# A GEOLOGICAL APPROACH TO THE HISTORY OF ENGLISH ALABASTER

by

R. J. Firman

**Summary**

Alabaster is a rare form of gypsum which has been used in this country for sculpture and decorative work for at least eight centuries. Fauld mine in Staffordshire is the only commercial source today, all other deposits having been virtually worked out including former major producers at Chellaston, near Derby, and Red Hill, near Ratcliffe, Nottinghamshire. Geological and historical evidence combine to suggest that alabaster was a near surface deposit probably formed by rapid, cold hydration of anhydrite under periglacial conditions. These near surface occurrences thus become pre-dominantly plaster grade gypsum at deeper levels.

The documentary and geological evidence for the sources, extraction methods and output are critically examined. The industry was small, probably on average producing no more than 70 tons per year between 1350 and 1550 A.D. most of which came either from the Castle Hayes–Fauld district in Staffordshire or Chellaston. White or colourless alabaster became difficult to find by the mid-sixteenth century but, once coloured alabaster became acceptable, the greatly increased demand after c.1580 was initially satiated by reopening old workings formerly worked solely for white alabaster. Discontinuities in the extraction history at Chellaston are explained by the patchy covering of glacial deposits which made prospecting difficult, and by the lack of continuity down dip. Irregular underground workings popularly attributed to the Middle Ages probably are no older than about 1800.

Neither texture, structure nor chemistry are sufficiently distinctive to identify the provenance of the majority of English alabasters. However, some unusual varieties, such as the Chellaston green, Somerset red and black, and the Yorkshire porphyroblastic alabasters are diagnostic of their localities or stratigraphic horizons.

## Introduction

This country is plentifully endowed with the mineral gypsum, which for at least seven hundred years has been used for the manufacture of building plasters. A small proportion of this gypsum, in a few favoured localities (text-fig. 1), has the requisite properties to be used as an ornamental stone. This material, known as alabaster, commended itself to medieval sculptors because of its softness, which permitted it to be most intricately carved, and for the ease with which it could be painted and gilded. Later, particularly during the eighteenth and nineteenth centuries, alabaster became valued for its decorative properties; the "marbled" appearance, translucency and high polish that could be achieved, becoming as important as its workability.

Alabaster has three main disadvantages which make it less durable than most building stones. Firstly because of its softness it is easily damaged, either deliberately or accidentally; secondly it calcines at comparatively low temperatures forming first plaster of Paris, between 128 °C and 163 °C, and then anhydrite, above 200 °C. Consequently alabaster is easily damaged by fire. Thirdly, being slightly soluble it easily weathers and has to be protected from rain and generally damp conditions. Consequently much alabaster statuary has been destroyed or badly damaged by fire and neglect in addition to that deliberately destroyed during and after the Reformation.

Most of the surviving pre-Reformation and many post-Reformation alabasters have been described in meticulous detail by art historians. Similarly the geology of almost all English gypsum deposits has been described in detail. Historians have tended to neglect post-Reformation alabasters and geologists have often not differentiated between plaster grade and alabaster quality gypsum. Little attempt has been made to harmonise



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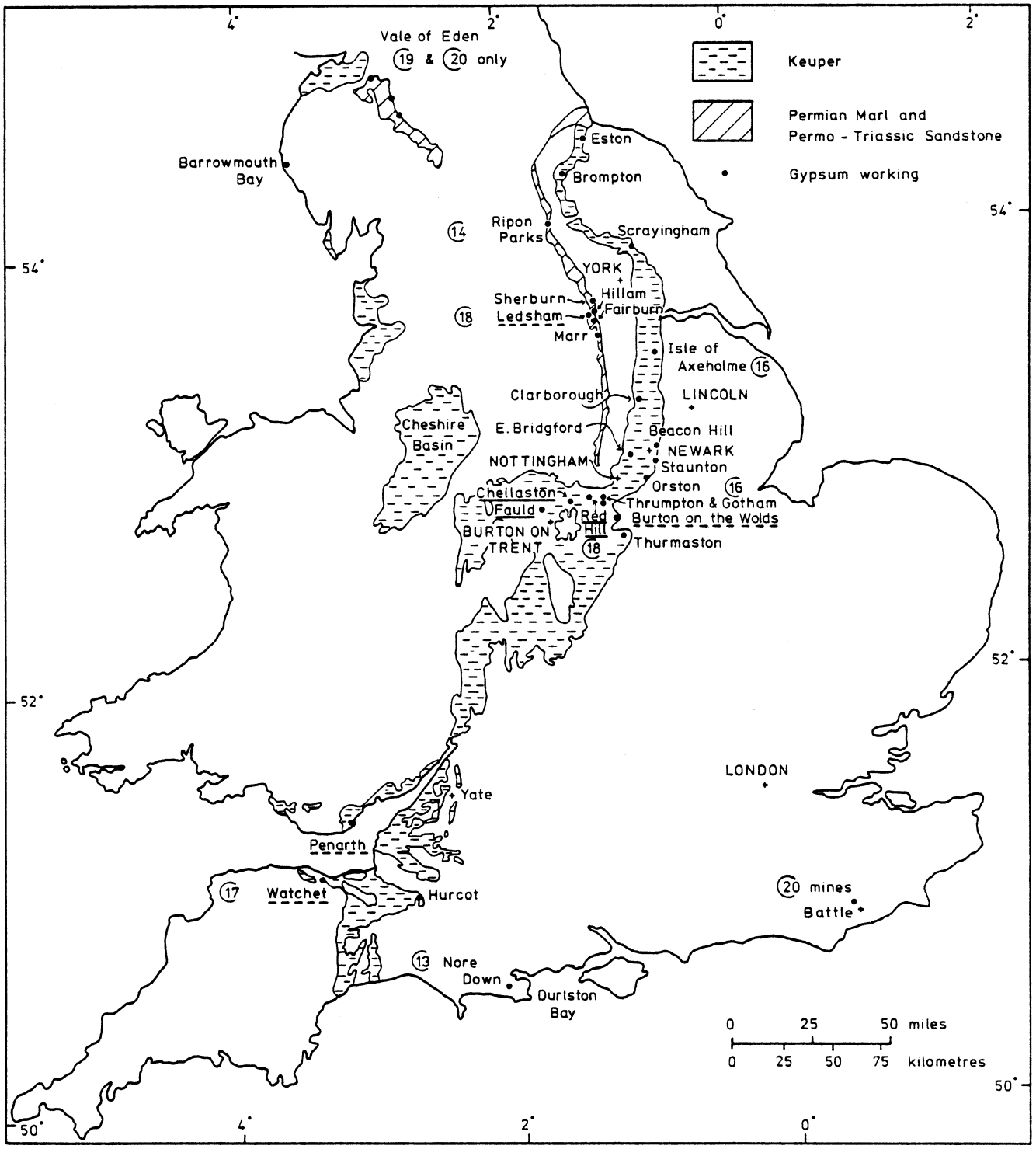



Text-fig.1 Principal locations of gypsum plaster and alabaster workings with dates of the earliest documented exploitation. Alabaster producing localities underlined, minor producers indicated by dashed underlining.

geological and historical evidence. In order to do this it is essential that the term alabaster should be closely defined and that present ideas about its geological origin be outlined before any historical analysis is attempted.

## Definitions

"Alabaster" is usually defined as a fine-grained, compact, translucent form of gypsum ($CaSO_4.2H_2O$) capable of being carved and polished. Varieties ranging from pure white to those streaked or mottled with orangy red, or occasionally green, marls have been used for eight centuries in Britain for ornamental and sculptural purposes. Some forms of fibrous gypsum (e.g. the "satin spar" from East Bridgford, Notts.) have also been used for ornaments but these have long thin parallel crystals texturally quite unlike alabaster and are therefore excluded from this definition.

Large blocks of alabaster often contain veinlets of satin spar and patches of coarser grained gypsum and are thus, strictly, not wholly made of alabaster. Nevertheless if the block as a whole can be carved and polished it is properly called alabaster. In the field the distinction between alabaster and ordinary gypsum is difficult to establish since the textural differences are subtle and alabaster frequently merges into less translucent usually coarser grained, varieties of gypsum. During mining alabaster is distinguished from plaster grade gypsum largely by its translucency, pieces up to a foot thick transmitting light from a miners lamp.

The term "alabastrine gypsum" (Ogniben, 1957) is not synonymous with alabaster but is applied to all fine-grained gypsum including alabaster which has the microscopic textures, but not necessarily the physical properties, of alabaster. In particular much of the alabastrine gypsum described by Ogniben (1957), Holliday (1970) and many other writers, either lacks the translucency of alabaster *sensu stricto* or is of too low a quality to be carved and polished. The mere possession of alabastrine micro-textures similar to those described by Richardson (1921) from Derbyshire alabaster is therefore not sufficient to identify alabaster.

Gypsum which cannot be used for ornamental purposes has usually been termed "plaster" because its principal use has been for the manufacture of gypsum plaster. Historically the terms "alabaster", "plaster" and "gypsum" have been used imprecisely. Thus Leland (c. 1543) states that the upper part of the Isle of Axeholme "hate plentiful Quarres of Alabaster communely caullid Plaster", leaving the reader uncertain whether alabaster, or plaster, or both were produced. Nor is the ambiguous use of the word alabaster confined to early writers and historians. Woodward (1906) a geologist, described the cliffs at Watchet, Somerset, as containing gypsum or alabaster, and Ussher (Anon, 1889) describing the same area, is reported to have classified gypsum into three forms, "the compact granular or finely crystalline, as Alabaster; the fibrous Satin Spar; the visible crystalline, as Selenite", thus obscuring the fact that the texture of his "alabaster group" ranges from the very fine genuine alabaster to the very coarse granular "plaster" which constitutes the bulk of the Somerset deposits. In view of these and other ambiguous usages it is recommended that the mere record of alabaster in literature is not accepted unless it is supported by evidence that it was actually used as alabaster.

To some extent the distinction between "alabaster" and "plaster" is subjective and dependent on supply and demand. Thus, when the demand for alabaster tended to outstrip the supply in the early seventeenth century, forms of gypsum not previously considered usable as alabaster were developed. Conversely nowadays, when there is little demand for alabaster, some of the gypsum mined which could be carved and polished is made into plaster and therefore not classified as alabaster. Nevertheless it is also true that of the 3 to 4 million tons of gypsum produced annually in Britain only a few hundred tons could be described as alabaster. This constrasts with the many references to alabaster and "alabastermen" in medieval records. Thus any hypothesis about the origin and history of alabaster must reconcile its present rarity with its apparent abundance in the past.

## Origin

In Britain primary gypsum ($CaSO_4.2H_2O$) and anhydrite ($CaSO_4$), were precipitated from evaporating sea-water and saline ground-waters, particularly during the Permian, Triassic and Upper Jurassic periods approximately 280, 200 and 140 million years ago respectively. These formed extensive stratiform deposits whose structures and textures were subsequently so profoundly modified that the varieties of gypsum, including alabaster, now seen in mines and quarries, owe their origin chiefly to post-depositional processes. These processes included compaction and dehydration during burial, leading to the conversion of the original gypsum to anhydrite; hydration during exhumation, leading to the formation of gypsum from both primary and secondary anhydrite and solution and reprecipitation as fibrous gypsum or fibrous anhydrite or selenite.

By analogy with sub-Arctic examples Holliday (1970) and Mossop and Shearman (1973) argued that alabastrine textures formed during very rapid, cold hydration of anhydrite exhumed in periglacial conditions. In Britain this could have occurred during the Ice Age concommitantly with the melting of ice sheets (cf. Spitsbergen today, Holliday, 1967). If this hypothesis is correct alabaster, like the bulk of gypsum in this country, was formed in geologically recent times from more ancient sulphate precursors. Most of the commoner coarse-grained,

porphyroblastic, massive gypsum seems to have been formed by slow hydration at depth in somewhat warmer conditions compared with the rapid, shallow or surface cold hydration which probably led to the formation of alabastrine textures. Recrystallisation due to tectonic or load pressures (Ogniben 1957) which might form or modify alabastrine textures seems less important in Britain than periglacial weathering. Moreover a periglacial origin partly explains why alabaster is so rare today and was apparently more plentiful in the Middle Ages. If, as suggested, it formed only at or near the surface, many original alabaster workings would pass from alabaster to normal coarse-grained gypsum (i.e. "plaster") as they followed the gypsum layers down dip. This mode of formation does not fully explain why sources of usable alabaster are so restricted geographically, alabastrine textures being far more widespread than alabaster. Periglacial weathering for reasons which are not understood, does not always produce the translucency, characteristic of high quality alabaster, in alabastrine gypsum. Moreover, hydration frequently appears to have been a multistage process. Where early slow hydration has resulted in patches of coarse grained gypsum it may render the whole mass unusable as alabaster. Other factors, unconnected with the hydration process, affect the workability of a potential alabaster deposit. These include thickness, spacing and number of "flaws", such as joints and late stage fibrous veins; the amount and distribution of included clastic sediment; and the extent of solution by ground and surface waters. All these factors combine to make economically viable alabaster deposits very rare.

## Discovery

Because of its solubility (1 part in 495) all forms of gypsum, including alabaster, outcrop at the surface only where erosion is more rapid than the rate at which gypsum is dissolved. Notable amongst these localities are the Somerset coast near Watchet and the South Wales coast at Penarth where some alabaster and much plaster grade gypsum is exposed in the cliffs. The absence of evidence of extensive medieval use of alabaster from these sources may well be due to the lack of sufficient alabaster of the pure white quality favoured in the Middle Ages.

Other natural exposures of gypsum, but not necessarily alabaster, occur in river cliffs such as those on the Trent in Nottinghamshire and on the rivers Ure and Derwent in Yorkshire. These were undoubtedly exploited at an early stage for plaster (Firman, 1964; Vellacott, 1912) and any minor amounts of alabaster they might have contained.

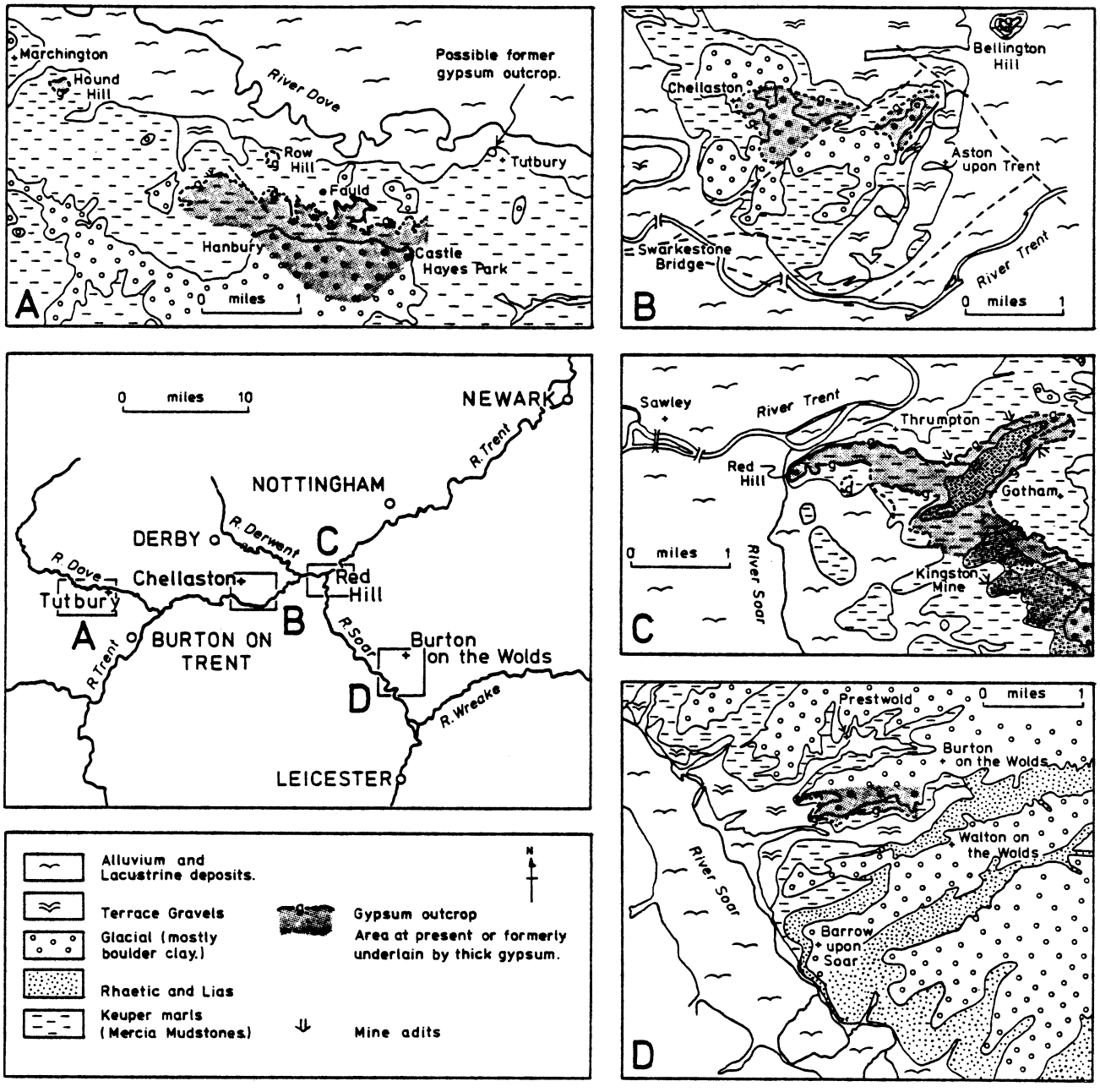
Other than these natural exposures, discovery is most likely to have been made when digging wells or foundations for major buildings, as may have occurred at Tutbury and Chellaston.

## Documented sources

Theoretically any surface or near surface gypsum deposit could have produced alabaster in the past. Such surface workings could have been obliterated by later deeper workings for gypsum plaster. In fact geological and documentary evidence combine to suggest strongly that only the mid-Trent Valley and its tributary valleys the Soar and Dove, were major producers of alabaster with minor amounts being won from Yorkshire, Somerset and possibly South Wales and Cumbria. The evidence is discussed below.

### The Tutbury District, Staffordshire

The oldest alabaster carvings in this country are in the second order of the Norman west doorway of Tutbury Priory Church (c. 1160-70). Being partially protected from weathering by six outer orders they have survived for eight centuries remarkably well. Any comparable alabaster carvings in more exposed positions would probably have had to have been replaced by more durable material. A very weathered alabaster roundel has been noted by the writer on the west side of the thirteenth century south porch of Rolleston Church, 2 miles south-east of Tutbury. the Tutbury carvings may not, therefore, have been the only experiment with the external use of alabaster. However, Tutbury Priory Church is also the site of two other inappropriate and apparently unique uses of alabaster. Massive slabs are said to have been used to support the buttresses of the south aisle (Warwick, 1967) and gypsum can still be observed in the footings. In addition an alabaster coffin, of unknown date, cut from massive blocks of water-worn gypsum of alabaster quality has recently been unearthed from the churchyard. Tutbury is thus both the site of the earliest known alabaster carvings and of uses which imply a lack of understanding of its' properties. 'Alabaster' is also said to have been used in the foundations of Mary Queen of Scots lodgings in the Castle grounds (Somerville, 1960) and blocks of gypsum, some of which is fine-grained like alabaster, are incorporated into the fourteenth century walls of this castle.




Text-fig.2 Details of the chief East Midlands alabaster producing areas based on Geological Survey one inch maps and published with the permission of the Director of the Institute of Geological Sciences.

The source, or sources, of the alabaster used at Tutbury are unknown but there is some evidence that it may have been dug from the foundations of the castle itself. Gypsum apparently does not now outcrop, although there is evidence that it formerly occurred here. For instance Stebbing Shaw (1801) quotes a survey of Tutbury published in 1563 which stated that Tutbury Castle is situated "upon a round rock of alabaster". Earlier, in 1440-41 seventy cartloads of alabaster (i.e. gypsum not necessarily of alabaster quality) were sold from the East Tower at 9d a load. According to Sommerville (1960) this tower was being rebuilt at about this time, thus it is probable that these seventy cartloads were dug from the foundations. If this inference is correct then Tutbury Castle Hill like the geomorphologically similar, though smaller Row Hill and Hound Hill, was the site of an outlier of the Tutbury Gypsum seam. This necessitates a modification of the Geological Survey map (text-fig. 2A) and a reassessment of the geology of the Tutbury area which is beyond the scope of this paper. Tutbury Castle Hill is therefore likely to have been the earliest source of alabaster being used at least as early as 1170 in the construction of the Priory Church. The source was, however, limited by the smallness of the outcrop and could only be exploited when building or rebuilding of the castle permitted the excavation of its foundations.

Alternative sources were probably sought in the Tutbury area at an early stage and at least by the fourteenth century the main outcrop south-west of Tutbury was being worked. Precisely how, when and where the initial discovery was made is not known. Possibly the seam was first worked in the Castle Hayes area and subsequently followed westward along its outcrop. The Castle Hayes—Fauld area seems to have produced good quality alabaster for a longer period than any other area in Britain. The earliest alabaster tomb, reputed to be of Sir John Hanbury who died in 1303, is in Hanbury Church only two miles west of Castle Hayes. Documentary evidence from John of Gaunt's accounts (Camden Society, 1911) demonstrates that by 1374 the district was an important producer. Burton (1622) writing in 1597 mentioned alabaster "which is gotten in the Castle-hay Park at Tutbury, or at Falde near adjoining". By 1686 the full extent of the gypsum outcrop seems to have been explored but the alabaster at Castle Hayes was still considered to be the best. As expressed by Robert Plot (1686) "the whole bank of red marl between the Forest or Chase of Needwood, and the River Dove, from Marchington to Tutbury, has alabaster in it; but that at Castle-Hays is incomparably the best, of which they make gravestones, Tables, Paving-stones, Chimney-pieces etc., and in smaller things, Mortars and Salts: they torne it also into Candle-sticks, Plates and Fruit dishes or whatever else the buyer desires". Alabaster for the large altarpiece in Chatsworth Chapel is known to have been obtained from Castle Hayes and carved at Heanor in 1694 (Christian, 1959). Similarly the columns in Holkham Hall, Norfolk (c. 1753) are said to have come from Tutbury (Christian, 1959). In the nineteenth and early twentieth centuries the Tutbury district was, with Chellaston in Derbyshire, still the major supplier of alabaster, most of it being obtained from two mines near Fauld (text-fig. 2A) minor amounts being obtained from Marchington in the 1920's (Sherlock & Hollingworth, 1938). Alabaster was clearly still a thriving industry in 1907 when Trafford Wynne described one of the mines at Fauld. Unfortunately he gives no statistics for alabaster production although it is clear from his text that alabaster formed only part of the total gypsum production. By 1951, when the Fauld mines had extended to deeper levels where alabaster is less plentiful, 900 tons of alabaster were produced representing less than 1% of the total gypsum production (Bray, 1951). Today the B.P.B. mine at Fauld is the only locality still producing alabaster commercially albeit in very small amounts.

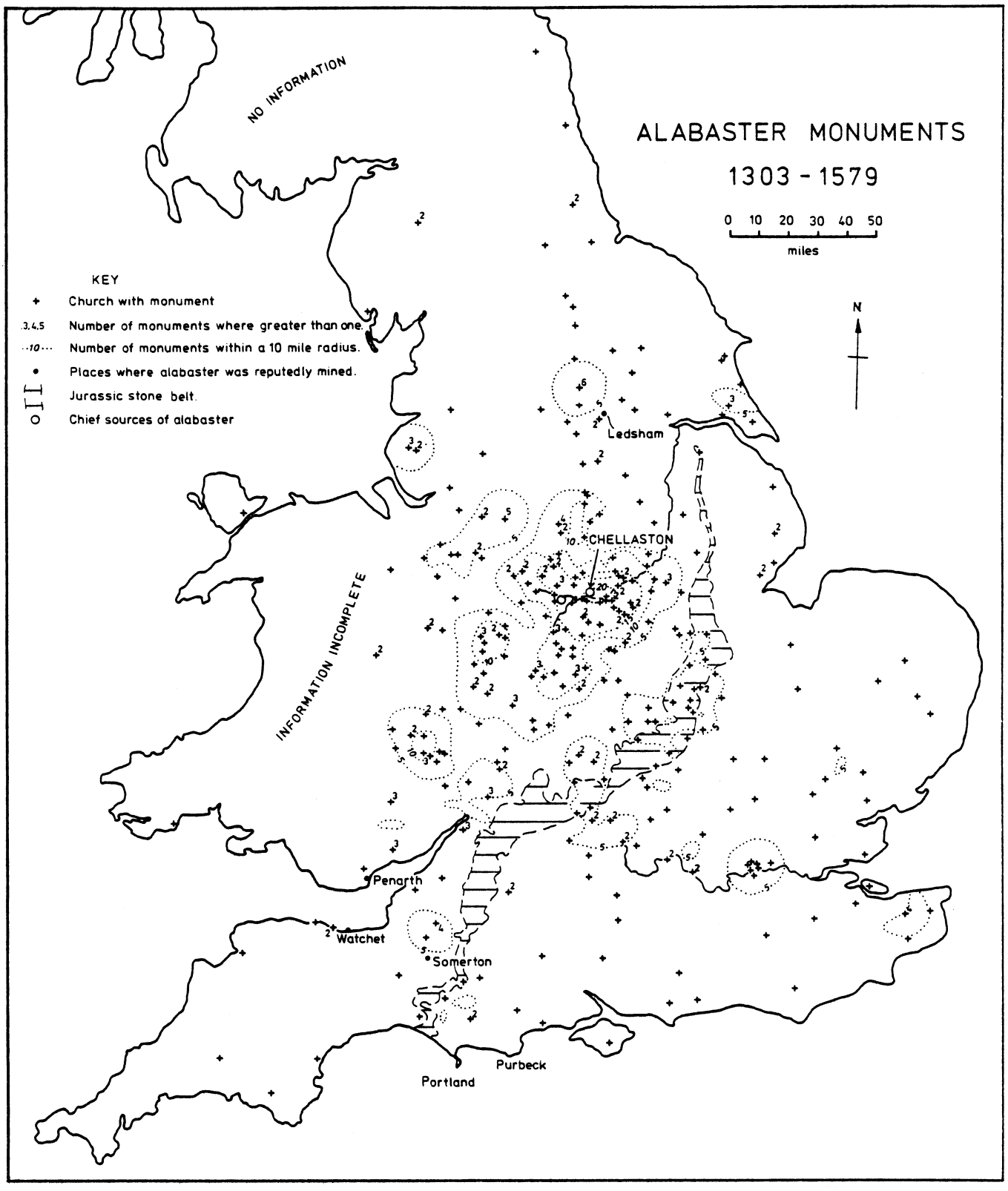
**Chellaston, Derbyshire**

Historical evidence for the production of alabaster is by no means as complete or covers as long a period of time as in the Tutbury district. This has led at least one author (Christian, 1959) to suggest that Chellaston's importance was confined to the latter half of the fourteenth and early fifteenth centuries. There are, however, other reasons, discussed below, for believing that Chellaston was an important centre at least for the production of large monuments throughout much of the Middle Ages, Tudor, and Jacobean periods.

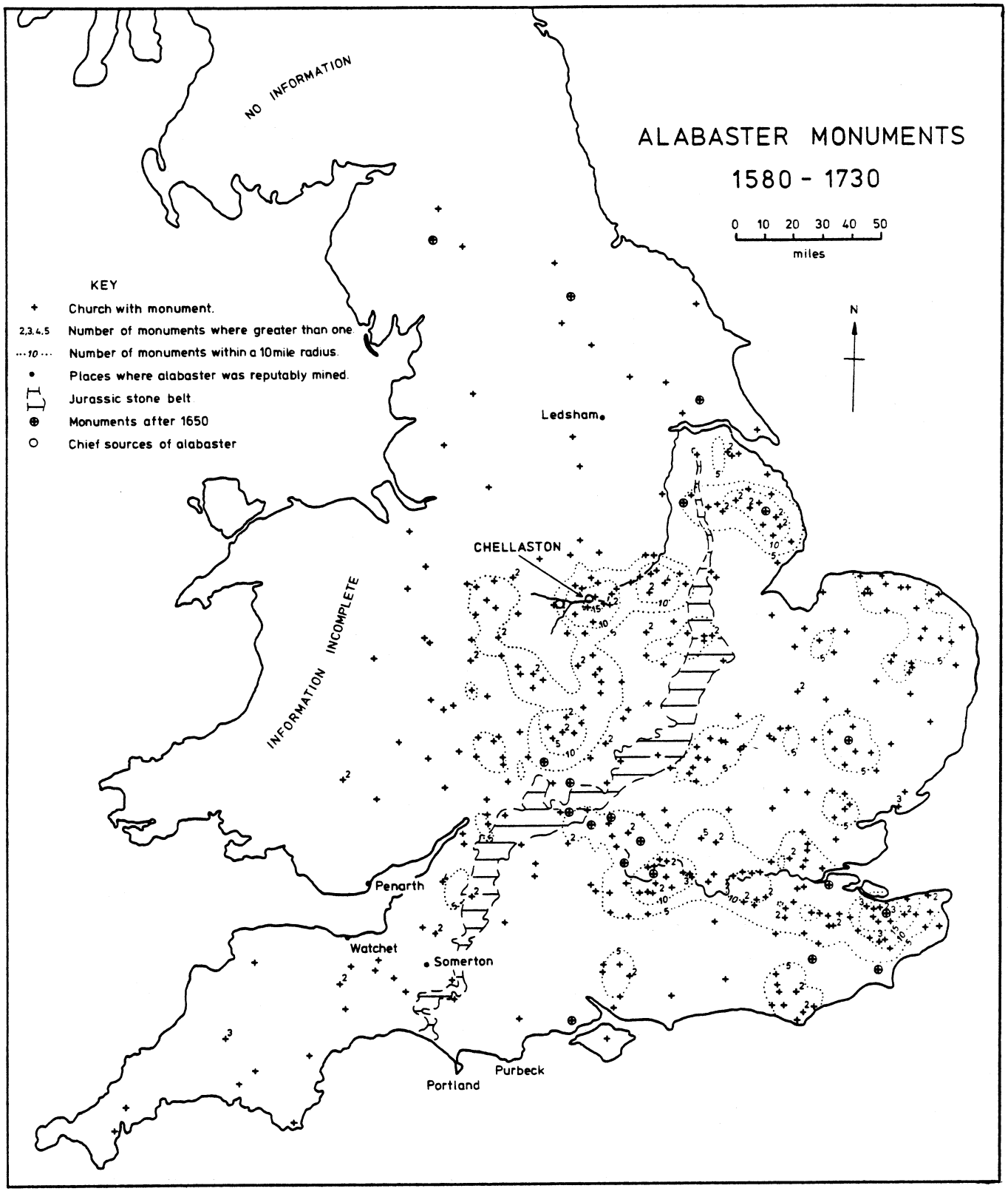
Documentary evidence so far discovered is sparse. No fourteenth century references have been found although John of Gaunt may have been thinking of Chellaston when, in 1374, he gave instructions that special blocks for his wife's tomb were to be sought elsewhere if not available at Tutbury (John of Gaunt, 1374). However, by 1414 Chellaston's reputation had evidently spread to France for in that year the Abbot de Fechamp visited Chellaston to purchase blocks of alabaster (Bilson, 1907). There is also a contract for Ralph Greene's tomb at Lowick, Northants, (Hartshorne, 1867) dated 1419, which implies that the alabaster was not only quarried but also carved at Chellaston. Strong support for this being the usual practice comes from the distribution of alabaster monuments which, prior to 1580 (text-fig. 3), shows a massive concentration centred on Chellaston. The lack of comparable concentrations centred on Burton-on-Trent (where it is known that monuments of Tutbury alabaster were carved) or on Nottingham, suggests that Chellaston was the more important centre for the production of alabaster tombs not-withstanding the lack of documentary evidence. Preliminary data shows a similar, though less pronounced concentration of post-1580 tombs centred on Chellaston suggesting such tombs continued to be carved at and distributed from Chellaston at least until the Restoration (text-fig. 4).

There is, as far as the writer is aware, no reference to alabaster from Chellaston during the seventeenth and eighteenth centuries. Glover (1829) noted that blocks of alabaster were sold to workers of cheap ornaments. Some alabaster was undoubtedly obtained from the Aston Glebe Mine which opened in 1835, but the principal revival came with the development of Messrs. H. Forman's quarries in 1909. Aston Glebe produced mostly plaster and relatively little alabaster whereas Forman's quarries appear to have been primarily alabaster producers. This appears to have been a completely new discovery, north of the Chellaston-Elvaston road, previously undetected because of a covering of glacial deposits. By 1930, however, alabaster production had ceased, although gypsum continued to be produced for plaster from the Woodlands and Aston brick pits until quite recently.

The general impression, from admittedly scanty evidence, is that Chellaston was as important as the Castle Hayes–Fauld district but that its production record was far less consistent. There are geological reasons for this, one of which is that much of the outcrop is hidden beneath a mantle of glacial deposits. In these circumstances it would have been difficult to trace an outcrop laterally since shallow surface diggings would reveal only glacial deposits. It is probably for this reason that Forman's quarry was not developed until the early twentieth century when cheap drilling exploration techniques were available. In the present context the late discovery is fortunate since the detailed description by Smith (1919) of these quarries, famous for their green and white alabaster, provide an invaluable impression of how the alabaster may have appeared to those working it, hereabouts, in the




Text-fig.3 Distribution of alabaster tombs earlier than 1580. Based solely on information in Pevsner and his co-workers (1951-74). Data prior to 1540 correlates well with Gardner (1940) but the information for the period 1540-1580 may be slightly underestimated (cf. text-fig. 5) due to the failure of Pevsner to always record the material used by the tomb-maker. This underestimate is unlikely to affect the marked concentration in the East Midlands centred on Chellaston.




Text-Fig.4 Distribution of alabaster monuments later than 1580 as recorded by Pevsner and his co-workers (1951-74). Additional information available from the Royal Commission on Historical Monuments inventories has not been included since it is available for comparatively few English counties.

Middle Ages. A further reason for lack of continuity of production appears to be that alabaster quality gypsum did not extend consistently very far down dip. Thus it was not possible to open mines, like those at Fauld, which could sustain a reasonable production for centuries.

The original workings on Chellaston Hill are now obscured by brick quarries, old workings for plaster quality gypsum and housing. Consequently the exact position of the original outcrop is uncertain. If, as shown on the Geological Survey one inch map (text-fig. 2B), it passed under the church then it seems likely that alabaster was first discovered when the foundations for the church were initially dug. The most extensively exploited area (cf. Smith, 1919, Fig. 1) extends south eastward from Chellaston to Woodlands. Probably most of the alabaster raised in Derbyshire came from this ½ mile strip of land on the western flank of Chellaston Hill (text- fig. 2B). As in Staffordshire, alabaster was obtained in quantity from a comparatively small part of a much larger deposit. The same seems to have been true for the very localised minor sources of alabaster in Leicestershire and Nottinghamshire described below.

**Leicestershire**

The exact whereabouts of the "faire quarre of alabaster stone 4 [or 5] miles from Leicester" (Leland c. 1543) is uncertain. Possibly it was near Burton-on-the-Wolds (text-fig. 2D) where there was in 1597 " a quarry of Alabaster and white stone, serving for cutters and picture makers for Statues, Tombes, and proportions but not altogether so hard and cleare, as that stone which is gotten at Castle-hay Parke neare Tutbury or at the quarries neere Falde." (Burton, 1622). There appears to be no later record of alabaster from this area so perhaps its poorer quality did not continue to commend it to "cutters and picture makers". Similarly there is no evidence that any other gypsum outcrops in Leicestershire, such as those at Thurmaston and Whitwick near Leicester (Sherlock & Hollingworth, 1938) ever produced alabaster. Enigmatic descriptions by Nichols (1795 v.3 pt. 1 p.143) of alabaster in Charnwood Forest almost certainly refer to quartz veins!

**Nottinghamshire**

Further down the Soar valley, near the confluence with the river Trent, quarries at Red Hill (text fig. 2C) produced substantial quantities of red mottled alabaster during the mid-and late-eighteenth century. According to Throsby (1795) this was used for columns in Kedleston, Staunton Harold and Stanford halls and for chimney pieces in many country residences. Additionally Lowe (1878) claims that the columns for the mausoleum at Yarborough were obtained from these quarries. There appears to be no documentary evidence of earlier workings. An earlier suggestion (Firman, 1964) that material for the sixteenth century Sacheverell tombs at Ratcliffe-on-Soar may have come from Red Hill has not been substantiated by documentary evidence. By 1811 Red Hill was apparently primarily a plaster quarry complete with kilns (Farey, 1811), so its life as an important alabaster producer may have been short-lived.

Alabaster was also quarried further east near Thrumpton but this was apparently of poorer quality. Nichols (1795) commented that "Mr. Hind, owner of Swithland slate-pits has many years since has made chimney pieces for gentlemen in the neighbourhood from a quarry of alabaster at Thrumpton in Nottinghamshire; but it does not answer for that purpose, as it will neither stand cold nor heat, changes colour, and becomes yellow".

The only other known source of alabaster in Nottinghamshire was at Kingston-on-Soar where, it was reported that, "green alabaster is said to be got as an exceptional circumstance" (Sherlock & Smith, 1915). Laird (1810) mentioned alabaster from Gotham and Beacon Hill but may have been using the word as a synonym for gypsum.

**Sources of alabaster outside the East Midlands**

Although gypsum is plentiful in Yorkshire, the Vale of Eden, West Cumbria, Gloucestershire, Somerset, South Wales, Dorset and Sussex (text-fig. 1) only in Yorkshire and Somerset is there unambiguous evidence of relatively early alabaster workings. The Lincolnshire evidence (Leland, 1543) is more debatable.

**Yorkshire**

Gypsum occurs both in Permian and Triassic strata, and has been worked for plaster in several localities. Only near Ledsham in Permian Middle Marls, has the gypsum been described as alabaster. Vertue (1742) writing in the early eighteenth century stated that, "at Fairborn near Ledsham by Leeds, are several Quarries of Alabaster—the finest is used for Images (to be cutt) and Funeral monuments—for which are dug up pieces of a Tun weight— sometimes two or three Tun wt." This description leaves no room for doubt that the gypsum was used as alabaster but the blocks obtained were small when compared with those obtainable from Fauld in Staffordshire (cf. Trafford–Wynne's (1907), description of 18 blocks each weighing about 15 tons and Bray's (1951) comment that the average size of alabaster blocks from Fauld in 1950 was 4 tons). A four ton block (traditionally 6′ × 3′ × 4′ i.e. about 2 × 1 × 1.3 metres) is probably the minimum size for a medieval tomb with two

effigies and therefore it seems improbable that, as suggested by Esdaile (1946), the fifteenth century tomb of Lionel, Lord Welles at nearby Methley was made of Ledsham alabaster. What is much more likely is that quarries in the neighbourhood of Ledsham and Fairburn were essentially plaster workings from which occasionally blocks of alabaster were obtained. This alabaster might well have supplied workshops in York, which are known to have existed in the Middle Ages (Hope, 1904). They are unlikely, in the writer's opinion, to have ever supplied sufficient for life size effigies. Certainly by 1829 as noted by Sedgwick, all gypsum workings in the Permian Middle Marls of Yorkshire were disused and referred to by him as "old plaster pits."

There is no known documentary evidence that the gypsum in the banks of the river Ure, at Rippon Parks (Forbes, 1958; James *et al.*, 1981) has ever been used as alabaster. Nevertheless the presence of scattered isolated dark selenite porphyroblasts up to 20 mm in diameter set in an alabastrine matrix closely resembles the alabaster used at Sherriff Hutton, Yorks. for an effigy reputedly of Prince Edward who died in 1484, and it is possible that Rippon Parks was the source for this particular monument.

In the Permian Upper Marls gypsum was formerly worked at Hillam and equivalent strata are being developed at the Sherburn Mine where in 1973 the annual production of gypsum was 250,000 tons (Smith, 1974). None of this is used as alabaster and there is no evidence that alabaster was ever worked in the Hillam–Sherburn area.

Although it is known that gypsum has been worked in the upper part of the Triassic, at an equivalent level to the Newark Gypsum, at Eston, Brompton and Scrayingham (Smith, 1974) these beds are far too thin ever to have yielded alabaster.

**Lincolnshire**

Other gypsiferous strata, the Clarborough beds, occur somewhat lower in the Triassic in Lincolnshire and Nottinghamshire. These are probably equivalent to the East Bridgford Gypsum of south Nottinghamshire (Firman, 1964). Most of the outcrops, with which the writer is familiar in Nottinghamshire, consist of fibrous gypsum veins and nodular gypsum so intimately mixed with marl that it could never be used as alabaster. However, further north, in the Isle of Axeholme, it may occasionally thicken sufficiently to be used as alabaster. Leland's reference (1543) is unfortunately ambiguous and makes no reference to the material having been used for sculpture. Moreover his description implies that the beds he saw were too thin to be used for monumental purposes. Perhaps the alabaster "communely there caullid plaster", was in fact used for making plaster. Leland's description (1543) which is now considered to apply to the Epworth gypsum (Cameron, 1890) is as follows:-

"The upper part of the Isle hath plentiful Quarries of Alabaster communely caullid Plaster, but such stones as I saw of it were of no great thickness and sold for vii$^{d}$ the lode; they lie on the ground lyke a smooth table and be bedded one flake under another, and at the bottom of the bed of them be rough stones to build withal."

Cameron (1890) described the exposures at Epworth and Burnham in the Isle of Axeholme as "being found either as thin veins, ramifying through the Marl, or as huge tabular blocks". The latter may have been sufficiently fine grained to have been used as alabaster. Unfortunately Cameron (*op. cit.*) neither described the texture nor the use to which the gypsum was put. The Isle of Axeholme "alabaster" must remain an enigma until more positive evidence is forthcoming.

**Somerset**

Gypsum, some of it of alabaster quality, abounds on the Somerset coast and inland at Hurcot, near Somerton. Surprisingly the earliest reference appears to be by Gerard (1633), who gives the impression that the alabaster deposit had been newly discovered. Describing Minehead, which he probably confused with Watchet, he wrote, "At this place in our tyme a Dutch man hath found out mines of excellent alabaster, which they use much for tombs and chimney pieces". Little is known of the history of Somerset alabaster although it is known that it was still being carved into trinkets such as ash-trays and light houses for the tourist trade in the early part of this century (Wedlock, personal communication, 1981).

The only other references to Somerset alabaster, known to the writer, are more ambiguous. Young (1791) records that alabaster was sold from the Hurcot quarries, Somerton, at 2s 6d per cwt. Unfortunately, it is not clear if the word 'alabaster' was simply used as a synonym for gypsum or whether it was actually used for decorative purposes. The fact that it was sold by the cwt suggests that at best only small pieces of alabaster were available. There is, however, later but equally equivocal evidence for alabaster at Hurcot. As noted by Sherlock and Hollingworth (1938) "the word Alabaster is engraved on the 2nd edition of the geological map, revised in 1871-2 but the place does not seem to have been mentioned in any memoir and the pits are now overgrown".

**South Wales**

Gypsum outcrops on the cliffs at Penarth and elsewhere in South Wales. Much of this gypsum is too thin and too coarse to have been used for monuments. There is, however, a record of alabaster tiles having been obtained from levels in the cliffs at Penarth and used in some of the buildings of University College, Cardiff which were built during the early part of this century (Sherlock & Smith, 1915). No other reports of alabaster workings hereabouts are known to the writer.

**Cumbria**

Alabaster seems to have been mined at Barrowmouth Bay, specifically for ornamental purposes, from at least 1847 to the 1880's (Shipp, personal communication, 1982).

**Summary**

From the foregoing review of the available evidence it appears that almost all British alabaster came from two strips of land no more than 1 mile long and ½ mile wide south of Chellaston, Derbyshire and west of Castle-Hayes, Staffordshire. Other resources in Staffordshire at Tutbury and Marchington; in Leicestershire near Burton-on-the-Wolds; Red Hill in Nottinghamshire; the Ledsham area, and possibly Rippon Parks, Yorkshire; Somerset and West Cumbrian localities, were minor producers for comparatively short periods of time.

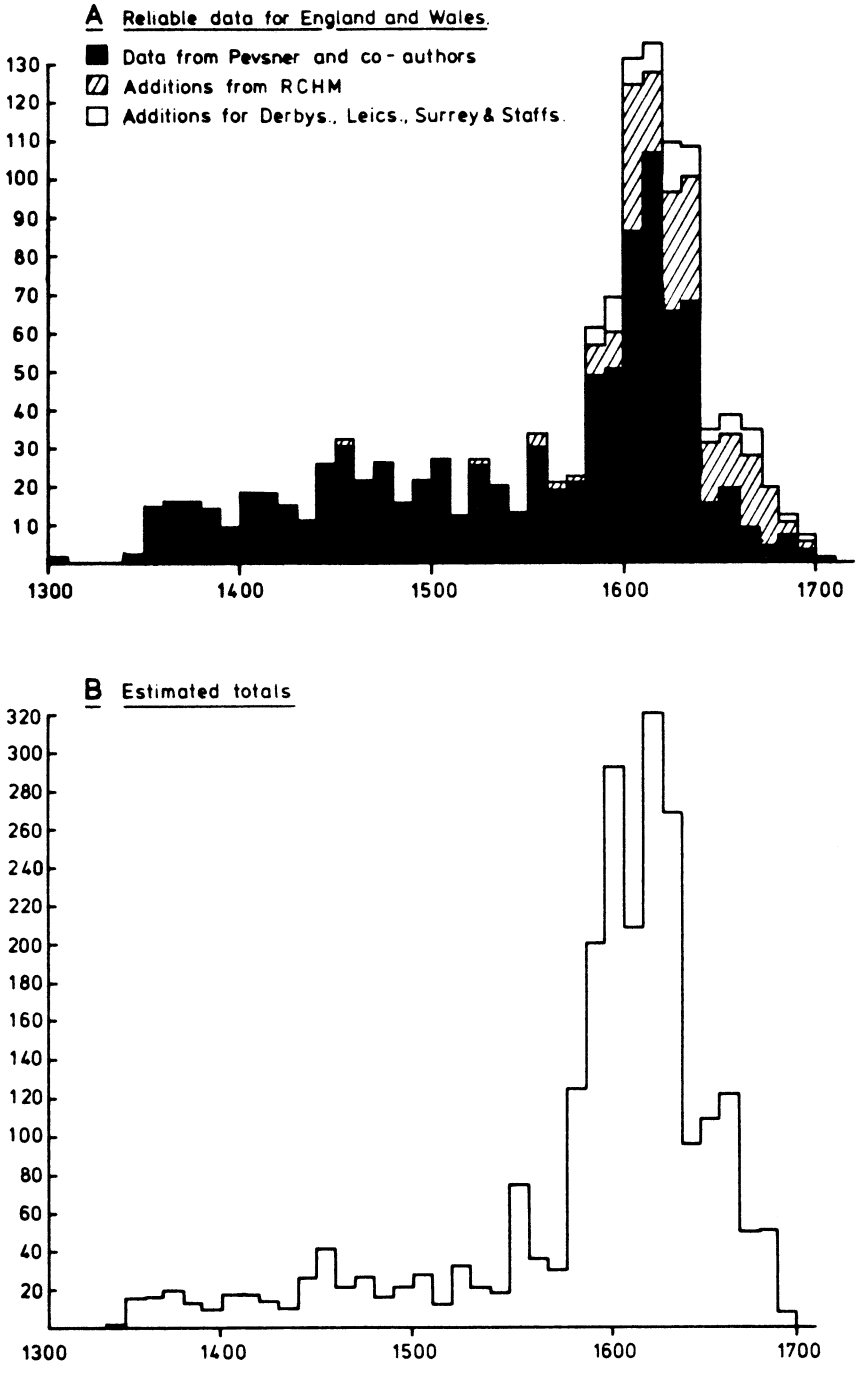
## Methods of mining and quarrying

Following the initial discovery of alabaster, further prospecting would have been necessary since it does not occur in continuous seams and its outcrop is not easy to trace. As with most gypsum in the Trias, nodular discontinuous layers are frequent, each workable mass or 'pillar' is usually separated by 'coarsestone' (containing more gypsum than marl) and 'foulstone' (containing more marl than gypsum). Bernard Smith's description (1919) of the alabaster quarries at Chellaston is probably closely analogous to most of the alabaster worked during the Middle Ages. The pillars at Chellaston were described by him as being "nearly circular in plan, except where they abut one against another, when they may be roughly polygonal. They are usually shaped like basins and are sometimes slightly concave above but more frequently the surface is gently domed and irregular. A large pillar measures 12 feet [3.7 m] in diameter and from 8 to 9 feet [2.4 to 2.7 m] thick. The 'foulstone' occurs chiefly between the more widely spaced pillars."

This 'foulstone' which separates most 'pillars' from each other is sufficiently soft, when weathered, to be dug by hand. Thus in the earliest workings the earth was probably dug from around the pillars and then either a slice from the top of the pillar removed or else, where small enough, the whole mass would be extracted bodily. Traces of such early surface workings have been described by Trafford Wynne (1907) who also described the methods, then current, for extracting blocks of alabaster from underground mines. Doubtless these methods, apart from the use of explosives, were similar to those used in earlier periods. Essentially they consisted of 'topping' the rock (i.e. cutting a slot above the good rock 0.8 to 1 m high and 1.4 to 1.5 m deep, to allow workmen access), then cutting vertical 'gutters' about 250 mm wide at the back and sides of block. Where the working faces of alabaster was say 2.5 m high two blocks 1.3 m thick, about 1.4 m deep and 1.3 to 6.5 m long (depending on the width of the pillar) could then be prised off using traditional wedges and feathers. Doubtless similar methods were used to deal with the larger pillars in surface or near surface exposure.

Smith's detailed description (1919) of the pillars at Chellaston emphasises that hereabouts the purest, whitest alabaster is confined to the top 2 or 3 feet [0.6 to 1 m] of the pillar. If this was generally true throughout the Chellaston and Tutbury region, wherever white alabaster occurred, it helps to explain how the industry was able to respond so readily to the considerable increase in demand for large blocks towards the end of the sixteenth century (text-fig. 4). As noted by several authors (e.g. Hope, 1904; Gardner, 1940; Cheetham, 1962) only the purest, whitest alabaster was used during the fourteenth and fifteenth century and it was not until the late sixteenth century that coloured varieties became common. Thereafter white alabaster was rarely used, presumably because it was not readily available until the discovery of new deposits in the early nineteenth century.

If, as at Chellaston, white alabaster was confined to the top 0.6 to 1 m of the pillars, then it is probable that throughout most of the Middle Ages only the whitest alabaster was taken leaving approximately the lower two thirds in place. By the middle of the sixteenth century new deposits of white alabaster were becoming difficult to find but ample reserves of pink alabaster remained in the old surface workings. Without further prospecting the greatly increased demand during late Elizabethan and early Jacobean periods could easily be met, once coloured alabaster became acceptable, simply be re-opening the partially worked older diggings. This unprecedented




Text-fig.5 Histograms of monuments made wholly or substantially of alabaster based on Pevsner and co-authors (1951-74) in black with additional information (shaded) for the counties of Bucks., Cambs., Dorset, Essex, Hereford, Herts., Hunts., Middlesex, Westmorland and the cities of Oxford, Cambridge and London from the Royal Commission on Historical Monuments. Information for Derbyshire (Cox 1875-9), Leicestershire (Nichols 1795), Staffs. (field-work), and Surrey (Manning and Bray 1804-1814) is probably less complete than the RCHM data.

Note that monuments made before about 1550 the tombs tended to be all about the same size whereas later they varied from huge "double deckers" to modest wall tablets. There is, therefore, no simple correlation between the number of monuments and the quantity of alabaster used. Nevertheless the marked increase in the number of monuments produced after 1580 does indicate a considerable increase in the use of alabaster.

The estimated total (text-fig. 5B) is based on the assumption that similar discrepancies between RCHM and Pevsner apply to counties and cities not yet surveyed by RCHM. Note that the vertical scale is half that of text-fig. 5A.

boom in the alabaster trade, exemplified by the considerable increase in the number of alabaster-tombs, lasted about 70–80 years before declining as rapidly as it had begun (text-fig. 5). Changes in fashion and the availability of foreign marbles may well have been important factors but it seems equally probable that it coincided with the easily accessible alabaster in the re-worked older diggings becoming exhausted. Lack of proper forward planning and prospecting programmes would have resulted in home produced alabaster of any type abruptly becoming scarce and expensive.

Considerable uncertainty exists about the antiquity of underground mining for alabaster, irregular workings are commonly thought to be medieval but it seems unlikely that underground working would have been attempted when easily accessible near surface material was available. Early writers such as Leland (1543), Burton (1622) and Plot (1686) mention quarries and make no reference to mines. Not until as late as 1811 is underground mining implied in any of the texts read by the present author. Then Farey wrote that at Fauld Hill gypsum is "dug in considerable quantity under 8 or 9 yards of Red Marl" thus implying that either adits had been driven into the hillside or that a quarry with a very thick overburden was being worked. The former suggestion is in harmony with Trafford Wynne's (1907) vague comment that the Fauld Mine had been worked for considerably more than 100 years and that it was originally a quarry. The evidence thus suggests that the first relatively large scale underground mining for alabaster began in the late eighteenth or early nineteenth century at Fauld. Farey (1811) refers to all other gypsum working in Derbyshire as "pits" and describes Red Hill (Notts.) as a quarry;Nichols (1795) also mentioned a quarry at Thrumpton. Some indication of the depth of these "pits" is provided by the discovery in 1850 of some wedge shaped picks, the remains of an oaken ladder and an unmoved slab of alabaster at a depth of about 4.9 m. Since the gypsum seam was commonly 3 m and exceptionally 5.5 m thick, these discoveries seem to be consistent with shallow surface diggings which subsequently collapsed. By 1878 (Stokes) however, true underground mining had developed at Chellaston utilising the "pillar-and-stall" method in which about 25% of the strata was left intact to support the roof. The same system is used today differing only in that fast moving transporting equipment necessitates a very regular geometrical arrangement of straight stalls and 6 m square supporting pillars. On mine plans earlier workings can easily be distinguished from the rigidly symmetrical modern developments. Unfortunately the earliest workings are indistinguishable from the late nineteenth century when Stokes (1878) wrote that "the workings of a gypsum mine are very varied and without definite system, the roadways deviating first one way and then another being guided by the direction in which the blocks appear most plentiful". Even as late as 1907 Trafford Wynne commented that at Fauld gypsum mine "there is not the regularity in size of stalls and pillars that is ususal in coal mines, as this depends so much on the varying conditions in various parts of the mine, how the roof stands and the quality of the rock. The great aim being to leave as little good stone as possible in the mine, the pillars are, so far as possible, left where the stone is inferior. They are generally cut through again when the working places are finished". Environmental constraints, particularly those arising from the danger of subsidence, now preclude this formerly common practice of robbing the supports of useable gypsum which added to the irregularity of the workings when finally abandoned. Thus although "early" workings can easily be distinguished by their irregularity, this does not indicate a medieval date. In fact they are more likely to be nineteenth or early twentieth century.

## Alabaster and plaster output

Writers on the history of alabaster give the impression of a thriving industry producing goods for both the home and overseas markets. But how large was the quarrying industry which supplied the raw material? The geological evidence indicates that the bulk of English alabaster was dug from two small areas one south of Chellaston and the other in the Castle Hayes–Fauld district of Staffs. Were these two areas, which amount to no more than 21 acres of land, sufficient to produce all the alabaster used in the 500 years before underground mining began? This question can in part be answered by considering recent gypsum output and estimating probable alabaster production assuming that conditions were similar to those described by Smith (1919) at Chellaston.

The Tutbury Gypsum seam, the main source of alabaster in the East Midlands (text-fig. 2) is known to have produced 10,000 to 15,000 tons of gypsum per acre during the early part of this century mostly from underground workings (Sherlock & Hollingsworth, 1938). Except in areas where the gypsum has been dissolved by ground or surface water, 15,000 tons per acre seems likely to have been a reasonable return from open-cast workings. Thus, if the total acreage worked can be estimated the total tonnage of gypsum produced from surface workings can be calculated. For example, between Castle Hayes and Draycott in the Clay, 5.7 miles of sinuous outcrop (text-fig. 2A) has been mapped largely on the basis of evidence of old surface diggings. Outliers also crop out at Row Hill, Hound Hill, and possibly formerly at Tutbury Castle giving a probable total of 6 miles of worked outcrop. The steep topography, particularly in the narrow valleys incised into the escarpment, results in a very narrow strip averaging 20–25 m wide from which gypsum could be worked from surface diggings. Assuming an output of 15,000 tons per acre this suggests that about 700,000 tons of gypsum could have been produced. Impressive though this figure is at first sight, it represents an average output of no more than 1,400 tons per year from the presumed beginning of gypsum extraction in the late thirteenth century to the development of underground mining in the late eighteenth century. It may also be contrasted with an annual output from Staffordshire of

50,000 tons in 1905 (Trafford Wynne, 1907) and of double that amount from one mine at Fauld in 1951 recorded by Bray. By modern standards gypsum extraction was, until recently, a very small industry.

But how much of this small production was alabaster? Historic records and recent mining strongly indicate that workable alabaster in Staffordshire was virtually restricted to the Castle Hayes–Fauld area. Thus probably no more than a third of the Staffordshire surface workings are likely to have produced significant quantities of alabaster. Even within these favoured areas less than half the gypsum could have been extracted as useable alabaster (cf. Smith's, 1919 descriptions of the alabaster 'pillars' at Chellaston and the foregoing discussion on methods of working). Allowing for losses resulting from failure due to undetected flaws as well as 'coarsestone', 'foulstone' and other gypsiferous material which had to be removed to obtain the alabaster blocks, probably less than a third of all the gypsum extracted from alabaster rich ground is likely to have been of alabaster grade. Thus in Staffordshire no more than 75,000 tons of alabaster is likely to have been raised before 1800 equivalent to an average of only 150 tons per year.

A similar analysis of the Chellaston area, where apparently only the ground south of Chellaston church yielded alabaster before the twentieth century, suggests that some 6 acres produced up to 30,000 tons of alabaster equivalent to an average of 60 tons per year from c. 1350 to 1850. In terms of land usage these tonnages are minute being equivalent to the production from 145 square yards at Fauld and 54 square yards at Chellaston per annum. If these calculations are of the correct order of magnitude it is clear that 2 or 3 men working part-time could usually have produced the required alabaster. These calculations are based on the assumption that all available alabaster was extracted, but before the mid-sixteenth century only white or near white alabaster was used leaving the red stained alabaster intact. At Chellaston white alabaster occupies the upper third of the deposit and hence an average annual output of only 20 tons from Chellaston and 50 tons from the Fauld area would seem to be more likely before the Reformation. Small though this appears to be, 70 tons is, in the writers opinion, more than enough to account for all surviving and lost alabasters. For instance pre-Reformation tombs (text-fig. 5) were probably the largest consumers of medieval alabaster yet an average production of only 12 tons per year would account for all the alabaster required for these monuments. It seems unlikely that as much as a further 58 tons per year would have been required, to make effigial slabs, tablets depicting biblical scenes and all the small articles for domestic use known to have been produced during the Middle Ages.

The amount of alabaster used after the Reformation is equally difficult to estimate largely due to a lack of adequate inventories of surviving alabasters. Preliminary data on tombs (text-figs. 4 and 5) suggest an expotential increase in demand after 1580 and a widespread distribution throughout much of England, particularly east of the Jurassic stone belt (text-fig. 4). These provisional conclusions are contrary to the views previously expressed by the writer (Firman, 1964). An equally marked decline in the demand for alabaster for tombs occurred in the seventeenth century. It is uncertain whether this mid-seventeenth century decline in the demand was paralleled or compensated for by use of alabaster in contemporary buildings. Nor is it known if it indicates a temporary exhaustion of exploitable alabaster. Until the seventeenth century use of alabaster can be quantified these questions will remain unanswerable. Certainly by the mid-eighteenth century alabaster was again in demand not for tombs but for interior decoration of great houses such as Kedleston Hall, Derbyshire, new sources of supply by then having been found.

## Provenance

Few contracts exist for the purchase of alabaster but where there is such documentary evidence it provides a starting point for matching textures and structures in sculptured alabaster from known sources. Less confidently art historians can match styles and deduce the probable sculptor. Combined documentary and stylistic evidence has resulted in the compilation of lists of monuments made by sculptors working at Burton-on-Trent, with alabaster from Staffordshire and from Chellaston (Bayliss, personal communication). This in turn has allowed the writer to compare alabasters from these two localities. This research is not complete but already it is apparent that there is an extremely wide range of textures and structures from any one specific locality and few, if any, unique characteristics. This is confirmed by such veritable museums of alabaster as the chancel at Dunstall, Staffordshire, and Glasgow Town Hall. Not only are the complete range of nodular, structureless and nodular-mosaic, mosaic, wispy structures and their combinations (Holliday, 1971) exhibited, but the size of the nodules varies from about 0.02 m to at least 0.50 m and the amount of incorporated sediment from virtually nothing to about 15% (cf. Archbishop Sandys' tomb in Southwell Minster). Moreover this sediment may be dispersed throughout the gypsum or concentrated between the nodules. In addition laminated varieties and minor faulting has been noted.

With such a wide range of structures and textures it is hardly surprising that alabasters exhibit an equally wide range of trace element geochemistry. East Midlands alabasters from different localities cannot be discriminated from each other chemically or from plaster grade gypsum (Aljubouri 1972; Wardley, personal

communication, 1979). Moreover, as demonstrated by Aljubouri (1972) chemical variations in one apparently pure homogeneous gypsum nodule can show almost as big a variation in chemistry as samples from the whole of the East Midlands. Although neither texture, structure, chemistry nor colour can be used to distinguish between the majority of alabasters from different localities in the Triassic Mercia Mudstones of the East Midlands there is a rare green variety which seems to have been produced only from Chellaston and Kingston-on-Soar (Smith, 1919: Sherlock & Hollingworth 1938). Similarly the Somerset alabaster though in the same strata and chemically, texturally and structurally indistinguishable from East Midlands gypsum (Aljubouri,1972) frequently contain black sediments which could be diagnostic. Unfortunately black copper-uranium minerals such as chalcocite and coffinite (Aljubouri, 1972 and subsequent research by the writer) are not uncommon in Nottinghamshire gypsum and therefore the rare black patches observed in some alabaster effigies may be due to Cu-U mineralisation in alabaster monuments and not the incorporation of Somerset black sediments. Close examination, possibly using a scintilometer might help to establish the provenance of such alabaster but much research needs to be done both locally and in Somerset.

More promising are the Yorkshire Permian alabasters which are isotopically distinct (Taylor, 1983) and often exhibit textures which have not been recorded from the East Midlands. Particularly characteristic is the gypsum from Rippon Park with its large dark selenite porphyroblasts set in an alabastrine matrix. This texture so closely matches that used for the fifteenth century effigy, in Sherriff Hutton church that it is tempting to postulate that the alabaster came from the Rippon Parks area. However, other parts of the Permian sulphate deposits as at Hurworth Place, Darlington(Smith & Moore,1973) and Hillam (Sherlock & Smith,1915) have similar textures and more field work is needed before a definitive attribution of provenance can be established. In particular there is a need to locate the quarries and samples of alabaster obtained from the Ledsham–Fairburn area (Vertue, 1742). Although it may not be possible to identify the precise source locality, textures in the Sherriff Hutton effigy are diagnostic of a Yorkshire alabaster. Similar though not identical textures are shown by fragments of alabaster carvings in the Yorkshire Museum at York. These most closely resemble textures in gypsum from Hillam collected by the author but again without a more detailed knowledge of the range of textures in Yorkshire alabasters it is impossible to be certain that this is the only likely source.

At least one further complication in determining the provenance of alabaster remains to be investigated. During the Renaissance much foreign marble in great variety was imported and it is not impossible that some foreign alabaster (e.g. from Leghorn, Italy) might also have been used. The writer has not seen any alabaster which could have been imported but since he is unfamiliar with foreign alabaster the possibility of an overseas provenance for some should not be ignored.

## Conclusions — some historical and geological implications

Geological and historical evidence combine to confirm that the Castle Hayes–Fauld area of Staffordshire and Chellaston, Derbyshire were the only sources producing large enough blocks of alabaster for life size effigies for tombs during the Middle Ages. Smaller pieces suitable for altarpiece panals, small statues and other carvings could also have been obtained from other sources particularly at Red Hill, Nottinghamshire; Burton-on-the-Wolds, Leicestershire; the Somerset coast and the Yorkshire, Permian. There is, however, no documentary evidence of any of these localities having supplied alabaster during the Middle Ages, the earliest recorded dates outside the East Midlands being early seventeenth century in Somerset and early eighteenth century in Yorkshire. In contrast geological evidence, particularly the textures and structures observed in sculptures and outcrops, strongly suggests that relatively small pieces of alabaster were quarried in Yorkshire at least as early as the late fifteenth century. Somerset alabaster remains to be similarly investigated. Notwithstanding this evidence, that alabaster was obtained from elsewhere, it is certain that the bulk of English alabaster of whatever date came from the East Midlands and most of this from two very small areas in Staffordshire and Derbyshire. That these were also producing plaster (Firman, 1964) seems very likely.

Consideration of the size of the outcrops, the length of time they were worked and the probability that underground mining did not begin until about 1800, leads to the conclusion that output was very small indeed. Probably no more than 200 tons per year on average, and considerably less than this say 70 tons per year during the Middle Ages, was produced. This small tonnage contrasts oddly with the picture of a thriving industry which during the Middle Ages exported altarpieces of which an estimated 3,000 panels still survive, to Iceland, Denmark, Germany, France, Holland, Spain, Italy, and probably other countries (Cheetham, 1962). However, at least 50 panels could be made from a 4 ton block of alabaster and thus a year's production is sufficient to account for all surviving English medieval alabaster in Europe. For this and other reasons discussed in preceding sections of this paper, the very small scale of the medieval alabaster quarrying operations is undeniable. In spite of a temporary boom in the demand for alabaster for tombs, the scale of the industry can hardly have been significantly bigger until the nineteenth century.

The post-Reformation period is particularly poorly documented, there being no comprehensive inventories of alabasters comparable to those available for earlier periods (e.g. Gardner, 1940). Preliminary data for church monuments (text-figs. 4 and 5) contradicts the writers previous impression (Firman, 1964) in that it demonstrates that far from declining and becoming virtually confined to the Midlands the use of alabaster increased expotentially and spread to most English counties. Furthermore, when more nearly complete data is available, as in the Royal Commission on Historic Monuments county publications, it is evident that not only did the amount of alabaster used for monuments substantially increase but the proportion of tombs made largely of alabaster sharply increased. Thus alabaster became more popular and not less as previously thought. Probably the preoccupation of other writers (e.g. Esdaile, 1946) with the Burton-on-Trent school of sculptors who worked almost exclusively with alabaster has obscured the fact that Renaissance sculptures elsewhere in England were using proportionately more and not less alabaster than their predecessors. A detailed historical study on the effects of the Reformation on the local alabaster trade and its subsequent recovery, expansion and mid-seventeenth century decline would be well worth attempting.

Suggested geological explanations have been given in this paper for the apparent abundance of alabaster during the Middle Ages compared with its rarity today; for the change from colourless to coloured alabaster in the mid-sixteenth century and for the apparent discontinuous production at Chellaston. Such suggestions cannot be rigorously tested without more precise historical information.

The historian looks to the geologist to provide evidence of provenance but paradoxically were the historian able to provide reliable provenance information the geology could be interpreted more meaningfully. Alabaster carvings are the best and frequently the only means of studying the textures and structures of alabaster deposits most of which have long since been obliterated. If the source localities are known regional similarities and differences can be deduced. For instance knowing that all the alabaster in Kedleston Hall, Derbyshire came from Red Hill, Notts., the writer (Firman 1964) was able to estimate the probable minimum size and shape of the "pillar" from which the individual blocks of alabaster were extracted. All the alabaster historically recorded as having come from Red Hill is nodular and incorporates much red marl interstitially between the nodules thus resembling the bottom portion of the alabaster deposits at Chellaston (Smith, 1919). Further west at Thrumpton there is documentary evidence (Nichols, 1795) that the alabaster, as noted earlier, becomes poor in quality and changes colour when heated. It is tempting therefore to conclude that when traced westward from Chellaston to Red Hill the white and green top layer (Smith, 1919) dies out and the proportion of red marl increases being replaced, further west at Thrumpton, by easily oxidisable sediments. The proof of such postulated changes in facies is crucially dependent on the identification of sufficient alabaster from known localities to be able to confidently define the range of types produced. Such identification in turn depends on historical evidence which as yet is insufficient to permit firm conclusions about facies changes in East Midlands alabaster deposits.

The geological approach to the history of alabaster may help solve historical problems and conversely more historical data may be helpful to the geologist. There is, therefore, a need for a more integrated approach to both the history and geology of mineral deposits which have been worked intensively in the past as have the English alabaster deposits.

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Dr. R. J. Firman
Department of Geology
University Park
Nottingham NG7 2RD.