Journal of

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Volume 1 December 1984

Geoblanks

A geological quiz set by Paul Olver. The initial letters of each of the eleven one-word answers can be rearranged to form an important structural feature. You'll find it hard to be torn away from this one!

1 Plymouth Sound is an example. Ans ....

2 The zone fossils of the Cambrian. Ans ....

3 Basalt lavas of higher viscosity often show this structure on their upper cooling surface. Ans ....

4 The Carboniferous of South-West England. Ans ....

5 These large folds dominate the Helvetic Alps. Ans ....

6 Assemblages of both metamorphic and sedimentary rocks can be described by this word. Ans ....

7 One type of surface seismic wave. Ans ....

8 The 18th Century originator of the Neptunean Theory for the origin of the Earth. Ans ....

9 Triassic gypsum is an example of this type of deposit. Ans ....

10 A metamorphosed acid volcanic ash. Ans ....

11 A calcium chromium silicate and the rarest of all the garnets. Ans ....

Cover illustration by Audrey Price

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A Special Mention

The Editor and all the contributing authors would like to give a very special thanks to Yvonne Gilfrin. Her advice and knowledge of the "new technology" meant that the typesetting of this fourth issue posed few problems. Our thanks are also due to Peter Bower, Lyn Linse and Lothar Neubert for the excellence of their artwork and to the Journal Sub-Committee for their continued support in the arduous task of proof-reading the submitted copy.

WEEKEND IN THE PEAK

Catherine Clemesha

Trips without leaders can be likened to armies without officers. However, Cath Clemesha shows how a small group of ten Society members turned such a trip into a very successful weekend.

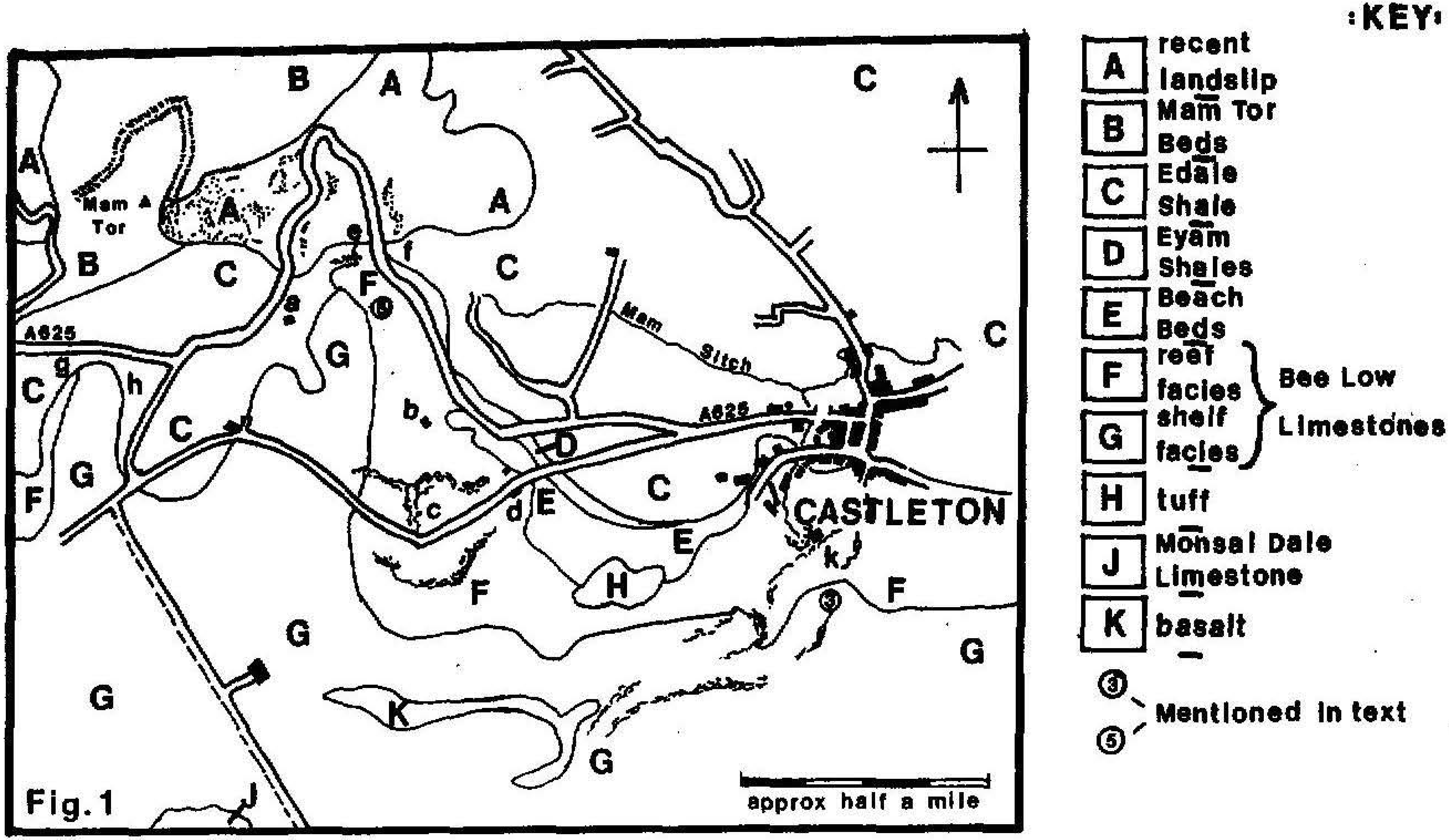
The customary northwards dash on the evening of Friday May 25th brought the group to the Marquis of Granby Hotel at Bamford. A dull but dry Saturday greeted us as we set off for our first locality at High Rake, near Longstone Edge (208734). Here, the spoil heaps from a disused mine are being reworked for fluorite, at one time gangue but now of economic value. Good samples of the yellow, colourless and purple varieties were collected alongside quartz and galena.

Our next stop was Monsal Head where we ate our picnic lunch overlooking Millers Dale and Monsal Dale (185715). Then we walked to a disused railway cutting (190713) where the structural geologists amongst us put their theories on the succession to the test. There were limestones with chert, mudstones and muddy limestones with brachiopods, plenty of ostracods and trilobites (Alan Darling found two!). The famous phrase "goniatites have been found" was noted in the guide!

The next stop was Tideswell Dale to look at some volcanic rocks. In the car park was a weathered dolerite sill (155743). We walked up the path to the picnic site which is the levelled floor of an old quarry in vesicular basalt. Various boulders on the ground were of basalt and of the marmorised white limestone which outcrops at the contact with the dolerite sill (155738). By now we were finding the "no hammering, no collecting" rule rather frustrating. We walked on up Tideswell Dale to a fault with a downthrow of 15 m to the south which threw limestone against the dolerite sill. We returned to the hotel after having driven up the side of the Ladybower and Derwent reservoirs and taken photographs of the various dams.

After dinner, Sunday's itinerary was discussed and we all prayed for fine weather. Our prayers were NOT answered. It rained more or less all day, getting heavier in the late afternoon. We cut our losses and decided on a conducted tour of Treak Cliff Cavern at Castleton (140830) and saw extensive areas of Blue John in the roof plus the usual stalactites and stalagmites.

After this we drove through Winnat's Pass, which is a wide, grassy gorge through reef limestone about 160 m thick, to the landslipped face of Mam Tor. The road past it has been closed for some years because of the landslip. This was the Millstone Grit part of the trip. We did not stay there long but we were looking for goniatites in nodules (not easy when you are not supposed to hammer!) Colin Wilson had climbed down a very steep,



(a)·Blue John Mine,(b)·Treak Cliff Cavern,(c)·Winnats,(d)·Speedwell Cavern,(e)·Odin Mine,(f)·spoil heaps,(g)·Windy Knoll,(h)·Bone Cave,(k)·Peveril Castle.

FIG. 1. Geological Map and Localities in the Castleton, Cave Dale, Treak Cliff and Mam Tor areas.

wet, grassy slope to locate a rich fossil bed at the base of Mam Tor. He had just found it when we all decided it was time to move on as we were windswept, soaking wet and frozen. So we never saw the fossils which included brachiopods, corals, crinoids, bryozoa, gastropods, goniatites and fragments of trilobites! (REF. POINT 5 FIG. 1).

Castleton was our next stop - for lunch and a look round the gift shops and bookshops. The tree on the green gave a lot of us some shelter for our picnic. We really felt almost warm and dry for a while.

In the afternoon we walked up Cave Dale, through the reef limestone, past a 2 m wide vertical calcite vein on both sides of the Dale (REF. POINT 3 FIG. 1) and up to where a well developed columnar basalt lava flow could be seen (148823). The calcite vein must originally have gone right across the Dale before erosion removed it. At the margins of the calcite we found patches of galena and purple fluorite. The basalt had been weathered to clays and chlorite. The hexagonal shape was easily visible and the columns were about 45 cm across. At the top the lava was vesicular, with amygdales of calcite and chlorite. The walk should have continued over the limestone to meet Dirtlow Rake but it was so wet that we decided to go back to Castleton and drive the cars along the Rake from the other end. Here we looked over the disused tips and found more fluorite, banded barytes and galena.

On Monday the rain had stopped. Our destination that day was the Cresswell Crags Visitors Centre. This sits snugly in a gorge of Permian Magnesian Limestone where several caves display the evidence of occupation by prehistoric man and animals. Dr. Roger Jenkinson, the Director, took us on a guided tour which lasted about two hours and was packed with interesting information on recent research into the discoveries that have been made, mainly covering the last 45,000 years, but also with the geology of the area included. The Centre is well worth a visit as it contains a small museum showing the history of the area, with exhibits of the bones found within the caves. There is a picturesque lake between the walls of the gorge and a bookshop which is one of their main sources of revenue.

Being unable to find an expert leader for the area, Wally Stedman and I put together a trip, using the Geologists' Association guide (No.26) to the area and "The Peak District" by I.M.Simpson. We tried to make it as varied as possible and to include stratigraphy, palaeontology, mineralogy and scenery. Those who went on the trip agreed that it was refreshing, occasionally, to try to unravel geological problems for themselves and that this type of trip was best suited to a small party.

FURTHER READING

NEUBERT, L., 1981. Castleton - A Geological Crossroads. Jour. Farnham Geo. Soc., 1, 1-4.

GEOLOGICAL AND HYDROLOGICAL PROBLEMS IN THE SURREY MINES

Paul W Sowan

For convenience, the term 'mine' is adopted here to include the underground building stone quarries which are far more important in Surrey. At least five distinct geological formations in the historical county of Surrey have been worked underground - the Thanet Sand, the Chalk, the Upper Greensand, the Folkestone Sand, the Sandgate Beds and, perhaps, the Weald Clay. Naturally the geological and hydrological features influenced the distribution of these workings, their depths, internal layouts and the methods of working. Comparing the Surrey with other subterranean building stone quarries in England and Europe, however, makes it clear that, at times, economic and political factors dictated the working of second-rate stone from quarries that were far from convenient from the practical point of view.

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1. Mines and Underground Quarries

Before the last century neither term carried any implication of subterranean or opencast working. Historically, a mine was a place where any exceptionally unusual or useful material (usually metallic) was obtained; and a quarry was a place for digging sound stone capable of being squared or otherwise shaped for building. It only became usual to qualify the terms by adding such descriptions as 'openwork','opencast', or 'subterranean' during the 19th century, until ultimately the passing of the *Metalliferous Mines Regulation Act in 1872*, and of the Quarries Act in 1894, fixed the modern connotations. For these reasons, older documentary sources often fail to make it clear that a working was subterranean - and uninformed researchers have failed to realise quite how extensive mining, in the modern sense, was in the lowland counties.

Our Surrey mines, then, were for bulk-minerals such as sand, fullers earth, and hearthstone, which were taken out in disaggregated form and were required for their particular chemical or physical qualities. Quarries yielded larger, preferably rectangular, blocks of sound stone for use in ashlar work or carvings in buildings. It is obvious that in homogenous ground, mining need produce little waste as everything taken from the working face is useful. In a quarry, however, the extraction ratio may be considerably smaller as waste and chippings are inevitably produced in the taking out of squared blocks. Surrey's more important underground mines and quarries are shown on the map (FIG.1).

2. Why go Underground?

Surprise is often expressed at the extent of pre-20th century underground working. But before the advent of the steam shovel about 1880-90, all overburden had to be stripped by hand. Underground working avoided (at least until a collapse occurred!) disturbing valuable agricultural or urban land above and exposure to the weather! And occupiers of land could obtain valuable materials which might otherwise have had to be taken from more distant openworks perhaps on another's land, incurring transport and payment of royalties. The Reigate sand-mines and the Kentish and Essex Chalk deneholes begin to make sense when viewed in this light. The Mesozoic and Cainozoic limestones of England and nearby European countries have been severely affected at outcrop by the periglacial environment during the Quaternary period. The shattered and disturbed first few metres visible at the top of the face in any chalk pit tell the story. Thus, and for further reasons to be elaborated later, building-stone quarries were usually taken underground following the sound unweathered stone in southern and south-eastern England, and in France, Belgium and Holland.

3. Surrey Stone Quarries

In West Surrey, the stone quarries appear always to have been openworks. Bargate stone and Farnham malmstone were presumably raised after the removal by hand of soil and worthless overburden. Throughout much of the county, requirements for stone for building were satisfied by rubbly stone from open pits. Random rubble walling was as good as could be afforded even for many of our village churches. It was the demand, especially in London, for sound stone for fine ashlar work, and freestone for decorative carvings, that led to the operation of our East Surrey subterranean quarries in the Chalk and Upper Greensand. Indeed, such prestige stone is found only in the grander Surrey churches and mansions until about 1800, when it begins to appear in vernacular architecture in and around the 'mining parishes'.

We have at least two subterranean quarries for hard chalk in Surrey at Guildford and at Mickleham (Westhumble) and perhaps others may be found (Sowan,1976a). Here published descriptions and photographs (Lee & Russell,1924) and personal examination at Westhumble make it clear that particularly coherent hard layers of chalk were worked, and had of necessity to be followed into the hillside. The galleries were worked between convenient parting planes, and very flat floors and ceilings resulted. Quite apart from its liability to shattering at outcrop, this stone could only have been won opencast by the removal of massive quantities of chalk overburden not of the required quality. Although not on the scale of the Beer (Devon) or Totternhoe (Bedfordshire) or other subterranean chalk quarries, these Surrey workings did yield significant quantities of material for walls in their localities, as may be seen in houses around Shalford, in Betchworth Castle, and in several churches including that at

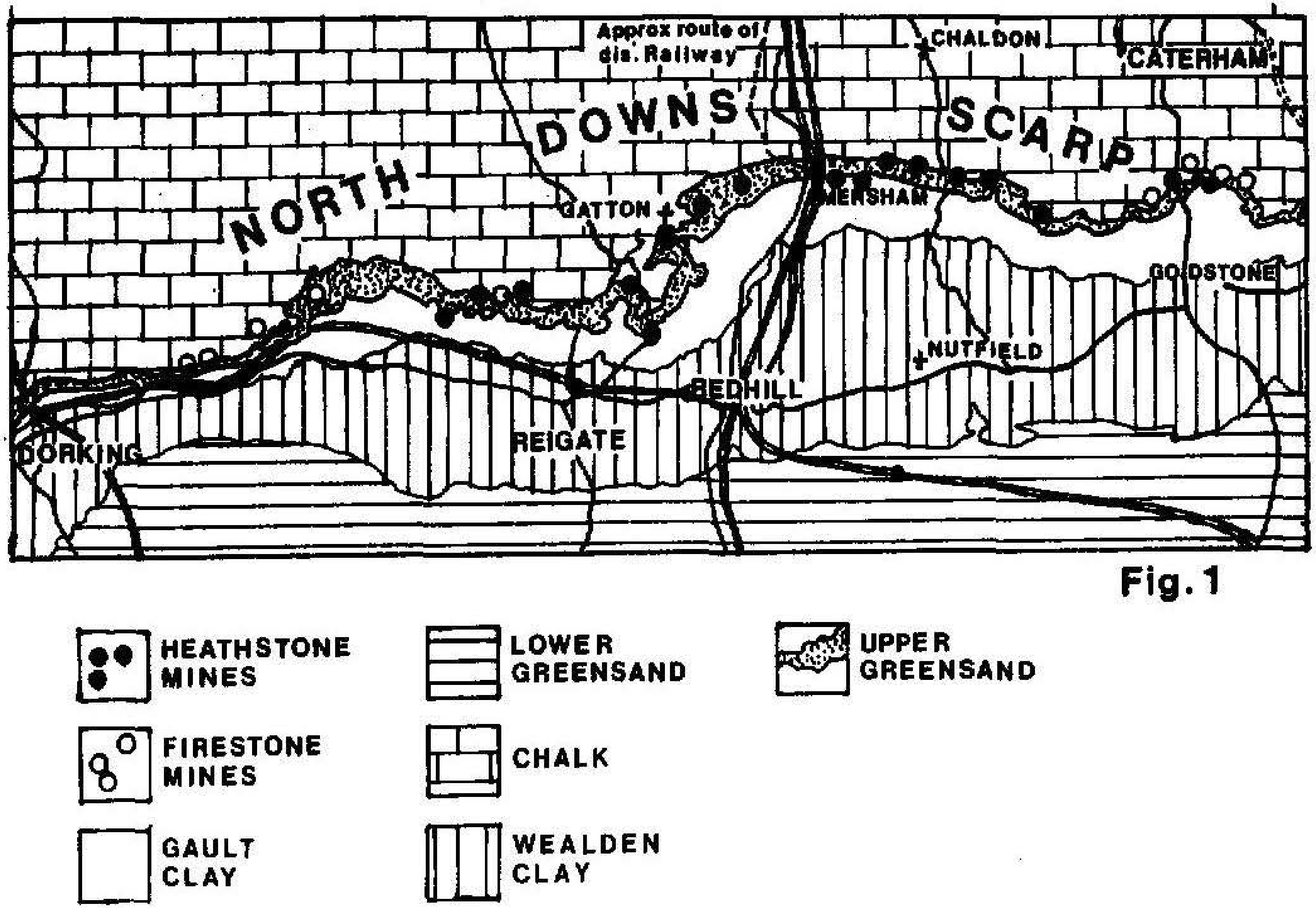


Fig.1

FIG. 1. Underground Mines and Quarries in the Dorking and Merstham areas of East Surrey.

Leatherhead. It is clear that the material was valued as a freestone from its use for carved fireplaces and similar work in Guildford (a fine example exists in the museum at Castle Arch) and at Loseley. And chalk from the Guildford quarries, south of the Castle, can almost certainly be identified with the 'Guildford stone' used between 1685 and 1690 in St.Paul's. The building accounts of 1561-69 for Loseley (Evans,1856) are further witness to this use of chalk. Entries for 'hewn stone' or 'white stone' are quite distinct from those for 'rough stone' and 'chalk for lime'. The stone was from Guildford, and apparently also from 'Halfpenny Lane' at the Chilworth end of Shalford; the chalk for lime was cheaper and from sites closer to Loseley. Hunt's pioneer Mineral Statistics (1860) reveal that as late as 1858 'much of the harder and lower portions of chalk around Guildford is used for building'.

However, the Loseley accounts also refer to the importation from East Surrey of at least two consignments of firestone from the Gatton Upper Greensand, and of a consignment of similar secondhand stone from Merstham, via Merrow. These may have been for chimneys and hearths - the material is called firestone from its refractory properties, and this was often used for making hearth-stones (not to be confused with the later use of the word 'hearthstone' described below). Why the very similar Farnham malmstone was not used is not clear. The East Surrey firestone quarries have been described in some detail elsewhere (Sowan,1976b), and are still the subject of further research. Made in the Upper Greensand, they appear to have been entirely subterranean, and many are still accessible. Although technically 'drift-mines' in which the galleries follow the bed of stone sought, they were rarely or never entered by straightforward drift entrances from the Upper Greensand escarpment. Rather, entrance pits wre dug on the dip slope (FIG. 2), and drift galleries excavated in the stone bed when sufficient depth was reached. Site investigations for the M23 motorway at Merstham revealed what might have been expected - the Upper Greensand outcrop at the escarpment, where it overlies Gault Clay, is badly fractured and liable to landslipping. Any drift entrance made through such ground would have had to penetrate much unstable and worthless stone. Danger, and expenses for timbering and working through useless ground, would have been factors to be reckoned with. It is probably escarpment and dip-slope mine entrances that Martin (1851) is describing when he reports:

> .... the "Fire-stone" (the plateau of the Upper Greensand) is generally quarried by shafts (i.e. pits) sunk near or even through the chalk; as was anciently done at Merstham quarries, and is now done at Reigate Hill. But I remember inspecting a quarry many years ago opened by Alderman Waithman at Ray Common, near the latter place, and worked by an open adit, in the entrance to which, to the extent of 20 or 30 ft or more, the rock-masses lay in great disorder, broken up and contorted in situ, and not in the manner of the blocks and broken materials of the talus of the sea-cliff.

Once stone-winning had penetrated beyond the problems of weathering, periglacial shattering and landslipping at outcrop, all was still not plain sailing. As a result of its diachronous boundary with the underlying Gault Clay, the Upper Greensand thins towards the east and is virtually absent at Folkestone. The formation becomes too thin to mine just beyond Godstone in East Surrey. Thus it is that considerable quantities of freestone required for decorative work at Rochester, Canterbury and Leeds in Kent were taken from Surrey to the Thames, and thence as close as possible to their destinations by water. Westwards, another problem is encountered in the progressive steepening of the dip as the Hogs Back is approached. The mine tunnels dip at about 5° with the strata at Godstone, 7° or more at Merstham, and as much as 21° at Brockham beyond which the stone was not worked until Farnham is reached. There is some evidence that different horizons were exploited in various quarries, although the existence of two sets of superimposed mine galleries at Reigate is open to some doubt. The westerly increase in thickness did not result in roomier mine galleries, and in fact all the Surrey quarries are remarkable for their restricted headroom (1.5 m is a good average ceiling height) compared with, say, similar quarries at Chilmark or Box (Wiltshire), Purbeck (Dorset), Caen (Lower Normandy, France) or Maastricht (South Limburg, Holland).

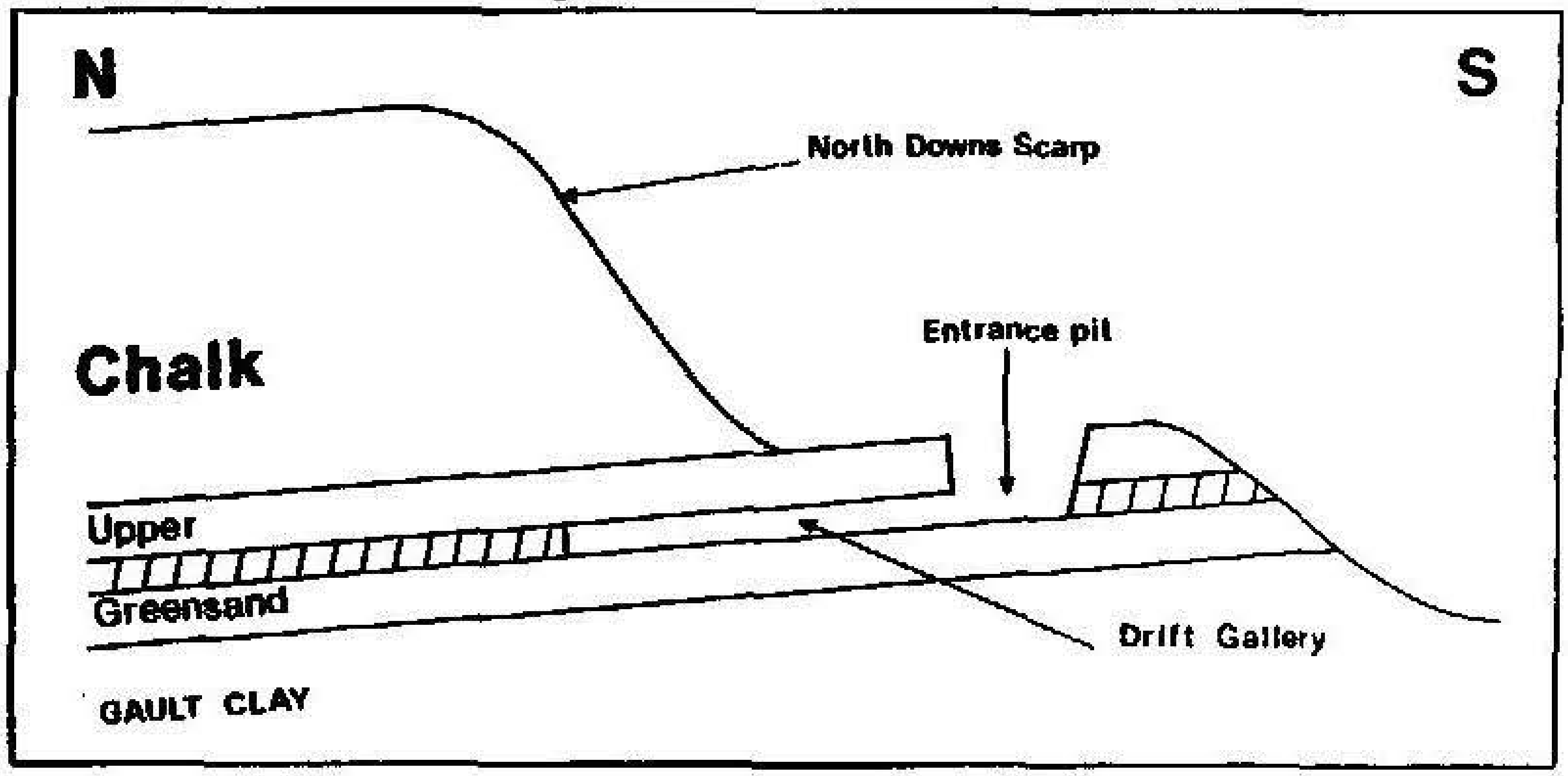


FIG. 2. Drift Mining in the Chalk escarpment.

The Surrey quarries compare unfavourably with those above in other ways. Whereas at Maastricht (Sowan,1980-81) good sound stone was worked, in a series of lifts, from galleries up to 10-15 m high (the only waste being the cherty bands, and dust and chippings necessarily produced in picking or sawing blocks from the face), in Surrey not even the whole height of the 1.5 m face was worthwhile stone. Although visually all of similar quality, it seems that only particular levels yielded stone durable enough for use in prestige buildings. Thus the Surrey quarries are extraordinary for their exceptionally low extraction ratio, and the immense volumes of rejected stone waste walled-up in abandoned galleries behind kilometres of dry-stone walls.

At Caen, where ceiling heights of 7 m are not unusual (Sowan,1982a), what little waste there is (arising largely from the blocks being worked with picks rather than saws) has been back-filled over the quarry floors to relatively shallow depth, or taken out for use in lime-burning (an option not open to the Surrey quarrymen, whose material was calcareous sandstone rather than limestone). At Maastricht, the main waste left is the occasional mass of stacked chert nodules.

The dip of the strata was also against the Surrey quarrymen, At Godstone, in a succession of dry years, the galleries could be taken about 300 m down-dip from the entrances. But after a series of wet winters the ground-water rose to fill two-thirds of the quarries. There are detailed records of the 19th century floodwater levels underground at Godstone, and these have been correlated with the rising and the flowing of the bourne streams in the nearby Caterham valley on the Chalk dip-slope. As soon as the water-table was encountered, in the form of wet rock and occasional flooding, the only option was to open a new quarry to east or west along the strike of the beds. Thus the principal quarry areas are now complex networks of interconnecting workings extending relatively short distances north-south between entrances and often-flooded working faces, but for some kilometres east-west along the strike. Remedial action in the face of the groundwater problem appears not to have taken any more positive form than working further down-dip when dry winters allowed, and shifting sideways along the strike when unavoidable, until about 1800 at Merstham (Sowan,1975). Here the arrival of the terminus of the Croydon,Merstham & Godstone Iron Railway in 1805 (Sowan,1982b) and of Jolliffe & Banks' civil engineering partnership in 1807 (Dickinson,1933) led to the development of stone-quarrying and lime-burning on an enhanced scale, albeit in steadily deteriorating geological conditions so far as extension of the quarries was concerned. Internal quarry plateways (Osborne,1982), the inclined plane and the steam winding engine came as part of Surrey's rather small industrial revolution. Between 1807 and 1809 an ambitious drainage adit, or 'sugh', was constructed. This impressive tunnel was evidently made from one end only (we have no evidence for intermediate working shafts) from lower ground in the Gault Clay at the foot of the escarpment, inclined gently upwards for some 500 m or so, and successfully de-watered the flooded underground quarry from below without recorded incident other than the cessation of the nearby village water-mill! The mobility of the Gault Clay at the escarpment, however, appears soon to have caused adit collapse and subsequent flooding. Despite a steam engine on site, there is no evidence that this was used for pumping - it seems to have been purely a winding-engine.

The last measure resorted to at Merstham in the face of the floodwaters was up-dip mining from the entrance pit, working southwards towards the scarp as recorded by (Webster,1821) (FIG.3). This working can still be visited, by arrangement, and it is clear that desperate measures were by then being resorted to. Although much of the face contains very poor cherty stone, as much as could be taken was removed and even the inferior 'floor-stone' was taken out for sale, making this probably the only fire-stone quarry in which one can stand upright in comfort! If the Merstham fault is a reality, and the flexures in the Upper Greensand revealed during the making of the 1899 'Quarry' railway line are any guide to the state of the beds, it seems clear the Merstham stone quarries were being developed into even less amenable ground than usual. Not surprisingly, they were virtually abandoned by the 1820s and contrary to local folklore they did not yield any stone even for the filling of the new London Bridge!

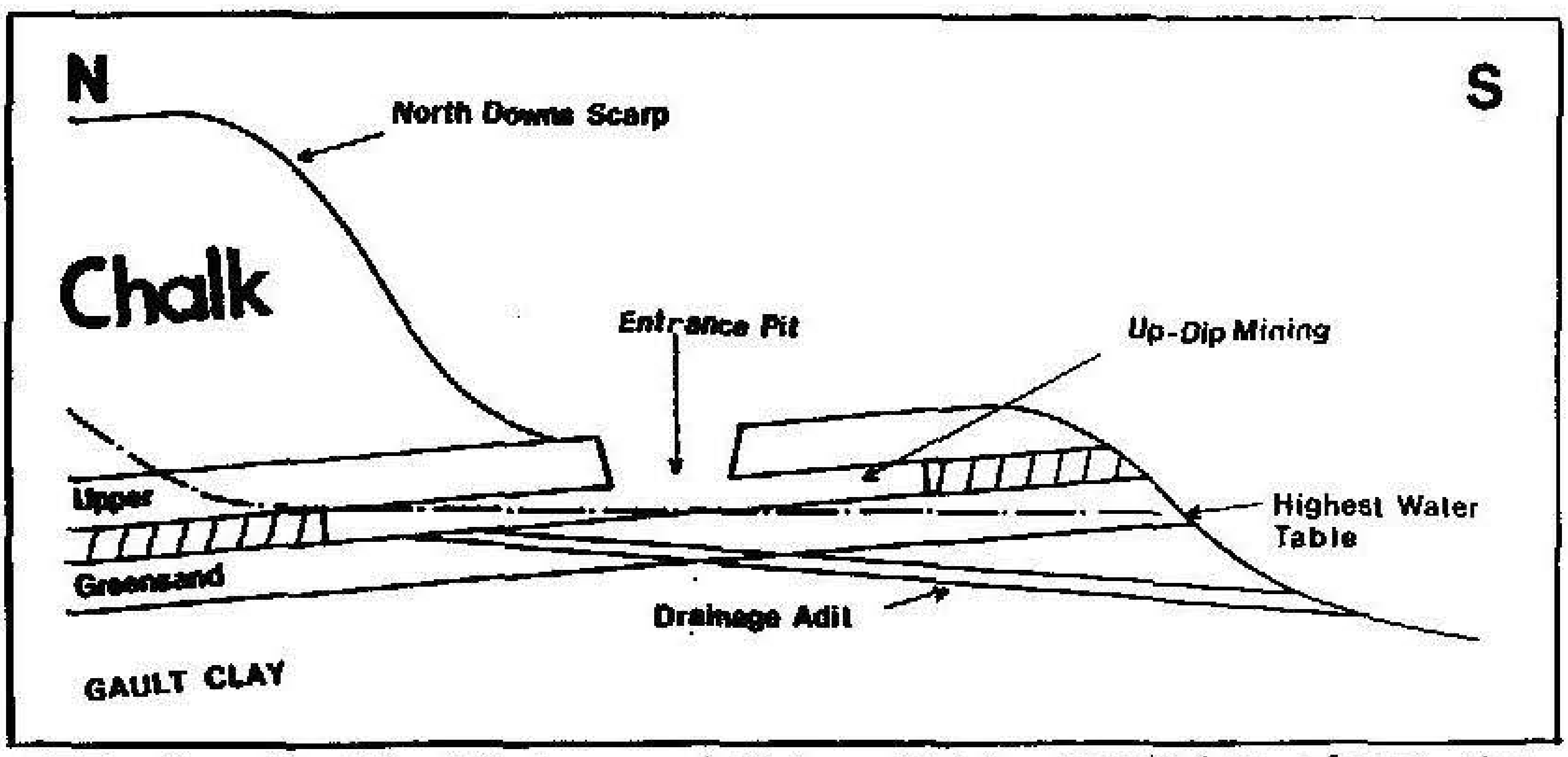


FIG. 3. Up-Dip Mining and Water Table position along the escarpment.

Comparison with other English and European quarries has already been made. Surrey firestone, as a freestone valued for its suitability for carved decorative work in prestige buildings throughout the Middle Ages, had during that period only one really serious competitor - Caen stone imported from Normandy. Whereas our Surrey quarries were low, wet, in inclined strata and yielded second-rate stone unsuitable for exterior use, at Caen we find by contrast excellent stone, flat-bedded, in quarries unaffected by ground water and allowing depths of 7 m or more to be taken. And from Caen to London there was relatively inexpensive water transport all the way. Merstham shares with Chilmark the peculiarity of being throughout the Middle Ages a source of bulky and heavy freight which had to be transported, expensively and with much labour, overland for distances of 30 km or more before it could be put onto water. It is, therefore, with surprise that we discover that the price of Caen stone delivered in London throughout the Middle Ages was not substantially higher than that for Surrey firestone or 'Reigate', 'Chaldon' or 'Merstham' stone. Did we resort to the use of our own Surrey quarries only when we neither controlled nor were at peace with Normandy? Apart from minor uses in vernacular architecture in and around the mining parishes, the Surrey quarries lost their importance as a source for prestige stone about the 16th or 17th century. Stone for rebuilding the London churches after the Great Fire, for example, came by sea from Portland. By then, Oxfordshire quarries were supplying the capital and, with the opening of the Kennet and Avon Canal and the Great Western Railway, the Wiltshire Bathstone quarries were fully developed. Caen stone continued to arrive in London, although those quarries were abandoned about 1952 (Noel,1970). The last stone worked underground in Surrey for building was probably about 1900 at Godstone or Reigate.

4. Surrey Hearthstone Mines

All was not lost, however. The crumbly calcareous sandstone worked in the quarries, and perhaps especially the softer material formerly rejected and left underground by the quarrymen, had during the 19th century found a use as domestic 'hearthstone' for whitening stone hearths, floors, and doorsteps. Lumps of the stone, wetted and rubbed on the surface to be treated, left a white chalky deposit with which to impress neighbours and visitors with the order and cleanliness of the house. Extraordinarily, the supply of hearthstone, especially to the northern cities where stone floors and steps were more common, proceeded at such a pace that redundant firestone quarries found new leases of life as hearthstone mines. Nor was it all a matter of simply removing the previously rejected and stacked 'deads' as mine workings were physically extended and entirely new mines opened, as at Betchworth and Brockham. By the 1890s over 12,000 tons a year of hearthstone were being won in Surrey, and the last mine closed at Colley Hill, Reigate, as recently as 1961. With the invention of 'artificial hearthstone', for which stone, waste or dust was ground and moulded into blocks with various brand-names impressed to order, there was even less need to extend the mine galleries. The only geologically interesting feature of the hearthstone mines not shared with their predecessor firestone quarries is George Taylor's proposal for a water supply for Reigate by 'upward boring for water'(Taylor,1900) in the Colley Hill hearthstone mine. The idea was to bore a series of vertical two-inch diameter holes upwards through the main mine gallery ceilings through the relatively impervious 'Chalk Marl' to tap the chalk aquifer. Although a start was made on the incorporation of this novel idea into Taylor's then existing private local water supply undertaking (later taken over by the East Surrey Water Company), it appears never to have been actually put into operation. At Folkestone however a similar scheme was undertaken, and to this day a part of the town's supply is from the purpose-made 'Terlingham tunnel' tapping water from the Chalk by way of vertical bores.

5. Fullers Earth Mines

Relatively little is recorded concerning the Fullers earth workings of Nutfield and district, although mines are known to have been worked there certainly in the second half of the 19th century and a number of small sections of underground workings have been discovered and surveyed in recent years. Much has been lost by subsequent opencasting. Whereas the firestone quarries suffered from beds too thin to work conveniently, the reverse was the case at Nutfield. One mine recently inspected had galleries a mere 2 m high running below a substantial roofstone overlying a seam of excellent fullers earth upwards of 6 m thick. Such low galleries in such a thick seam, widely spaced, were dictated in a pillar-and-stall mine in such conditions as roof-pressures on the clay left for support were immense in relation to the strength of the material. It is hardly surprising that even with steadily increasing overburden as the deposit is worked northwards towards the Chalk scarp, opencasting has long since been resorted to.

6. Sand and Chalk Mines

Sand-mining in Surrey seems to have been characteristic of the towns and larger villages on the Folkestone Sand outcrop. Perhaps these mines developed by stages from extensions of cellars conveniently excavated out of the sand banks and cliffs against which so many of the older houses backed. Once underground, the more ambitious sand-miners appear to have had scant regard for property boundaries! What seems to be the oldest sand mine at Reigate, off the London Road at the west end of the Castle mound, is a most complex working on five interconnected levels with internal haulage shafts. Working was not restricted by stratification, and the mine seems to have spread through the considerable available thickness of sand above the water-table by 'gophering' or simply following the best, least-contaminated, sand wherever it led. The sand was used largely for sanding floors in centuries past, and perhaps to an extent for glassmaking. More recent, 19th century, sand-mines at Reigate and Godstone have a more regular 'pillar-and-stall' layout, narrow but high galleries being created by taking sand up repeatedly from the floor throughout the system in a number of lifts. This method of mining, with narrow galleries of tall arch section, is characteristic of subterranean chalk mines too, although no good examples are as yet known from Surrey. (the subterranean chalk quarries, with flat ceilings and restricted headroom, already mentioned are quite distinct). Such chalk mines may yet come to light. A number, some of them worked as recently as 1920 but abandoned unrecorded, have recently come to light in Berkshire, Hertfordshire (a truly breathtaking mine!), Suffolk, Kent and Middlesex. They appear to be generally associated with 19th century brickfields on the outskirts of built-up areas such as Reading, Pinner, Dartford, etc.

7. Miscellaneous Mines

Such other mines as Surrey has possessed at various times, including those for Thanet Sand in the north-east of the historical county, those for flint at West Horsley, and perhaps some for clay iron ore in the Weald were all relatively small and shallow and exhibit few or no special geological features.

8. Acknowledgements

The subterranean parts of my researches into the Surrey mines would not have been possible without the assistance of members of the Croydon Caving Club and Unit 2 Cave Research & Exploration, whose expertise and specialised equipment allow exploration in safety. Attempts to explore old mines should never be made without proper equipment, training and leadership. Caving Club members also do much in their own right in terms of documentary researches, subterranean surveying and so forth. And all concerned with underground Surrey constantly keep safety and the need to conserve antiquities, geological features and bat hibernaculae in mind.

9. References

DICKINSON, H. W. 1933. Jolliffe and Banks, Contractors. Transactions of the Newcomen Society 12 (1931-32), 1-8

EVANS, J. 1856. Extracts from the Private Account Book of Sir William More, of Loseley, in Surrey, in the time of Queen Mary and of Queen Elizabeth. Archaeologia 36. 284-310

HUNT, R. 1860. Mineral Statistics ... Part II for 1858. Memoir of the Geological Survey ... 172-75.

LEE, H E., and J RUSSELL. 1924. The Guildford Chalk Caves. South-eastern Naturalist and Antiquary 29, 63-64 + plan.

MARTIN, P J. 1851. On the Anticlinal Line of the London and Hampshire Basins. Philosophical Magazine 2: 62pp

NOEL, P. 1970. Les Carrières Françaises de Pierre de Taille. Paris: Société de Diffusion des Technique du Bâtiment et des Travaux Publica.

OSBORNE, B E. 1982. Early plateways and firestone mining in Surrey. An interim report. Proc. Croydon Natural History & Scientific Society 17(3), 73-88.

SOWAN, P W. 1975. Stone mining in east Surrey. Surrey History 1(3). 83-94.

SOWAN, P.W. 1976a. Chalk mines in Surrey as a source of Freestone. Proc. Croydon Natural History & Scientific Society 16(2), 82-87.

SOWAN, P.W. 1976b. Firestone and hearthstone mines in the Upper Greensand of east Surrey. Proc. Geol. Ass., 86(4), 571-91.

SOWAN, P W. 1981-82. Building-stone mines in the Upper Cretaceous in Holland and Belgium. Bull. Subterranea Britannica 12, 3-9; and 13,3-9.

SOWAN, P W. 1982a. The underground stone quarries at Caen, Lower Normandy, France. Bull. Subterranea Britannica 15, 11-16; and 16,3-8.

SOWAN, P W. 1982b. The southern terminus of the Croydon, Merstham & Godstone Railway. Jl. Railway and Canal Historical Society 27(6), 159-67.

TAYLOR, G. 1900. Upward boring for water. Proposed scheme for Reigate and Redhill. The Quarry 5(8), 331-44; also in Water 2, 256-65.

WEBSTER, T. 1821. On the geognostical situation of the Reygate stone ... Trans. Geological Society 5, 353-57.

BAPTISM BY MUD

by A. B. Ginner

An interesting artefact, probably created by Homo Ignorans (early form of Sapiens) is puzzling geologists. To whit, a boot. The geology is confusing, as the object has been overlaid at different periods by muds and clays.

The earliest deposition, mainly inside the boot, consists of Folkestone Clay with bivalves, shattered, as if crushed by a heavy body. The second bed, uneven and consisting of London Clay, contains fossils usually associated with Sheppey, in a matrix of fossilised cheese. The youngest bed is of shaly clay, curiously mixed with limestone, dog biscuit and errant gastropods.

It is difficult to understand the strata, as Carbon 14 dating is unable to reveal a sequence in the organic remains.

ARMS AND THE WOMAN

I often keep on me a substantial hammer, a sharp knife or several lumps of jagged rock. But then I am a professional geologist and all is legal. If ladies registered for geology evening classes or joined their local geological club, perhaps they could carry weapons legally.

(Daily Express Readers' Letters January 1981)

BEDROCK, FLORA AND FAUNA - A PRELIMINARY INVESTIGATION OF TWO LOCAL HABITATS

Susan Hoare, Margaret Lawson and Gwen Macklin

Following a series of geology lectures at the Institute of Adult Education, Farnham, the group attempted to investigate, during two mornings in December 1983, the way in which the underlying geology might influence the soil and natural history of two local habitats - a beechwood and an area of open heathland. Questions and suggestions are raised for further study.

1. INTRODUCTION

The countryside of the Weald exhibits greatly contrasting areas of vegetation (e.g. Yew and Beech woodland, coniferous forest, chalk downland and heathland). This would appear to be related to the diversity of underlying rocks and to the absence of large amounts of overlying mixed geological material which were deposited in other parts of the country, by the ice sheet during the Pleistocene (Sankey 1975). Indeed, a geological map of the locality reveals a complex pattern of rocks and soils exposed on the surface of the landscape.

The aim of the present study was to investigate the relationship between the underlying geology, soil and associated plant and animal communities. Following a series of autumn lectures on the geology and natural history of the Weald, two local habitats were studied in the field in December. Strongly contrasting habitats were selected for this preliminary survey, a beechwood and an area of open heathland.

2. GEOLOGY

Site 1: Sheephouse Copse - SU 858 417 (I.G.S.284)
The site in Sheephouse Copse lay on the dip slope, at the western end of the North Downs, at the boundary between Upper Chalk and an area of clay with flints, at an altitude of about 152 m with a slight slope in the direction N.N.W.(FIG 1). Sheephouse Copse is a climax beechwood, about 150 years old. It is subject to woodland management.

Site 2: Frensham Little Pond - SU 858 317 (I.G.S.301)
The site at Frensham Little Pond was situated near the base of a hill sloping towards the south-east, at an altitude of about 60 m above sea level (FIG 2). This area lies on Folkestone Beds, these being the youngest of the marine deposits of the Lower Greensand. Patches of river gravel were present. There was evidence of gravitational movement within the sand where sand overlay these river gravels. This was possibly attributable to the effects of rainfall.

Frensham Little Pond is an area of open heathland under conversation, dominated by the heather Calluna vulgaris. Also present in the area are managed stands of Scots Pine (Pinus sylvestris) which appear to be encroaching on the heathland.

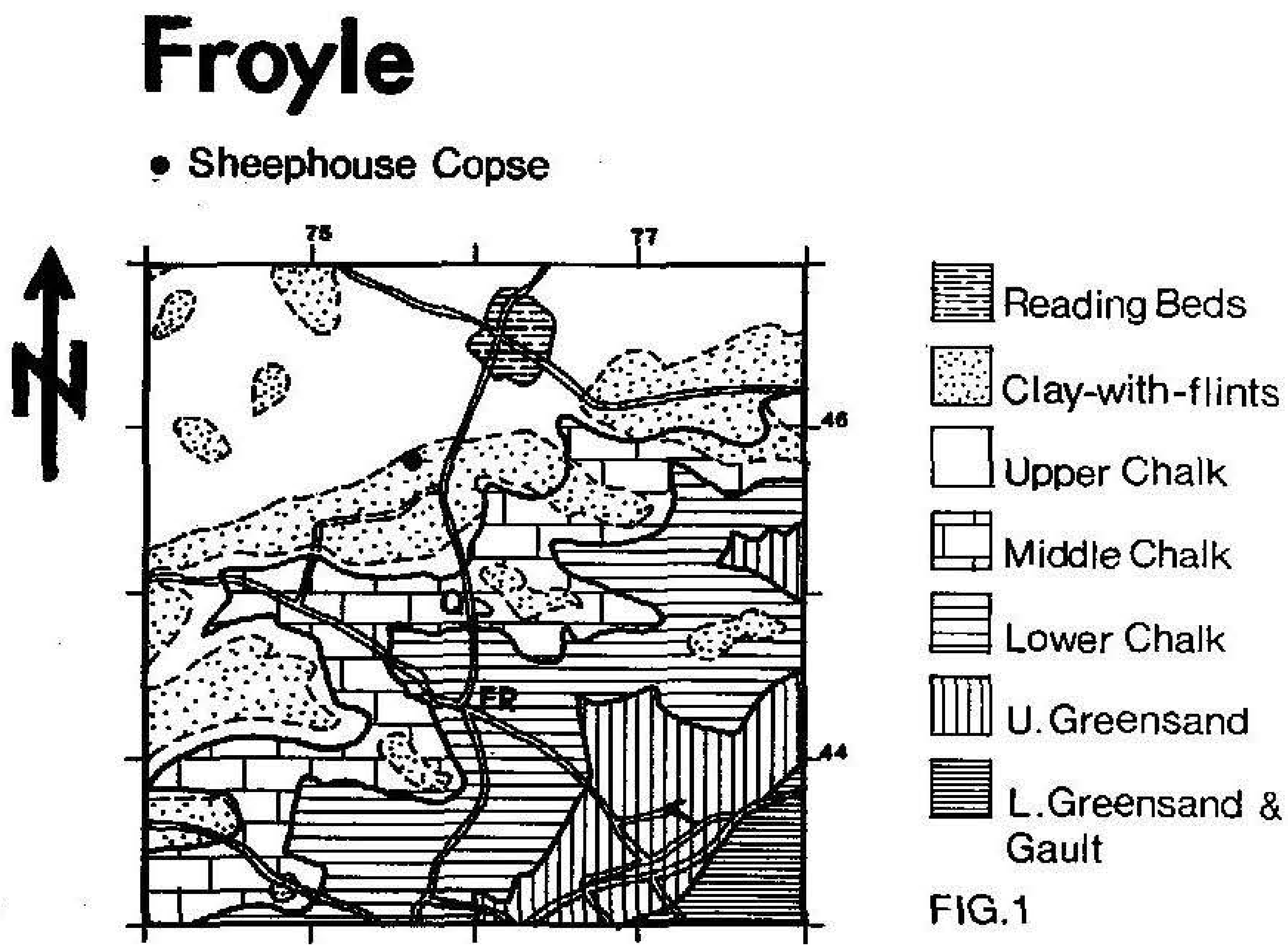


FIG.1

FR - Lower Froyle Q - Quarry

3. METHOD

The habitats were first surveyed generally and the relevant abiotic factors recorded (TABLE 1). The soil texture was noted, and samples of soil collected so that the composition of the two soil types could be determined and compared. The relative contribution of clay, silt and sand were estimated by performing a sedimentation test (Beckett 1978).

The water content of the soil was determined under two conditions. Air drying a sample to constant weight and then subjecting it to a temperature of 100°C, until constant weight was achieved, enabled the percentage water content of the sample to be calculated. Strongly heating a dry sample of soil until all the humus content had been burnt away, leaving a sample of constant weight, allowed the humus content to be calculated as a percentage of the sample (Beckett 1978). The soil pH was measured in the field using B.D.H. indicator.

Frensham

• Frensham Little Pond

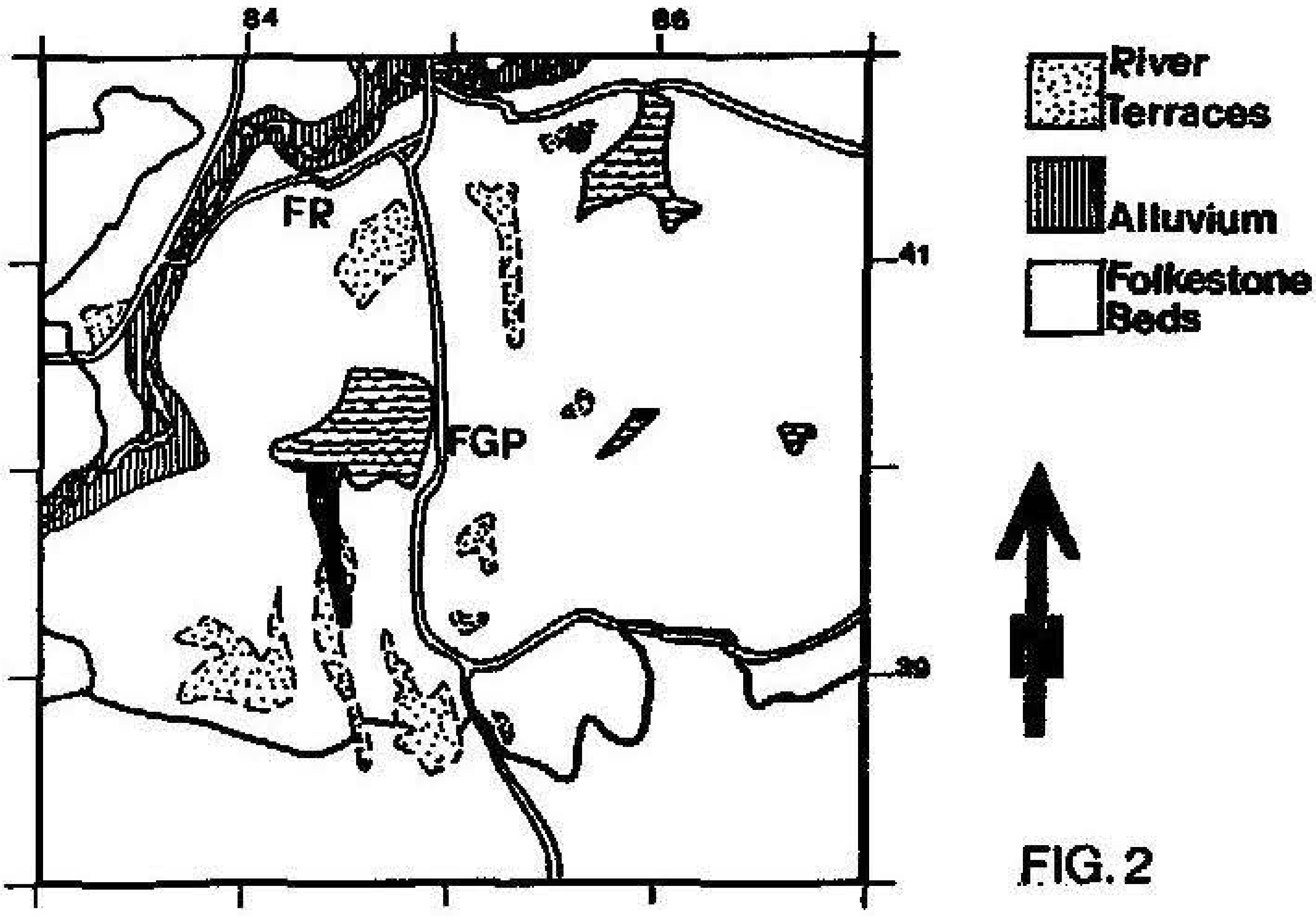


FIG. 2

FR - Frensham FGP-Frensham Great Pond

A *more intensive investigation* of flora and fauna in a 0.5 m^2 was carried out in each area. The use of a single non-randomly selected 0.5 m^2 quadrat is generally to be deplored as an ecological method. However, only two hours were allocated for each excursion and this method provided a critical basis for discussing the *validity of sampling techniques!*

A beating tray was used to dislodge animals living in the heather. The wildlife of the tree trunk and canopy of the beechwood were beyond the scope of this study. The percentage cover in each quadrat was recorded. Loose twigs and leaf litter were then inspected for any associated life forms, before being collected for weighing. The flora and fauna in each quadrat, up to a depth of 4 cm, were recorded.

4. RESULTS

The results shown in Table 1 suggest that Sheephouse Copse and Frensham Little Pond differ in their geology, soil type, soil pH *and pattern of vegetation and fauna. Moreover, a greater number* and variety of invertebrates were recovered from Sheephouse Copse. Only springtails were found, in any number, at Frensham Little Pond and nothing was recovered from the heather in the beating tray.

5. DISCUSSION

The contrasting habitats studied appear to represent a sharp contrast with respect to their associated bedrock, soil type and reaction, and associated pattern of vegetation and fauna. However, it must be remembered that these conclusions were based on the results derived from a single quadrat in each habitat sampled in winter. They therefore serve only as an indication of the situation that might pertain and as a guide and stimulus to further investigation.

The beechwood was situated on Upper Chalk overlain with clay and flints. A field assessment suggsted that the slightly acid soil (pH 6) was a loam. This was supported by the results of a sedimentation test (TABLE 1).

The soil was less alkaline than anticipated in view of the chalk bedrock. However the pH of the sampling area may have been modified by the present of clay and flints and by the fact that the site was awt the top of a slope. The latter might predispose the soil to leaching of calcium salts. In addition, the soil contained humus, covered by deep leaf litter, and had been subjected to several days of heavy rain. Since the soil has good water retention properties (29% being released on exposure to air at room temperature and a further 4% after heating to 100° C), it is likely that acid rainfall remained in the topsoil. In order to test these alternatives it would be necessary to examine the soil profile and to test the pH of the soil at a variety of depths.

The open heathland, by contrast, was situated near the base of a hill on Folkestone Beds of the Lower Greensand, with patches of river gravel. The soil, a sandy loam (TABLE 1), proved to be far more acidic than that found in the beechwood (pH 4-6). Moreover, it appeared to have a lower capacity for water (19% compared with 33% - TABLE 1). However, since the samples were not collected on the same day, and the preceding weather conditions were significantly different, these figures are not strictly comparable and need to be repeated.

The greater readiness with which water was lost from the heath-land soil sample (all water lost at room temperature - TABLE 1) may be a reflection of its coarser, sandier texture. It suggests a free draining soil that might be depleted of some soil minerals and nutrients.

The vegetation observed in both habitats differed significantly. Sheephouse Copse supports beech trees (Fagus sylvaticus), which are generally considered 'lime lovers' (calcicoles), and suggests that although the topsoil is slightly acid, the roots of the old trees extend into the soil where calcium concentration may be higher. The soil is well drained and this too would favour their presence (Wooldridge & Goldring 1972). The dense canopy of the climax must limit the amount of incident light falling on the woodland floor particularly during the summer months. The

TABLE 1 - Results of Sampling two Sites

	Sheephouse Copse	Frensham Little Pond
Habitat	Beechwood	Heathland
Date/Time	13/12/83/10-12am	21/12/83/10-12am
Temperature/Wind	45-47°F/Light	34°F/Light
Sun/Cloud	Overcast/Bright	Sunny/Thin Cloud
Conditions during previous 24 hrs	Heavy rain(4days)	Heavy Frost
Soil - water content		
(a)Air dried sample	29%	19%
(b)After heating to 100°C	33%	19%
Humus content	6%	8%
% clay:%silt:%sand	17%:33%:50%	6%:29%:65%
Soil Texture	Slightly silky	Compacted & sandy
Soil Type	Loam	Sandy loam
pH	pH6	pH4
%Ground Cover	Grass 10%) Wood Avens 1%) Moss 0.25%)100% Leaf/Twig) Litter 89%)	C. vulgaris 50%) Lichens 25%)80% Moss 5%)
Litter/0.5 m^2 in gms	Leaf/Litter 630)1495 Twigs 865)gms	Twigs)150 gms Heather)
Fauna		
Phylum Annelida		
Class Oligochaeta - Earthworms	6	-
Phylum Nematoda	1	-
Phylum Mollusca		
Class Gastropoda - Snails	1	-
Phylum Arthropoda		
Class Arachnida -		
Spiders	6 (3 varieties)	eggs
Mites	11	-
Harvestmen	3	-
Class Crustacea - Woodlice	1	-
Class Diplopoda - Millipedes	2	-
Class Insecta -		
Ants	1	-
Springtails	11	many
Pupae	3	1 (? Fox Moth)
Shield Bug	1	-
Beetles	1	-
Flies	many	
Grubs	-	1
Gnats	-	1

absence of undergrowth was therefore not unexpected. The presence of Wood Avens (Geum urbanum) was observed and other plants might be expected during the spring, before the canopy is in full leaf.

The area between the canopy and the woodland floor affords a relatively sheltered environment. The presence of a substantial layer of decomposing litter (circa 1.5 kg/0.5 m^2) probably ensures moist, protected conditions with a variety of ecological niches. This may be sufficient to account for the greater number and variety of animals observed (TABLE 1).

The heathland habitat, by comparison, was more exposed with Calluna vulgaris the dominant species. The lichen Cladonia sp. and occasional moss were also present (TABLE 1). It is interesting to note that lichens are opportunists and possess the unique ability to exploit hostile environments (Roberts 1982). Moreover, 20% of the soil was exposed and only one tenth of the amount of litter in the woodland observed. The more open structure of the soil together with the lack of insulating material suggest that the soil moisture content and temperature may be subject to a greater degree of fluctuation than that in the beechwood. This may help to explain the dearth of fauna (TABLE 1) at Frensham Little Pond. The heather plants themselves are directly exposed to environmental extremes and possibly too hostile to be exploited in December. It was perhaps not surprising that nothing was recovered after using a beating tray.

Springtails occurred in great abundance in the soil and are to be expected since they assume greater importance as decomposers under conditions of acidity. The greater variety of decomposers in the beechwood (springtails, millipedes, nematodes and mites - (TABLE 1) and the greater volume of litter would tend to support the view that the humus content should be greater than on the heathland. However, beech leaves decay only slowly (Morris 1983) and sample estimations yielded the anomalous situation that the heathland contained 2% more humus than the woodland. Clearly this requires clarification.

An assessment of the variety of vertebrate life present was beyond the scope of this project, though rabbit droppings were observed at Frensham Little Pond. The establishment of an observation hide and the use of Longworth small mammal live traps (Angel 1972) would go some way to remedy this situation.

This preliminary survey has raised a number of questions well worth further investigation. In any future study the habitats would be more effectively sampled using transects or a greater number of randomly selected 0.5 m^2 quadrats. In addition, the soil should be examined to an appropriate depth. Moreover, invertebrates might be collected more efficiently from the litter using a 'Berlese funnel' (Chinery 1982) or a 'Tulgrem funnel' (Jackson & Raw 1966) and a 'pooter' (Chinery 1982) would enable their more rapid recovery from a beating tray. In addition, monthly sampling would allow seasonal changes in species abundance and diversity to be monitored.

Despite the limited nature of this investigation it was a useful and informative exercise in developing an appreciation of the numerous factors influencing a habitat. Like palaeontology, the study of the natural history of an area provides a valuable link between the past and the present.

It seems likely that the geology of an area does influence the soil and, as a consequence, vegetation and wildlife (TABLE 1). However, more definite conclusions must await more extensive studies of a larger variety of habitats. It is perhaps worth emphasizing that complex ecological situations cannot be reduced to simple laws. Moreover, it is surely indisputable that such complex inter-relationships must never be underestimated nor must the influence of Man himself!

6. ACKNOWLEDGEMENTS

We wish to thank Helen and Marie, our class colleagues, for their assistance during field trips: Dr. Paul Olver for guidance on matters geological and Dr. John Hobrough for helpful discussion.

7. REFERENCES

ANGEL, H. 1972. Nature Photography, Its Art and Techniques. Fountain Press.
BECKETT, B.S. 1978. Biology: A Modern Introduction. O.U.P.
CHINERY, M. 1982. Insects in Britain and Northern Europe. Collins.
JACKSON, R.M. & RAW, F. 1966. Life in the Soil. Studies in Biology No.2. Arnold.
MORRIS, P. (Cd.) 1983. The St. Michael Natural History of the British Isles. Hamlyn Publishing Group Ltd.
ROBERTS, M.B.V. 1982. Biology. A Functional Approach. Third Edition. Thomas Nelson and Sons Ltd.
SANKEY, J. 1975. The Flora and Fauna of Surrey. In 'The Surrey Countryside - The Interplay of Land and People'. Ed. J.E. Salmon, University of Surrey. 218pp.
WOOLDRIDGE, S.W. & GOLDRING, F. 1966. The Weald. Collins. 276pp.

AN APPEAL FROM THE EDITOR!

The Journal urgently requires short articles, poems and general space fillers for next year. No excessive erudition required! Let's make it a bumper fifth issue!

THE MAKING OF CEMENT

Lothar Neubert

Visits to cement quarries are a regular feature of Society trips. However, although the main constituents of cement may be familiar, it is hoped that this brief outline of the manufacturing processes will assist in a fuller understanding.

1. Introduction

The manufacturing of cement involves the preparation of raw materials, the burning of the raw material and the grinding of the resulting clinker into powder (cement). There are two processes used, the "WET" or "DRY", depending on the moisture of the raw material. Figure 1 shows the transformation of the quarried material into cement.

Cement is made from a suitable mixture of Limestone, Marl, Clay or Shale with Gypsum. The large pieces from the quarry are sent to the crushing plant where the hard raw material is subjected to reduction down to 150 mm in size. A secondary crushing is then done where the larger lumps are reduced to about nut size. From this crushing they go to an Impact Crusher which is capable of delivering the finished material to a size which can then be put into a Wash Mill.

A wash mill consists of a tank in which rakes are suspended from a Rotary arm which drags through the slurry and breaks up the material. The slurry passes through a filter into a sump and from there it goes into a mixing tank. In these tanks, the required homogenous slurry is achieved.

2. Burning Process (Wet)

The wet prepared raw material, the slurry, contains approximately 35-40% water which must be evaporated. This evaporation takes place in the chain zone of a long wet process kiln with internal heat exchange devices.

In the feed end part of the kiln you see first the slurry heater which is followed by the numerous chains suspended to form a chain curtain (See FIG.2). The slurry adheres to these chains and comes into contact with the hot kiln gases. The slurry is thus dried and then crumbles away from the chain curtain.

During passage through, drying is completed in cross heat exchange sections. This is followed by Calcination and eventually clinker is formed in the Sintering zone.

Rotary kilns can be fired by coal, oil or gas and the method chosen at any particular works is largely governed by economic considerations.

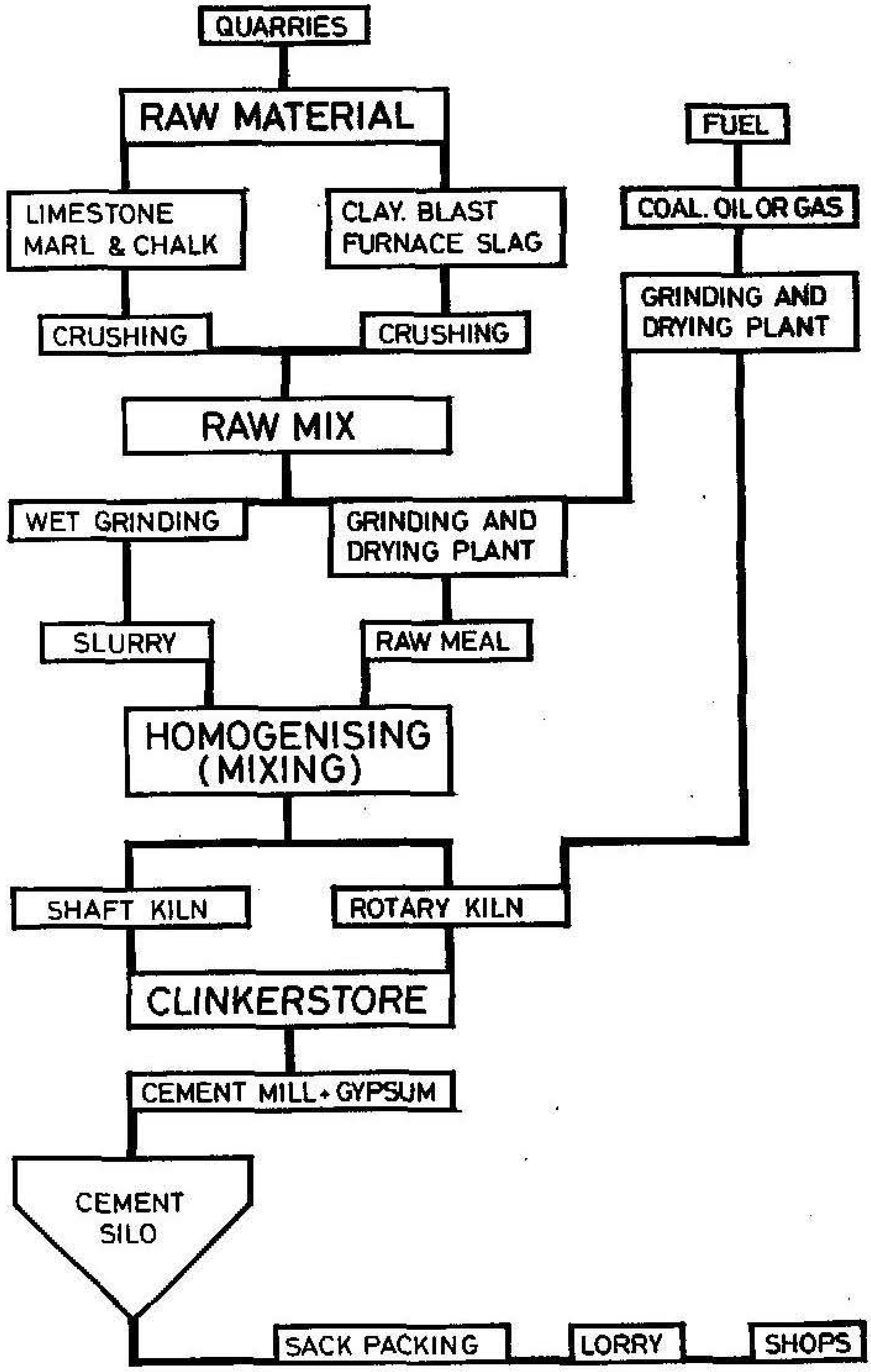


FIG. 1. Flow diagram to illustrate the production of cement

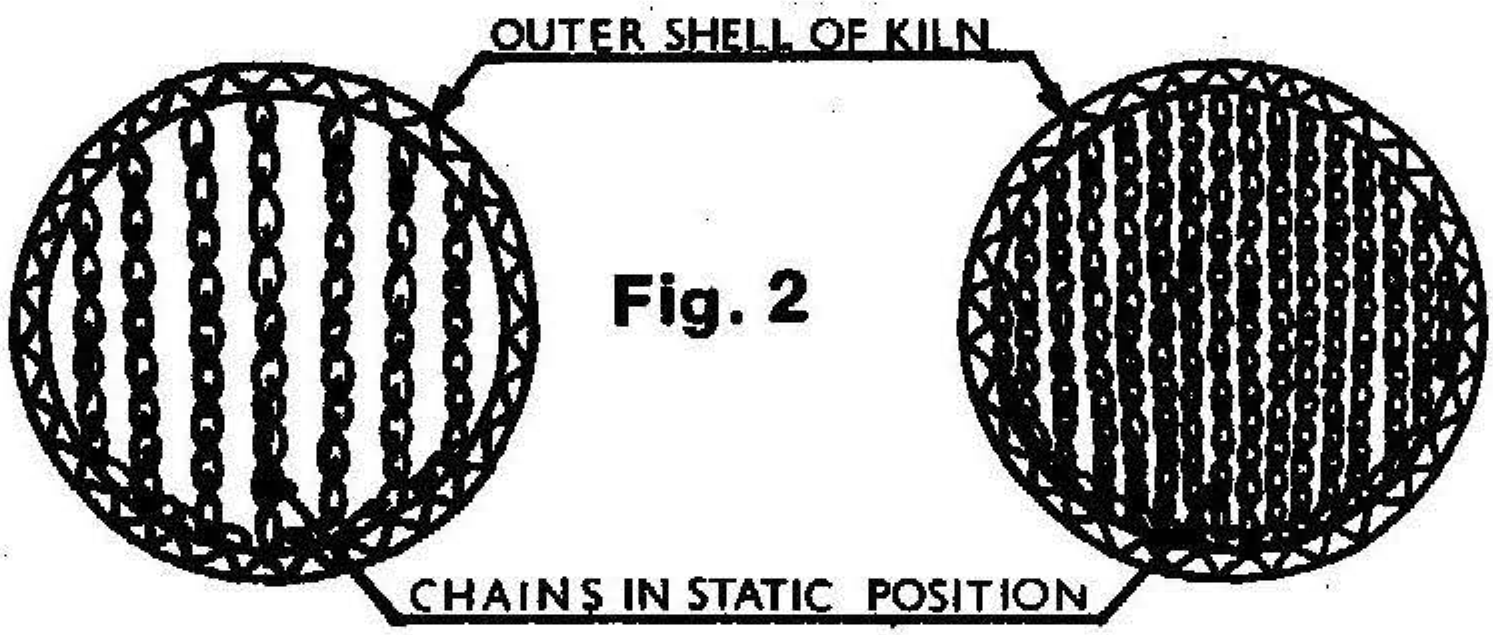


FIG. 2. Diagram of a chain curtain

3. Burning Process (Dry)

The dry process is similar to the wet in that, either long Rotary Kilns with internal heat exchanger inserts or short Rotary Kilns with pre-heat are used. In the long dry process Rotary Kiln, a number of chain curtains (See FIG.2) and cross segments as well as the brick lined Kiln walls, ensure perfect transfer of heat from Kiln gases to the processed material. The raw meal is fed first into a pelletiser which converts it into small pellets with the addition of 8-14% water prior to going into the Kiln. These nodules are approximately 10-30 mm in diameter.

The short Dry process needs a pre-heater for drying. The most frequently used pre-heater is the Lepol grate. The grate consists of a dust tight housing of steel plates, which is lined with fire bricks and can be easily entered by manholes. An endless strand of movable grate plates travels through the housing with a speed of 3-4 metres/hr. A 200 mm thick layer of nodules is carried to the Kiln and is slowly pre-heated by the gases coming from the Kiln. The space above the grate is sub-divided into a hot chamber and drying chamber. The gases pass downwards through the layer of nodules in the hot chamber - the temperature dropping from 1000° C to 300° C. The gases are then dedusted outside the grate housing in the intermediate dedusting plant which consists of several cyclones. From there, the gases are passed downwards through the nodules for a second time in the drying chamber. This process causes the temperature to drop from 300° C to approximately 100° C. By this process the nodules on the grates are finally pre-heated to approximately 900° C. They then pass through a connecting chute into the Rotary Kiln and are burned in the usual way to clinker.

4. Coolers and Crushers for Clinker

The raw material which has been burned to clinker in the Rotary Kiln drops from the Kiln into the grate cooler, where the clinker is cooled as far as possible by cold air. The cooling air is heated up and is then totally, or partly, used in the Rotary Kilns as combustion air. At the end of the grate cooler a crusher is installed to further reduce the clinker which is in large lumps and to recirculate the particles back for further cooling.

5. Further Processing of the Clinker

The clinker is stored in large open or closed storage halls. From here the clinker is ground with the addition of Gypsum. The finished cement leaves the mill and is lifted by bucket elevator to a separator, which selects out the cement of sufficient fineness and returns the grits to the mill. The finished cement then goes to the cement silos. The cement from the silos is then conveyed to the packing plant or pumped directly into the cement lorries as bulk cement.

6. Conclusion

I hope that the above process has shed some light on the mysterious machines grinding away in all cement quarries and that Society members will now be able to at least identify their purpose.

GEOLOGICAL HOWLERS

The lowest form of fossil is a cast.

Coal is a superior type of peat.

Sir Edward Bollock's computer fit...

The orogeny occurred because the proto-Atlantic belt was moving around the Circum-Pacific by way of Malaya.

Hystrosaurus lived in hot climates and was as big as a sheep. Questions were asked as to how such an animal could have reached Antarctica, since it could not swim.

When a human being dies, he or she is committed to the ground and buried in a coffin. This basic idea was introduced 600 million years ago at the beginning of the Cambrian.

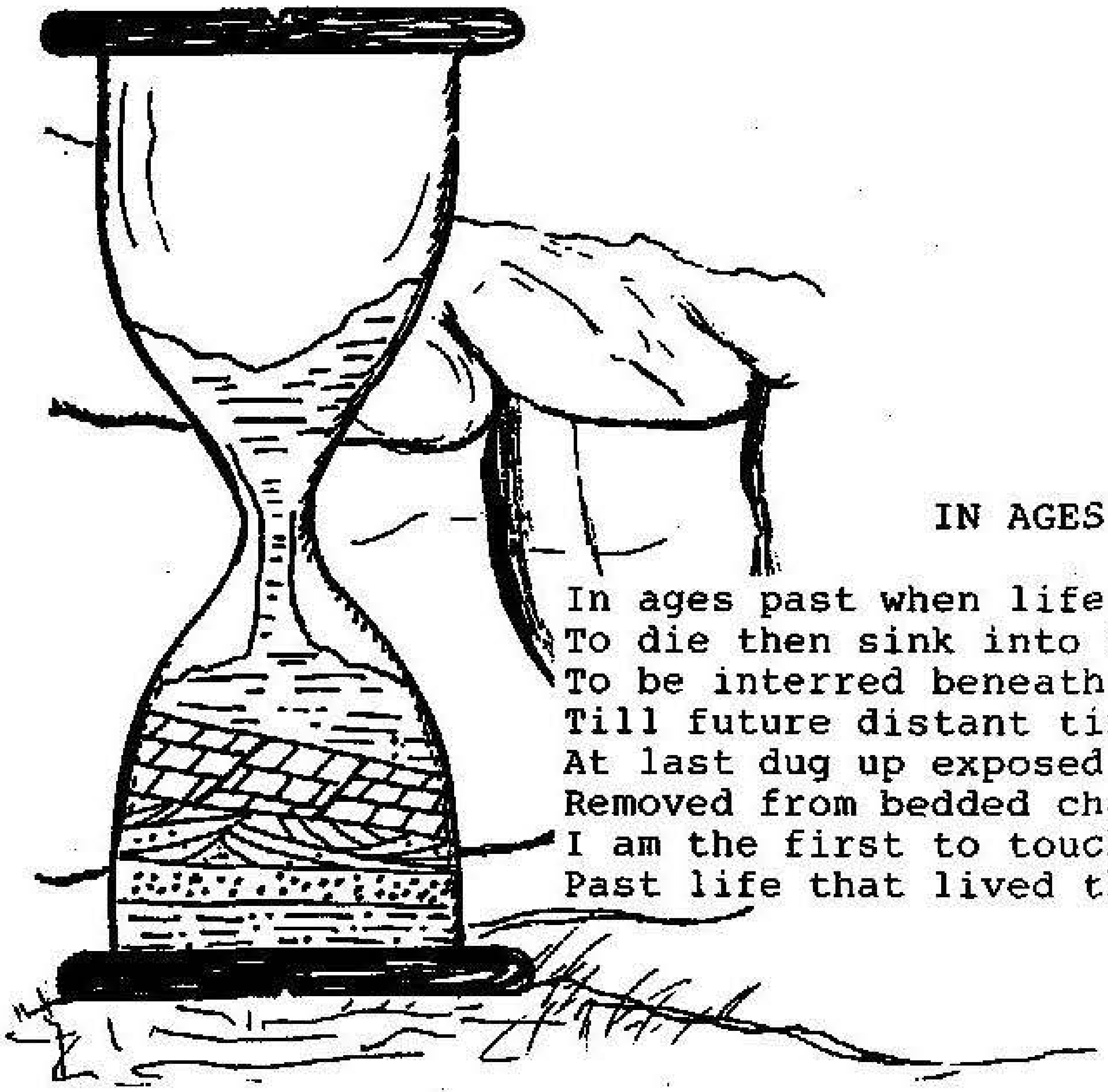
A fossil is not simply something dug up since a potato is not a fossil.

The belemnite was a swimmer, but by using its spear-like nose, it could easily burrow for safety. It was an unspectacular creature.

When the continent of Pangaea split up, the penguin went with it.

The first man to date the Pleistocene was a Scandinavian called Varve. He also wrote 'Varve from the madding crowd'.

GEOPOETRY



IN AGES PAST

In ages past when life had grown
To die then sink into the dark unknown
To be interred beneath the clay
Till future distant times to stay.
At last dug up exposed to sight
Removed from bedded chalk so white
I am the first to touch and see,
Past life that lived then ceased to be.

Cyril Potton

"Sermons in stones,..."

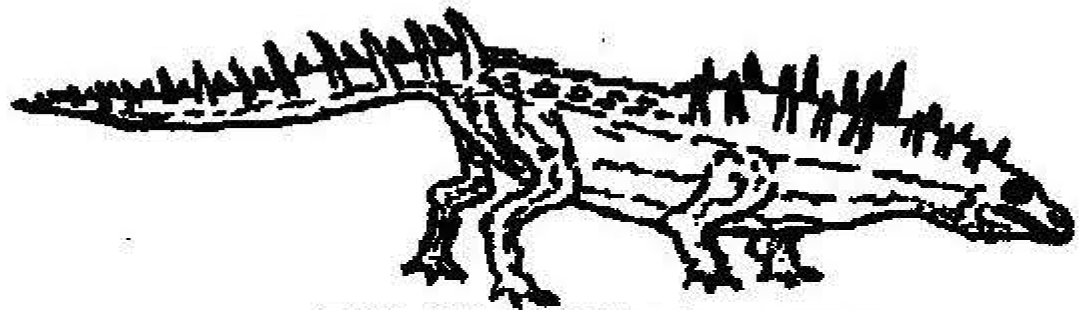
A Trilobite Tale

A group of rock bashers from Surrey,
 Tumbled out of their coach in a hurry,
There developed a fight,
 O'er the one trilobite,
Which they found at the base of the quarry.

A Structural Story

A tectonic student from Farnham,
 Taught his cat to sing excerpts from Carmen,
To escape from the fate
 On the Eurasian plate
He subducted with Bizet to graben.

NEWS



POLACANTHUS FOXI

THE FARNHAM GEOLOGICAL SOCIETY

For Forms of Proposal for Membership, and further information, please apply to the Secretary, Farnham Geological Society, Farnham & Ash Adult Education Institute, 25 West Street, Farnham, Surrey, GU9 7DR.

PROGRAMME FOR 1985

January 11th	Annual General Meeting.
February 8th	Prof. Derek J. Blundell, University of London, An Introduction to BIRPS - deep reflection profiling work that is providing information about the lower crust and its evolution.
February 15th	Annual Dinner
March 8th	Dr. Bill McGuire, West London Institute of Higher Education, "The Volcanology of Mount Etna".
April 19th	Dr. P. F. Fisher, Kingston Polytechnic, Drainage evolution of the Mole/Wey/Blackwater System - Dr Fisher will lead a field trip to some of the above areas on Sunday 21st April.
May 10th	To be arranged.
June 14th	Dr. L. B. Halstead, University of Reading, "The First Vertebrates".
July 12th	Members evening.
August	No meeting. A chance to nip away and practise your geological skills.
September 20th	To be arranged - Please note date
October 11th	Mr. Les James, Bulmershe College of Higher Education, Reading, will talk on 'Raised Beaches'.
November 8th	Dr. Margaret E. Collinson, Kings College, London, will lecture about Kenyan Wildlife Ancient and Modern.
December 18th	Dr. A. M. Duncan, Luton College of Higher Education. At this Christmas meeting the talk is to be about 'Gemstones'.

NOTE FOR THE GUIDANCE OF AUTHORS

Papers and article on any topic within the earth sciences are welcomed especially those of local interest. Short papers of 2000 words or less are preferred although longer papers not exceeding 5000 words can be accepted.

Two copies of the typescript should be sent to the Editor. Typescripts should be doubled-spaced, including references, on one side of A4 paper with a wide margin on the left and a narrower margin on the right. All pages should bear the author's name and numbered serially.

Papers and articles should be arranged as follows:

1. Title, brief and specific.
2. Name of author(s).
3. Summary: this should not exceed 100 words.
4. Address of author(s).
5. Main body of paper or article: subdivided into separate headings which are to be numbered serially.
6. Acknowledgements.
7. References.
8. Legends for text-figures and plates (if any).

Measurements should be given in S.I. units. Standard palaeontological and stratigraphical conventions should be followed throughout the text. Generic and specific fossil names to be italicised throughout. Localities referred to in the text should be precisely located by their Grid Reference or by an appended index map.

References should be listed alphabetically by author at the end of the paper. Attention should be paid to convention as regards the abbreviated titles of journals. Authors are responsible for the accuracy of their references.

Figures used to illustrate articles should be prepared at twice the size of their eventual reproduction. Any letters or numerals should not be less than 1mm high after reduction. It is suggested that white card or a colourless tracing medium be used with black indian ink and dry transfer lettering.

Typescripts, enquiries concerning editorial matters and all correspondence should be addressed to: The Editor, Journal of the Farnham Geological Society, Farnham & Ash Adult Education Institute, 25, West Street, Farnham, Surrey GU9 7DR.

PAUL OLVER Editor

The Farnham Geological Society

This Society, founded in 1970, exists to promote interest in Geology and to extend knowledge of the science by research and by publication. It holds meetings for the reading of original papers and the delivery of lectures, organises practical demonstrations and conducts regular field excursions.

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