The Edinburgh Geologist

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EDITORIAL

The Edinburgh Geologist is five years old in March. Whoever thought it would last this long? Those wishing it to continue should forward their literary contributions to the Editors. We have begun the mammoth task of compiling an index to be published with the 25th issue!

But before we start celebrating we should remember that if the age of the Earth is represented by one year then the life-time of the magazine to date is 0.035 seconds. And on that contemplative note we wish our readers well.

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THE MODERN EVOLUTIONARY DEBATE

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"What do you think Darwin himself would have thought about this present debate?" said a colleague recently. "One gets the impression that a number of biologists and palaeontologists have given up believing in evolution altogether!" suggested another. So what is this new debate all about, and how far has the status of evolution theory been affected by it? And where do geology and palaeontology now stand with respect to evolution?

Let us begin by briefly summarising orthodox evolution theory, which is based upon the original work of Darwin combined with an understanding of inheritance coming from the much later development of genetics. According to Darwin animal species reproduce more rapidly than is needed to maintain their numbers, though populations tend to remain stable. Consequently there must be continual competition within and between species for food, living space and mates, if the characters that individuals bear are to be transmitted to the next generation. Now within all species there is much individual variation, and this is inherited; in the "struggle for existence" only those individuals best fitted to survive in a particular environment will live and reproduce. The favourable characters are inherited by future generations, and the accumulation of different favourable characters leads to the separation of new species well adapted to particular environments. And this, in a nutshell, is "Natural Selection".

Darwin knew little about inheritance, which is of course critical to the theory, and it was the unique contribution of genetics in this field that made further development of evolution theory possible. It is now understood that characters (structural, physiological etc) are controlled by genes, located in the chromosomes of each cell. The genes are the units of heredity; they carry a "genetic blueprint" which directs the development and functioning of the whole animal. Each sexually reproducing animal carries its chromosomes in paired sets, and one chromosome of each homologous (corresponding) pair comes from each parent. When an egg is fertilised, therefore, the homologous chromosomes from different parents come together and pair up (recombination) – so the characters of the offspring, though based upon existing genes are not identical to those of either parent. It is upon this variation that natural selection operates.

Sometimes changes (mutations) in one or more genes can lead to somewhat different gene expressions or characters, and if a mutant is favourable it may be positively selected, and if the population is small it will spread. New species normally arise when such a population carrying its own sample of the overall "gene pool" of the parent population splits off and becomes isolated. New and favourable mutations may then accumulate in the population in a classic Darwinian manner and eventually the descendants will be different enough to be a new species.

We have here been considering in very simplified terms, classic Neo-Darwinism – a synthesis which gives a logical explanation of how species arise. It is, however not complete in itself. Our understanding of how the information in the genetic blueprint actually works so as to produce a functional organism is still very limited. It is the task of molecular biology to unravel this, and it will take a very long time to do so. Until this is done many rather acute problems will remain unsolved.

Whereas orthodox Darwinism, combined with genetics and molecular biology, tells us something of the mechanism of evolutionary change, it is only from palaeontology and from the geological record that we can know about the course of evolution. Palaeontology furthermore makes another unique contribution – how rates of evolution have varied through time – a matter I shall shortly discuss in more detail.

Here we come to the current debate about evolution, which has particularly centred on palaeontology and which has generated, in the columns of *Nature*, between November 1980 and July 1981, no less than 60 letters and 6 editorial articles. This controversy derives from two separate though related developments. One is the concept of "punctuated equilibria", the other is known as cladistics.

The first of these, "punctuated equilibria" in essence claims that evolution progresses in a series of steps and not by gradual transformation. And there is nothing in this which is in any sense antagonistic to Neo-Darwinian evolutionary theory, (or even to Darwin's own writings), even though some correspondents in *Nature* have claimed otherwise. In the fossil record, one rarely sees gradual transformation. There are indeed a few well-documented examples such as in the Cretaceous burrowing sea-urchin *Micraster*, (which occurs in an uninterrupted sedimentary sequence and where the relatively small changes can be interpreted functionally as adaptations to deeper burrowing). But generally new species appear very suddenly in a vertical sequence, often associated with a distinct sediment type, thereafter the species persists with little if any change. When the sedimentary environment alters, so the species frequently disappears and may be replaced by another.

What has happened here is that the first species, derived from a peripherally isolated and small population of a parent group has migrated into the area in question. It carries its own gene pool and has probably collected some favourable or neutral mutations as it rapidly becomes adapted to the environment represented by the sediment. This stage of evolution is very rapid indeed – the small population either adapts quickly through natural selection or dies out. If successful it will spread rapidly (in geological terms instantaneously) and since it is now well adapted, it will not change greatly as long as the environment does not – this is the equilibrium referred to. When there is such a change, either the species dies out or it survives elsewhere where the environment persists. Alternatively a small part of the population may be able to adapt and become the "founding fathers" of the next species – but the population is so small that the chances of finding the transitional group is remote.

There is nothing in this which is in any way contrary to Darwinism. It provides an explanation for the innumerable discontinuities in the fossil record, and is quite in accordance with genetic and population theory and with what is actually seen in the rocks. And although the theory has been worked out in great detail by the North American palaeontologists Steven Gould and Niles Eldredge, it was first hinted at by Darwin himself, in the fourth edition of the *Origin of Species*, as a possible mechanism for evolutionary change. It is a pity that the suddenness of appearance of species has been seized upon, not only by the self-styled 'creation scientists' who have a clearly stated antagonism to Darwinism, but also by some other eminent figures, Sir Edmund Leach, for example, who seem to have misunderstood the theory and who in consequence seem to be critical of Darwinism. It has become a rather silly debate, largely unnecessary, and sadly blown out of all proportion by the media.

Now let us consider cladistics. This is in its simplest form a procedure for classifying living or fossil organisms, and taxonomy is nothing else than an attempt to classify organisms in a rational manner, indicating their degrees of similarity and difference, and ultimately their evolutionary relationships. In cladistic methodology, cladograms (Fig. 1) are

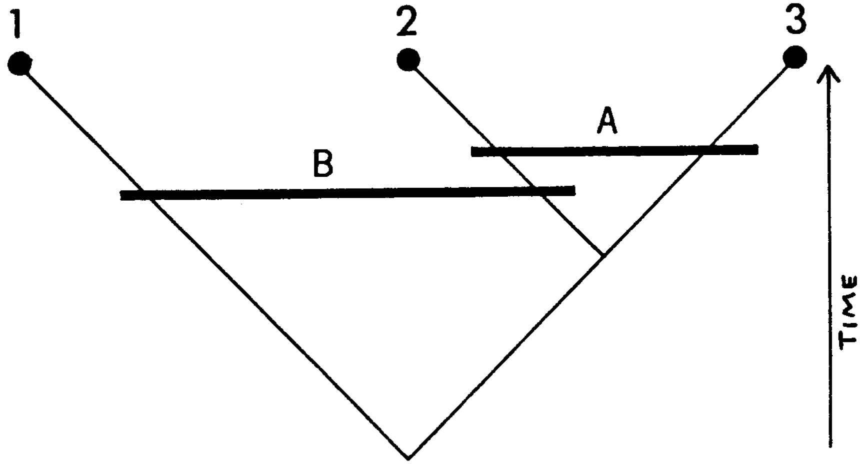

Figure 1. A cladogram of three taxa. Taxa 2 and 3 share an evolutionary novelty (a "synapomorphy," indicated by the black bar labeled A) not possessed by taxon 1. Taxa 1 and 2 share a primitive similarity (a "symplesiomorphy," indicated by the black bar labeled B) not present in taxon 3. Shared possession of a derived similarity by taxa 2 and 3 is direct evidence that they are more closely related to each other than either is to taxon 1. Shared possession of a primitive state by taxa 1 and 2, in contrast, is not indicative of any special relationship between them.

used to determine or to express such relationships and in many ways this is no more than an intendedly rigorous standardisation of normal taxonomic procedure. Consider three taxonomic groups (e.g. species, genes, families etc) 1, 2 and 3. Of these 1 and 2 *share a primitive similarity* (symplesiomorphy) (B), whereas 2 and 3 *share an evolutionary novelty* (synapomorphy) (A). In cladistic methodology 2 and 3 are thus believed to be more closely related to each other than either is to species 1, and are assumed to have originated more recently. Conversely the possession of *shared primitive* similarities between 1 and 2 does not necessarily indicate a close relationship. In the construction of the cladogram it is assumed that when an ancestral species gives rise to new species it will do so dichotomously* and so the cladogram represents an arrangement of *nested hierarchies* in which the three species referred to can be placed in a logical relationship.

So far, so good – some taxonomists find that the ordering of thought involved in the construction of such a cladogram is really valuable, others have made plain that they order their groupings instinctively and that cladistic methodology is really nothing more than old-fashioned taxonomy formalised in the extreme, and certainly overloaded with jargon.

But here we come to the first real problem. Cladists do not consider it necessary, or even desirable, to bring stratigraphy into the argument – the order of succession of fossils is considered irrelevant in determining relationships; these must be based upon apomorphics and plesiomorphics alone. Traditionalists disagree absolutely; they argue that a good deal of the fundamental evidence on ancestor-descendant relationships is thereby thrown away, and to this the cladists reply that stratigraphy can, of course, be used as a confirmation of relationships previously determined through cladism! This may seem to be a case of hair-splitting, but the cladists do at least seek to escape from the circular argument which would allow an evolutionary hypothesis to be used to produce a classification, which is later used to "show" what course evolution has actually taken.

It is, as much as anything else, this fear of circularity which has really been the cause of much apparent trouble. For some of the more extreme cladists have insisted that classifications can and indeed should be made without any reference to any evolutionary ideas at all and that one could be a perfectly competent taxonomist without ever knowing any evolution theory. Going further along the same path, it could be argued that there is no reason why there should not have been mammals in the Cambrian – it is merely that we have not found them! At this point the whole process of thought becomes preposterous, for

*Footnote: Branching into two new species with the extinction of the original species.

either we believe in what our fossil record has to tell us or we throw it all away. Fortunately there are few who would take so extreme a view. Indeed there are some cladists (Eldredge for example) who believe that 'family trees' are perfectly valid, and that it is legitimate to construct them using the observed order of succession of fossils and whereas cladistic methodology has to be used first in assessing primary relationships these can later be assessed in stratigraphical perspective.

Having said all this, have we actually got anywhere? Has anything new emerged? We have learned certainly that in the appreciation of the new cladistic methodology to taxonomy, some extra objectivity may be gained. Conversely, we have also seen that too rigid a straitjacketing can take us far away from what has already been established – and even to ludicrous extremes. And when the media seize upon some of the more bizarre manifestations in the latter, and especially when they are taken out of context, a quite unnecessary furore ensues, which generates a great deal of froth and bubble and not much else.

I suspect it will all die down, and that we shall not go back upon the gains so far made by Neo-Darwinism. Of course, this does not mean to say that evolution theory is finally settled. We seem to know quite a lot now, but it may be that we have only really probed the more easily accessible evolutionary phenomena. It is one thing to understand, in Neo-Darwinian terms, how new species arise from pre-existing species (i.e. as variations on a theme), though even here some respected philosophers such as Karl Popper consider the whole concept of natural selection to be tautological. It is quite another matter however, to comprehend the origins of the incredibly complex *systems* found in living organisms, in which electrical, mechanical and biochemical functions are all harmoniously integrated. The fossil record doesn't help us here as shown by two examples which have particularly interested me. Firstly the eyes of trilobites (the oldest known visual system) seem on their first appearance in the Cambrian to be perfectly good, highly complex compound eyes; and later evolution for the next 350 million years only played upon this already established theme and we know nothing of its origins. Secondly, the mouthparts of the modern caridoid (shrimp-like) filter feeding crustaceans are masterpieces of mechanical ingenuity. They have dozens of little pieces, all of which move in different directions, during their feeding process and they extract food particles from the water and send them to the mouth. As with a watch, all the components are necessary; they have to be the right shape and size and they must all operate together with absolute precision. One looks for ancestral forms to try to understand how such a magnificently integrated system arose. The earliest known caridoid crustaceans are of Lower Carboniferous age – they occur beautifully preserved, in several localities in Central Scotland. But their preserved mouthparts seem to be just as complex as those of modern shrimps. They give no clue as to their origins. We are quite in the dark as to how this astonishing feeding system arose.

The real advances in understanding evolution for the time being must come from molecular biology for until the actual mode of operation of the genes is known; how they control the synthesis, organisation, regulation, and building-up into functional systems of the molecules from which the living body is made, there can be only limited progress. We need more fact before further theory.

There may however be other dimensions to evolution so far almost totally unexplored. Von Bertallanfy's vision in 1970 of "an organismic universe of many levels, the laws of which are a challenge to future research", and the concept which Alister Hardy and Arthur Koestler have popularised that "evolution can only run in archetypal grooves gradually actualising potentialities already present in the amoeba" may in fifty years' time be taken quite seriously.

That there has been this current debate on evolution at all may indicate a rather general dissatisfaction with the limitations of our present picture. The Darwinian paradigm, useful though it is, shows signs of strain. What we are really looking for is a new and general theory of evolution, which bears the same kind of relationship to Darwin's *Origin of Species* as Einstein's *General Theory of Relativity* does to Newton's *Principia*. It may need a figure of Einstein's intellect to transform the current model, but such is the threshold upon which evolutionary theory now stands.

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A PEEK BEHIND THE CURTAIN

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The IGS Staff Handbook on "How to be a Good Civil Servant" informs us that "every good civil servant should clean out his or her drawers at least once a month". While doing so for the first time this year I came across the following poem.

This little ditty was composed by a group of students employed as pack horses back in the early days of the Regional Geochemical sampling programme (circa 1969). The work consisted of tramping along all the streams in Caithness and east Sutherland taking samples of stream sediments with the aid of a shovel, two 24 inch diameter sieves, a similarly sized pan made of mahogany (and therefore heavy) and numerous poly bags. Wet sediment samples weighing at least two kilos each were then loaded into a rucksack, care having been taken to remove one's lunch first. The sieves, pan and shovel were strapped on to the rucksack frame with the aid of an elastic octopus or, in moments of economic fervour, a sextopus. One shudders at what the present set of cutbacks might produce! An attempt was then made to lift the whole, put it on one's back and stagger a couple of kilometres or so to the next site. The poly bags containing the wet sand leaked of course and I can well remember the feeling of squelching out across midge infested peat bogs with water trickling out of the rucksack, down the back of my jeans and into my wellies. It was at that point in my hitherto sheltered life that I learned some very colourful and original expressions from my fellow workers as they expressed their ? joy at conditions. Indeed, the experience altered one's values in life to the extent that a good pair of non-leaking wellies had been known to change feet for as much as a whole week's beer money! After field collection the wet sediment samples were taken to what we were told was a field lab in Dornoch. In fact it was the local nick complete with bars on the windows and huge locks on the doors. "Are they trying to keep us in or them out?" was the question on everyone's lips. Here the samples were removed from their now sopping poly bags, put in pyrex dishes like mud pies and placed in a warm oven to dry out overnight. As there were several ovens on permanently, the premises soon became somewhat tropical in temperature and with a superabundance of hot water always on tap, laundry lines bloomed in profusion giving the old place an air of domestic intimacy. When dry and cool the mud pies – sorry – geochemical samples were put through various processes of sieving, grinding and splitting before a small representative sample was finally sealed in a little polythene tube and sent off to London for analysis. The bulk of the residues accumulated in a storeroom and the resultant "mountain" reached such proportions that the floorboards eventually gave way. There is a moral for the EEC in this tale somewhere.

THE CAITHNESS PEAT (Tune: Jug O'Punch)

1 As I stepped out in my walking shoon
One fine morning in the month of June
A birdie flew up from beneath my feet
And the song he sang was the Caithness Peat.

CHORUS: Tooralooraloo Tooralooraloo
Tooralooraloo Tooralooraloo
A Birdie flew up from beneath my feet
And the song he sang was the Caithness Peat.

2 What more diversion can a man desire
Than to tramp for miles through the bog and mire
Of sieves and samples upon his back
And of good fresh air he hath no lack.

Chorus

3 Then after hours in the bar he'll be
With a pretty girl sitting on his knee
A Glenmorangie clasped in his hand
The happiest student in all the land.

Chorus

4 The academics with all of their finesse
Can't take water samples like the IGS
For midstream samples we always try
But in peat hag streams are often dry.

Chorus

5 And when I die send me to the lab
All neatly tied in a poly bag
Put me in the oven, turn it up high
And leave me in there until I'm dry.

Chorus

6 Turn the thermostat up a few degrees
For where I'm going I'll never freeze
The fires down there will give out great heat
When we stoke them up on the Caithness Peat.

Chorus

7 And when I'm buried and in my grave
No costly tombstone will I crave
Just lay me down in the Caithness Peat
With my sieves and spade at my head and feet.

Chorus

GEOLOGY AND PLANNING IN LOTHIAN REGION

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The observations expressed in this paper are those of the author.

Introduction

The practical use of geology has long been appreciated by those who have exploited the riches of the earth, but until relatively recently, geological input to land-use planning has been slight. Land-use planning is controlled by statute, the most up-to-date legislation being the Town and Country Planning (Scotland) Act of 1972 which is administered by local authorities and, in Lothian Region, by both Lothian Regional Council and the District Councils of East Lothian, Midlothian, West Lothian and the City of Edinburgh.

Jointly the planning authorities are responsible for the production of the Development Plan which sets out the framework for land-use. The Development Plan is sub-divided into the Structure Plan, a document which is submitted to the Secretary of State for Scotland for approval, and Local Plans. The first Structure Plan for Lothian Region, which has been approved in part, will guide the development of land and consequential changes to the environment during the 1980s.

Of four principal aims in the Lothian Structure Plan the third is of particular interest to the geologist. It states that the Regional Council will aim 'to conserve all resources including farm land and minerals and to utilise wisely infrastructure and vacant urban land'. This aim is realised in the Countryside Section of the Structure Plan Policy para. 94 which states that 'THE REGIONAL COUNCIL WILL SEEK TO PROTECT ALL SIGNIFICANT MINERAL DEPOSITS FROM STERILISATION BY PERMANENT DEVELOPMENT BUT WILL RESIST MINERAL WORKING IN CONSERVATION AREAS, SITES OF SPECIAL SCIENTIFIC INTEREST, PLANNED LANDSCAPES AND COASTAL DUNES'.

Public involvement in the planning process

Good communication between trade and planning authority results in a better mutual understanding of the mineral operators' need and the planners' position. In response to the Verney Committee Report, the Structure Plan policies on minerals were drawn up by the Joint Lothian and Borders Aggregates Working Party in consultation with the District Councils and Mineral Operators. The Working Party included representatives from the District Councils, the Institute of Geological Sciences (IGS), the extractive industries and other interested parties. At each stage of its preparation, the Structure Plan has involved contributions from members of the public, and, in addition to the Report of Survey and Structure Plan documents, a Public Consultation Report was published by the Regional Council.

Supply and demand

The problem of mineral supply and demand has never been satisfactorily resolved. None of the many forecasts of demand have been usable as the detailed input required to calibrate the various production models is not to hand. Demand for minerals fluctuates with the variation in the state of the economy, but economic health is not immediately reflected by a change in the production of raw materials. Past production figures give an indication of future demand but such statistics may not be readily available either for all minerals or for region by region.

Mineral workings tend not to be welcome neighbours and objectors to new operations argue that there is no need, particularly in their area. Without supply and demand data, the operators' case is greatly weakened. A freer exchange of information between mineral operator and planner could do much to resolve matters.

National planning guidelines

Planning at the local level does not operate in a vacuum and must take into account planning policy of Central Government for both the United Kingdom and Scotland. At present aggregates (gravel, crushed rock etc.) and groundwater are the only two aspects of mineral planning covered by national planning guidance. As there is no statutory obligation for local authorities to follow these guidelines their recommendations may not be fully implemented.

Implementation of the Structure Plan

The main problem of administering the Structure Plan is that the document is not site specific. Consequently significant minerals have had to be defined and their areal extent and resource information quantified.

The areal extent of mineral deposits has been obtained from published geological sheets and from unpublished material of the IGS. Most of Lothian has been geologically surveyed relatively recently and only a small portion of West Lothian and the extreme south of Midlothian is not covered by maps at the 1:10560 scale.

Lothian is fortunate in that much has been written about its minerals. The most comprehensive account *The Mineral Resources of the Lothians* by A. G. MacGregor was published in April 1945 by HMSO. Although in need of updating, this publication by and large gives a good insight into the resources of the area. However, qualitative and quantitative information on resources is not generally available. For sand and gravel this deficiency should be made good during the 1980s when the IGS may survey parts of Mid and East Lothian, but no detailed studies of other minerals are planned at present.

To date, the Regional Council have designated sand and gravel, igneous rock, limestone, coal, fireclay, silica sand and brickmaking materials as 'significant minerals' in the terms of Lothian Region Structure Plan Policy para. 94. Peat and oil-shale have not been designated and build-sandstone is currently under consideration.

The following notes, which are not comprehensive, describe the Region's 'significant minerals'. Potential resources of other minerals (excluding peat and oil shale) and the problem of mining subsidence are also discussed.

Sand and gravel (Fig.1)

Sand and gravel is concentrated east of the Pentlands. In West Lothian small deposits are worked at Couston and Linlithgow. In Edinburgh almost all deposits are sterilised by development. In other words, they have been built over. Midlothian's sand and gravel which occupies the valleys of the River North Esk, the River South Esk south of Carrington, and the Tyne Water is worked near Loanhead and Roslin. In east Lothian, deposits fringe the Lammermuir Hillfoots, the Dunbar Coastal Plain and the mouth of the River Tyne: the only working is at Longyester.

Uses of sand and gravel include building, concrete and asphalt manufacture. Deposits in Midlothian tend to be contaminated with coal which is difficult to remove, and in the East Lothian gravels tend to show high percentages of greywacke, which may cause concrete made from it to shrink on drying.

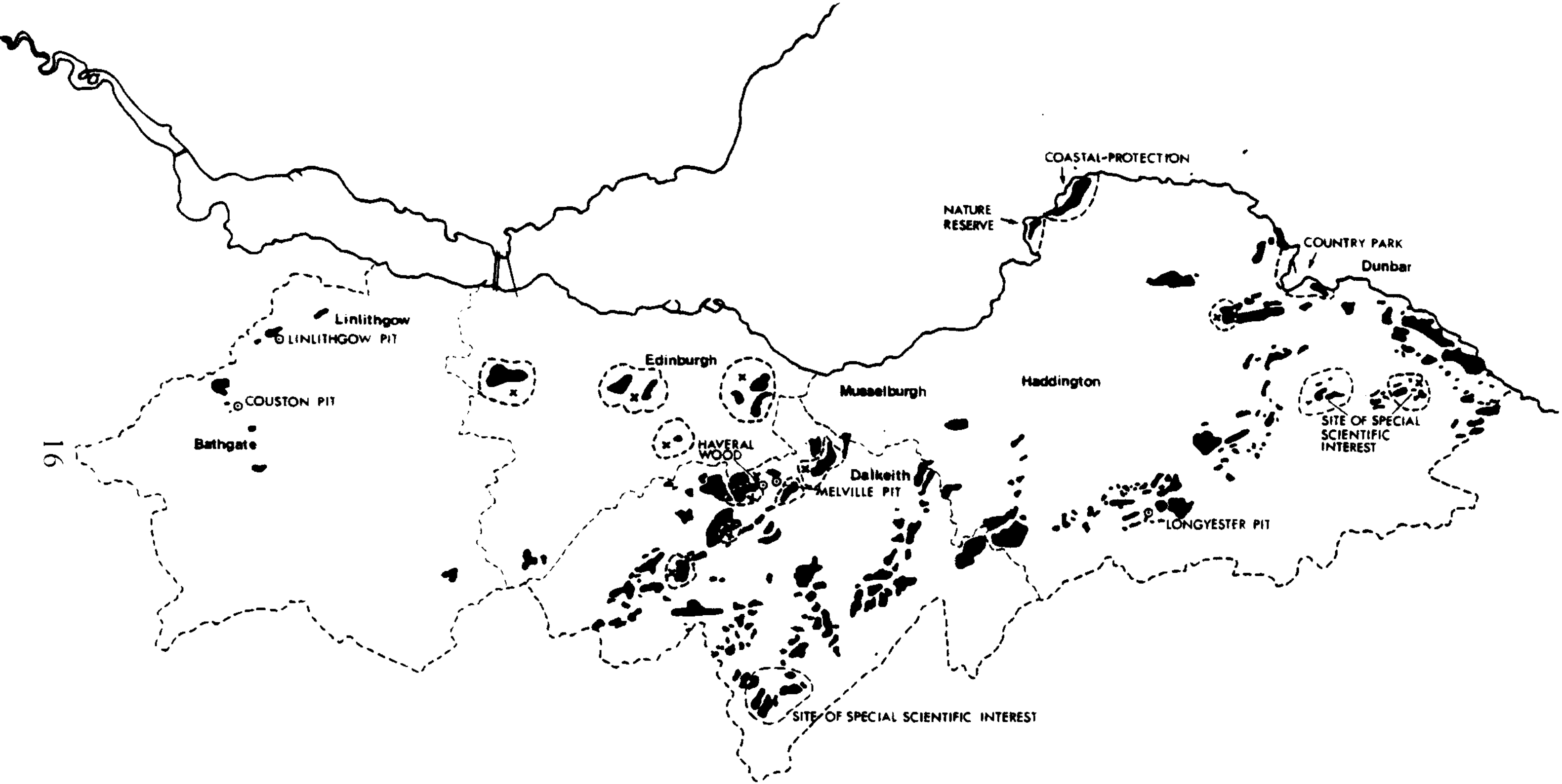
Igneous rock (Fig.2)

Intrusive igneous rock (dolerite) and extrusive (basalt) are both designated significant minerals, although emphasis is placed on protecting the intrusive varieties which tend to provide a better all purpose construction material. Intrusive igneous rocks are used for concrete and for road surfacing; the extrusive varieties supply material for fill and road bottoming.

Most of the intrusive igneous rock crops out in West Lothian and Edinburgh. None of the West Lothian outcrops are being worked and in Midlothian one is worked intermittently. Four quarries operate in the Edinburgh area and one in East Lothian. Two workings are in extrusive igneous rock, one in Edinburgh, the other in East Lothian.

Limestone (Fig.3)

Throughout Lothian limestone has been extensively mined and quarried in the past. There are major deposits near Dunbar and Saltoun in East Lothian which extend into southern Midlothian. Deposits in West Lothian and Edinburgh are probably too thin or too steeply



BASED UPON THE ORDNANCE SURVEY MAP BY SANCTION OF THE CONTROLLER

SCALE 1:312,500 5 miles to 1 inch

LOTHIAN REGIONAL COUNCIL
DEPT. OF PHYSICAL PLANNING

BASE GEOLOGY
SOURCE: Institute of Geological Sciences

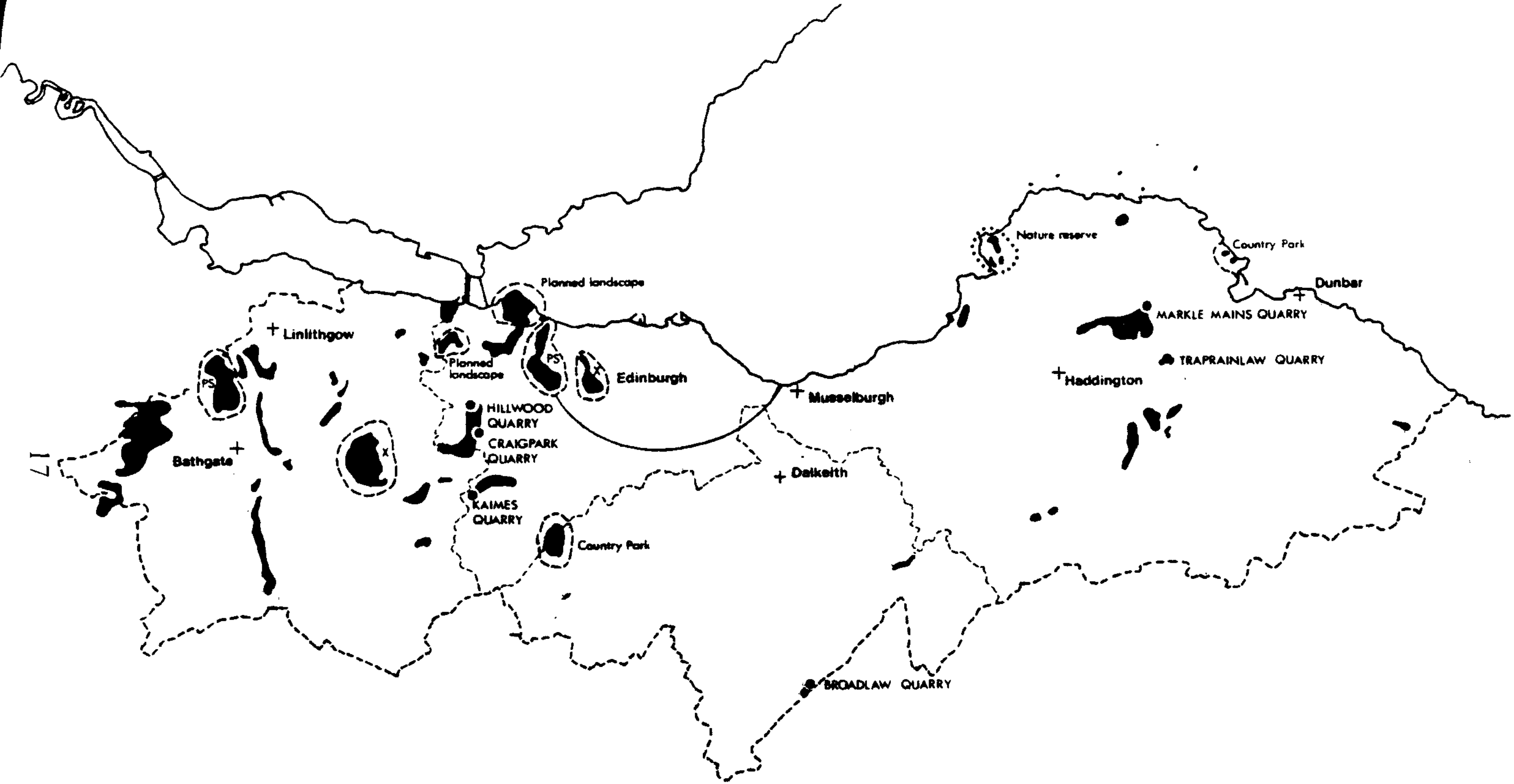
SAND AND GRAVEL DEPOSITS

STERILISED

PLANNING CONSTRAINT EG. COUNTRY PARK

Figure 1

SAND AND GRAVEL DEPOSITS



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SCALE 1:312,500 5 miles to 1 inch

LOTHIAN REGIONAL COUNCIL
DEPT. OF PHYSICAL PLANNING

BASE GEOLOGY
SOURCE: Institute of Geological Sciences

IGNEOUS: INTRUSIVE OUTCROP AREA

PS Part sterilised

X All sterilised

Planning Restriction
eg. Nature Reserve

Figure 2

IGNEOUS: INTRUSIVE

dipping to be of economic interest at present. Only two operations remain, one each in Midlothian and East Lothian. The Middleton Quarry in Midlothian produces ground lime for agricultural and other purposes: near Dunbar in East Lothian the Blue Circle Group manufactures cement. Magnesian limestone is imported into the Region from the North of England as a substitute for locally produced limestone.

Coal (Fig.4)

Coal is concentrated within two main subdivisions of the Carboniferous, the Coal Measures and the stratigraphically lower Limestone Coal Group, although other subdivisions do contain coals of workable thickness. The Lothian Coalfield occupies most of Midlothian and the western portion of East Lothian. The western half of West Lothian is underlain by part of the Central Coalfield.

Deep mines

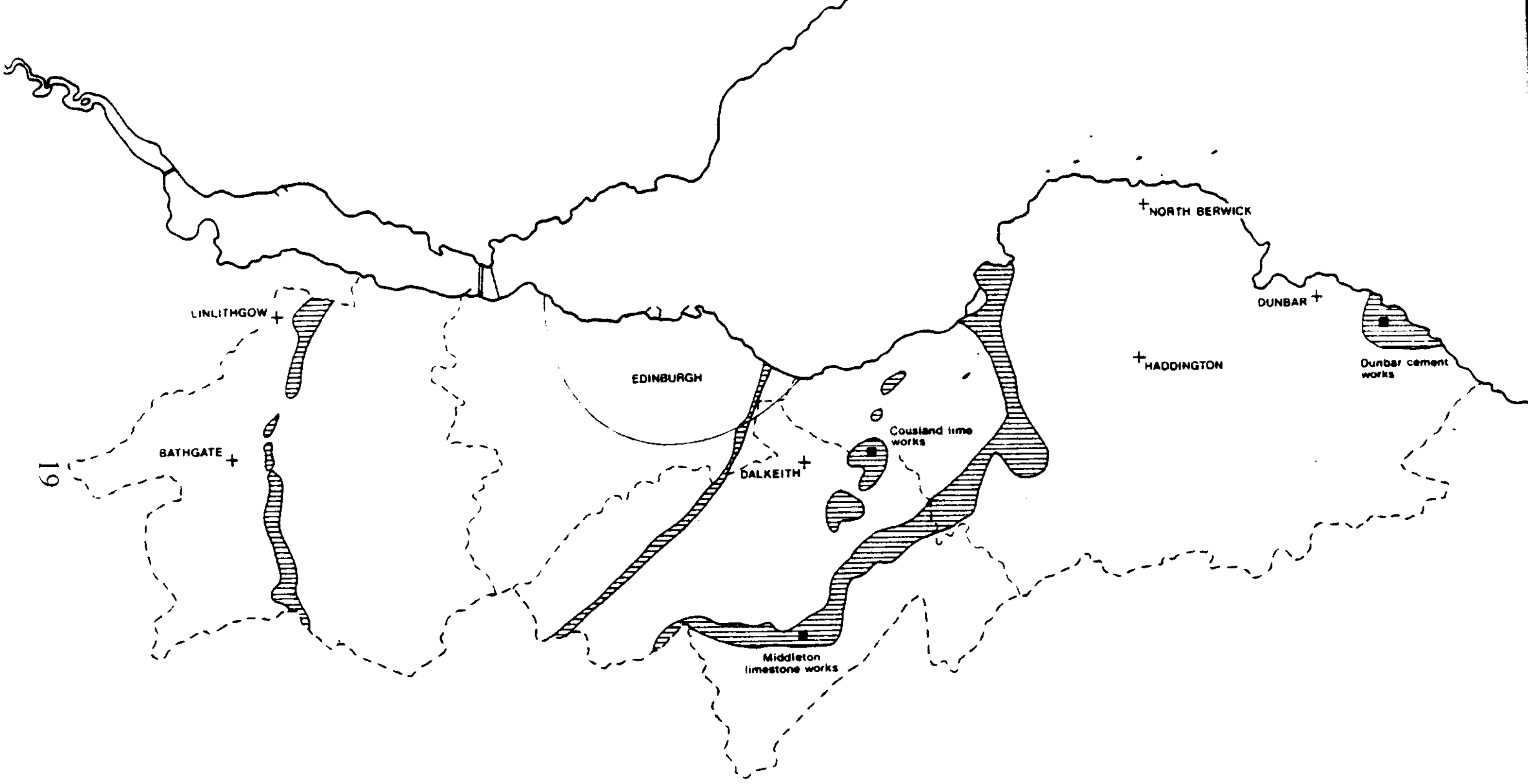
Some of Scotland's (and the world's) oldest workings are recorded in Lothian and the winning of coal has continued to the present day. The shallower reserves in both the Coal Measures and Limestone Coal Group have been extensively exploited. Mines at Monktonhall, Bilston Glen (both Midlothian), and Polkemmett (West Lothian) take the deeper reserves of the Limestone Coal Group. Coal is worked by private mining concerns in Midlothian near Gorebridge and Temple.

The length of life of the deep coals of Lothian is difficult to assess but most should continue well into the next century.

Coastal collieries such as Prestongrange dug coals of the Limestone Coal Group from under the Forth. The National Coal Board (NCB) are currently planning to win reserves in the Coal Measures under the Forth near Musselburgh. Details have not been finalised but the proposals include the sinking of a man-riding shaft at Musselburgh and extending underground roads from Monktonhall where coal would be brought to the surface.

Opencast

A large potential source of coal, in both the Coal Measures and the



BASED UPON THE ORDNANCE SURVEY MAP BY SANCTION OF THE CONTROLLER

SCALE 1 : 312,500 5 miles to 1 inch

LOTHIAN REGIONAL COUNCIL
DEPT OF PHYSICAL PLANNING

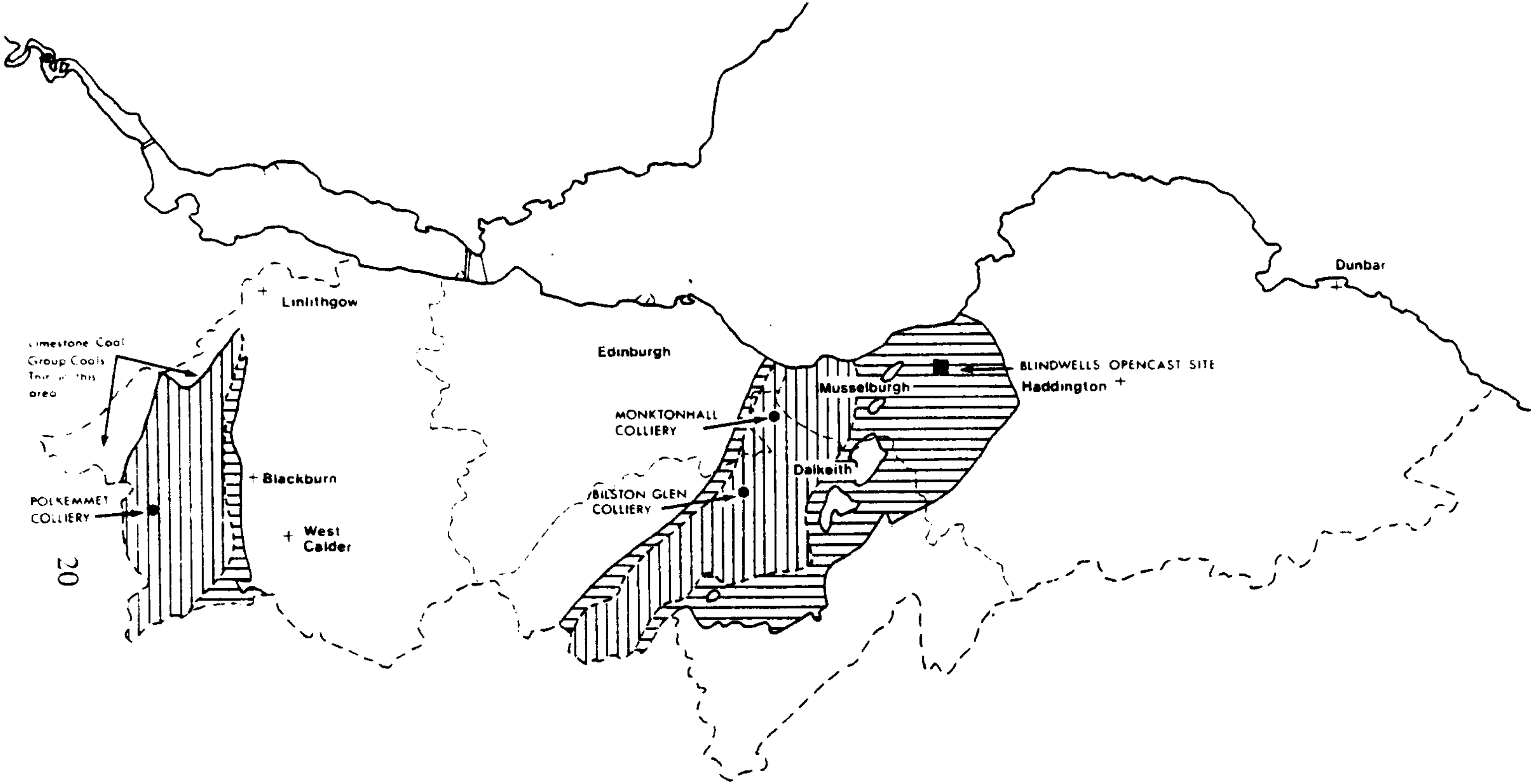
Base geology source Institute of Geological Sciences

OUTCROP AREA OF LOWER LIMESTONE GROUP

Note . Localised limestones have been worked in the calciferous sandstone lower and upper oil shales limestone coal group and upper limestone group

Figure 3

LIMESTONES IN LOTHIAN



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SCALE 1:312,500 5 miles to 1 inch

LOTHIAN REGIONAL COUNCIL
DEPT OF PHYSICAL PLANNING

BASE GEOLOGY SOURCE Institute of Geological Sciences

- AREA OF PAST MINING AND PRESENT AND FUTURE OPENCAST WORKING
- AREA OF PAST PRESENT AND FUTURE MINING

Figure 4

LIMESTONE COAL GROUP COALS

Limestone Coal Group lies at shallow depth and may be workable from the surface. Depths to which coal can be extracted by opencast mining have increased over the years and are likely to continue to do so as the comparative costs of mining and surface working diverge. Several opencast sites have been worked by private contractors near Gorebridge in Midlothian and also in West Lothian. The only NCB site in operation is at Blindwells near Tranent in East Lothian. [The Society's Excursion programme includes a visit to this site on 12th June. Eds.]

In recent years the Opencast Executive of the NCB have prospected a number of sites including Torbane and Longford in West Lothian; Lugton Bogs and Park Burn jointly in Edinburgh and Midlothian; Roslynlee in Midlothian, Airfield in Midlothian and East Lothian; and Howe Mire near Wallyford in East Lothian.

Fireclay

The term fireclay is used here to describe materials which have physical and chemical characteristics which give them refractory properties. Both seatclays which underlie coals and individual fireclay seams which do not are included. Refractory products comprise clay pipes, tiles and liners for blast furnaces.

Although fireclays are available throughout strata of Upper Carboniferous age the main commercial interest is restricted to rocks of the Passage Group and the Lower Coal Measures. The Lower (Bents) Fireclay of the Passage Group is regarded as being amongst the finest refractories in the United Kingdom. The Upper (Drum) Fireclay is also worked and recently operators have been turning their attention to seatclays underlying coal seams in the Lower Coal Measures.

Although sediments of the Passage Group and Coal Measures crop out on both sides of the Pentlands, economic activity has been focussed on the deposits of West Lothian. In the last three years, two fireclay mines at Whitrigg and Wallhouse have closed, leaving only the Ballencrieff Mine and the Pottishaw Mine in production. The refractory companies have been turning towards opencast working and if this trend continues, it is debatable if there will be any fireclay mines in Lothian by the 1990s.

Despite problems associated with the impurities of fireclays in the Coal Measures, one new opencast site near Armadale, West Lothian has recently been given consent to work the coal and fireclay. In such circumstances it is important to ensure that both minerals are put to good use.

Silica sand

Silica sand contains a high percentage of silica which renders it suitable for various purposes including glass-making and as a moulding sand. Various sandstones have been worked in Lothian and the only remaining operation is based at Levenseat near Fauldhouse in West Lothian.

The main sandstones of economic interest are the Muldron Sandstone and the Levenseat Sandstone which lie at the top and base of the Passage Group respectively. It is likely that these deposits extend northwards from the Muldron/Levenseat area but as yet there is no detailed information about their potential.

Brickmaking material

Brick can be made from a number of materials. In Lothian there are three manufacturers. At Pumpherston in West Lothian SOL brick uses waste retorted oil shale with cement to make a pink product. Brickworks at Armadale in West Lothian and Niddrie in Midlothian use clays with colliery washery waste.

Mudstone and shale occur frequently in the Carboniferous. At Newbiggin near Rosewell in Midlothian mudstone is worked and at Wallyford in East Lothian a mudstone at the base of the Upper Limestone Group has been identified as of economic potential. Some interest has been expressed in using oil-shale for brickmaking as the brick manufacturers require the raw material to have some carbonaceous content to aid firing. No superficial clays are worked for brickmaking in Lothian but these have been exploited in the past.

Building sandstone

Continued demand exists for genuine stone as opposed to architectural cast stone for work in conservation areas of Lothian. Apart from its physical attributes, the stone must be of a specified colour. Until recently only one small sandstone quarry at Hopetoun, West Lothian was working but this has closed.

One quarry could not meet the range of colours required and the cost of opening a number of small quarries to meet the demand could not be justified. As a result the bulk of the stone used in Lothian is imported. A number of sandstones mostly in the Oil Shale Group of West Lothian are potential sources of building sandstone. Deposits of the Old Red Sandstone in East Lothian and the Coal Measures in West Lothian might also be potential sources.

Some other materials

Lothian has a wide range of other minerals which are unlikely to be of immediate economic interest. Shell marl and diatomite are found in Edinburgh; haematite (iron ore) was mined in the Garleton Hills near Haddington; copper is reputed to have been mined near Currie and at Priestlaw in the Lammermuirs near Garvald; silver was won at Hilderston in the Bathgate Hills where it was mined in antiquity; lead and zinc mineralisation has also been noted in various locations; blackband and clayband ironstone have been extensively mined in Lothian.

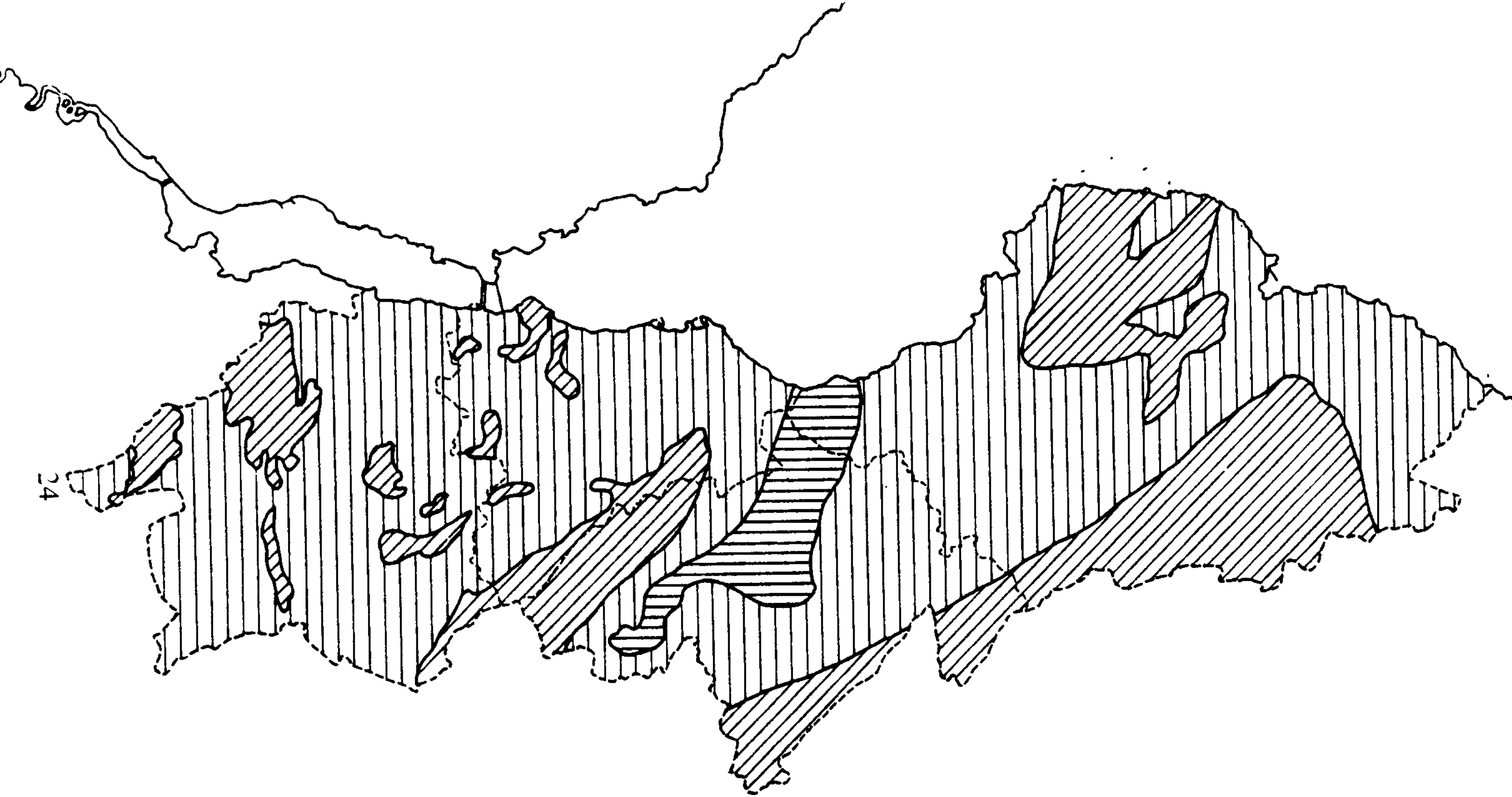
Semi-precious stones have been found in the drift including agate and jasper. Amethystine quartz has been obtained from a locality near North Berwick; agate and jasper have been recorded in igneous rocks.

Oil and natural gas

Oil and natural gas have been exploited in the past from the Cousland Anticline of Midlothian. In recent years a few Exploration and Production Licences have been issued to Oil Companies but as yet none have proved any commercial quantities of oil or gas.

Underground water supply (Fig.5)

In Lothian water from underground sources is not extensively used



BASED UPON THE ORDNANCE SURVEY
MAP BY SANCTION OF THE CONTROLLER

SCALE 1:312,500 5 miles to 1 inch

LOTHIAN REGIONAL COUNCIL
DEPT. OF PHYSICAL PLANNING

SOURCE: Institute of Geological Sciences

PRODUCTION POTENTIAL PER BOREHOLE

- OVER 200,000 GALLONS PER DAY
- BETWEEN 50,000 AND 200,000 GALLONS PER DAY
- LESS THAN 50,000 GALLONS PER DAY

Figure 5

UNDERGROUND WATER SUPPLY

but has potential. Strata are estimated to be capable of yielding between 50,000 and 200,000 gallons of water per day per borehole.

Waste material

The role of waste materials as a substitute for natural products has not been overlooked although the planning powers to control their extraction have not been clear until now.

Several tens of million tonnes of waste retorted oil-shale lie in tips in West Lothian and this material has been used for bulk fill on construction projects. The NCB promote the use of colliery waste for construction purposes. The general order of preference of materials on the basis of a weight to bulk ratio is oil-shale, burnt colliery waste and unburnt colliery waste. However haul distance can influence the choice of material used.

Unburnt colliery waste can be used for brick manufacture and coal slurry has a ready market at coal-fired power stations.

Power stations produce waste pulverised fuel ash (pfa) and other ashes. Pfa can be used for lightweight highway embankment building and in the manufacture of lightweight aggregates. In Lothian, pfa from Cockenzie Power Station is disposed of in lagoons at Musselburgh which will provide a recreational area adjacent to the racecourse.

Mining subsidence

In Lothian, mining subsidence cannot be ignored. Many stratified minerals including coal, fireclay, limestone and ironstone have been extensively mined and locally metaliferous vein minerals such as copper, silver and haematite have been won. Writers of the 1800s even noted that some Midlothian coal miners took slabs of sandstone from the coal roof to the surface to sell for building stone and a Tranent entrepreneur paid men to enter the old wastes for sandstone which he sold to the Railway Company. Such actions only serve to increase the risk of subsequent collapse.

Two main sources of concern arise from mining subsidence; the first is that which arises due to present coal mining, the second is caused by the failure of old shallow workings. The former can be estimated with a fair degree of accuracy and the effect on all types of structures quantified. Only where uncharted old workings overlie areas of present day mining are the levels of subsidence likely to exceed those predicted. The risk of failure from shallow workings is always present and cannot be predicted. The shallow depth means that the movement at the surface tends to be large and localised. Only properly constructed structures can withstand such movement.

Planning regulates the use of land and it is important to know the risks involved in developing an area of past mining. Mining records may be good, bad or non-existent and frequently a knowledge of the local geology is the only key to indicating potential problems. Factual details can only be gained by carrying out a properly designed and supervised boring programme to accurately determine the local geology and evaluate the extent of old workings.

At present the only planning guidance issued by Central Government advises planning authorities to ignore the site stability when considering a developer's proposals. Undoubtedly any site may be developed at a cost providing it is adequately investigated and appropriate foundations designed. However, it is arguable that the planning process should recognise the likely development costs arising from the need to stabilise ground.

This paper has been prepared from a wide variety of sources, too numerous to list. The author would be pleased to provide reference information to interested readers.

REVIEW

Building Stones of Glasgow by Judith A. Lawson, Geological Society of Glasgow, 1981; 29 pages; £1.00.

Geologists have been remarkably successful in communicating their specialist knowledge to one another. Evidence of this is to be found in the proliferation of specialist groups over recent years, as in the Geological Society of London. Generally, geologists have been remarkably unsuccessful in communicating their subject to the public at large. That *Punch* cartoon of the young couple asking the ancient bearded geologist the way has more than a grain of truth in it!

One way in which geologists could encourage a wider interest in their subject is through the link between locally available building materials and actual buildings. Particularly in Britain, there is much of interest here in exploring the diversity of building styles and methods. Some time ago, The Reader's Digest Association sketched the pattern of regional building in their *Complete Atlas of the British Isles*. More recently, on television, Alec Clifton-Taylor has added to his excellent book by his exposition on selected English towns. And until I saw the recent television programme and the marvellous exhibition in the Hayward Gallery in London on the work of Sir Edwin Lutyens, I had not quite appreciated how few modern architects there have been who had the ability to conceive a building in three dimensions combined with a sensitivity towards the use of local materials.

In recent years, members of IGS have done much to promote an appreciation of building stones to be seen in London. The re-vamped *Circular of The Geologists' Association*, under Eric Robinson's guidance, is also pointing out some of the visual and historical delights to be seen in our urban environments, not least in the often overgrown and neglected cemeteries.

In 1975, Drs Simpson and Broadhurst produced a little *Building Stones Guide to Central Manchester* (at 40p for 39 pages) and this is clearly the model which Judith Lawson has followed in producing her guide to Glasgow (at £1.00 for 29 pages).

Armed with this well-produced booklet, the visitor from Edinburgh will instantly recognise the cover drawing as he or she steps out of Queen Street Station (if there is a train to step out of). Glasgow has always fascinated me – did you know, by the way, that they actually and literally sweep their rubbish under the pavement into specially constructed waste bins?

A well-written introduction includes some drawings showing the textures of common rock types and a map of Scotland and Northern England locating the source of some British stones mentioned in the text as being seen in Glasgow. This map is incomplete, unfortunately. For example, neither Furnace in Argyll nor Newbiggin in Fife are shown. There follows the itineraries of four walks together with some excellently produced photographs. Three of these are in or near George Square (eminently worth a visit, especially when they are putting up the hideous Christmas decorations in October) and one around the University of Glasgow on Gilmorehill. This last walk ends at Colin Gribble's paired phallic symbol from Ballachulish outside the Department of Geology. Visitors from Edinburgh should make a special effort to penetrate inside to see the marvellous mural in the entrance lobby, recently praised by the Scottish Crafts Council.

My only criticism is that I would have liked to have seen a large scale, detailed map showing the location of all the mines and quarries within Glasgow which provided a good deal of the building stone used in the city. However, this guide is a timely reminder to the Society in Edinburgh to re-start its building stones project which foundered some time ago due to a lack of enthusiastic extra-mural direction.

Norman E. Butcher

Plants invade the land by W. G. Chaloner and P. Macdonald, Royal Scottish Museum/HMSO, 1980; 16 pages; £1.20.

This attractive, well illustrated booklet, sub-titled 'Early land plants from the Rhynie chert of Aberdeenshire, Scotland', is intended for the lay enthusiast, although the serious student should also find it interesting and informative.

As the sub-title indicates, the bulk of the text is concerned with a description of the early vascular plants from the unique, silicified peat deposits of Old Red Sandstone age at Rhynie in Aberdeenshire. The introduction describes the early evolution of plant life, tracing it from the possible blue green algae of the Pre-Cambrian Fig Tree Group to the truly land living flora of the Silurian and Devonian periods. However the evidence for the transition to the eukaryotic state of plants is rather thin. A very useful description of the adaptations required by land living plants follows, and a comparison of *Rhynia major* with present day plants is particularly helpful.

The section on the diversity of flora in the Rhynie chert contrasting *Rhynia* and *Asteroxylon* is well presented and the very useful stratigraphic range chart on the inside back cover displays graphically the diversification of plants.

An excellent section on the life cycle of the Rhynie plants and plant-animal interactions introduces the palaeoecology of the deposits and the section on later developments rounds off an altogether concise and very readable little booklet. A list of suggested reading and a very good glossary all help towards the understanding of a fairly complex subject. The authors are to be congratulated on striking that very difficult balance of the presentation of technical data in a general enough way.

Each part is well illustrated with photographs and diagrams and the colour plates in the centre section are excellent. I found the illustration of a 'Devonian botanical garden' slightly irritating and difficult to assimilate quickly, and some of the figures were difficult to find because of the confusion with page numbers. At £1.20 I felt that the price was slightly high, but would hope that this would not deter too many potential readers.

These are only minor criticisms of an otherwise well written and presented publication which can be thoroughly recommended to anyone interested in plant evolution or the Rhynie chert in particular.

Alistair Sutherland