive back issues. This problem has become particularly acute since Issue 19 when the journal began to increase substantially in length of issues, and the inclusion of a retrospective geographical site index in Issue 21 only went some way towards addressing this difficulty. For this reason we have compiled a more complete index for Issues 1 to 23 inclusive and included it with this issue. The index is in four parts covering geographical, geological and subject areas, along with a listing of featured articles. We will update the index periodically in the future.

In this issue we report on a welcome emphasis on the geological aspects of natural history in the proposed new gallery at Peterborough Museum, as a reminder that the NCC's commitment to conservation is not confined to SSSIs and NNRs, but extends, to an increasing degree, into the wider environment. We also focus in this issue on the recurring topics of cave conservation and coastal protection, which are two difficult areas of pressure on geological conservation. Although this may not seem immediately relevant to the work of the NCC, we consider that schools are of critical importance for two reasons. Firstly, because school parties are one of the largest user groups of field localities, and secondly, because of the opportunities available in schools of influencing the attitudes of future generations to our geological heritage and the importance of conserving it for posterity.

As we go to press, plans, involving the NCC, to selectively control the encroachment of scrub over parts of Cheddar Gorge SSSI are receiving much publicity on television and in the national press. We will report on the biological and geomorphological aspects of these proposals in the October issue of this journal.

Dr Des O'Halloran
Editor
Geologist appointed as the new NCC Assistant Chief Scientist

From 1 February 1988 Dr Keith Duff has been appointed as Assistant Chief Scientist (Earth and Marine Sciences), based at the NCC’s Peterborough headquarters. The responsibilities of this post cover the earth and marine sciences together with coastal ecology, toxic chemicals and pollution. The position carries responsibility for sixteen permanent scientific staff, ten of whom are earth scientists. Responsibility for the Chief Scientist Directorate’s other principal areas of activity, the terrestrial and freshwater sciences, rests with John Blackwood, the NCC’s other Assistant Chief Scientist.

Dr Duff is the first geologist to be appointed to a senior management post in the NCC and his appointment, which is warmly welcomed by NCC staff, will be well received in geological circles.

Keith, who is 38 years of age, is an invertebrate palaeontologist with a specialist interest in the Callovian faunas of the Oxford Clay. Since joining the NCC in January 1975 he has concentrated on the safeguarding of SSSIs and the application of planning law to earth science conservation. In recognition of this work he was appointed Head of Earth Science Conservation within the NCC in September 1986. Over the years Keith has become a well-known figure in the geological community for his conservation work, and he is a member of the Conservation Committee of the Geological Society of London. Between 1978 and 1982 he was Field Meetings Secretary of the Geologist’s Association, and a Vice-President from 1982-1985. He is currently on the Editorial Board of Geology Today, is a Council member of the Institution of Geologists, and a member of both the Palaeontological Association and the Palaeontographical Society.

Following upon his promotion it is expected that there will be a number of changes in responsibilities within the Earth Science Division over the coming months, and we will report on these in the next issue of Earth science conservation.

Geological conservation emphasis at Peterborough Museum

Plans have been announced for a major new gallery featuring geology and wildlife at Peterborough Museum. The geology displays will open in June 1989 and it is hoped that the wildlife displays will be opened in 1990. The gallery will focus on aspects of the past, present and future of Peterborough’s natural environment and, by reference to local SSSIs and NNRs, will incorporate a welcome emphasis on the natural heritage of this rapidly developing area.

Hitherto there has not been a proper gallery devoted to these subjects and it is hoped that the new gallery will be an imaginative and innovative means of plugging the gap. It is designed primarily to display some of the best specimens from the museum’s natural science collections and star exhibits will be skeletons of marine reptiles collected from the local brick pits.

The scheme, which is receiving grant-aid from the NCC, is intended as the first stage in a major re-development of the entire museum which should make a significant contribution to the attractiveness of the City of Peterborough. The new gallery is being constructed on the first floor of the museum, in three adjoining rooms with a total floor area of 160m². Exhibits will be organised on a one-way through-flow layout and will be designed to facilitate maximum use by school parties. The account given below describes the main features as the visitor proceeds through the gallery.

First, the visitor passes through a small introductory lobby, where the major themes of the gallery are briefly outlined. The vast timescale of geological history and the interdependence of biology and geology are among these themes, as is the great speed of changes due to human activity as compared with other agencies.

The visitor then enters a large area designed to convey the impression that he or she is submerged under the warm, tropical sea which covered the area during the Jurassic Period of some 150 million years ago. Around the walls are mounted skeletons of some of the animals which swam in this sea. Prime amongst these is the almost complete skeleton of the Dogsthorpe plesiosaur, donated to the museum by the London Brick Company.
in 1987. Another exhibit is a five metre long crocodile, while at other points are ichthyosaurs and various forms of fishes. A further display is devoted to ammonites, specimens are available for handling and the text is also on audio tape for those with reading difficulties, associated field data. In recent years the museum staff, as it is, the marine reptiles from Peterborough brick pits all man-made, being mainly brick pits in the Oxford Clay and gravel pits in the Ice Age river gravels. Indeed, without these pits our knowledge of Peterborough geology would be incomparably poorer; therefore in the interests of science that the brick and gravel pits make the area world famous to geologists. Consequently are ill-suited to conservation by means of designation as SSSIs. Careful re-development of worked out pits is also stressed in the gallery. Dugout brickpits can be reclaimed by infilling with refuse or power station fly ash, eventually to revert to land for agriculture or other development, while old gravel pits can become valuable wildlife and recreational facilities. The concept of landscape management for maximum all-round benefit is the central message.

The excavation of the plesiosaur skeleton, referred to above, is used to illustrate modern fossil collection techniques. Photographs illustrate how the skeleton was first mapped in detail as it lay in the ground, then carefully jacketed in plaster ready for transportation. It was then taken in manageable sections to the museum where it could be worked on under ideal conditions, carefully jacketed in plaster ready for transportation. Some of the skeletons were preserved in limestone nodules, which were carefully dissolved in acetic acid at Leicester University by Mr. Alan Dawn to reveal the bones and any hard contents of the creature's stomach. The skull was preserved in soft clay, and was prepared by Dr. Arthur Cruickshank using the facilities of Leicestershire University. The visitor then takes a massive leap forward in time, and enters the Ice Age section of the gallery. Here the visitor develops a deeper understanding of the adaptations that allow the survival of species in ice-age conditions. The museum displays a range of animals, including woolly mammoths and Ice Age horses, and explains the environmental factors that led to their extinction.

Recent studies of plants and arthropods at Ice Age sites near Peterborough have revealed some interesting findings. The museum displays a model of a Palaeolithic 'hunter-gatherer' to illustrate how people lived during the Ice Age. It also includes information about the importance of water in the landscape and the profound impact on the area of post-glacial sea-level changes, together with in more recent centuries, man-made drainage. The gallery then brings the story up to the present day, and illustrates how the coastline of the Wash area has moved back and forth over the last 5,000 years. This graphically illustrates the importance of water in the landscape and the profound impact on the area of post-glacial sea-level changes, together with in more recent centuries, man-made drainage. The final area of the gallery is intended to be a flexible resource, and is fitted with space for temporary exhibitions and events. In this area a variety of conservation issues relevant to Peterborough are discussed, the emphasis being on human responsibility for the natural environment. Suggestions are made as to what the individual can do, both to conserve and to enjoy the countryside. The Ferry Meadows country park, only a few miles from the museum, is mentioned as the obvious place for people to begin their explorations. Local groups such as the Peterborough Wildlife Group can use this last part of the gallery to put on their own displays or for meetings, and it is thus hoped that the museum will act as a focus for local environmental interests.

The gallery will, upon completion, represent the efforts and financial support from many quarters. Haley Sharpe Associates are the designers for the project, and funding is by Peterborough City Council and several other bodies. The largest grant towards the project is from the NCC, and grant applications are also being considered by the Countryside Conservation and by the Geologists' Association, while the Area Museums Service for South Eastern England is grant-aiding the cost of conserving and mounting the Oxford Clay vertebrate skeletons. It is also hoped that commercial sponsors will be found to help enhance the budget.
Section 52 of the Town and Country Planning Act 1971 and the NCe. These negotiations have continued now it now seems likely that a legal agreement through many detailed issues of principle. To establish a binding agreement over the nature of the development detailed and comprehensive conditions if planning negotiations should be held between the developers planning authority, Mendip District Council, to impose survived. In 1986, the NCC were consulted over a development in principle but strongly urged the detailed comments. The NCC did not object to this known as Shatter Cave as a public show cave, as part of planning application by the quarry operators, Hobbs Holdings Limited, for the development of the passage for the public to Battlefield Chamber. As at Fairy Cave Quarry the NCC raised no objections in principle to this proposal but concern was expressed about some of the fragile formations in the chamber, including unusual layered mud floors. These could be easily damaged unless development of the chamber, including pathways, railings, steps, lighting and so on was carried out very carefully. However, it was clear that these details could not be finalised until the tunnel was completed, to allow easy access for detailed surveying and the preparation of plans. It was therefore agreed that the tunnelling work could be granted planning permission with the deferment of detailed planning of the development of the chamber. These details would be the subject of further consultations after the completion of the tunnel. On this basis, planning permission was granted in April 1987, subsequently it has been announced by the operators that the development will not take place due to lack of funds.

White Scar Caves

White Scar Caves is an established show cave on the western flank of Ingleborough. The present show cave consists mainly of a large natural active streamway which carries water draining from Ingleborough Common. The streamway is decorated in places with flowstone including some small gours and stalactites. This cave, running up the valley beds of the Carboniferous Limestone, is a classic example of an unconformity cave and is quoted in many textbooks. Beyond the upper reaches of the active streamway are abandoned high level passages recording the early development of the system. One particular passage, known as Battlefield Chamber, is renowned for its size, beauty and spectacular formations. At present, reaching this chamber involves traversing an underground lake, Long Stop Lake, and squeezing through a tight, muddy entrance, restricting access to experienced cavers only.

During 1996 the cave owners applied for planning permission to extend the existing show cave into Battlefield Chamber by drilling and blasting a new tunnel from the downstream end of the lake. This would, however, have generated a large quantity of debris for disposal. On cost grounds the owners argued that this could not be removed from the cave and suggested instead that it should be dumped in the lake. However, the NCC and the Council of Northern Caving Clubs argued that the lake was one of the prime features of interest and should not be used for dumping.

In March 1987 a meeting was held at White Scar Caves to discuss this problem and an alternative method of spoil disposal was proposed, avoiding Long Stop Lake. It was suggested that the spoil used to construct a pathway which would be required to connect the new tunnel to the end of the present show cave tunnel. This solution was acceptable to all parties.

Shatter Cave presents special problems as a show cave development of this kind would require a corresponding increase in damage. Thirdly, the development of the recreational potential of these caves; the means of controlling the future development of the Two Scar Caves is an established show cave on the western flank of Ingleborough. The present show cave consists mainly of a large natural active streamway which carries water draining from Ingleborough Common. The streamway is decorated in places with flowstone including some small gours and stalactites. This cave, running up the valley beds of the Carboniferous Limestone, is a classic example of an unconformity cave and is quoted in many textbooks. Beyond the upper reaches of the active streamway are abandoned high level passages recording the early development of the system. One particular passage, known as Battlefield Chamber, is renowned for its size, beauty and spectacular formations. At present, reaching this chamber involves traversing an underground lake, Long Stop Lake, and squeezing through a tight, muddy entrance, restricting access to experienced cavers only.

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Quarrying can have a major impact, in both social and economic terms, on a locale during the extractive phase, but its long-term legacy is the conspicuous, engineered appearance of the quarried rock faces which remain after working has ceased. From a geomorphological perspective these faces may be viewed as created landscapes which will evolve under the influence of natural processes. From a planning point of view, however, quarries are generally viewed as eyesores which detract from the quality of a landscape, and are seen as detrimental on amenity grounds. Mineral Planning Authorities are increasingly taking advantage of the powers bestowed on them by the Minerals Act 1981 to specify strict restoration conditions when granting planning permission for extraction. This is particularly true in the Peak District, which produces 25% of the U.K.'s quarried limestone, and lies largely within a National Park noted for its natural beauty and landscape character.

The research at Manchester Polytechnic aims to investigate the evolution of quarry faces in order to make a contribution to the interpretation and rehabilitation of the quarried landscape. As part of this, a technique of restoration blasting is being developed to modify abandoned faces and restore quarry profiles to a sequence of landforms, which not only mimic those of a natural daleside, but which will evolve in a predictable manner through the agency of natural processes.

The research to date has focused on eleven abandoned quarries in Great Rocks Dale, a dry valley 3 km east of Buxton and running for some 5 km north-west to south-east. The criteria for quarry selection were:

- Age - time since active working ceased.
- Methods of working - especially drilling and blasting methods.
- Size - area of working and height of faces.
- Overall end-form and topographic situation within the dale.
- Availability of quarrying records - this requirement was easily met as CI plc currently own and have previously worked all the sites.

In all, 2 km of limestone quarry rock-face were studied, ranging in time since abandonment from currently active to over 80 years.

The study identified a suite of landforms analogous to those of natural dalesides (Coggon and Gunn, 1987) including limestone towers or buttresses, sinkholes or dolines, rock collapse, fracture cones and debris flows. The landforms include those which are natural but modified by quarrying as well as those entirely induced by quarrying. Examination of the drilling and blasting methods used on particular faces forms the basis for drawing rock face profiles which show both the landforms in, and potential stability of, different parts of the face as shown in one of the accompanying diagrams.

This descriptive and analytical work on the abandoned face provides a scientific datum which can become the starting point for further blasting but now with restoration as the objective. The aim is to produce a daleside landform composed of artificial rock faces, buttresses and crests, the scale and extent of which will mimic those of a natural daleside. Four specific elements contribute to producing the required effect:

- Reduction of face height by the construction of scree blast piles which will:
  - mask the regular sequence of scorch marks of previous production blasts,
  - cover the quarry face to varying heights thereby reducing the extent of face available to liberate rock falls,
  - have varying angles of rest to differ from the relatively uniform of production blast piles,
  - vary in their degree of fragmentation both vertically and laterally.
- Indentation of the crest line by a series of semi-circular cut-backs to mimic the collapse of natural stackstone and blast fracture cones.
- Formation of a 'ragged' rock headwall in the upper third of the quarry face.
- Stabilisation of the scree blast piles by leaving a rock stump at the base of the face and/or by varying the fragmentation of the blasted rock downwards through the scree blast pile with the coarser material residing at the base.

Restoration blasting trials at ICI Tunstead Quarry have resulted in the formation of a landform sequence possessing many of the required characteristics. For the NCC, restoration blasting may offer a method of conserving and making safe selected areas of special geological interest in quarried faces, in a manner acceptable both to mineral operators, for whom it can be a cost-effective restoration method, and to mineral...
The geological heritage

Many classic geological localities occur along the coastline of Britain, such as the Jurassic sequences of Dorset, the glacial and interglacial sediments of the North Norfolk Coast and the stratotypes of the Hampshire Basin. Unfortunately, many of these coastlines are inherently unstable, suffering average rates of erosion of up to 2–3 m per annum. Where such cliffs occur in close proximity to areas of habitation or recreation, there is strong local pressure to find an engineered solution to the problem of coastal erosion. Traditionally, such schemes involve the construction of concrete sea walls, cliff grading and cliff drainage, leading in some instances to the obliteration of any geological interest which may formerly have existed.

Many of the sites have value far beyond their purely academic interest as they are an indispensable economic resource in terms of their usefulness as a training ground for future generations of geologists. Scientists, thus trained, go on to fulfill vital roles in society such as locating oil, gas and other mineral resources. Geology is a practical science and the many schools, polytechnics and universities which run courses in the subject have an obvious need to take their students into the field. For this, geological outcrop, be it natural or man-made, inland or coastal, is a basic prerequisite and it is essential that as many of the classic exposures and sections as possible remain accessible to student parties. Many of these important teaching and research sites are located along the coastline of Britain, the exposures being kept fresh by continued marine erosion. Therein lies the conflict of interest between civil engineers and conservationists. Certainly, in some instances, if there is to be effective conservation of particular localities then some forms of coastal engineering and slope stabilisation must be regarded as incompatible with achieving that aim. However, in planning terms, it must be realised that earth science conservation is but one element in the equation and that consideration needs to be given to other aspects and interests before a decision can be taken on coastal protection works.

The NCC as a statutory consultee

Since 1980 the NCC has been regarded, firstly by the Department of the Environment (DoE) and then by the Ministry of Agriculture, Fisheries and Food (MAFF), as a statutory consultee over all proposed coastal protection works, so the opportunity exists for the NCC to comment on all coastal engineering schemes which fall within the purview of the planning process. Of the many consultations received annually, only a few require comment and fewer still are the subject of an objection from the NCC. The NCC attempts to represent a consensus view from the academic community when responding to these consultations and is not simply proffering its own opinion on particular schemes. Teachers and research geologists using these coastal sites obviously cannot be accorded the same rights of consultation over individual coastal engineering schemes, so it is up to the NCC first to canvass their views and secondly to evaluate these responses. Objections to coastal works are not made lightly, but in the knowledge that the validity of those objections will possibly be tested at a Public Inquiry.

However, the whole issue of coastal protection is becoming increasingly politicised as local councillors and MPs are drawn into the debate over particular schemes as a result of lobbying by those whose house or livelihood seems threatened by cliff retreat. In the event of an objection being raised to coastal protection on geological grounds, the NCC is frequently berated, both privately and in public, by those promoting a particular scheme. Accusations of over-zealous behaviour and bureaucratic insensitivity abound in the one-sided war of words as local residents and their representatives promulgate their case. The NCC can only state and restate the scientific case, but this is usually somewhat less newsworthy than the plight of the hapless individual who stands to lose everything as the edge of the cliff marches ever closer to his front door.

Types of coastal protection works

There are many methods of protecting this coastline – a few of which are illustrated here. The purpose of most of these engineering structures is to stop marine erosion by placing a barrier, in the form of a sea wall or rock revetment, along the base of the eroding cliff line, thus inhibiting the action of the sea. No longer subjected to marine erosion, the cliffs become stabilised and overgrown within a matter of a few years. The resultant slope is of little value as a teaching or research site, as the underlying strata are no longer readily accessible to the field geologist. Once
stabilised, there is a marked reluctance on the part of the landowner to allow future geological sampling to take place as this would necessarily involve disturbing the equilibrium of the slope.

Legislation governing coastal protection works

Protective works do, by and large, require planning permission, and the NCC's comments are invited in its capacity as a statutory consultee on all planning matters relating to SSSIs. There is a second opportunity to make a case when MAFF, the central government department who fund coastal protection works, seeks the NCC's views.

The legislative basis is provided by the Coast Protection Act 1949 which was enacted to ensure that works are efficiently designed and that the effects of new works on adjacent stretches of coastline are taken into account. It has certainly been our experience, albeit limited to the effect that such works have on SSSIs, that this aim is not always realised. The Act empowers the maritime district councils in England and Wales and the regional and island authorities in Scotland to carry out coastal protection work. There are 88 such authorities in England, 22 in Wales and 11 in Scotland, all with a duty to protect land from marine erosion. There are a number of celebrated examples where the actions of one authority appear to have led to increased problems of coast protection for a neighbouring authority.

These shortcomings have been recognised by MAFF, and in a Green Paper entitled Financing and Administration of Land Drainage, Flood Protection and Coast Protection in England and Wales, a number of structural changes have been recommended. This document suggests that the ten water authorities would be a more appropriate focus for coastal defence works, although district councils could retain a 'designated' responsibility for particular lengths of coastline within their area. However, the situation has become somewhat confused by the proposed privatisation of the water authorities and at this time there is no clear indication of how the situation will be resolved. It seems likely, whatever the outcome, that MAFF will remain in overall charge of policy towards and financing of coastal protection works.

In its discussions with MAFF and individual maritime district councils, the NCC has always promoted the idea of innovative design in coastal engineering works. At present, many of these schemes are designed to stop marine erosion in its tracks and rely heavily on the use of concrete and similar materials. This effectively ensures that any pre-existing geological interest is destroyed or significantly damaged. This is difficult to reconcile with the spirit of Government policy on the matter which is given in DoE Circular 27/87 Nature Conservation. Paragraph 32 of this circular states "it is particularly important to take steps necessary to prevent valuable geological formations which are important for education and research from being obscured by dumping or tipping, or where they appear as coastal outcrops, if possible from damage by the effects of coastal protection schemes".

The maritime district council is faced with a dilemma. On the one hand, it is being instructed as the planning authority to provide effective protection to geological SSSIs within its area of jurisdiction, whilst on the other hand, MAFF requires each coastal protection scheme to...
Concrete seawall under construction, West Runton, Norfolk

Note recurved lip designed to direct spent waves backwards.

In these times of financial stringency, it is perhaps a nationally and internationally important sections will continue to be lost. Areas which are perhaps worthy of feeding techniques. In addition to the financial penalty on-going expenditure falls on the local ratepayer. Such full and proper consideration to such alternative

extent that it is no longer providing a significant input of beach forming material, then the effects of this loss are likely to be felt downstream with the subsequent impoverishment of intertidal areas. It may be that, in some circumstances, beach feeding or engineering works have to be undertaken to make good that loss.

Conclusions

There is an obvious requirement for coastal engineers and conservationists to be jointly involved in discussion at an earlier stage of the design process where proposed works fall within an SSiS, so that there is a greater opportunity for alternative methods of coastal protection to be considered. With a greater emphasis on innovation and a more sympathetic approach to the environment, it may also be possible in the future to design methods of coastal defence which are effective in their primary aim, yet incorporate some measure of

Changes in the way in which coastal protection works are administered are obviously desirable and such a restructuring seems a likely consequence of the review of the Coast Protection Act. Finally, it is incumbent upon those involved with earth science conservation to explain their case to the lay public, engineers and the planners, so that a fuller understanding exists of the social and economic significance of the subject and also the value of associated field localities.

Wooden revetment under construction, West Runton, Norfolk.
As a consequence of about twenty years evolution and adoption of teaching methods and materials, there is now a fund of energy and understanding of the natural environment which has grown in response to the changing nature of these science courses and their changing role in the curriculum. On the negative side, this has given rise to the 'problem' that there is a wide and firm perception of what a school science education is, what it should contain and a reluctance of many science teachers, parents and employers to accept radical change.

Regrettably, there has been no 'Nuffield Geology', or anything analogous, to geology and all other science subjects have always had a rather tenacious position in schools and has relied on individual, enthusiastic teachers to promote any interest or acceptance. When geology is offered as a 4th and 5th form option, pupils often do not have a clear perception of the subject because they have been denied the chance to experience this area as part of their science education in earlier years. As a result, option groups are often small, and the teachers and pupils constantly worried that their subject will no longer be seen as viable.

For these reasons, geology has never had any real prestige and this is a concomitant of its amateur status and image, together with the very antipathetic attitude of individuals in the education system towards geology as an entry requirement to courses. It has become widely seen as an 'extra subject' which can be crammed into a sixth form programme or as a subject for the less able, as it is generally regarded as less demanding than physics or chemistry. As a theoretical study with relatively low status and priority, geology is usually provided with the minimum of teaching resources, a problem made worse because geology has often been championed by physical geographers in schools and taught under the auspices of the geography department where there is a rather wide range of laboratory facilities for experimental work.

Specialists in biology, chemistry and physics are at present actively involved in discussions about future curricula, but wherever geology is considered as a component part, rarely is it suggested that they might involve anyone from the geography department, even in a consultation role, because geologists are convinced that they could cover any geological input to courses and that geographers could not become members of the science teaching team without excessive in-service training and support, even if there were vacancies available.

The effects of the low status attributed to geology have been compounded as secondary school rolls have fallen and non-essential subject teachers have been redeployed, a crisis which has deepened as new subjects, such as computer studies and craft, design and technology have started to compete for fewer pupils.

The question of the content is fundamental. Course content will need to be severely limited in quantity, not only in use of resources but because further limitations will be inevitable once 'process-based science' is inherently more demanding of time. Work programmes will be centred on enquiry, investigation and problem solving, throughout which the pupil will have much greater control of his or her own learning by employing the methods of science as a means of developing their own knowledge and skills. In this context content is the means to the end and not the end itself; most important is what people can do, not what they say they think they can do.

The place of geology in the cultural development of man; how an understanding of the natural environment has changed relative to that of other aspects of human endeavour. The two greatest cultural revolutions are both an integral part of the earth sciences: the Copernican and the Darwinian.

Geology and process-based science

Some clarification on what we mean by process-based science may be appropriate. The first stage is always the appreciation of a problem which relates to some natural phenomenon, but for school pupils this must be based on concrete experience and arise through them making first hand observations. The subject of these observations may arise naturally, but more usually they are introduced by the teacher and chosen because, in
the normal course of the process, the activity will take the pupils into new areas where active learning can occur. It is from these observations and subsequent discussion that the pupils start to ask questions and, under the guidance of their teacher, identify and articulate specific problems.

Most of the practical work carried out in school science involves results and demonstrations. These may be teacher-based, but often they are pupil-based with the student being asked to follow a set of instructions in order to record the result. This is all to the good, providing that the recording reflects good scientific practice and does not itself become the aim of the lesson. Tragically, the results of these observations are often called ‘conclusions’ and the observations themselves called ‘experiment’ and it is this short-circuiting of the process must be remedied by earth science specialists if they are to stand alongside the more professionally competent biology, chemistry and physics specialists.

My own realisation of this problem came to me some years ago during a field excursion which was part of an Association of Teachers of Geology conference programme. The field leader pointed out some pillow lavas and their general shape, and then said “we therefore conclude that they are becoming younger in that direction”, pointing out to sea. A voice inside me shouted, “that’s not a conclusion, that’s a hypothesis.” He had fallen into the trap of going from observation to conclusion without any regard for the investigative and evaluative stages of the scientific process. This is a particularly serious problem in ensuring that geology is compatible with other sciences in its teaching methodology. For years, geology teachers have plugged basic concepts, such as rock descriptions, or fossil records, into some ‘key’ which miraculously converts them into factual conclusions; the most important part of the science process is then by-passed. As the ‘key’ is often based upon sweeping generalisations, it may be particularly misleading to pupils apart from the unhelpful contribution which it makes to summing the delusion that what is being done is science.

The second stage is, of course, for the pupils to suggest solutions to their problem and to devise methods by which hypotheses can be tested. The questions should emerge naturally and will include those which might be tackled by the pupils themselves. This will lead to the design of alternative methods by which the problem might be tackled. It is important that we do not give the idea that there is an absolutely right way of going about things. They will need time to follow up their ideas even though the teacher may know that a particular method may not give the ‘usual’ result. The skills of writing a clear and accurate account of their work, and the use of safe and appropriate methods will need to be acquired over a longer period of time, these certainly could not be achieved within a one year course, but because there is a demand, it seems likely that examination boards will accept one-year’s work by pupils for assessment, even though such a policy contradicts the spirit of the National Criteria for Science. For this reason, the sooner ‘geology’ disappears from the 11-16 curriculum the better.

The final stage in the process is examination and evaluation involving the pupils who will need to ask the students whether they have got an answer to their original question. If they have not, then they may need to reconsider the method which they adopted. If they have achieved a positive result, and here the collaborative aspect of science can be engendered by some consensus being drawn through discussion groups, then they will need help in fitting the new knowledge and skills into the framework of scientific understanding. At this stage, either a totally fresh observational input can be introduced or additional problems may be tackled based on the original input.

Only if an activity is carried out in response to a reasonably established question, which is under-stood and identified by all the class, is that activity an ‘experiment’. However, many earth science teachers have difficulty providing the right sort of starting point to this process so that, through the experience that the pupils are going to learn some essential skills, methods and concepts which are recognisably scientific. Here we really have to be very firm in our resolve to radically change the nature of geological education.

Biology specialists use, as examples, organisms which are accessible. They may think that studying the feeding habits of the Nile crocodile may make a more colourful lesson, but to develop investigational skills they are rather more pragmatic and choose woodland or earthworms because they are available and within the pupils everyday experience. In terms of the process it makes no difference whether it is a worm or a crocodile, the same skills and methods would be required, so they choose the humble worm.

Similarly, the Grand Canyon may be very interesting and dramatic and so it may feature in text books as a theoretical example of a certain type of erosional feature, the problem is, of course, that it is not within travelling distance using the school minibus! The implication is that the Grand Canyon does not provide an appropriate starting point for an earth science investigation; it is outside the pupils direct experience, and they are not able to test their ideas through observation and thus particular questions may not be answered by means of the process. Even a case-study approach limits the process in that it restricts the potential scope of the observation; the writer of the case-study acts as a ‘gatekeeper’ for the information available and therefore the study is predetermined by definition.

The range of field sites at which to carry out investigative work is becoming increasingly scarce. It is not the large, well known or ‘classic’ sites which are of primary interest to me as an educationalist, they are in good hands. It is the number of small and unglamorous sites, which are within easy reach of every school which is my concern. Earth science can never be taught effectively in schools unless they are there in abundance and easily accessible. Conservation and protection must not only be based on the academic and research value of a site, ask the science teacher of class 3C what his or her requirements are!

Practical teaching methods

Traditional school geology text books are a millstone around the necks which we could well do without. While they are still on the shelf, the mould will not be broken and there will still be the temptation to teach about geology rather than geology itself. Regrettably, such books are still being used as models in some current curriculum development!

Firstly, we must be absolutely certain about what educational objectives we are trying to meet at any particular stage in a pupil’s science education, these must be continuous and progressive and in accord with the pupils general growth in intellectual and cognitive ability, the development of the skill to carry out science will grow over the five years of compulsory secondary schooling. Our work with young people must be based on a meaningful, relevant and accessible (which is still, thankfully, a requirement insisted upon by the GCSE examination groups), the field sites must be chosen carefully to ensure that they are suitable. We must also ensure that the field site to which we introduce pupils is appropriate for that specific stage in the pupil’s development.

If pupils visit a site and find that they are not able to carry out accurate and appropriate observational work, ask themselves questions and define problems for themselves and have the background skills, knowledge and confidence to organise the investigative work, then they are not ready for that site. If they are not yet able to handle the geological problems at that site, we should choose one where the problems are more realistic and within range of the pupils abilities.

What must also be guarded against is the temptation to persist with the Cooke’s Tour approach to field work. When time away from school is very limited, it is easy to understand why so much observation is squeezed into a day’s itinerary, but what we must realise is that field work is not the climax, or drawing together, of theoretical school-based work; that a field study itself is not the end product. In a process-based philosophy for science education, fieldwork too must be the means to the end, not the end itself. We must get away from the field lecture and any temptation to describe features and geological events exemplified at a site just because they are there, regardless of the readiness of the pupils for such a didactic onslaught.
Geological Conservation Review

Progress on GCR site selection

In the last issue of this journal we reported on the GCR site selection position as at 15 April 1987. Since that time the total number of sites selected has risen to 2740, with a further 407 sites envisaged, giving a projected final total of 3147 sites. The bulk of the remaining sites will be selected by the end of March 1988, although some blocks (principally Pleistocene/Quaternary blocks where site clearance is needed before final assessment can take place) will not be completed until mid- to late-1988. A process of further periodic review of new work will continue after initial selection is completed, but this will be on a limited scale at least until the GCR publication programme is approaching its conclusion. The detailed current position is set out in the accompanying table.

GCR site selection position: 18 January 1988

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<th>Stratigraphic blocks</th>
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Quaternary and geomorphology blocks

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<td>Total 23 blocks</td>
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The second GCR Contributors Meeting was held in London on the 25 January 1988, when over thirty GCR contributors, together with the NCC's earth science staff, gathered at the Geological Society's Apartments at Burlington House.

The NCC first initiated this series of meetings in 1986 in order to provide a forum for airing GCR-related issues and discussing future strategies. The many GCR contributors are widely dispersed throughout Britain and the meetings offer a rare opportunity to gather as a group, and to get to know each other and the NCC staff. The NCC is also keen to use these occasions to brief contributors on current and future plans for the GCR, and to seek comment and promote debate on both GCR and other issues arising from its work in the area of earth science conservation.

The morning session of the second meeting was chaired by Dr. Keith Duff, one of the NCC's Assistant Chief Scientists, and took the form of a number of short presentations by the NCC staff followed by discussion sessions. Dr. Bill Wimbledon, Editor-in-Chief of the GCR, reported on progress with site selection and on publication plans for the GCR series of volumes (for details see elsewhere in this issue). Particular interest was generated by a series of artwork 'mock-ups' of the outer cover for the series, and by a sample finished examples of site-maps intended for inclusion in the Tertiary Igneous volume. This type of advance consultation was clearly well received by contributors and, in response to the interest shown, the NCC has agreed to use future issues of the GCR Newsletter to keep contributors up to date on developments and to provide further guidance documents for writers and editors, for instance on an agreed GCR format for maps and figures. Dr. Duff concluded the morning's proceedings by presenting a paper outlining the range of contractual options available to prospective writers of GCR volumes.

Vol. 37: Quaternary of Scotland
Editor: Dr. D. G. Sutherland
Writers: Dr. J. E. Gordon with contributions from others
Text completion date: February 1988

Vol. 38: Quaternary of Wales
Editor: Prof. D. Q. Bowon
Writer: Dr. S. Campbell
Text completion date: Summer 1988

Vol. 44: Quaternary of the Thames
Writer and editor: Dr. D. Bridgland
Text completion date: Spring 1988

Candidate writers and editors have been identified by the GCRPMC for a further 25 volumes, and discussions have been started with the aim of agreeing terms and commencing work. Guidance notes concerning style, format, manuscript preparation, and contractual procedures have been prepared to assist writers and editors in their work, and to ensure an overall consistency between volumes in the series.

The second GCR Contributors Meeting was well attended by contributors, and there was a feeling that the meeting had been most successful in drawing them more closely into the mechanics and details of producing the GCR series, and in giving them, for the first time, a 'feel' for what the final published product would look like.

In response to the demand for a further Contributors Meeting, the NCC plans to convene the next meeting in late 1988, by which time publication plans for the initial volumes of the GCR series should be well advanced.

Dr. Keith Duff rounded off the afternoon session with a presentation on the increasingly important role that commissioned research is assuming in enabling the NCC to meet its obligations in the area of site safeguard. Commissioned research provides a means of acquiring detailed scientific and technical information relating to sites, and the results of this type of applied research enables NCC staff to make highly informed, professional decisions, both on individual casework issues and in the formulation of broader policy. Dr. Duff invited contributors to consider what role such research might play in safeguarding GCR sites within their particular specialist interest fields, and to make suggestions for future research proposals to the NCC. He also reminded those present that funds for commissioned research were 'new money', and did not derive from diversion of funds from the Geological Conservation Review.

Prof. Knill, in his closing address, echoed the feeling evident amongst contributors that the meeting had been most successful in drawing them more closely into the mechanics and details of producing the GCR series, and in giving them, for the first time, a 'feel' for what the final published product would look like.

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Vol. 39: Tertiary Igneous
Editor: Dr. C. H. Emeleus
Writer: Dr. M. Oyopara
Text completion date: April 1988

Vol. 33: Metagenesis
Writer and editor: Dr. L. J. Haynes
Text completion date: December 1988
SSSI notification and denotification

The latest statistics recording progress on notifying OCR sites as SSSIs are presented in the accompanying table. The term Single Interest Locality (SIL) means a particular locality selected to illustrate geological or geomorphological features for a particular OCR interest block (for example, Tertiary Igneous). However, several SILs may be adjacent or indeed overlapping (for example a Tertiary Igneous SIL may also show excellent raised beach features), and for this reason be in addition to a Quarternary of Scotland SIL). Where this happens the area of land notified as a single SSSI may comprise several SILs.

To date 2740 SILs have been selected by the OCR, and 2460 have been fully processed: the distribution of the latter figure between countries being 1425 in England, 570 in Scotland and 356 in Wales. Notification packages, detailing the Potentially Damaging Operations (PDOs), for 2162 of these have been issued to the NCC's Countryside, Act 1949.

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To date 2740 SILs have been selected by the OCR, and 2460 have been fully processed: the distribution of the latter figure between countries being 1425 in England, 570 in Scotland and 356 in Wales. Notification packages, detailing the Potentially Damaging Operations (PDOs), for 2162 of these have been issued to the NCC's Countryside, Act 1949.

The process of denotification removes such localities from the legal protection afforded by SSSI status, and the NCC, being fully aware of the significance of such a move, is concerned that in each instance the decision to denotify has been carefully weighed in advance by the OCR and that the underlying logic is understood by the geological community.

Readers will be aware that the main purpose of the Geological Conservation Review is to re-assess the relative significance of Britain's geological and geomorphological sites and to ensure that the coverage of SSSIs adequately represents the most important localities in these subject areas. The most well-known result is that a substantial number of new localities worthy of SSSI status has been identified, and that these are in the process of being notified as SSSIs to ensure their future protection. Perhaps less well-known is the fact that a number of localities, which were notified as SSSIs before the OCR started work in 1977, have been re-assessed as part of the OCR exercise and found not to measure up to the more rigorous selection criteria now being used, and are now being removed from the list of notified SSSIs.

The process of notification removes such localities from the legal protection afforded by SSSI status, and the OCR, being fully aware of the significance of such a move, is concerned that in each instance the decision to denotify has been carefully weighed in advance by theOCR, and that the underlying logic is understood by the geological community.

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SSSI denotation

<table>
<thead>
<tr>
<th>OCR site (re)notification position: 18 January 1988</th>
<th>Number of SILs processed</th>
<th>Number of notification packages sent to NCC regional staff</th>
<th>(equivalent number of SILs)</th>
<th>Number of geological SILs which have been notified under 1981Act</th>
<th>(equivalent number of SSSIs)</th>
</tr>
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<tbody>
<tr>
<td>England</td>
<td>1425</td>
<td>1010</td>
<td>(1319)</td>
<td>563</td>
<td>(718)</td>
</tr>
<tr>
<td>Scotland</td>
<td>670</td>
<td>413</td>
<td>(557)</td>
<td>204</td>
<td>(270)</td>
</tr>
<tr>
<td>Wales</td>
<td>356</td>
<td>229</td>
<td>(296)</td>
<td>115</td>
<td>(141)</td>
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<tr>
<td>Totals</td>
<td>2460</td>
<td>1661</td>
<td>(2162)</td>
<td>902</td>
<td>(1134)</td>
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</table>

Since the inception of the NCC's involvement in geological conservation in 1960, geological SSSIs have always been selected on a national basis, unlike their biological counterparts which are usually selected locally. In this way the national or international significance of earth science SSSIs has been an important selection criterion from the start, and this fact has been most instrumental in the NCC's successful record in defending the sites against development proposals. Over the years, however, the perception of 'national significance' has changed in line with the expansion of geological research in Britain and the rapid development of the science in the last twenty five years. There has also been the realisation that some of the sites added to the SSSI coverage through ad hoc revisions prior to the OCR did not measure up to the stricter criteria now being used.

In order to ensure that the credibility of both the OCR and the earth science SSSIs as a series of nationally important sites was not undermined, the NCC therefore decided, in 1977, that pre-OCR sites not reaching OCR standard would be denominated.

We are well aware, however, that whilst these sites no longer satisfy OCR standards, they still retain in many instances significant earth science interest on a regional or local basis, and that there is considerable merit in trying to safeguard and conserve such sites through the use of mechanisms other than SSSI protection. For example, county naturalists trusts can be encouraged to become involved in the conservation of such sites, perhaps with the co-operation of local, regional or national geological societies. Other options could include the establishment of formal or informal adoption schemes, and encouraging local authorities to add the localities to their inventories of locally important conservation sites. The NCC, in fulfilling its commitment to conservation in the wider environment (that is, away from SSSIs and NNRs), can assist in promoting such alternative approaches to conserving particular sites. Denotification does not mean that a site is unimportant, simply that the SSSI mechanism is inappropriate in planning its safeguarding.

To help earth scientists and conservation bodies to identify the sites concerned, a full list of all the pre-OCR SSSIs which are now recommended for denotation is set out in the accompanying tables. For some of these, the process is well advanced or has been concluded, but for many others no firm action has yet been initiated. Further details of the precise location of a particular site, and the nature of the geological interest are available from the NCC upon request. We hope that anyone with an interest in any of the sites will therefore be able to investigate the possibility of making alternative local conservation arrangements if they feel it desirable. As indicated above, the NCC will be pleased to offer advice and background assistance as appropriate. We would also be interested to receive any other comments related to the list; these should, in the first instance, be addressed to the Editor of the journal.
<table>
<thead>
<tr>
<th>Greater Manchester</th>
<th>Hampshire</th>
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<tr>
<td>Goyt River Section*</td>
<td>Candovers Farm Pit*</td>
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<td>Headley Farm Pit*</td>
<td>Farlington Redoubt Pit*</td>
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<tr>
<td>Kinshalewater Stream Section*</td>
<td>Kingclosures Farm Pit*</td>
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<td>Micheldever Station Cutting*</td>
<td>Paulgrove Pit*</td>
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<td>Greater London</td>
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<td>Kenley Station Chalk Pit*</td>
<td>Knockullett Pit</td>
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<td>North End Pit*</td>
<td>Lene Lane Wood Chalk Pit</td>
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<td>Riddlesdown (Rose &amp; Crown Quarry)*</td>
<td>Sayer’s Woodland, Ramsgate</td>
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<td>Barlow Green Pit</td>
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<td>Little Bowland Knoll*</td>
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Surrey
Badshot Farm Chalk Pit
Chelsham & Woldingham Group (includes Nore Hill Pinacile LNR)*
Claydon Traverse
Greyhans Chalk Pit
Jolly Farner Pit, Rundold
Leith Hill
Ranmore Common
Thursley, Handley & Frensham Commons (includes the Devil’s Jump)
Upper Hale Gravel Pits

Tyne and Wear
Bolton Golf Course Quarry*
Downhill Quarry*

Warwickshire
King’s Hill Boulder (Erratic)
Knowle End Tramway Cutting
Parkfield Road Quarry (Victoria Pit, Rugby)
Stepney Lane Section (Perky Park)
Stockett Quarry
Tattle Bank Quarry
Windmill Hill Quarry (Judkins Quarry)*

West Midlands
Dudley Castle Hill Canal basin
Rubery Cutting & Leachgreen Quarries

Wiltshire
Calstone & Cherhill* Clay Hill*
Devizes Gash Pit*
Dodds Clay Pit*
Hursley Bottom*
Leigh Delamer*
Ogbourne Maceley Chalk Pit*
Porston Brick Pit*
Quiddington Chalk Pit*
West Kington Lane Section*

Scotland
Aberdeen
Balgownie Bridge
Angus
Leynall Quarry*

Argyll and Bute
Das Mor Dubh, Mull*
Glen Forsa, Mull*
Gunnart Flats*
South Bute Coast*
Stafla*

Barf and Buchan
Aberdour Coast*
Buchan Ness*

Berwickshire
St Helens Church Dry Channel*

Clydebank
The Bank*

Cumnock and Doon
Ballochmylie Quarries

Cumberland
Gleann Dubh*
Gardie Cutting*
Heslephead Quarry*
Portcrosse Coast*

Dunbarton
Dunbarton*

East Lothian
Aikengall*
Bass Rock*
Markle Quarries*
North Berwick Law*

Edinburgh
Cramond Sand Pit*
Cragleshill Quarry*
Craglockhart Hill West*
Dalmeny Quarry*
Morton Hill Quarry*
Torphin Quarry*

Invercyle
Bogle Stone*
Craigmuschat Quarry*

Kincardine and Deeside
Slack of Barrie*

Kirkcaldy
Orrock Hill*

Kyle and Carrick
Balantrae Shingle Beach*
Newlands Quarry*

Lochaber
Acharacle*
Cailleart East, Loch Leven*
Camas Calhurn*
Clemmore Plug*
Inverlochy*
Loch Nevis*
Mamore Coast*
Ormesaybeg Shore*

Morningside
Brewsterford*

Moray
Ardwell Inn River Section*
Earth Pillars, Fochabers*
Rosebriar Quarry*

Nairn
Kingsthep Quarry*
Leithen (North Park of Mackie Burn)*

Nithsdale
Crochteope Linn*
Loisteen Burn*

North East Fife
Drundryan Quarry*
Duns Den*

Orkney
Bookan Quarry*
Brockenshot St Peter’s Pool*
Mirkady Point*
Scrogy Head, Rousay*
Swuersquoy (Wetterick)*

Ross and Cromarty
Cromarty Gullies

Stratharn
Leintzown Esker*

Sutherland
Cnoc na Beiste*
Dornoch Esker*
Eilean Nan Ron*
Loch Assynt Quarry*

Tweeddale
Clen Dean Banks*
Stobo Slate Quarry*

West Lothian
Hill House Quarry*
Leithgow Loch*

Western Isles
Gribister, Baleshare and Eackaness*

Wigtown
Lady Bay*
Public Inquiries

Morrich More Public Inquiry result
Morrich More SSSI, Ross and Cromarty

In September 1987 the Secretary of State for Scotland granted outline planning permission to Land and Marine Engineering Ltd for the building of a pipeline assembly corridor and maintenance road along the north-west side of the Inner Channel, near the south-eastern corner of the Ross of Rannoch. The decision, which was in line with the Reporter's recommendation, followed upon a Public Inquiry in 1986, representing a major setback for the NCC and the implications of the case are worthy of examination in some depth.

The geomorphological importance of the sand dune and saltmarsh complex was outstanding in Earth science conservation 23 p 4-25, and will not be repeated here. The NCC considered on geomorphological grounds alone that the proposal would be severely damaging but it is important to realise that equally compelling arguments applied on biological grounds. The assembly corridor would in particular threaten the transitional saltmarsh area, where steep gradients of fenitic composition exist, and which is a favoured feeding and breeding ground for the bar-tailed godwit. In particular a small breeding population of the rare stonchat was afforded protection under the Wildlife and Countryside Act 1981, and the NCC acted accordingly.

The Secretary of State concluded that the proposed location was not contravention of the planning approval and that the site could be safely and effectively protected. The assembly corridor was to be replaced by a more appropriate route which would not threaten the site to its original condition. For this reason the NCC welcomed the outcome, as evidence that we are prepared to resort to legal proceedings to defend sites, and that the term 'direct and indirect employment potential' of the project in an area of high unemployment was of overriding importance. However, it is felt that the direct and indirect employment potential of the project should be given due consideration in future planning applications.

The effectiveness of the NCC's evidence was reflected in the Reporter's conclusions that there was no doubt of the exceptional value of the SSSI for nature conservation, and that the assembly corridor would pass over a particularly sensitive area. However, he felt that the direct and indirect employment potential of the project in an area of high unemployment was of overriding importance. The condition of the planning approval is the requirement that a pipeline corridor must be awarded to the company before any works commence. We do not yet know if Land and Marine Engineering Ltd can meet this condition but we will continue to report this and other developments as they unfold.

Major casework

The NCC wins Chesil Beach court case
Chesil Beach SSSI

In October 1987 Bridport Magistrates Court found Mr T Richards, owner of part of Chesil Beach, guilty of carrying out two Potentially Damaging Operations (PDOs) at Cogden Beach without prior consultation with the NCC. Mr Richards was fined £750 on each count and ordered to pay the NCC, who brought the prosecution, £1000 costs. The case is the first instance of a successful prosecution for breach of PDOs on an earth science site, and although legal precedents cannot be established in a Magistrates Court, it illustrates the effectiveness of the Wildlife and Countryside Act in the area of enforcement action in situations where the NCC's preferred course of action through negotiation proves fruitless.

Chesil Beach is a site of international renown for coastal geomorphology on account of the exceptional size of the linear storm beach, the systematic size-grading of pebbles and cobbles along shore and for the availability of historical records of beach changes. The beach has been the subject of what development pressures over the years, as reported in EDC 19, p 26, 21, p 45, 23, p 28 and detailed in Dr Alan Carr's article in EDC 30, p 2-10. Green extraction from the beach has a long history, possibly over 700 years, but in 1986 it was determined at Public Inquiry that such activities were detrimental to the preservation of the Beach and should cease. This decision was in line with earlier refusals on the part of Dorset County Council, to grant planning permission for continued extraction at Cogden Beach by Mr Richards.

Under the decision of the Public Inquiry all working of the gravels should have ceased by December 1986 and the NCC could be forgiven for thinking that the matter had finally been brought to a close. However, in December the level of activity was dramatically increased with Mr Richards employing two large front-loading machines in conjunction with a fleet of lorries. Dorset County Council became alarmed at this turn in events and issued Mr Richards with a verbal instruction to cease this illegal operation, followed shortly by Stop and Enforcement Notices. After a period of reflection Mr Richards agreed to cease extraction and attempt to make good the damage by repairing the disturbed beach area using material from a stockpile which had been established nearby. Although extraction had by now ceased stockpiled material was still being removed from the site and Dorset County Council subsequently petitioned the High Court and obtained an injunction preventing Mr Richards from removing any further material from the site.

The NCC was still concerned that the extraction had damaged the natural grading of the beach, and that the restoration, however visually effective, did not restore the site to its original condition. For this reason the NCC decided to initiate a prosecution under Section 28 of the Wildlife and Countryside Act 1981 on the grounds that regulations governing Potentially Damaging Operations had been breached. Specifically, the NCC alleged that 'modification of natural features by clearance of loose rock or shingle' and 'extraction of minerals including shingle or gravel' had taken place without prior consultation. The changes were made in July 1987 when the case came before Bridport Magistrates Court. Mr Richards pleaded 'not guilty' and a trial date was set for October 1987.

At the court case the NCC had to demonstrate that the proper procedures had been followed in notifying the site as an SSSI; that Mr Richards was aware of the scientific interest and that the PDOs had been carried out without prior consultation. The NCC produced six witnesses, covering these aspects and the special scientific character of the site. Our case was greatly assisted by being able to call a witness from Dorset County Council who had taken a video recording of Mr Richards' extraction operation at its height, which clearly illustrated the scale and scope of the extraction.

Mr Richards was found guilty on the two counts of breach of PDO procedures, and fined £750 in each instance. This penalty is three-quarters of the maximum fine which could have been imposed. Although the NCC welcomed the outcome, as evidence that we are prepared to resort to legal proceedings to defend sites, it is to be regretted that it was necessary. Wherever possible the NCC prefers to effect the conservation of our natural heritage through negotiation and persuasion.

Cliff collapse endangers apartment block
South Dorset Coast SSSI

Darlington Bay GCR site, which lies within the larger South Dorset Coast SSSI, is the type locality for the Upper Jurassic Purbeck Beds and is internationally
famous for the diversity of its invertebrate and vertebrate faunas, the reptile and mammal remains being of particular interest. The site has been studied intensively for over one hundred years and is arguably one of Britain's most important stratigraphic and palaeontological localities.

In 1972 it was proposed to build a block of flats adjacent to the rapidly eroding coastline at Durlston Bay. The NCC pointed out the inherent instability of the cliffs, and the fact that this was exacerbated at this particular locality by the presence of a fault running parallel to the cliff edge. In spite of these unfavourable ground conditions planning permission was granted by Purbeck District Council and the flats were constructed with an assurance to the NCC from the architects that "it is not proposed that any work to the cliffs will be necessary nor is it intended that any be carried out within the area scheduled as being of special scientific interest". The NCC had already indicated that it would strenuously object to any proposals to stabilise the cliff.

Some fifteen years on successive falls have pushed the cliff line back to within a metre or so of the building's foundation to the understandable alarm of the NCC and more particularly the owners and occupiers of the flats. The Council commissioned an investigation by a firm of consulting engineers, and their report, produced in November 1988, outlined a number of proposed coastal protection measures designed to remedy the situation. Purbeck District Council made an application to pursue this scheme and informed the NCC in its role of statutory consultee. The NCC in line with its earlier statements on the subject, strongly opposed the proposals. The Secretary of State for the Environment, once appraised of the NCC's objections, issued an Article 10 Direction which effectively prevented the District Council, as the agency charged with responsibility for coastal protection, from granting itself planning permission for the scheme.

The NCC, aware of the political difficulties which could ensue from objecting to remedial works in a case where the problems were so evidently acute, decided to commission an independent appraisal from Sir Alexander Gibb and Partners to review the problem and the Council's proposed remedial works. The findings were alarming in the extreme, indicating that the factor of safety for the existing situation was as low as 0.51. A factor of safety less than unity is an indication of inherent instability of the cliffs, and the fact that this was exacerbated at this particular locality by the presence of a fault running parallel to the cliff edge, In spite of these unfavourable ground conditions planning permission was granted by Purbeck District Council and the flats were constructed with an assurance to the NCC from the architects that "it is not proposed that any work to the cliffs will be necessary nor is it intended that any be carried out within the area scheduled as being of special scientific interest". The NCC had already indicated that it would strenuously object to any proposals to stabilise the cliff.

The NCC's suggestion an alternative option of diverting the road away from the bank was considered, but the Council pointed out that the cost would be prohibitive. The Council proved more receptive to a further option - that of diverting the course of the river, by means of a pre-cut channel, away from its present position. The NCC and the Council are now jointly pursuing details of this scheme. Although the Quaternary section will no longer be kept fresh by continued erosion, it will nonetheless remain available for study as a result of this imaginative compromise. The NCC wish to thank Strathclyde Regional Council for their co-operation on this matter.

Strathclyde Regional Council has expressed concern for a number of years over the rapid bank erosion in these unconsolidated sediments, which is now threatening to undermine a minor road which runs adjacent to the river and underneath which are located electricity cables and water mains. The Council initially proposed to stabilise the bank by constructing a gabion wall at its base. This would have obscured the lower exposures, and in time would have encouraged vegetation to take hold on the upper part as well. At the NCC's suggestion an alternative option of diverting the road away from the bank was considered, but the Council pointed out that the cost would be prohibitive. The Council proved more receptive to a further option - that of diverting the course of the river, by means of a pre-cut channel, away from its present position. The NCC and the Council are now jointly pursuing details of this scheme. Although the Quaternary section will no longer be kept fresh by continued erosion, it will nonetheless remain available for study as a result of this imaginative compromise. The NCC wish to thank Strathclyde Regional Council for their co-operation on this matter.

Coastal protection threat to Northumberland Quaternary site

Sandy Bay SSSI, Northumberland

Sandy Bay is an important Quaternary site for the study of glacial till. It shows the fullest development of Late Devensian till on the Northumberland coast, and many of the characteristics of lodgement deposition. The till rests partly on a stranded shore platform and partly on glacially disturbed bedrock.

At the northern end of the section the cliff is to some extent protected from erosion by the boulder-strewn rock platform, but in the south the coastline is serrated where the sea has cut out a series of small embayments. The landowner and the manager of a coastal caravan park, concerned at the relatively rapid rate of erosion, recently approached the NCC with a view to agreeing a method of coastal protection which would reduce the rate of cliff retreat. The NCC is examining various options which might meet the needs of the owner and occupiers without significantly damaging the scientific interest.
development threats of this type, but the Ballinteer case was an example where the public need for safe roads impinged closely on the geological interest as a result of the peculiarities of the local topography. The NCC's involvement ensured that the damage to outcrops, which could not be totally avoided, was minimised and that the most critical outcrops were protected.

**Threat to Tertiary palaeontological site Colwell Bay SSSI, Isle of Wight**

The cliffs at Colwell Bay provide important exposures of the Headon Hill Formation, of Eocene age, and the section is noted for its abundant and diverse marine and freshwater fauna, especially molluscs. Over a hundred species of molluscs have been reported to occur in the 'Venus Bed'. The Limestone Chine Member is internationally famous for its palaeobotanical interest and over forty species of plants have been recorded, including flowering plants, conifers and ferns, and for eight of these species that is the type locality.

In 1978 a Public Inquiry was held to consider an application to extend the holiday camp complex which lies immediately inland from the SSSI. At that time, as reported in ESC 15, p 22, 17, p 16, the NCC presented evidence to demonstrate the active recession of the cliffs as a result of marine erosion and pointed out that the cliff has already been cut back to within 50 feet of the 50m Sea wall. The NCC's involvement ensured that the damage to outcrops, which could not be totally avoided, was minimised and that the most critical outcrops were protected.

In January 1987 the NCC was approached by Hunting Gate Chine, concerning the building of a large industrial unit and warehouse complex on the floor of the disused pit. Part of the floor of the old quarry had previously been given over to use as a car park, but in the 1960s this was extended by infilling with industrial waste from a local foundry, to the level of the adjacent Hugenhaven Avenue. Indications from the plans were that the new unit was to be sited close to the western side of the site and therefore adjacent to the fossil-bearing exposures.

On site inspection revealed that pits had been prepared for the footings in one area close to the fossiliferous exposures. At meetings between the representatives of the developers and the NCC, the scientific value of the exposures was explained. As a result the building was repositioned such that the western corner of the unit remained adjacent to the exposure, but the remainder of the western side of the unit was angled away from the exposures. In this way access to the site from the southern side remains unimpaired for palaeontological purposes. In addition, the developers undertook to clear the faces of part of the cliff exposure in order to improve access to the base of the exposure.

In all the development now seems to represent an excellent compromise between the scientific requirement for unhindered access to the faces and the need of the developers to position the unit as close to the western limit of the site as possible, in order to maximise the forecourt parking area.

**Cretaceous brachiopod site protected High Wycombe Pit SSSI, Buckinghamshire**

High Wycombe pit is an exceptionally important late Cretaceous Chalk fossil site, which shows an abundant, varied and well preserved marine fauna dominated by both 'rhynchonellids' and 'terebulinos' brachiopods, as well as showing abundant remains of burrowing organisms. The fossil-bearing horizon is found relatively varied and well preserved marine fauna dominated by both 'rhynchonellids' and 'terebulinos' brachiopods, as well as showing abundant remains of burrowing organisms. The fossil-bearing horizon is found relatively elevated above the floor of the quarry. The NCC's case was backed up with letters of support from the many academics with an interest in the site, and on the basis of these representations and other considerations the application was refused. However the accuracy of the NCC's argument in predicting future demand for coastal protection works has recently been demonstrated. The SSSI is under renewed threat with a proposal by South Wight Borough Council to lay a breakwater of concrete blocks at the cliff toe over a 50m stretch along the holiday camp frontage.

The NCC has proposed that alternative schemes, which would go some way to reconciling the need to slow down the rate of coastal retreat with the requirement to protect the geological exposures, should be investigated. A combination of beach replenishment and groyne construction would probably have the desired effect but would not be cost-effective in terms of the guidelines laid down by central government. As a result it would not attract grant aid from the Ministry of Agriculture, Fisheries and Food in its role in funding coastal protection works. For this reason the Council is unable to consider such a scheme further.

The NCC has now formally objected to the proposals and unless a satisfactory method of conserving the fossiliferous exposures is found, development will go ahead. The NCC's involvement ensured that the damage to outcrops, which could not be totally avoided, was minimised and that the most critical outcrops were protected.

In recent years rapid coastal erosion has led the landowner at Broughton Bay to implement make-shift protection measures designed to safeguard his property. These have involved the laying in early 1987 of two blocks of Carboniferous Limestone – in the form of a revetment at the base of the cliffs. The NCC has attempted to resolve this unsatisfactory situation through discussions with the owner and the local planning authority, but the owner, who perceives his property and livelihood to be stakes, has refused to remove the blocks. The NCC's concern is heightened by the fact that the quality of the exposure is deteriorating through mass wasting and vegetation as marine erosion is no longer keeping the section fresh.

In an attempt to research the problem in greater depth the NCC commissioned a reconnaissance study by Geo Sea Consulting Ltd, of the erosion problem and its impact on the geology of the site. The report indicates that the blockstone wall will offer little protective effect, and may indeed actively promote erosion of the foreland. The difficulty however is that alternative methods of coastal defence, such as the building of a breakwater to alter wave refraction around Tool Point, would be costly and could have significant implications for coastal stability along adjacent stretches of the coast. For this reason it is essential that the hydraulic and associated sediment movements in Carmarthen Bay as a whole are taken into account. Just such a study has recently been proposed by the Welsh Office and a consortium of local authorities and the NCC is keen to participate. It is hoped that this wider study will provide a basis for resolving the current impasse at Broughton Bay to the satisfaction of both the landowner and the NCC.

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**Bishopstone Cliffs agreement in jeopardy Bishopstone Cliffs SSSI, Kent**

Bishopstone Cliffs, on the north Kent coast, provide classic exposures spanning the Palaeocene-Eocene boundary, and the locality is one of Britain's most important palaeobiological sites. The unglipted Tertiary-Rosian succession spans the Thanet-Woolwich-Oldhaven-London Clay interval and yields the only unequivocal Palaeocene floras in Britain.

The protracted history of the NCC's efforts to protect the site in the face of strong pressures for coastal defence works have been reported in previous issues of this journal (ESC 20, p 19, 21, p36, 22, p58). Following a period of lengthy and often difficult negotiations between the NCC and Canterbury City Council, an important breakthrough was made when, in 1984, the NCC and the City Council signed an agreement which offered the prospect of successfully reconciling the
conflicting requirements of geological conservation and coastal protection. Under the agreement the existing main cliff exposures would be retained behind an energy-absorbing block apron covering the upper foreshore. Cliff fall debris which could be expected to accumulate at the base of the cliffs would be removed so as not to obscure the exposures. A further important element was the City Council's express commitment to designate the cliffs a Local Nature Reserve to enable the site to be sympathetically managed for the purposes of geological and biological conservation. The NCC had grounds for optimism that the agreement offered a sound basis for the future safeguard of the site.

Regrettably the course of events since 1984 has not proved smooth. The City Council has yet to designate the site as a Local Nature Reserve, and implementation of the agreed coastal protection measures has also led to difficulties. The block apron on completion is some 30m longer than specified in the original plan, and is extended eastwards by a further 150m in the form of a clay embankment which did not figure in the original scheme and over which the NCC was not consulted. The dumping of the clay has obscured a significant amount of rock exposure.

The NCC has had further discussions with the City Council and is particularly concerned that the slumped debris behind the apron, and the clay embankment, be removed. No progress has been made on the former issue as the City Council now argues that removal of the slumped debris may undermine the stability of the cliffs. Provisional agreement has been reached to cut through a trench through the clay embankment to facilitate more rapid removal of material by wave action. More broadly the NCC is of the opinion that the agreement was signed in good faith by both parties with a realistic expectation that its contents would be enforced, and it is its intention to ensure that the terms of the agreement, both in detail and in spirit, should be adhered to.

The dumping of the clay has obscured a significant amount of rock exposure. The City Council has yet to designate the site as a Local Nature Reserve, and implementation of the agreed coastal protection measures has also led to difficulties. The block apron on completion is some 30m longer than specified in the original plan, and is extended eastwards by a further 150m in the form of a clay embankment which did not figure in the original scheme and over which the NCC was not consulted. The dumping of the clay has obscured a significant amount of rock exposure.

Site management

Site clearance

South Elmsall Quarry SSSI

A fine example of a stromatolite reef in the Upper Permian Lower Magnesian Limestone of West Yorkshire is present in South Elmsall Quarry (SSC 20, p37, 21, p10). In 1985 West Yorkshire Metropolitan County Council purchased the site for conservation purposes and set up to improve its condition and appearance. The work undertaken included installing a notice board describing the geological interest, tree and shrub planting, laying out paths and erecting seats. The site, which with the demise of the metropolitan county councils is now owned by West Yorkshire County Council, is in excellent condition and was formally opened to the public in 1986. The NCC wishes to congratulate the Council on their conservation efforts.

The condition of the site is being monitored by Mr Roy Olcott of Yorkshire Geological Society as part of the NCC's informal site adoption scheme.

Site access

Hannaborough Quarry SSSI, Devon

An important exposure of lamprotophytic lava belonging to the poorly-exposed Exeter Volcanic Series outcrops in Hannaborough quarry. A further major feature of interest is a breccia which has been variously interpreted as a vent agglomerate and a debris flow.

In recent years vegetation has been encroaching upon the outcrops and the NCC and the tenant of Hannaborough Farm are pursuing a management agreement to cover the future maintenance of the site. The farmer, Mr R Mackenzie, is keen to facilitate continued access to the site for geologists but is concerned that acts of vandalism by hammer-wielding students and damaged cars on the site should not be repeated. It is now been agreed that bona fide geologists and educational parties may visit the site provided that permission is requested in advance from the NCC, 49 Brack Street, Tavistock, telephone number (0822) 612292. Access is subject to the further provisions that parties undertake to supervise student behaviour on site, and that visits should preferably occur between Mondays and Fridays.

Coten End Quarry SSSI, Warwickshire

Coten End Quarry has been known since the nineteenth century as the source of a unique assemblage of Middle Triassic terrestrial vertebrates. The fauna represents the broadest range of reptile of this age in Britain, including Rhynchosauria, and occurs within the normally indistinguishable Brunssum Sandstone Formation, formerly the Keuper Sandstone.

This site has now passed into the hands of a new owner who intends to clean up the faces by removing garden refuse tipped in from adjoining houses and cutting back scrub growth. To prevent illicit dumping the gates are to be locked and access permission and a key will be required for geologists who wish to visit the quarry.

Requests should be directed to the new owner, Mrs W Vaughan, at 21 Mallory Road, Bishops Tachbrook, Warwick, CV35 9QX.

Halfway Quarry SSSI, Powys

Halfway Quarry, also known as Capel Horeb, is an important site for stratigraphic and palaeoenvironmental studies at the base of the Old Red Sandstone in Wales, with a sequence spanning the Ludlow, Downtonian and basal Devonian strata. It is an internationally important palaeontological locality providing evidence of the earliest vascular land plants.

The present owners recently became concerned about the high levels of usage of the site by visiting geologists given the unsafe condition of some of the faces, and for this reason felt obliged to refuse access. Following discussion with the NCC the owners have relented in part and will now permit access for research geologists provided they obtain written permission in advance from the NCC, Deasville, Spa Road, Llantrisant Wells, Powsy, LD2 5ET.

Wotton Hill SSSI, Gloucestershire

Wotton Hill quarries provide an almost complete section through the Inferior Oolite of the south Cotswolds. Of particular interest is the Cephalopod Bed which has a notably rich ammonite fauna.

In 1986 the owner contacted the NCC and expressed concern over continuing trespass by parties of geologists. He was especially worried that collecting of fossils was undermining the stability of the rock faces, and about his liability should a rockfall result in serious injury. The NCC and the owner, Mr P Hodson, are in agreement that intending visitors must request...
permission in writing in advance. Please write to Mr Hodsman, c/o Grossmann Solicitors, 12 The Plain, Thornbury, Bristol BS12 2BE.

**Gribun Shore SSSI, Argyll and Bute**

Gribun Shore, on the western coast of Mull, is a classic locality for geological parties visiting the island. The unconformity between the Moine rocks and the overlying Triassic red beds is superbly exposed and the site is also significant for palaeoenvironmental studies of the Triassic sediments, Rhaetic sandstone and Upper Cretaceous silicified chalk.

In 1986 Mr I MacFadyen, the tenant who farms the adjoining fields, complained to the NCC about the behaviour of geologists who take short cuts across arable land. The NCC and Mr MacFadyen have agreed to regularise the routes that geologists can take by means of signposts, stiles and clearly marked pathways, as indicated on the accompanying map. The NCC is grateful to Mr MacFadyen for permitting geologists continued access to the shore but would remind all visitors that they must observe the courtesy of calling at Balmeanach to ask permission before using the path to the shore.

**Holywell Coombe rescue excavation**

Holywell Coombe, near Folkestone, is a key locality for late Devensian and Flandrian tufa deposits, containing fossil molluscs, plant remains and beetles. In the last issue of *Earth science conservation* we reported Eurotunnel’s agreement to fund a large-scale rescue dig to investigate the site prior to major engineering works for the Channel Tunnel destroying much of it. During the late summer of 1987 Phase One of the excavation was successfully accomplished by a team of scientists led by Dr Richard Preece of Cambridge University.

Phase One involved the drilling of 150 further boreholes in a series of transects across the area. The aim of the borehole survey was to provide a more detailed picture of the three-dimensional nature of these highly variable late Devensian and Flandrian deposits. Each core was logged and samples were taken from those providing a record of lateral changes in the lithostratigraphy or where biostratigraphic analyses of the fossils in the cores could be used for correlation.

A large trench, 40m x 8m x 2m deep, was also cut in order that the detailed lateral variation within the deposits could be examined in open sections. Two smaller trenches were cut within the larger trench so that the full depth of the deposit could be examined and sampled.

As part of the project a detailed archaeological excavation was undertaken by the Canterbury Trust for Archaeology. This involved the careful and painstaking excavation of the upper 2m of the sequence. Artifacts have been recovered from all levels but of particular interest are those from the Iron Age, Bronze Age and Neolithic levels.

The NCC is presently awaiting the go ahead for a second phase of field work involving the construction of further deep trenches in key areas identified in the borehole survey.

Excavation on the trench in the tufa deposits, Holywell Coombe.
Archaeological excavation in the upper levels of the sequence, Holywell Coombe.

Trenched cross-section through the upper levels of the deposit, Holywell Coombe.

**Cambridge Greensand – a gap in the GCR coverage**

Continental, as distinct from marine, deposits of Middle-Cretaceous age are rare in Britain, and no sites to represent them are as yet included in the GCR coverage. However, a literature review of the work done by Richard Owen, T H Huxley and Harry Govier Seeley in the 1860s and 1870s suggests that a modern review of Upper Greensand sites in the Cambridge area could be most rewarding. In the late nineteenth century a considerable collection of fossil material was made in the phosphate washings of the villages of Barnwell, Boston, Haslingfield, Reach and Trumpington in the Cambridge area. Most of the material is now in the Sedgwick Museum in Cambridge and includes the remains of dinosaurs, crocodiles, lizards, pterosaurs, birds and even some rare pleosaurus and ichthyosaur remains.

The fauna is particularly important for its dinosaurs and ten species belonging to the genera Acanthopholis, Anoplosaurus, Microsaurus, Euskelosaurus, Strongosaurus and Thalassotherium. The latter genus is represented by T. cantabrigensis which is believed to be the earliest representative of the Hadrosauridae, or duck-billed dinosaurs, which became extremely abundant and diverse in North America and east Asia in late Cretaceous times but remained curiously rare elsewhere. Very recently, Peter Welliniofer of Munich has reported Brazilian pterosaurs which seem remarkably similar to the species described by Owen and Seeley from the Cambridge Greensand. Both of these taxa seem to be characterised by a curiously wedge-shaped tip to the snout.

In recognition of the increased attention which dinosaurs and pterosaur research is focusing on the Cambridge Greensand, the NCC and the University of Cambridge are considering possible ways of documenting the Greensand localities and re-excavating some of the more promising localities.

**Recent palaeontological discoveries on GCR sites**

It is always pleasing when discoveries highlight the research potential of SSSIs and vindicate their selection as GCR sites. Two such instances are described below and draw attention to the value of strong relations between amateur fossil collectors and the scientific community.

**Hanover Point – St Catherines Point SSSI**

This stretch of the Isle of Wight coast is important for its Cretaceous stratigraphic and palaeontological interest. A couple of years ago Nick Chase, a graduate biologist and keen fossil collector, chanced upon dinosaur fragments exposed after a recent cliff fall. The material collected proved to belong to the iguanodont species I. athelfieldensis and although the skeleton was incomplete it included both hindlimbs and the pelvis as well as many vertebrae, ribs and most importantly, a very fine skull. The skull is largely complete although broken into a number of pieces and it has proved possible, unlike many such occurrences, to investigate the interior with relative ease. Dr Dave Norman of the NCC is currently preparing a detailed monograph on the cranial morphology of I. athelfieldensis and this new specimen has provided the basis for the best and most accurate reconstruction yet of the species.

**Smokejack SSSI**

Smokejack brick pit in Surrey is renowned as the most prolific reptile site in the Lower Cretaceous Weald Clay, and in 1986 lived up to its reputation with the discovery of a new family of dinosaur. The discovery by an amateur fossil collector, Mr William Walker, of a large claw led to a major excavation by staff of the British Museum (Natural History) and to the naming of the animal as Baryonyx walkeri. Although the popular press continued to prefer the name "Claws", Alan Charig and Angela Milner have described the fossil animal as a new and extremely unusual carnivorous dinosaur, the like of which has not been encountered before. Apart from the large claw, which may have belonged to either the front or back feet, the skull is unusually long and flat, and its curiously crocodile-like, with the teeth at the tip of the mouth being somewhat larger and splayed outward in a rossette fashion. Furthermore there is a strong suspicion that the animal moved around on all fours, unlike its typically bipedal carnivorous relations, and may have been a fish-eater. The enlarged claw, if attached to the front foot, could have served as a gaff for catching fish, and if supported by evidence of fish scales of a large fish named Lepidotes in the area of the rib cage of the skeleton. An alternative interpretation has been proposed by Andrew Kitchener, of Reading University, who has suggested that the animal was a scavenger rather than an active predator and that the large claws were used to tear through the hide of dead dinosaurs.
Field education

New Burrator and Wenlock Edge trails published

We are pleased to announce that the new Burrator Dartmoor landform trail and the Wenlock Edge geology teaching trail have now been published. The trails, which were described in some detail in ESC 23 p46, are the latest in our series of earth science teaching trails and details of how to obtain your copies are given at the end of this issue.

Public participation in geological conservation

Since the last issue of Earth science conservation, we have had many requests for copies of our information pack entitled Help conserve geology. The pack was originally produced for distribution at the Association of Teachers of Geology conference at the University of Bath in September 1985 and is now out of print. We intend to cover the subject matter of the pack with items and articles in future issues of Earth science conservation, but in response to requests, we are reproducing an edited version of the text below and this outlines the two main areas in which interested groups or individuals can become involved.

Informal site adoption

ESC 22 p 23-24, ESC 23 p 36

Earth scientists in the NCC are frequently involved with clearing exposures which have become overgrown or buried beneath weathered debris. Such exposures are cleared for two reasons: firstly to aid research in the selection of Sites of Special Scientific Interest and secondly to provide alternative localities suitable for educational fieldwork. Over 250 exposures have been cleared to date, many of them in disused quarries and railway cuttings.

A recent survey into the condition of exposures cleared specifically for educational fieldwork found that many were showing signs of deterioration. The majority could easily be restored and it is in this area that groups of volunteers are being encouraged to take an active role. We are currently developing a nationwide informal site adoption scheme involving volunteers from schools, colleges, universities, geological societies and county trusts for nature conservation and hope that groups will take responsibility for selected sites in their own area. Regular site visits are needed to monitor deterioration and vandalism, and to carry out simple maintenance tasks. These might involve cutting back vegetation or clearing loose talus and downwashed soil from rock faces. It should be remembered that talus slopes may be a useful source of material for collecting or provide a means of examining the higher parts of a rock face, and should not be removed as a matter of course. It must also be emphasised that the landowners consent must always be obtained before any work is carried out and that, as with all earth science fieldwork, each group is responsible for its own insurance arrangements.

Preparation of geological site description sheets

ESC 23, p 44-45

In many areas of Britain, important and well-known geological and geomorphological SSISs are being damaged by the large numbers of earth scientists visiting them each year. To conserve over-visitated sites, the NCC tries to find similar localities which are suitable for teaching purposes. Details of these alternative sites are published in field guides or teaching trails as site description sheets.

The first project on this type was carried out in Mortimer Forest near Ludlow in 1976. Mortimer Forest was of international importance as the type area for the Silurian Ludlow Series and also receives heavy educational use. Thirteen small quarries were cleared as alternative localities for fieldwork and these form the basis of an educational study and these have been described in a field guide. A similar, but more widespread, project was completed in 1986 in the east Mendips. Here 39 localities, covering all aspects of Mendip geology from the Lower Palaeozoic to the Pleistocene, were selected as being suitable for educational study and these have been described in a field guide.

There is a growing need for information about new fieldwork localities in Britain, particularly sites suitable for elementary study in GCSE Science courses. We believe that local geologists, whether amateur or professional, teachers or students, can play an important role here. By using local knowledge, museum records and published literature, suitable sites can be selected and descriptions prepared. These descriptions could take the form of simple information sheets and if submitted to the NCC, could be published as part of our new ‘geological site description sheet series and distributed with forthcoming issues of Earth science conservation.

For further information, advice and guidance about either of these valuable areas of voluntary conservation work please contact Mike Harley at the Earth Science Division of the NCC.

Geological site description sheets

In ESC 23 p 44-45 readers were introduced to a new educational initiative on the part of the NCC, when we produced three geological site description sheets as the first examples of a new series intended to promote the structured use of selected geological and geomorphological localities for educational field work.

The attentive reader, however, will have noticed that in the accompanying article we stated that four such sheets were enclosed. The reason that the fourth sheet had to be omitted was due to unforeseen site access problems which arose shortly before the journal was due for distribution. Unfortunately, despite lengthy discussion with the landowners, it has not proved possible to agree access arrangements and the NCC has been asked to state that the site, Stoney Littleton Quarries near Radstock in Avon, is no longer available for study.
Earth science conservation in Roumania

In July 1987, Dr Dave Norman, the NCC palaeontologist, visited Roumania on a scientific exchange sponsored by the Royal Society and the Roumanian Academy. While the visit was primarily concerned with a collaborative palaeontological research project on the late Cretaceous Maastrichtian vertebrate fauna of Transylvania, Dr Norman was keen to learn more of attitudes to geological conservation in the People's Republic.

Although the NCC is abreast of geological conservation efforts in Western Europe and North America, comparatively little is known about earth science conservation in some of the East European states. Whilst in Bucharest Dave Norman was introduced to Dr Dan Grigorescu of the Faculty of Geology and Geography at Bucharest University, who leads an active and enthusiastic group of conservationists concerned with monitoring geological sites. At present the group is very much in its infancy, having only been formed two years ago, and working largely on a voluntary basis. However the group are compiling a database which will be of immense value in future years as the pressures from development and urbanisation exert their increasing effects upon Roumania's countryside.

It is hoped that Dr Grigorescu will be able to visit England as part of a reciprocal research exchange in the future and that his visit will offer a further opportunity to learn about the Roumanian perspective on earth science conservation.

London (Grays Inn Road) – Friday 20 and Saturday 21 May
Aberystwyth – Thursday 14, Friday 15 and Saturday 16 July
Edinburgh – Friday 28, Saturday 29 and Sunday 30 October

Described as “splendid examples to the general public of geology in action” and as “immensely valuable to the profession as a whole”, the exhibits and demonstrations are designed to entertain as well as enlighten and all members of the general public will be welcome.

For further details and confirmation of dates and times please contact Dr Brian Taylor at BGS Keyworth telephone number 06077 6111 extension 3392.

Brownend Quarry becomes nature reserve

Brownend Quarry SSSI, Staffordshire

Brownend Quarry, an important geological site near Waterhouses, is the first new reserve announced since the launch of the Staffordshire Wildlife Appeal in April 1987. The site is of national importance for its sequence of Lower Carboniferous rocks, and is designated as a Site of Special Scientific Interest. It is the first geological reserve to come under the control of the Staffordshire Nature Conservation Trust, and only the 46th county trust geological reserve in Britain.

The quarry exposes the oldest Dinantian rocks in the Derbyshire/north Staffordshire region, and the steeply dipping sequence of Chadian to Asbian age appears to lack the intervening Arundian and Holkerian stages. The site shows what has been interpreted as a condensed sequence, with the development of reef limestones in an otherwise basinal situation. Some horizons are fossiliferous and examples of corals, brachiopods, crinoids, conodonts and trace fossils can be seen in situ and in fallen blocks. The site has immense research potential but is also particularly suitable for educational purposes. The steeply dipping strata provide easily accessible and identifiable rock units and the site is much visited by fieldwork parties.

Purchase of the quarry has been made possibly by contributions from a range of bodies including the NCC, Peak District National Park, Staffordshire Moorlands District Council, the Geologists' Association and the Geological Society of London. A further £5000 must now be raised to enable the Trust to complete the purchase and carry out essential management and public interpretation, including the removal of debris from the site.

It is intended that the reserve will be opened to visitors by appointment in 1988, and shortly thereafter freely available to the public once interpretive facilities have been installed. Intending visitors should contact John Drewett on 08897 534 for access permission and further information.

Following the outstanding success of the Open Days held by the British Geological Survey in 1985 and 1986, when over ten thousand people attended at Keyworth alone, further Open Days are now planned between May and October 1988. The dates where known are as follows and opening hours will be between 1000 and 1700 hours.

Keyworth – Thursday 5, Friday 6 and Sunday 8 May
Newcastle – Thursday 5, Friday 6 and Sunday 8 May
Exeter – Thursday 12, Friday 13 and Saturday 14 May

BGS announces 1988 Open Day dates
# Earth Science Conservation — Index for issues 1 to 23

We present below an index for issues 1 to 23 inclusive of Earth science conservation. Issues 1 to 14 originally appeared under the title Information Circular. The index is in four parts as follows:

- **Geographical index**: lists place names according to country and county or, in the case of Scotland, district. The term Greater London is retained for convenience. The term Cornwall is included where appropriate for localities.
- **Geological index**: this listing is intended to assist readers in determining which localities fall into the geological subject area of particular interest to them and cannot be fully comprehensive as, for example, most references to localities.
- **Subject index**: this is designed to assist readers in locating terms relating to various recurring themes, such as coastal protection.
- **Featured articles**: these are listed chronologically according to issue number.

Each entry consists of the volume numbers, indicated in bold, followed by the page number(s).

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Earth science publications from the NCC

Geology teaching trails

Wren’s Nest NNR: geological trail
Wren’s Nest NNR: geological handbook
Staple Edge geology teaching trail: booklet
Staple Edge geology teaching trail: student’s worksheet (x3)
Salt Hill Quarry geology trail
Mortimer Forest geological trail
Burrator Dartmoor landform trail
Wenlock Edge geology teaching trail

Field-guides

Tertiary Igneous Rocks of Rhum
(C. H. Emelius and R. M. Foster, 1979)

Earth science conservation

A limited number of back issues of Earth science conservation numbers 1 to 22 (1968-1985) are available free of charge direct from the Earth Science Division.

Information leaflets

Practical geological conservation

Paid items are available post free from Publications, NCC Peterborough. Payments should be made by cheque or postal order payable to the Nature Conservancy Council. Unpriced items are available free of charge from the Earth Science Division at the same address.

Acknowledgements

Photographs of Holywell Coombe were supplied by Q. A. Photos Ltd.

The photograph of Gaping Ghyll was supplied by John Forder.
The Nature Conservancy Council is the body responsible for advising Government on nature conservation in Great Britain. Its work includes the selection, establishment and management of National Nature Reserves; the selection and management of Marine Nature Reserves; the identification and notification of Sites of Special Scientific Interest; the provision of advice and dissemination of knowledge about nature conservation; and the support and conduct of research relevant to these functions.

This is one of a range of publications published by the Interpretive Services Branch. A catalogue listing current titles is available from Dept. ESC, Nature Conservancy Council, Northminster House, Peterborough PE1 1UA.