

GYPSUM WORKING IN THE PARISH OF ORSTON NOTTINGHAMSHIRE

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Abstract: This paper presents detailed evidence of quarrying, mining and processing in the parish of Orston from the definitive record in 1541 to the final decline and abandonment in the early 20th century. A comprehensive study is included of the rise and fall, during the 1860s and 1870s, of the Vale of Belvoir and Newark Plaster Company Limited whose main factory was just outside the village. The venture, typical of its time, was on a grand scale but financially was a 'white elephant'.

INTRODUCTION

The English East Midlands, especially Staffordshire, Derbyshire and Nottinghamshire have long been famous for the quality and quantity of their gypsum, as hydrated calcium sulphate ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) used since the Middle Ages mainly either as alabaster (Firman 1984; Young 1990) or for the production of gypsum plaster (Young 1984; Firman and Young 1986).

Throughout the region the most commercially available gypsum occurs in nodular beds in the upper parts of the Triassic Mercia Mudstones. In Staffordshire, Derbyshire and western Nottinghamshire most of the workable gypsum is available in one bed averaging about 3 m in thickness. In contrast in eastern Nottinghamshire (the subject of this paper) an equivalent thickness of gypsum is distributed between about a dozen thin seams, interbedded with Mercia Mudstones in a package of strata 15-18 m thick. Moreover, whereas in western Nottinghamshire, Derbyshire and Staffordshire the thick so-called 'Tutbury Seam' could be easily worked from horizontal adits, in eastern Nottinghamshire the 'Newark Gypsum' (Sherlock 1926; 1928) tends to crop out on relatively flat land and had, therefore to be opencasted or exploited from shafts or inclined adits. Water, too, was much more of a problem in south east Nottinghamshire since most of the workable gypsum lay beneath the water table. Not surprisingly these were the most difficult and expensive gypsum deposits to work in the East Midlands and consequently were the last to be fully exploited. Moreover, they lacked the substantial amounts of the alabaster-grade gypsum which so much added value to the deposits further west (Firman 1984). It was not until the advent of modern earth moving equipment that these very pure deposits became readily profitable without the necessity of an accompanying brick industry to offset the costs of stripping otherwise useless overburden.

This paper records the history of one small but typical part of the 'Newark Gypsum' belt before modern earth moving equipment was used. It provides a detailed supplement to a previous paper on *Gypsum in Nottinghamshire* (Firman 1964). Readers are referred to companion papers on *Gypsum in Derbyshire* (Sarjeant 1962; 1965) for general accounts of the history of gypsum extraction and utilisation.

THE GEOGRAPHICAL AND GEOLOGICAL SETTING

Orston is one of an arc of villages in south east Nottinghamshire which are strung out along the Vale of

Belvoir, close to the Lincolnshire border. It differs from all other villages in this chain, ranging from Langer in the south to Cotham in the north (Fig 1), in that it alone is not situated on top of the low (c. 10 m) west-facing escarpment which bounds the western edge of the heavy clay lands of the Vale. Whereas villages to the north and south of Orston, when approached from the west, tend to be prominent on the skyline, Orston itself nestles at the foot of the Rhaetic escarpment. The reasons for its unusual location are not known. Certainly a spring issues from the foot of the escarpment which is sufficiently dissected to have encouraged the establishment of trackways which were not excessively steep. However such features are not unique and settlements did not develop elsewhere close to the foot of the Rhaetic escarpment in similarly favourable

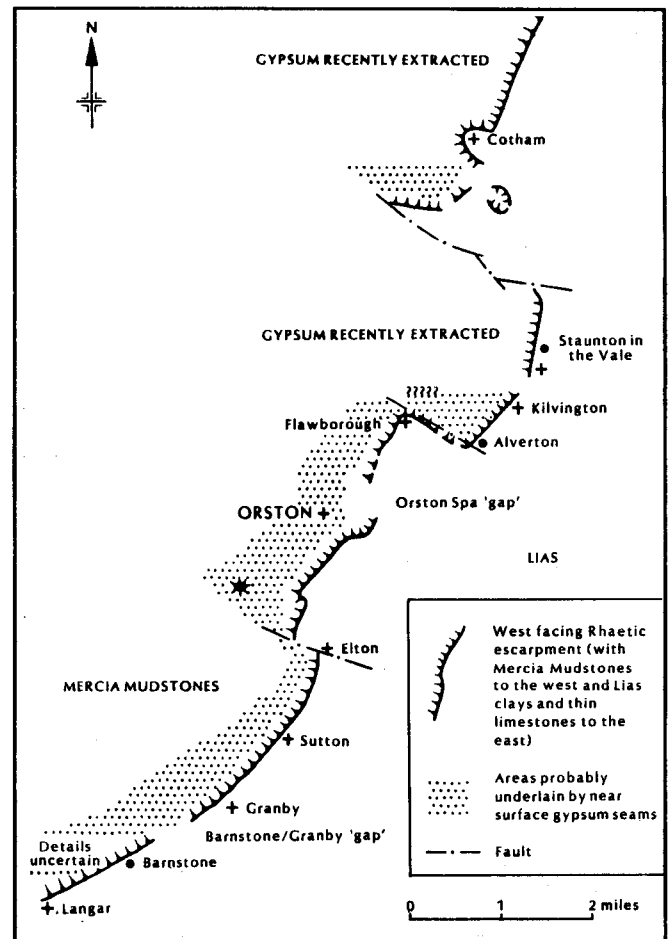


Fig 1. The geographical and geological setting of Orston.

circumstances (e.g. near Granby). Other villages in south east Nottinghamshire are further from the Rhaetic and are often on higher, better drained land formed by outcrops of sandstone, locally known as skerries (see Geological Survey one inch sheet 126).

Whatever the reason for its location the net result is that Orston is only one of two villages whose buildings are underlain by commercially viable massive gypsum deposits. Like Cropwell Bishop the nature and distribution of gypsum must have been an important factor in the development both directly and indirectly even though, because of its solubility, it would not have been exposed on the surface. As was proven by extensive drilling in the 1960s, supervised by one of the authors (R.J.F.), near-surface gypsum in eastern Nottinghamshire may be wholly or partially dissolved, either by upward-moving sub-artesian groundwaters (Firman and Dickson 1975) or downward percolating meteoric waters (Elliott 1961), resulting in sub-surface voids where gypsum nodules previously existed. Alternatively such voids, which might be as much as two cubic metres in volume, might have collapsed creating natural subsidence hollows on the surface. Where the sub-surface gypsum is intact the ground is stable but where dissolved potentially unstable conditions or an irregular ground surface would have made building substantial structures difficult. The history and rebuilding of Orston

parish church provides an example, for as Gill rightly maintained, "the necessity for frequent reparations is attributable to the geological formation of the site". He was, however, mistaken in claiming that the church was built on a clay bed which "shrinks and swells with every change of temperature, and thus wrecks havoc on the foundations" (Gill 1920). The "frequent reparations", "the billowy effect seen on the floor of the church" and "the wavy lines of scroll-moulding which runs beneath the window sills in the north aisle" described by Gill are all likely to have resulted from subsidence of land undermined by the solution of gypsum rather than by shrinkage of clay. Such clays do occur in the Vale of Belvoir, but not at Orston.

Arguably it might be expected that the pattern of village settlement and the location of its streets would, in part at least, have been controlled by the distribution of gypsum outcrops and by the extent of sub-surface dissolution of gypsum (Firman 1964). Probably this is most clearly illustrated in the south western part of the village. Here two lines of ponds, probably representing modified marshy subsidence hollows, closely correspond to outcrops of the two uppermost and thickest gypsum seams (Fig 2). Judging by the enclosure award map of 1793 (NAO, DD2/8) there was until recently no building on the outcrop of the thickest gypsum seam, no doubt because the land was badly drained whereas between the two seams it was drier and more stable. Similarly Moor Lane,

formerly an important bridleway to Whatton, developed on the northern drier side of the subsidence hollows marking the outcrop of the uppermost gypsum bed (Top Grey White on Fig 2). Interestingly the 1793 plan does show some building athwart the Top Grey White east of Lombard Street but few survive, the present houses being almost exclusively again on the up-dip, drier western side of Lombard Street away from the probably wet Top Grey White outcrop (fig 2). Unfortunately the pattern of outcrops of gypsum and the state of their subterranean solution is not known in sufficient detail to pursue this analysis much further although it may be noted that the Geological Survey map (Sheet 126) does show a gypsum outcrop close to and parallel to High Street suggesting that its location may also have been similarly influenced by the pattern of gypsum outcrops. There are, however, discrepancies between the unpublished six inch geological map of Orston which shows a gypsum outcrop east of the High Street and the published one inch Geological Sheet 126 map which shows the same outcrop west of High Street! Fieldwork confirms that the six inch geological map (in the BGS

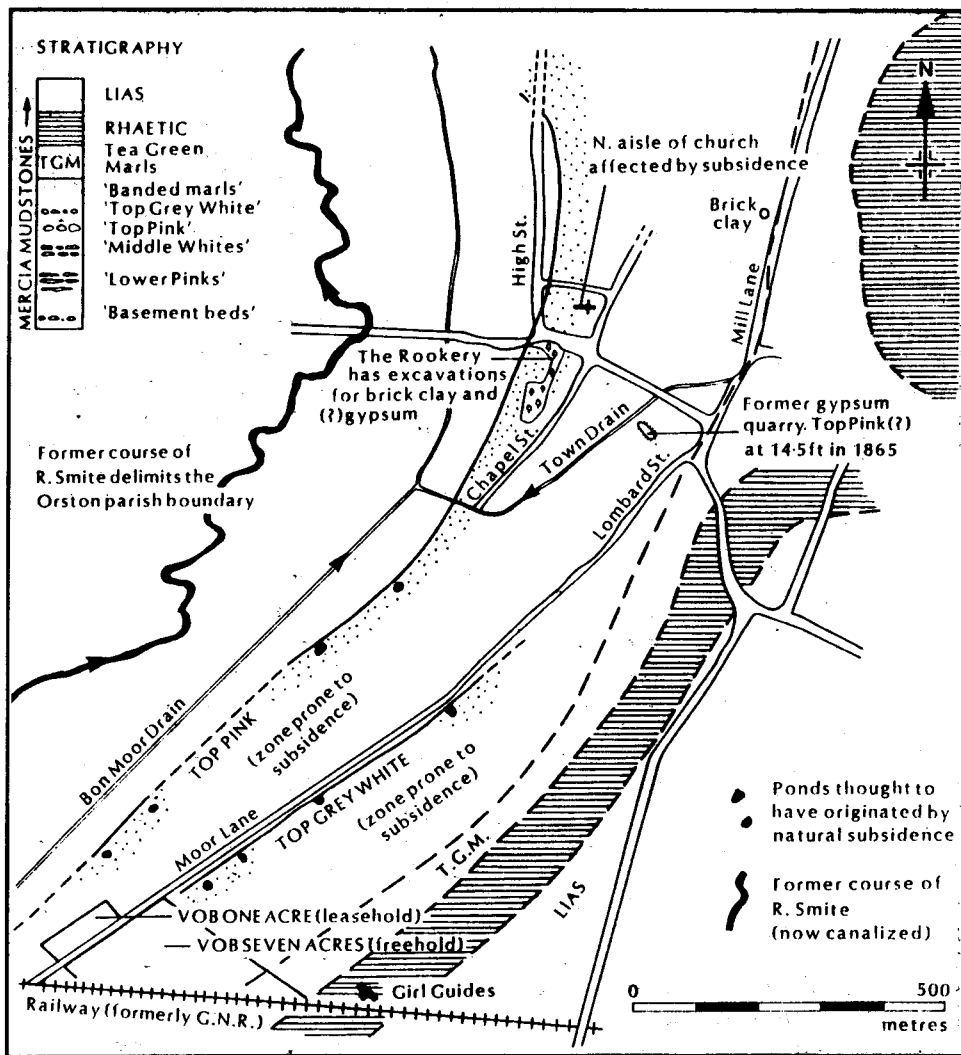


Fig 2. Sketch map showing the geological boundaries and gypsum workings. The gypsum 'boundaries' are the western limits of subsidence associated with particular gypsum seams.

Library, Keyworth) correctly depicts a line of subsidence hollows associated with the Top Pink Gypsum and thus High Street, like Moor Lane developed on the drier, more even side west of these subsidence features.

Thus it seems likely that gypsum influenced the development of the village even before its presence had been detected. Once it had been discovered, perhaps when digging foundations for building or when sinking wells, and had begun to be used for plaster, holes specifically dug for its exploitation would further restrict the distribution of potential building sites, a prime example being the land between Chapel Street and Lombard Street which during the 19th century, if not earlier, was extensively dug over for gypsum.

In addition to the effect of gypsum on the built environment of Orston, it must have had an important influence on its water supply and, although undocumented, on the quality of locally made beer! Doubtless initially water was obtained from the spring issuing from the base of the Rhaetic and the stream which flows from it, later to become Orston Spa and Orston Town Drain respectively. Orston Spa water is arguably too iron rich for normal domestic purposes and no doubt the town drains became unduly polluted. Smaller springs, marked as "Rises" on Ordnance Survey maps are unlikely to have provided adequate alternative supplies and hence wells were sunk. It is not known when the first wells were dug but the 25 inch OS map of 1900, Sheet 44/2, shows over 30 wells and pumps so by then the bulk, if not all, of Orston's water supply came from local underground sources. Since these wells would have been sunk through gypsum bearing strata there would have been a high concentration of dissolved gypsum in the groundwaters. Orston, therefore, would have shared with places like Newark and Burton on Trent the advantages of water rich in gypsum. Although the advantages to the brewing industry are now well known (there is a small but thriving export trade in gypsum for "burtonizing" foreign beers, (Sherlock & Hollingworth 1938)), there is no evidence that Orston was aware or took advantage of their gypsum-rich water.

EARLY HISTORY.

Documentary evidence for the use of gypsum and building clays at Orston before the late 18th century is sparse but, judging by developments elsewhere, it is possible that gypsum was being dug, at least for local use, for plaster from as early as the mid thirteenth century and Orston may have shared in Nottingham's boom in bricks from the late 17th century onwards. Throughout much of the Middle Ages, Tudor and later periods the East Midlands were famous for the quality of their alabaster - a fine grained, often translucent, readily carvable form of gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$). Most of this material was obtained from thick seams in either the Tutbury district of Staffordshire or Chellaston in Derbyshire (Firman 1984); Nottingham before the Reformation being a major centre for its sculpture (Hope 1904). Although good quality red-veined alabaster was obtained from Red Hill in south-west Nottinghamshire during the 18th century, most of Nottinghamshire's gypsum was too coarse and granular to be suitable for sculpture. This is particularly true of the gypsum seams in east Nottinghamshire which are rarely thick enough to yield large blocks of alabaster even if the requisite fine-grained material is located (RJF's personal

observation of boreholes and quarries). Thus, although this very valuable material may have been sought it would rarely have been found, and then frequently of poor quality and in comparatively small pieces. Correspondence dated 1869 discussing the possibility of supplying blocks of alabaster from Orston states that the "the longest piece that we can raise would be from 18 inches to 2 feet long & the same width" (NAO DD.H. 167/107) but there is no evidence that these were ever supplied to the customer. The NA 2/8/1865 also mentions "the white stone workings" in the village centre at Orston "from which, bye the bye, the most exquisite vases have been turned". Nevertheless, most of Orston gypsum, like most of the gypsum deposits fringing the Vale of Belvoir, would not have been usable as alabaster but would have been chemically very pure and eminently suitable for the manufacture of high quality gypsum plaster.

We do not know when gypsum plaster was first made at Orston but given that the first known medieval commission was in 1252 for work in Nottingham Castle (Salzman 1952 p158) and that from the 14th century onwards the East Midland region was this country's most important source of gypsum, medieval workings in and around Orston seem likely. Unfortunately the first definitive evidence that gypsum was being exploited in east Nottinghamshire seems to be some 250 years after Henry III instructed that a wooden dias in Nottingham castle was to be made (i.e. finished) with French plaster (franco plastro). There is, therefore, a considerable gap in our knowledge of the history of the gypsum plaster industry in the East Midlands although Salzman has shown that during the 14th and 15th centuries it was made both locally in Dorset and Yorkshire and was imported (Salzman 1952 p158-159). No doubt gypsum plaster was also a significant by-product of the thriving medieval East Midlands alabaster industry, although there is as yet no documentary evidence to support this assertion.

By the early 16th century, however, gypsum plaster was definitely being produced, if not at Orston, somewhere nearby in east Nottinghamshire. As shown by Salzman (1952 p159) the Collyweston accounts for 1502 state that payment was "made to 'William Upton of the Vale of Bever for 62 tonne of plaster of Paris' at 3s.0d. the ton, with carriage - stated to be 22 miles". The only conceivable gypsum outcrops, from which this could have been obtained, lie between Newark and Cropwell Bishop on the western edge of the Vale of Belvoir. The distance, 22 miles, is too short if these were statute miles but there is evidence, from the writings of Leland (c.1541) that in Tudor times a longer mile of about 11 to 12 furlongs was in use (see Firman 1964, for fuller discussion). Thus Orston, which is about 22 long English miles from Collyweston could have been the source. However, so too could either Staunton-in-the-Vale or Elton. Air photographs of both show pre-Enclosure diggings on gypsum bearing land (Firman 1964) and, indeed, this could apply to almost any gypsum locality in south east Nottinghamshire. Although the precise locality is not known, this 1502 record does demonstrate that large amounts of gypsum plaster were being produced and transported by road up to 30 statute miles from its source. These 62 tons would have required an excavation at least 4m diameter and many cartloads to transport it. By the early 16th century, therefore, the Nottinghamshire Vale of Belvoir plaster industry seems to have been sufficiently well established to command large orders from relatively distant sites.

CORPORATE HISTORY OF THE VALE OF BELVOIR AND NEWARK PLASTER CO. LTD.

During the 1860s the quarrying of gypsum and the manufacture of plaster together with the accompanying industry of brick and tile making made great advances. The Royal Plaster Works were constructed in the centre of the village adjacent to the quarry shown in Fig 2. A few years later much larger works were built just outside the village (Figs 1, 2 and 3).

In July 1860 "The Royal Plaster Works" (presumably so named as the owner of the freehold was also the proprietor of the "Royal Oak" Inn) were built and worked by Messrs Willis and Co., of London. However, by 1864 that firm had failed (White 1864). Work was soon recommenced by William Jacobs, an established gypsum quarrier and manufacturer from Newark (NA 2/8/1865). It was probably this that attracted him to Orston together with his partner James Carter, an auctioneer and stock and share broker from Nottingham to dig the large quarry, and build the works outside the village and set up the Vale of Belvoir and Newark Plaster Co. Ltd. (VOB) although it continued to mine gypsum at the Royal Plaster Works on a small scale on a royalty basis. By 1869 the site was also worked by another firm, R.B. Tennant and Co. of London and Walbrook, probably also on a small scale (Morris 1869). In August 1869 it was sold, although the VOB continued to work the quarry for some time afterwards. As no records survive, it is not possible to know the precise scale of the operations. However, the sale particulars state that the works comprise of "nearly an acre of land, partly worked; seven-roomed dwelling house fronting Loughbon Street; stabling, coach house, ovens, engine house, and mill, with 14 horse engine by Worssam; 21 ft. boiler, mill machinery, and out-door plant, embracing every requisite for carrying on the trade; all in working order, having quite recently undergone thorough repair" (NAO, DD.H 167/171).

THE ESTABLISHMENT OF THE VOB.

In 1864 a new works on a grand scale started to be built by James Carter just outside the village, and connected with a siding to the Great Northern Railway line between Nottingham and Grantham which had been opened in 1851. This site was probably already worked on a small scale as it was alongside the Whatton Bridle Road (Moor Lane on modern O.S. maps) and there are hollows which may be old gypsum bell pits. The works took about two years to build and, until a limited company was formed to raise the necessary additional finance, the firm simply traded as Carter and Jacobs.

The raising of the necessary finance was attempted by means of the formation of a new company, the Vale of Belvoir and Newark Plaster, Cement and Mineral Co. Ltd., and the invitation, by way of prospectus in 1865, for subscriptions for 6,000 shares of £5 each. The £30,000 thereby raised would be used to purchase "the goodwill of the Business, and the Plaster-of-Paris and Cement Works, situate at Newark upon Trent . . . in the occupation of Mr. V. Jacobs and also for the purpose of purchasing the Buildings, Steam Engines and Plant, and of working and fully developing the valuable deposits of Gypsum, Clay and other Materials, underlying the Freehold and Leasehold Properties situate at Orston . . . belonging to Messrs. Carter and Jacobs and for the Manufacture and Sale of Plaster-of-

Paris, Cement, Gypsum, Clay, and other Mineral products" (NAO, DD.H 167/21).

The prospectus went on to say how the Newark works had been successfully run by Mr. Jacobs who had good connections in the trade and that he had supplied plaster for the internal decoration of the Grosvenor Hotel, London, "the International Exhibition of 1862, the Adelphi Theatre, the St James' Hall, a great portion of the Royal Italian Opera House, Covent Garden, and several Mansions and Public Buildings in England, and on the Continent". It said that Carter and Jacobs would retain a large financial interest in the company and that Mr Jacobs would be manager. It also said how buildings and plant at Orston were new, very extensive and that "In immediate contiguity to the Works, there is an almost inexhaustible deposit of the finest and purest Gypsum rocks ever yet discovered, extending over Nine Acres of Land, which will yield at least 30,000 tons per acre, lying at such a shallow depth from the surface as to render the cost of getting them a comparative trifle; there is also upon the upper surface most valuable beds of Clay, which can be manufactured into bricks and other materials. The quality of the Clay for bricks has already been tested, the whole of the several buildings having been erected from bricks manufactured upon the property".

Two features enabled it to claim to be the most efficient in Europe; the connecting line between the Great Northern and Midland Railways at Newark would pass close to the Works at Newark enabling it to send gypsum from Orston to Newark very cheaply. Secondly, the company would possess "fourteen ovens of the most modern construction with the necessary Mills, Engines and other apparatus. The process of calcining and grinding is simple and inexpensive, and the machinery is capable of producing one hundred and fifty tons of Plaster-of-Paris per week".

The prospectus said a little of the likely profitability of the venture for potential investors; "The demand for the various qualities of Plaster-of-Paris, Floor Plaster, Alba, Agricultural Gypsum, and Cement is very extensive, in fact almost unlimited and after careful investigation, a profit of at least £15 per cent. upon the capital employed is shown; and it is certain, from the connection and Trade already secured to the Company, that a dividend of at least 5 per cent. will be paid the first year.

In addition to the large profits realised from the Plaster, Gypsum, and Cement, a further considerable profit will accrue by working the vast beds of clay into bricks, drain pipes, &c., &c. The local demand for bricks and drain pipes (more especially the latter) is very great and combined with the Railway facilities, will ensure large profits from this branch of the business and a plant, kiln, &c., are already erected and complete".

The prospectus gave no further financial information. The "carefull investigation" refers to advice given by Robert Lineker which implied that the total reserves in the "seven Acre Freehold" would yield at least 50 per cent. more per acre, and could be extracted at considerably less cost than either the gypsum at Newark or in the centre of Orston (see the Appendix). The uncritical acceptance of this estimate, which subsequently proved as false as the "almost unlimited" expected demand for gypsum products, was but one of the many misjudgments which led to the decline and fall of the company. It should not necessarily be inferred

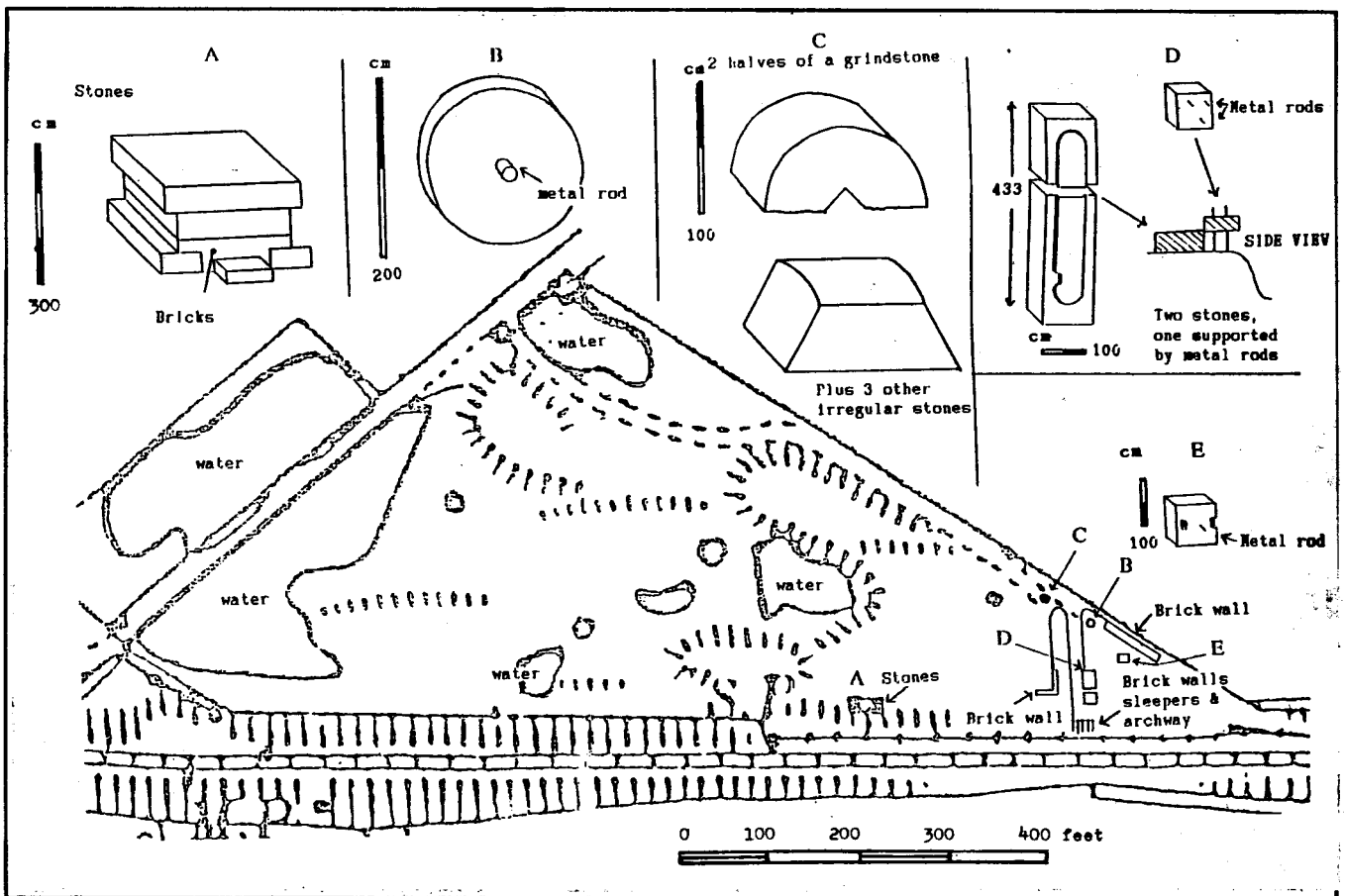
from this that the prospectus was deliberately misleading. However, at that time such documents were not subject to regulatory controls and "misrepresentation, if not the rule, was at least quite common" (Hein 1978). A common deception was to insert the names of well-known personages to give credence to the venture. The proposed directors comprised James Carter and five other notables, including the local MP Colonel Brownlow Knox, added respectability to the venture. [The manager and secretary was Jacobs, their "temporary offices" were at 22, Kirkgate, Newark, their solicitors were William Newton of Newark and Henry Smith of London and their brokers James Carter & Son]. As the five notables were neither involved with the venture before nor after the publication of the prospectus, their role must have been limited to its promotion. As no correspondence with Knox about his consent to appear exists it is possible that this may not have been obtained.

Despite these efforts at improving the prospectus's presentation and its appearance in the London financial papers, it failed to attract sufficient subscriptions. As the venture was already underway by Carter and Jacobs another attempt was made. This eventually took the form of individuals putting up a much smaller amount of money. Two years later, in March 1867, the Vale of Belvoir and Newark Plaster Co. Ltd. was formed, which was, incidentally, the first Newark joint stock company. Its purpose was precisely that of its conceived but unborn predecessor: to take over Jacobs's Newark business and the much larger developing business of Carter and Jacobs at Orston. Finance was tight and restricted to Carter and Jacobs together with the owner of a vital lease, James Robson and William Newton, the Newark solicitor. Carter's contribution was valued at £3,000 for which he and his family were allocated 300 £10 shares. Jacobs's

contribution was also valued at £3,000 for which he was to be paid a salary as manager of £350 p.a. "with an increase so long as the company pays £15 per cent." (NAO DD.H 167/46). It was also agreed that William Newton, who had funded the Orston venture until then by way of mortgage and had agreed to provide further advances and act as a surety to the firm's bankers, Nottingham and Nottinghamshire Banking Company, was to have an interest of £3,500 for which he was allocated 350 shares. Additionally the £4,000 mortgage loan was to remain. Finally, Mr. James Hobson of Newark and manager of Nottingham and Notts Banking Co., who had a lease of a small field at Orston was granted 50 shares for its use. There were also certain technicalities about unpaid shares but essentially this resulted in 900 shares of £10 each amounting to £9,000 being issued which together with the loan from Newton secured by mortgage on Orston freehold of £4,000 provided funds of £19,000. This bought the Trent Works, Newark from Jacobs for £3,000, the Orston Freehold land, buildings, machinery, plant, the cost of sinking a well, and the cost of opening the pits, for £9,500, and the Orston Leasehold land, engine pumps, plant and the cost of opening those pits for £500.

The interesting thing about the financing of the venture is that whilst Newton was not one of the founders, as a result of the failed prospectus he became the single largest backer with the most to lose financially if it failed. As the venture's profitability largely rested on Lineker's statement it is ironic that he had recently been taken to court by Newton for non-payment of a debt.

The company expanded further very quickly. In February 1868 it issued 350 more shares to partners in Hardy and Co., bankers from Grantham and owners of part of the Newark freehold land. The money raised was to buy the



firm of plaster manufacturers, Stocker and Roberts, at Beacon Hill and North Gate, Newark, which had been threatened with closure. Fifty other shares were also issued at the same time to Carter, Jacobs, Hobson and Newton as payment of part of their 1867 dividend (NAO DD.H 167/46-47).

CAPITAL ASSETS - LAND AND BUILDINGS

The area of the works and accompanying land comprised of (i) the Seven Acre Freehold which is in fact 7.83 acres, number 189 in "The Plan", (ii) Glebe Land of just over an acre which was leased at a royalty, and which lies on the north west of (i) the other side of the Orston to Whatton Bridle Road, (Figs 4, 5 and 6). A magazine, presumably the gunpowder store, is shown on the Ordnance Survey map a field away due west from the Glebe Land. Additionally, the company's records refer to stock at the "Leasehold Works" which were the Royal Plaster works in the village already mentioned.

The *Newark Advertiser* (NA 11/4/1866) recorded the official opening of the new works on 3 April 1866. "This took the form of a dinner to which a number of the principal inhabitants of the place, the workmen in the employ of the firm, and several private friends sat down . . . The whole village was astir and the bells rung a merry peal in honour of the occasion . . . The cloth having been drawn, Mr. Jacobs, proposed the health of his partner, Mr. James Carter of Nottingham, with that of the company's solicitor, Mr. W. Newton of Newark . . . The health of several friends present was given and responded to and a very pleasant evening was spent; the company remaining until a late hour. Prior to the dinner visitors were conducted over the works, which were in full operation, the steam engine of 35 horse-power driving the stones used in grinding the gypsum. The capacious ovens are arranged in the most convenient position for the reception of the plaster with the least amount of labour possible the grinding is carried on in close proximity, and a siding from the Great Northern Railway runs close to the works, so that the plaster is placed on the trucks from the building in which it is manufactured. The saving in cost of labour and cartage must therefore be immense. The first truck of plaster was sent away in the early part of February last, for the eminent firm of C.J. Hilton and Co., the extensive cement manufacturers, Upper Thames Street, London. W.C. Anderson, Esq. (one of the firm), had previously visited these works, and was well satisfied with their extent and construction, and the superior quality of the deposit of gypsum, that he gave an order for 1,200 tons to be delivered within twelve months. Brick making is carried on upon the premises, and one builder has given an order for about a million".

An insight into their early days and erection is provided in the record of a visit by "a Times Correspondent" to the works at Orston in the NA on 2 August 1865 which heralded the publication of the unsuccessful prospectus the following week. The "*Times Correspondent*" writes "A 10 minutes' constitutional brings us to the celebrated "Orston Siding Seven Acre Freehold". Here all is activity and bustle from the portable steam engine, pumping its gallons of water from the pit into a well 10 feet in diameter and 84 feet deep, to the diminutive lad picking auriferous-looking morsels from the heaps of this rivings. On the part of the field which has not been disturbed our vision is refreshed by

the verdant appearance of a crop of oats . . . Tramways are laid down between the pit and the manufactory, but as the undertaking is still in its infancy it will be still some time before the necessary mechanical and engineering appliances are perfected. The manufactory is built of bricks made on the ground (sic) and the building itself is one of the best planned and most convenient of the kind we have ever seen. Mr. Jacobs was his own architect and every part is so designed as to save labour, which in a manufactory of any kind is a most important feature . . .".

A sketch plan of the layout of the works by Jacobs survives in the NAO (DD.H 167/10). As the overall shape of the building there does not quite fit that which appears on subsequent maps and the 1897 estate plan, his plans must have been revised (see Figs 5 and 6). Various stock taking records, bills correspondence and auction particulars also survive together with some description by the Times Correspondent, who writes "The calcining house contains a lofty shaft and eight ovens, the crowns of which are fine specimens of brick work and the flues are constructed on a principle which will bear the test of scientific inquiry. The gypsum will be baked in these ovens, for that is the process required to rid the rock of its sulphuric-acid and water of crystallization, the remaining substance when thus calcined being in the Orston Rock pure sulphate of lime. This again has to be cooled and pulverised, and there are two large apartments constructed for this purpose, intersected by a shaft from a stationary steam engine of thirty-five horse power . . ." (NA, 2/8/1865).

The main body of the works comprised warehouse, counting house (conveniently located with their backs to the ovens and overlooking the sidings), calcining house, grinding room and boiler house, brick kilns etc. The 1873 auction particulars refer to the works as "comprising 8 large ovens, powerful 30 horse engine and boiler, two pairs of edge runners, 5 pairs of horizontal stones, Garners' dressing machines, powerful crusher, and extensive warehouse room . . ." (NAO DD.H 167/171). Nearby were the sidings, tramways, coal drops and manure shed. Manure would have been saved to be added to plaster to improve its setting qualities. The boiler house was used to raise steam for grinding the gypsum into terra alba. An entry in the directors' minute book for 13 October 1870 refers to a decision to "erect a dressing machine and other machinery to the two pair of stones at Orston for the purpose of making second quality terra alba". A Hoffman kiln which appears on the maps and plan was located a few yards away from the main works. It would have been used to bake bricks. Jacobs wrote to a customer "I would have done it (floor plaster) at that price by burning it on the brick kiln but now I should have to clamp it specially . . ." (NAO DD.H 167/107). Given the relatively small value of brick manufacture relative to gypsum products it is difficult to see how the costs could have been justified. Located about fifty metres to the west of the main buildings and also appearing on the maps and plan were, and still are, three large blocks of Millstone Grit, the purpose for which is unknown. Although they could have been used as for further grinding or crushing purposes it is more likely that they would have been counterbalances or stable bases for cranes or other earth moving equipment. Although all the buildings have now been demolished and most of the equipment taken away, many of the stones remain on the site of what would have been the grinding room. All the land owned or leased by the company was underlain by workable gypsum but, as discussed later, these assets (i.e. gypsum reserves) were not

as large as first estimated and were uneconomic to extract.

GYPSUM PRODUCTION AND PRODUCTS

The surviving business records are just sufficient to enable a rough calculation of total output to be made. This indicates that during the period of full production, 1868-1871, in which total sales were in the £12,000 - £14,000 p.a. region and about a sixth of that was for bricks [1.75 million p.a.], about 9,000 tons of gypsum p.a. was the total company output of which about 4,000 tons came from Orston including from diggings in the village itself. Although no statistics exist for those precise years, a total of 50,000 tons p.a. based on a total of 61,741 tons for 1876 (Mines Office Statistics) is a reasonable estimate for total U.K. output. This, therefore, suggests that the VOB about 18 percent of total U.K. production, of which 8 percent was from Orston. This was, judging from the subsequent financial problems, likely to have been the maximum or near maximum annual production at Orston. Figures for later years are not available but calculations based on probable yield from open-pit and under-ground mining (see 'Mining History' below) suggest an average output of 2,000 tons per annum over 50 years from VOB land at Orston.

No analysis of the total output according to products is available. The surviving business correspondence suggests that uncalcined, ground gypsum, mineral white or terra alba, was sold in large quantities, presumably for use in the paper, paint and lace industries. In 1871 the VOB claimed to be the only manufacturer of terra alba in the Newark area. Less pure varieties were also sold, notably for "Burtonising" beer (to produce bright ale) supplies of which went all over the country. Calcined gypsum, both in the form of cement and plaster of Paris, was produced. The latter was sold widely both locally for floors and to the London market, transported by rail. It was also shipped abroad and to the North of England. Both went by ship from Hull. The railway line to Stoke was exploited to supply the Staffordshire pottery industry plaster for moulds. Additionally, some ground gypsum was sold for fertiliser and occasionally pieces of alabaster were sold for carving. The substantial ancillary production of bricks, tiles and drain pipes were sold locally. Brick making was probably seasonal, the clay being dug in the autumn and allowed to weather over winter. (In November 1870 Jacobs wrote to a customer "I am sorry to say that we are now quite out of bricks at our Orston Works, therefore shall not be able to send you any more until next season" (NAO DD.H 167/107). Gypsum mining and plaster manufacture continued during the slack winter period.

THE DEMISE OF THE VOB

The excitement and optimism at the time of the opening of the works did not last. The VOB soon encountered problems. Little more than two years later, on 16 December 1868, the NA reported that "upwards of 60 men have been temporarily discharged from the Vale of Belvoir and Newark Plaster Company's Works, owing to the dullness of trade caused by the [impending] general election. The company have an enormous stock of raw and manufactured material on hand, so that even with a brisk demand they are not likely to add to their present staff of about 80 men until the early part of next year".

It is clear from the beginning that even if the VOB was profitable it would still have immense financial problems. It had not raised nearly enough cash - £13,000 rather than the required £30,000. Great efforts were made to raise further necessary funds. As early as 9 November 1869 Carter wrote to Newton "I am just returned (7 p.m.) from an almost painful interview with Mr Wilcockson [manager of Nottingham and Notts Banking Co.]. He declined to accept my assurances that the account shall be placed in a satisfactory state before the end of the year, and says he is quite sure that the Bank Directors will take some painfully hostile step at their meeting tomorrow. Do for Heavens sake let something be done to avert such a sad calamity" (NAO DD.H 167/139). Although the immediate crisis was averted another letter from Carter to Newton of 20 December 1869 indicates how it was to be resolved "I am sorry to find . . . that matters are so bad, still I hope that by raising the proposed loans on Debenture and placing the whole affair under proper supervision they may soon be brought into a more healthy state" (NAO DD.H 167/140). In May 1870 £3,000 was lent by way of mortgage debenture; one half by Newton, Jacobs and Carter. Hardy and Co., the Grantham bankers were persuaded to further finance the firm. Its partners John Hardy senior, Robert Johnston and John Hardy junior put up the other half.

It is also apparent that, although the early accounts reported a profit, the VOB never did make profits. Profits for 1867 and 1868 are reported but from 1869 onwards to the year of its liquidation they state that it lost money. In 1871 it re-examined its accounting procedures and revalued its assets more realistically. A large loss was the result indicating that the profits for 1867 and 1868 were illusory. It was common at that time for accounts to be misleading and not as usually supposed, conservative and understated profits (Brief 1965). Here profit was computed as the difference between the valuation of the stock, plant etc. at the opening and closing dates of the accounting period plus all the income and less all the running costs. As there were no particular rules or conventions at that time of how the opening and closing valuations should be made and how capital expenditure should be recorded, the reported profit was therefore effectively calculated according to the discretion of the directors and managers. For example, stocks may be valued at selling price and not marked down by as much as prudence would require. The re-examination in 1871 resulted in new calculations which revealed accumulated losses of £9,708.16.10½ (NAO DD.H 167/65-72). These arose from (i) trading losses during 1870 and 1871, £4,963.13.1½, (ii) a loss in writing down the value of land, buildings and plant from £15,123.5.10 to £11,000 [comprising Orston Works £9,000 and Trent Works, Newark £2,000 amounting to £4,123.5.10 and (iii) an overpayment of dividends on the 1868 profit of £621.17.11. Even if the accounts for 1867 and 1868 were to be believed and the company was profitable, actual cash flows were negative [i.e. it was losing money in cash terms]. Given the large bank overdraft, it must have been obvious that the VOB was in financial difficulties from its very beginning.

It is strange that the company minutes do not refer to the circumstances that lead to the re-examination. They merely record that a Mr Hickling acted as valuer rather than Carter & Co who had acted previously. The actions of Carter & Co may be seen as a clearly connected firm failing to act independently in an effort to give a favourable impression to potential investors. It is not possible to tell whether they intended to mislead Newton and Hardy & Co.

who had been drawn in to support the VOB and who had very limited experience of the business of gypsum mining and manufacture. It is also possible that Carter & Co were themselves misled.

There is another aspect with which Newton and Hardy & Co. would be more familiar. Despite the fearful financial prospects, the VOB continued to trade. This was a case of continuing because the losses incurred would be less than those that would be made if the quarries and works were closed. Whilst they continued to be worked there was the possibility of selling the business as a going concern. There is some evidence for this explanation. Despite its lack of finance the VOB paid two dividends. The first was in March 1868 as a result of the 1867 trading profit of £791.12.1 a dividend of 10 per cent amounting in total to £784.14.2 was paid, [£284.14.2 in cash and £500 by way of £10 shares]. A second dividend also of 10 per cent was paid for 1868. Obviously the proprietors did not believe the firm was doing well enough to justify these payments. They must have been paid in a desperate attempt to show potential financiers that the firm was doing well.

Although Newton and Hardy & Co. continued to support the business no one else came forward and there is some evidence to suggest that Jacobs himself had limited faith in it. As the only person with the necessary experience, he more than anyone else must have recognised the fragility of Lineker's assumptions. It is interesting to observe how financially he extracted himself as much as possible from the scheme without undermining it. As mentioned earlier, the terms of the acquisition of his business were that he was partially paid out [to the extent of £1,000]. He was not designated a director of the VOB, merely manager. Most important of all, he gradually reduced his investment. In November 1867 he sold ten of his shares for £10 each [i.e. at par] to James Hobson, an existing shareholder. He later sold a further ten shares and in June 1869 twenty five shares all for ten pounds each, the par value. The latter was a good deal as the only other share transfer in that year [April 1869] was for fifty shares for five shillings in total, reflecting the demise of the firm! There was some kind of problem with Jacobs from quite early on. On 6 April 1867 Carter wrote to Newton "it ought to be a matter for our serious consideration whether it would not be better to take him at his word and let him withdraw from the concern altogether" and ended "I write this in Masonic confidence . . ." (NAO DD.H 167/108).

By 1873 finances were so bad that it was decided to wind up the company. On 16 October James Carter & Son, the auctioneers, offered the works at Orston and Newark as three lots. The auction was reported in the NA on 22nd October: "The attendance was not large, nor the competition at all spirited, the reserves for both lots being barely exceeded. Lot one consisted of the Orston estate of seven acres, freehold with all buildings plant etc. save movables and the hammer fell to Mr Holland of the Market Place for £6,500. The lease [eight years unexpired] of the Balderton, Beacon Hill, Trent (Newark) works everything save movable plant realised £510 and was bought by the same purchaser. The stock in trade is to be taken by the purchaser". Mr Holland was either acting on behalf of, or immediately sold the two lots to, Hardy & Co. who continued the business of plaster and plaster-of-Paris manufacturing at both Orston and Newark under the name of the Vale of Belvoir and Newark Plaster Co., although Kelly's Directory (1881 edition) referred to Hardy & Co.

Mr R.P. Almond was manager [with possibly a share in part of the business] until 1897 when he bought the freehold land and buildings at Orston. As few records remain it is not clear what the scale of operations were. It is clear, however, that the partners in Hardy & Co continued to lose money in the business (MBA AF 3/5) until in 1928 Lissie Almond, R.P. Almond's sister and owner of the freehold, finally sold it to Lt.Col. N.G. Pearson who gave it to the Girl Guides Association who demolished the works to use the land as an adventure area. Plate 1 is a photograph of the works in 1930 just before demolition. The Girl Guides Association still own and use it today.

MINING HISTORY

The Evidence

Two contrasted types of documentary evidence provide insights into the history of gypsum extraction by the VOB at Orston after 1860. They are, respectively, the contemporary description mentioned above written by "the Times Correspondent" of the *Newark Advertiser* in 1865, and the Abandonment Mine Plan submitted after the mines collapsed in 1894 (Mines Dept. 1920). Apart from the gap in our knowledge of the period between 1865 and the 1890s each piece of evidence has its limitations, omissions and ambiguities. Each has, therefore, to be interpreted with care.

Initial Developments

Disentangling facts, presumably supplied by Jacobs, from the journalist's own, possibly erroneous, observations and interpretations, is difficult. The *Newark Advertiser* article does, however, prove that by August 1865 at least five gypsum seams were being obtained from a pit in the Seven Acre Freehold. The depth of the pit is not stated but four of the five seams are named and these appear to be the equivalent of the 'Middle Whites' of the former Bellrock quarry at Staunton-in-the-Vale. If this interpretation is correct the geological structure east of Orston, as deduced from boreholes, and surface mapping implies that the pit must have been at least 30 feet deep even if situated at the northern corner of the freehold where the gypsum seams are shallowest. Assuming that the word 'pit' refers to an open pit (i.e. quarry) it is evident that as early as August 1865 substantial quarrying had been done on the Seven Acre site.

Whether or not underground mining had begun is much more debateable, depending as it does on a speculative reinterpretation of the Times Correspondent's text (NA, 2/8/1865), particularly his description of a 'well' into which, according to him, water was being pumped. At "10 feet in diameter and 84 feet deep" this structure would have been unduly large and deep for a water-well on a site where the water-table could have been only a few feet below the surface. Nor is it likely, as the journalist implies, that it could have been used as a sump for water pumped out of the pit, for in such relatively impermeable strata, below the water-table, it could not have drained away. There seems little point in digging what would have become an 84 feet deep vertical reservoir! Since it was wide enough to allow men climbing access and to allow gypsum to be drawn to the surface in a kibble (i.e. a large bucket on a rope) it seems more likely to have been a mine shaft. At 84 feet,

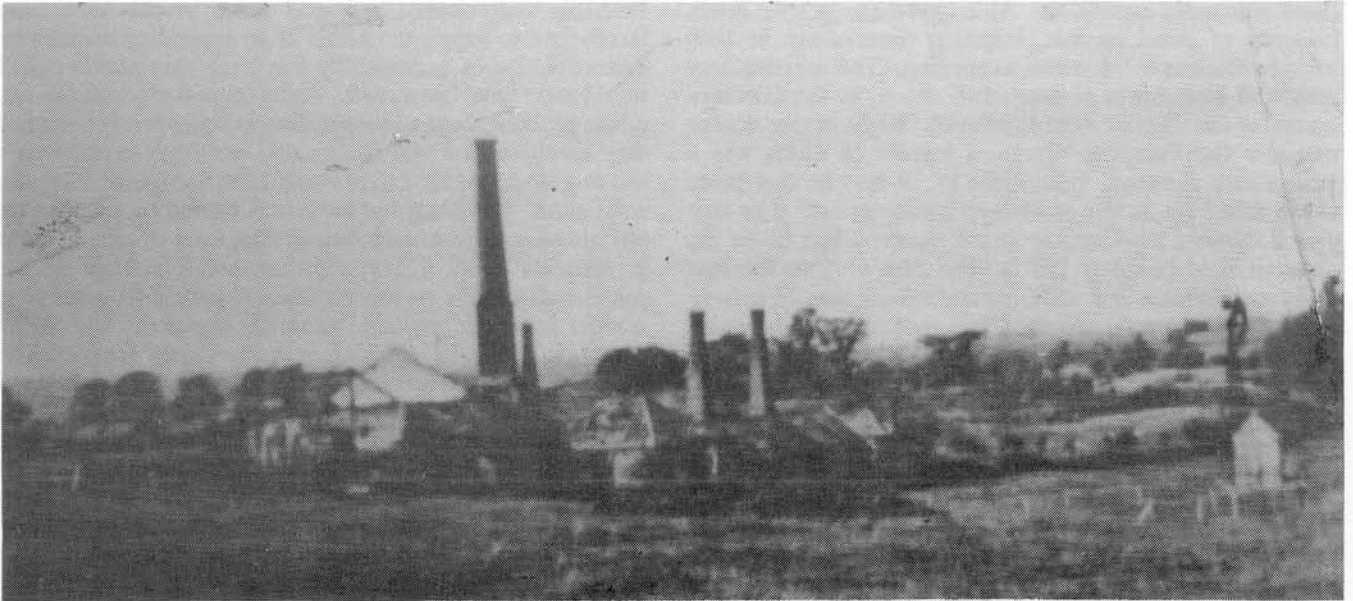
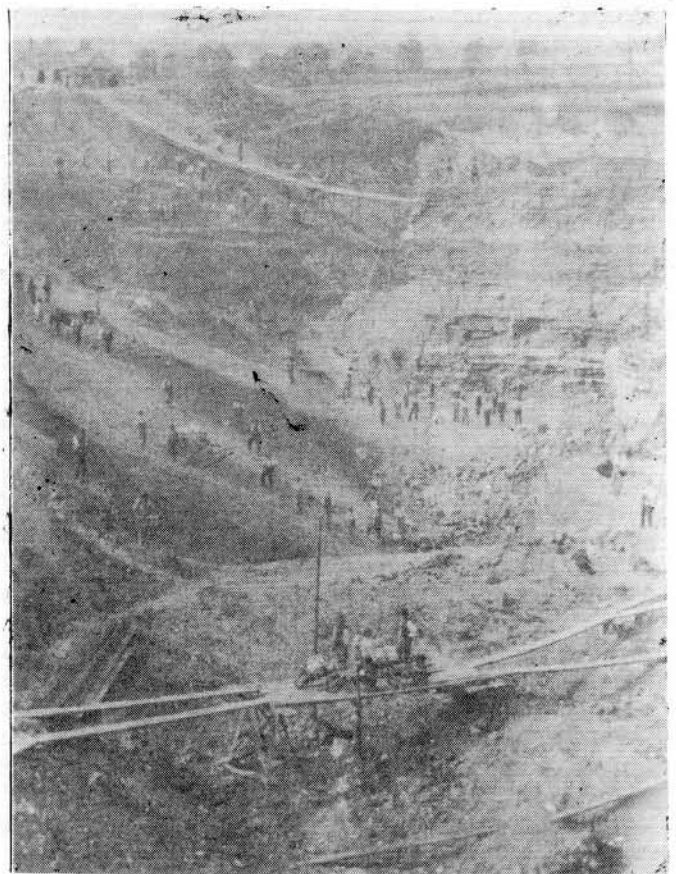


Plate 1. (above) The Works in 1930 just before demolition.

wherever situated, it would have been several feet below the lowest mineable gypsum. No doubt it was sunk to this depth partly to explore the mining potential at depth but principally to provide a sump or 'well' into which waters draining from the planned underground workings could flow, there to accumulate until they could be conveniently pumped to the surface and allowed to drain into surface ditches leading to the river Smite. Though plausible, this interpretation of the journalist's text does assume that he both understood what he was told and misinterpreted what he saw. Less ambiguity attends his description of "the diminutive lad picking auriferous-looking morsels from heaps of thin rivings". These 'morsels' were almost certainly pyrites (FeS_2) often, with good reason, called Fools Gold. Assuming that the lad was not simply picking them up to fool the journalist the most probable explanation is that, since pyrites cause problems in brick making, such as blistering and efflorescence, the lad was removing them prior to these 'rivings' being used for brick manufacture. These 'thin rivings' (i.e. fragments riven from the strata must have been dug from either the Tea Green Marls (Parva Formation) which occupy the eastern corner of the site or possibly basal Rhaetic which might have been encountered when the sidings were constructed, these being the only two formations likely to contain pyrites (personal observation by RJF; Elliott 1961; Sykes et al 1969). This observation is important since it demonstrated that in addition to the weathered red clay overlying gypsum it was also planned to use the less oxidised material excavated when the footings of the works and the sidings were excavated. Such material would produce much paler bricks than the usual red 'Keuper' type and might, therefore, account for the yellowish bricks currently lying around the site. Interestingly, old diggings near Mill Lane, Orston are also apparently on the Tea Green Marls close to the Rhaetic escarpment.

Plate 2. (below) Gypsum Working in eastern Nottinghamshire before the advent of mechanisation.

Unfortunately, both the date and location of this photograph are uncertain, since although filed in the Nottinghamshire Archives Office with papers relating to the activities of the VOB, it is in an envelope labelled Beacon Hill, Newark. Despite these uncertainties, it does illustrate the general appearance of the gypsum strata and the 19th century extraction methods.



1865-1869

Thus by August 1865, although the works were not fully operative, quarrying was well advanced, possibly a shaft had been sunk and material set aside for making bricks. Careful measurement of output per yard (discussed later) had been made and the pit and works were evidently gearing up for full production. Between then and 1868

there was rapid expansion. Although there is little direct evidence of developments, litigation proceedings in 1869 provide clues as to what was happening. The initial quarry may well have been, as suggested above, in the northern corner of the "Seven Acre Freehold". Right in that corner was also the Pumping Works, a feature of which was a large steam chimney. (See Plate 1). It may be that these works date from as late as 1869 as it was not until then that they became a legal matter as they encroached on to the adjacent field [number 188 in 'The Plan']. This incident also demonstrates that underground mining was on a large scale as it was legally admitted that they encroached under that field. Whether this encroachment was deliberate or accidental is not known. Certainly after four years mining (i.e. 1865 to 1869) it must have been evident that their reserves were nowhere near as large as Lineker had forecast but there would, in 1869, have been no shortage of gypsum elsewhere on the "Seven Acre Freehold" and thus no economic necessity to undermine adjacent property.

Probable later developments (1870-1887)

The Abandonment Plans, (Fig 4) deposited with the Mines Office after closure in 1894, give no details of pre-1872 mines as it was not until that date that mine owners were obliged by law to keep accurate plans of all underground mines. The plans also lack such useful information as depths of shafts and dates of successive surveys before 1891. Nevertheless despite these limitations it is possible to deduce the probable sequence of mining and quarrying operations provided it is assumed that the miners proceeded in a logical manner! The lack of mine boundaries on the north and north east sides suggests either that these were not available when the Abandonment Plan was drawn, or were perhaps lost when the company was sold in 1873, or that it was deliberately decided not to show the extent of the encroachment admitted in 1869. Whatever the truth, we know from the legal evidence that by 1869 mining had reached and gone under field 188. But where was the winding shaft which served this mine and where were the surface workings, or was it an adit from the quarry? As already suggested the most likely place to start quarrying would have been in the northernmost corner where the gypsum is nearest to the surface and may well have been previously part worked from bell pits. Subsidence hollows may also have suggested to the prospectors that gypsum was available without digging too deeply. Although there may have been mine adits driven from the quarry floor, this site was almost as far from the works as it was possible to be. Therefore, it would have been logical to sink a shaft near to the works. Such a shaft would have had the advantage of not only providing a source of gypsum near to the works but also, because the strata dip (judging from surface mapping and unpublished boreholes further north) at approximately 1:60 SE, of allowing the miners to work up-dip (i.e. from deeper to shallower levels in one seam) thus enjoying the benefits of water draining away from the advancing face. No shaft is marked on the mine plan but the most obvious candidate is the 'well' shown on both the Estate Plan of 1897 and subsequent Ordnance Survey maps. Such a shaft might have been used as a source of water after the mine was abandoned as apparently were other sinkings shown on the Abandonment Plan as 'Air Pits' and on the Estate Plan of 1897 as " °W " which presumably indicated either a 'well' or a 'winding shaft', confusion between the two being a long standing problem in interpreting mine plans.

Probably one quarry and one mine would have been insufficient to supply the needs of an expanding industry on a site this size. Consequently it is likely that another shaft would soon have been sunk. As so often happened the two mines probably began by operating independently but when they amalgamated one shaft could continue to serve as a winding shaft and the other would have been used solely for ventilation. It is likely but unproven, therefore, that the 'air pits' shown on the Abandonment Plan were originally shafts to separate small mines. Unfortunately neither do the documents survive to record when these shafts were sunk nor the details of any mine workings associated with them. Although no details of underground workings are shown on two thirds of the Abandonment Mine Plan the positions of three west-facing inclined adits are recorded. These, like the shafts, are undated but must represent a later mining development which could have been done after the removal of brick clay had sufficiently lowered the ground level to permit the construction of relatively short adits with gentle inclines. The first of these must surely have been that nearest to the works for it would have been hereabouts that the red clay for brick making was first stripped off. The second is likely to have been further west nearer to the surveyed underground workings (Fig 4). Assuming for reasons discussed below, that the earliest of underground pillars shown on the plan were the surveyed in September 1887 then both these mine entrances were made before that date. The third and most westerly inclined adit entrance is different. As drawn, it is superimposed on pillars of an earlier (? September 1887) survey, and leads to a line probably representing the working face as it was in the Autumn of 1869. It was, therefore, probably constructed sometime between these two surveys (? September 1887 and September 1889) and superseded an older entrance leading from a shaft which became solely used for ventilation (i.e. the 'air pit').

The final years of underground mining (1887-1894)

In contrast to the earlier period the last years of underground mining are adequately recorded (Fig 4). Two lines dated September 1891 and September 1893 show not only the position of the working faces at those dates but also the position, shape and size of every pillar left to support the roof during the intervening years. Pillars existing before September 1891 are also shown in comparable detail but the dates of the surveys are not given. Assuming that surveys were made at regular intervals and that the area mined was about the same each year, it is concluded that the Abandonment Plan (Fig 4) was based on an initial survey in September 1887, additional information being added in September 1889 (working face shown but undated) September 1891 and September 1893. The initial survey (? 1887) evidently incorporated boundaries from earlier plans and showed the position of mine entrances whether then currently used or disused but details of pre-1887 pillar-and-stall workings were left blank. These earlier workings would have been similar in scale and layout to those shown with roughly a quarter of the area consisting of unworked strata left to support the roof. The apparently random size and distribution of these supporting pillars was dependent on size and distribution of the lenticular masses of gypsum comprising the thickest but most discontinuous gypsum seams (the 'Top Pink') prised from the roof of the mine. Like the Derbyshire mines in thicker more reliably continuous gypsum seams the workings of Orston were "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" (Stokes 1878). As Trafford-Wynne (1907) in his description of the Fauld mine, Staffordshire, commented, "the great aim" was "to leave as little good stone as possible in the mine, the pillars" being "as far as possible, left where the stone is inferior". Extraction of gypsum from mines at Orston was more difficult than either Staffordshire, Derbyshire or west Nottinghamshire because to be economic a group of five or six relatively thin seams had to be worked instead of one thick seam. Moreover, the workings were shallow and became shallower as the mines extended westward. Not surprisingly, therefore, the mines were abandoned in August 1894 due to collapse of the roof which could not, then, have been more than 20 feet below the surface. The extent of this subsidence as it eventually developed is shown by the eight subsidence hollows on the Estate Plan of 1897. In the days before mine safety became paramount such subsidences were not uncommon. Indeed they were often deliberately caused by the miners 'robbing' pillars of as much gypsum as possible before withdrawing from an unsafe part of the mine. At Orston, however, the 1894 collapse seems to have been unplanned. What finally persuaded the management to abandon underground mining is not known but it should be noted that one of the collapses took place directly above, and presumably blocked, the entrance. There is no record of any miners trapped in this incident although local legend suggests that there were.

Developments after underground mining ceased (1894-1920)

This cessation of underground mining by no means marked the end of gypsum extraction, the continuation of which is partly illustrated by the 1897 estate plan and Ordnance Survey maps (see Figs 4, 5 and 6). Seven Acre Freehold, judging from the fact that only the western tip of the c.1891 inclined adit remained visible (Fig 5), probably reached the floor of the old mine workings. No doubt any gypsum remaining in the roof, floor and pillars of these c.1887-1891 mines was removed but it can hardly have been a very profitable operation. Admittedly many of the quarrymen would have had experience of working in these mines, so both men and management knew what was left and where it was situated. Nevertheless the objective during mining would have been to extract as much gypsum and as little interbedded strata (i.e. spoil) as possible. No more than a quarter of the original 'Middle Whites' gypsum would have remained in the pillars although some relatively thick gypsum might still have been obtainable from directly above these pillars and in other parts of the overlying strata not mined by overhead stoping. That much of the gypsum was, in fact, removed by stoping is strongly suggested by a Geological Survey report which claimed that the mining galleries were 21 feet high (Sherlock and Hollingworth, 1938). Some gypsum would, therefore, have been obtainable after mining ceased but almost certainly at greater cost than would have been the case had it all been worked opencast in the first place, there being no evidence of the extensive mechanisation which might have reduced costs.

The same is true of the other probable post-mining venture in the northern corner of the Seven Acre Freehold. Here, as is shown on both the 1897 Estate Plan somewhat ambiguously, and the 1890 Ordnance Survey 25" map, Sheet

No. 44/2, the existing quarry was deepened but exactly when is not known. This presumably was to exploit gypsum seams below the 'Middle Whites' which hitherto had not been thought to be worth working because more accessible seams at higher levels were still available. Elsewhere in the Vale of Belvoir they have often been left untouched although at Staunton-in-the-Vale, west of the railway they were worked in the 1960's using modern earth moving equipment but even so were only marginally profitable. At that time no such equipment was used; the principal tools for extracting and breaking gypsum being the pick, shovel, crowbar and sledgehammer. Wheelbarrows, often across planks resting on trestles, and carts pulled by a horse were the main means of transporting gypsum to the works. It is difficult to believe that thin, widely spaced beds could have been economically exploited by these means although more mechanisation may have been introduced before 1900. Not surprisingly, therefore, extraction of these lower seams was apparently restricted to the northern part of the site. After reworking by opencasting the collapsed mines west of the Seven Acre Freehold, all working stopped some time before 1920, when, as now, the opencast workings had all been flooded (25" O.S. Map of 1920, Sheet No. 44/2). The last record is in Kelly's Directory of 1912. Thus, as forecast in the NA in August 1865, these gypsum deposits did last about 60 years but were not worked at full capacity throughout this period and produced far less than the anticipated 30,000 tons per acre. This was partly because it proved uneconomic to extract all available gypsum. In about 5 of the 8 acres worked only pillar-and-stall mining was attempted yielding, as elsewhere in Nottinghamshire about 10,000 tons per acre (Firman 1964). In the remaining areas opencast reworking of the pillar-and-stall mines might have yielded further gypsum making the probable 'take' perhaps as high as 15,000 tons per acre and only in the northern quarry where the lowest beds were extracted would the yield have approached the 20,000 tons per acre achieved elsewhere in Nottinghamshire (Sherlock and Hollingworth 1938; personal communication from quarry managers in the 1960s). The total amount of gypsum extracted was thus likely to have been about 100,000 tons - less than half that forecast by Lineker.

DISCUSSION

Estimation of reserves based on Lineker's report (See Appendix)

No doubt early developments at Orston, Cropwell Bishop, Newark and elsewhere in eastern Nottinghamshire were unplanned, gypsum being dug where it was found with little attempt made to assess reserves or evaluate future prospects. The projected works south of Orston, planned in the 1860s, were different. They were to be on a much larger scale than anything hitherto envisaged; it being claimed that, when combined with the existing Trent works at Newark, they would be the largest in Europe. In the circumstances, therefore, it was prudent to assess reserves and estimate the likely costs of extraction before investing capital into the project. Moreover, in order to obtain the support of the necessary number of potential investors, it was wise to employ an independent consultant as a mineral valuer. Whether Robert Lineker was competent and independent may, with hindsight, be an open question but whatever the status of his report it was accepted by the company's promoters and widely publicised, no doubt because it showed that the company's property was

underlain by gypsum deposits at least 50% richer than anywhere else in the Vale of Belvoir.

But was Lineker or anyone connected with the project aware of the grossly over optimistic nature of the report? Certainly nobody could have, in 1865, appreciated the essential similarity (notwithstanding localised variations) in thickness, stratigraphy, appearance, quality and maximum yield which characterises the gypsum beds which underlie a narrow strip of land stretching from Newark to Cropwell Bishop. That has become apparent only in recent years as a result of extensive quarrying and exploratory drilling. What must have been obvious to all, in 1865, who had had practical experience of mining and quarrying gypsum was that, because of the nodular and often discontinuous nature of the gypsum, estimates of reserves based on only a few boreholes would be exceedingly unreliable. Possibly Lineker lacked this experience and consequently was misled by borehole or other records, such as wells, which fortuitously encountered considerably greater than average thickness of gypsum. Possibly also fragmentary recovery from boring may have given him the impression of exceptionally thick gypsum beds, it being very difficult to distinguish between gypsiferous marl and massive gypsum in the absence of unbroken cores. Unfortunately Lineker did not include the evidence for his conclusions in his statement so we cannot evaluate the adequacy of that evidence. However, one of his contemporaries almost certainly did have detailed knowledge of this evidence and moreover had the practical experience of mining and quarrying gypsum which arguably Lineker lacked. That man, Jacobs, the manager, judging from figures he released to the press, must have known or at least suspected by August 1865, that Lineker's estimate of 30,000 tons per acre available gypsum was a gross over-estimate. Since this was before the company published its prospectus based on Lineker's figures this suggests that Jacobs, and possibly his fellow directors, allowed the publication of the company prospectus knowing that the estimates quoted therein were false and unrealistically optimistic. Alternatively, Jacobs may have chosen to ignore, either consciously or unconsciously, the very evidence that he had laboriously garnered since Lineker submitted his report. This evidence was acquired by weighing each barrowload of gypsum extracted from a specific seam and recording the total area worked. Provided a large enough area was investigated, perhaps 100 square yards for the more consistent layers, the average yield per square yard could be calculated which in turn could be extrapolated to give the probable yield per acre. The precision of the figures Jacobs gave to the Times reporter bears testimony to the care with which he monitored the excavations and it is difficult to believe that he did not realise the significance of this data. As given in the press report four seams yielded 8 cwt 3 qrs 18 lbs; 9 cwt 1 qrs 0 lbs; 7 cwt 0 qrs 6 lbs and 7 cwt 0 qrs 14 lbs per square yard. Thus the sum of these four seams, which appear from the description to be the equivalent of the Middle Whites elsewhere in the Vale of Belvoir, was 1 ton 12 cwt 2 qrs per square yard. Extrapolated, this is the equivalent to a prospective yield of only 7,865 tons per acre. Since the 'Middle Whites' normally produce about 40% of the total available gypsum this suggests a total prospective maximum output of about 20,000 tons per acre. Possibly Jacobs was hoping for better things at deeper levels, certainly he apparently told the reporter that there were thirteen seams whereas Lineker had noted only ten, but even so it is difficult to believe that Jacobs, with his practical experience, could have convinced himself that

30,000 tons per acre were available from this site. The gradual withdrawal by Jacobs of his capital suggests that even if he was not immediately aware of the over-optimism he soon came around to this view.

This raises the issue of Lineker's experience, ability and motivation. It has been mentioned that the standard of prospectuses was not high at that time, but was Lineker an appropriate figure upon whose report the success of the venture depended? (Carter, a stockbroker, above all must have recognised that if the prospectus failed to raise the necessary funds the venture was virtually doomed to failure). Lineker was one of a small group of small, independent gypsum quarriers and plaster and brick manufacturers based in Newark. His business was probably not one of the largest, nor one of the most successful. Between 1856-1860 he had financial problems forcing him to sell most of his property and a judgement was made against him for a debt of £332.10.0 (NAO DD.H 167/9). By 1860 his interest in plaster manufacture probably ceased and he subsequently called himself a farmer. In 1861 Lineker, described as a brickmaker, went into partnership with S. Fretwell, a builder, as brick, tile and plaster manufacturers. It is not known how long this lasted as in White's Directory, 1869, Fretwell only is mentioned, as plasterer, slater and tiler. Lineker was, therefore, an appropriate person to make an expert opinion in the sense that he had experience of the business but was no longer commercially involved, but the extent to which he was sufficiently astute or independently motivated is perhaps open to doubt.

COSTS AND METHODS OF EXTRACTION

Lineker not only estimated reserves but also calculated the costs of recovering gypsum. The basis of his calculations were not stated but the implicit assumption appears to have been that all gypsum could be profitably extracted. This might have been a reasonable assumption had there been, as forecast, 14 feet of gypsum in 60 feet of strata and had it been uniformly distributed throughout the strata. Unfortunately, as Jacobs must have known from his experience at Newark and observations of the quarry in the centre of Orston, there is a tendency for the thickest, most closely spaced and hence most profitable gypsum beds to lie in the upper part of the succession with the thinnest, most widely spaced seams in the lower parts. This means that these lower beds are disproportionately expensive to work; so much so that even with modern machinery they are often deemed uneconomic. Thus it is probable that in the pick, shovel, crowbar and wheel barrow days of nineteenth century quarrying these lower beds, perhaps comprising 5,000 tons per acre would not have been worked because of the unfavourable gypsum to spoil (i.e. interbedded marl) ratios.

Also implicit in Lineker's estimates is the assumption that the gypsum would be worked opencast since only by quarrying could all the available gypsum be extracted. The main advantage of opencast methods is that all gypsum, even the thinnest seams, can be removed. The chief disadvantages were that to obtain this gypsum not only had the overburden to be removed but all the interbedded marls had to be shifted to expose the gypsum. Alternatively, if underground pillar-and-stall mining was practised there was no need to strip the overburden and by selective mining, backfilling and overhead stopping the miners could minimise

the amount of interbedded marl that had to be moved. Moreover, provided they worked up-dip (i.e. westward) and did not come too close to the surface, the working faces would be relatively dry and less dependent on the vagaries of the weather. The main disadvantages of mining underground were that output would have been reduced because not all gypsum seams were mineable, some being too close to the surface, others too thin and some had to be left in place in pillars supporting the roof. Moreover the number of men who could work at any one time underground would be less than in a quarry. Probably output would have been no more than 10,000 tons per acre if solely underground mining methods were adopted. Nevertheless, this might have been the least expensive means of extraction and appears to have been practised until the end of the nineteenth century at Cropwell Bishop and Orston, but not at Newark. Nowadays, with modern earth moving equipment, nobody would contemplate mining gypsum in eastern Nottinghamshire; mining is now restricted to areas where both the gypsum seam and overburden are excessively thick. In the nineteenth century, when all excavations were done by hand, the advantages of opencasts were not as clear cut. Critical considerations were the extent to which the cost of removing the overburden could be offset by using it for making bricks and the gypsum to spoil ratio of the strata. Doubtless if the gypsum to spoil ratio had approached 1:3 as implied by Lineker's figure of 14 feet of gypsum in 60 feet of strata, then opencasting would have been profitable. That the company soon turned to pillar-and-stall mining, in spite of the inevitably much lower outputs, provides yet further evidence the grossly over optimistic character of Lineker's statement.

CONCLUSIONS

The above are amongst the reasons for the VOB's failure. The fact that insufficient funds were raised to finance the venture (£13,000 rather than the £30,000 needed) ensured that it would have financial problems. Whilst the prospectus forecast a 15 per cent return (an acceptable figure) it did not substantiate how this could be achieved. The prospectus's failure indicates that investors were not convinced of the venture's financial viability. Subsequent events bore out this view. Even the best year's results, for 1868, indicated that while sales (£17,175) were in line with expectations, costs (on the basis of the favourable accounting methods used, £14,571) were too high indicating a much lower extractive efficiency than planned. The necessary return to shareholders was therefore unachievable. The financial results are similar for other years: that whilst demand for gypsum products was satisfactory, costs of extraction and manufacture were far too high so that new funds were not attracted and financial problems soon overwhelmed the VOB.

Extraction of gypsum on the site did not end in 1873. Under the same name, but under new ownership and not as a limited liability company, the enterprise continued to operate until around 1914 in a less ambitious and less costly way. This second venture, probably also unprofitable, extracted more gypsum than the first because it lasted over a much longer period. Nevertheless, the great expectations founded on Lineker's estimates of gypsum deposits were nowhere achieved.

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APPENDIX

Lineker's Report (NAO DD.H 167/18) July 20 1865

Sir:-

I herewith hand you the enclosed Report of the Plaster Works at Orston which I have made according to your request.

There is in the large Field seven feet six inches of clay in depth, which can be made into Bricks and Tiles at the rate of Four Million per Acre. This can be taken off at Six Pence per Yard which will reduce the price of Stone-getting. There is in the depth of Sixty Feet from the top soil ten beds of Plaster Stone averaging fourteen Feet in One Yard from top to bottom of Sixty Feet in depth, that will turn out Six Tons and a half in One Yard. There are Thirty-two thousand Tons and a Half in One Acre as near as can be estimated. This can be raised at Five Shillings per Ton, including all Apparatus, after the First Pit is taken out.

Yr. humble svt. Robt. Lineker. over

In the small Field there are six Beds of White Plaster Stone, which will turn out Three Tons and a Half in One Yard from the top soil to the bottom, of Forty Five Feet in depth. This can be raised at Four Shillings per Ton or Eleven Pence per yard including all Apparatus after the First Pit is taken out.

The Quality of the Plaster Stone I find in both fields is as Good as any in the Neighbourhood of Newark or anywhere else.

If it is required to raise the First Bed of Plaster Stone to the depth of Fifteen Feet only, there would be Two Tons in One Yard. If the Seven Feet Six Inches depth of Clay could be manufactured into Bricks and Tiles in the Large Field, the Clay could be taken off at Six Pence per Yard; the Seven Feet Six Inches of Plaster and Clay Marl could be raised and turned over at the cost of Two Shillings per Ton to the mouth of the Pit.

Yr. humble svt. Robt. Lineker.

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NA	Newark Advertiser
NAO	Nottinghamshire Archives Office

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