THE HISTORY AND HYDROGEOLOGY OF THE WEYMOUTH SPAS

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The existence of a sulphur spring at Nottington, near Weymouth, was first recorded in the Journal Book of the Royal Society in 1720. Later in the 18th Century it was enclosed and a series of medical practitioners sang its praises. 1831 saw the opening of an octagonal spa house at Nottington and the development of another source at Radipole about 1.5 km to the south. A decade of prosperity was followed by gradual decline and spa bathing probably ended about 1870. Modern geological mapping and chemical analyses of the waters suggest that they probably originate from limestones of the Cornbrash Formation. The presence of hydrogen sulphide and the mature chemistry indicate either a long flowpath and/or that the waters are confined beneath overlying clays of the Kellaways Formation.

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INTRODUCTION

Until the mid-18th Century most Englishmen regarded the sea as something which yielded fish and kept out foreigners. However, in 1750 Richard Russell, a Lewes physician, published a dissertation, in Latin, on the use of seawater in diseases of the glands (Russell, 1750). A pirated English version was published two years later (Russell, 1752) and proved highly influential, recommending the drinking of seawater and sea bathing as treatments for a wide spectrum of ailments. Weymouth was one of a number of coastal resorts which developed. It benefited from royal patronage; the Duke of Gloucester, spent the winter there in 1780, and his brother, George III, first entered the sea there in 1789 and visited regularly until 1805. In 1795, Weymouth was said to have everything to make it a fashionable resort except mineral waters (Hembry, 1990). This was inaccurate; there was a mineral spring close by at Nottington, which was to acquire some fame early in the following century. This paper briefly examines the development of Nottington, and an adjacent source at Radipole, and the hydrogeological conditions which gave rise to them. A more complete review of the history and ownership of the spas is provided by Reeby (1995).

Early in 1720, Samuel Cruwys, a Devonian who had been elected to the Royal Society in December 1718, sent to the Society two flasks of a mineral water from a spring near Weymouth (Anon, 1720). The spring was reported as rising in a small island in the middle of a river and was used by local people to cure their cattle and dogs of scab and mange. The officers of the society sent the flasks to Ambrose Godfrey-Hanckwitz (known in the Royal Society Journal Book as 'Mr Godfrey') who regularly performed analyses for the Royal Society at his laboratory in Southampton Street. He reported back three weeks later that, amongst other constituents, it contained about 6 to 8 grains in a quart of common salt (340 to 460 mg/l of NaCl) but no iron. The water had a 'strong foetid smell and unsavoury taste' but there is no mention of the presence of hydrogen sulphide.

In 1749 a sample from a spring at Nottington, some 4 km to the north of Weymouth and 400 m west of the main Dorchester/Weymouth road (A354) was analysed by Dr John Rutty, the English born, Irish based, Quaker physician. It reached him some two years after it had been collected via a Dr Fothergill who was based in London (perhaps John Fothergill the Quaker physician and naturalist). Despite the long period of storage the water had a 'strong fetid sulphurous smell and a flavour resembling that of boiled eggs and in one bottle like rotten eggs' (Rutty, 1757 p.519). It also had a marked blue colour when viewed from above in a tin vessel. Evaporation to dryness yielded a dissolved solids concentration of 42 grains per gallon (around 600 mg/l) of which 17% was insoluble earth and 83% an alkaline salt. This information was repeated by other mid-18th Century commentators on mineral waters (e.g. Russell, 1760 p.308; Monro, 1770 volume 1 p.183).

Hutchins, in his history of Dorset dated 1774, describes a medicinal spring in the village of Nottington as follows: 'The mud and earth about it is blue. In frosty weather it is thick and blackish, and the surface covered with a thick oily film, and never freezes. It has a strong fetid sulphureous smell, not much unlike gunpowder newly enflamed, and a flavour resembling boiled eggs, sometimes rotten eggs: its colour, when viewed from above in a tin vessel, is blueish.' (Hutchins, 1774 volume 1 p.420). The description of the water equates with that analysed by Rutty but not with that analysed by Godfrey some years before. Hutchins assumes that both waters are from the same source and this assumption has been made by subsequent commentators (e.g. Groves, 1896; Osborn, 1982; Reeby, 1995). However, the location of the spring sampled by Cruwys on a small island, the high salt concentration and the lack of any reference to hydrogen sulphide suggest that there may have been two entirely separate sources. If this was the case it was the sulphurous spring analysed by Rutty which was to develop into Nottington Spa.

The enclosure of Nottington spring

Hutchins' description of the spring suggests that at this time (before 1774) it was not enclosed or improved in any way. If it was to develop two things were needed, firstly, recognition by the medical profession and secondly some sort of well-house or bath-house with lodgings for visitors.

The first detailed treatise on the medical benefits of the Nottington water was written by the Dorchester physician John Crane. Crane's treatise is undated but is likely to have been published between 1786 and 1788 as it is mentioned in the 2nd edition of the *Weymouth Guide* published in 1789 (Anon, 1789 p.56) but not in the 1st edition of 1785 which reproduces Rutty's description of the Nottington water (Anon, 1785 p.92). Crane referred to the source as a well which 'has of late been in a very bad condition from neglect and will continue less useful to the public, till proper steps are taken to put it in order.' (Crane *c.*1787 p.37). Apparently diseased animals were being dipped in the well which, not surprisingly, was deterring many people from using the water. An adjoining rivulet frequently flowed through an opening in the well which lowered the strength of the water and diminished its medicinal value. At the end of his account Crane strikes a more optimistic note recording that 'Since these sheets went to press, the well has been properly cleaned, [and] a stone wall has been built around it…' (Crane, *c.*1787 p.43). The frontispiece of his treatise is an illustration of the well, complete with stone wall, as it must have looked at this time (Figure 1). Crane noted that the spring emitted a brisk smell of sulphur, had no chalybeate or ferruginous impregnation and was little different in specific gravity compared to distilled water. He regarded it as particularly good for the healing of old wounds.

A second treatise on the mineral water was written some five years later by Dr. Robert Graves who was in attendance at Weymouth in the summer of 1791. He noted that the 'Spring surrounded by a stone edifice is situate about three or four yards from rising ground, on the opposite side of it, at a short distance runs the river Wey. Within the space of ten or twelve yards from the well there are different places on the west which manifestly exhibit the presence of sulphureous matter; especially when the season is wet, so that the water collects above the surface of the ground.' (Graves, 1791 p.11). He gave an analysis of the water which has been recalculated in terms of modern units in Table 1. He suggested drinking '…one pint to three and upwards every morning, if nothing forbids, care being taken at the same time not to overload the stomach by drinking too large a quantity at once.' (Graves, 1791 p.48).

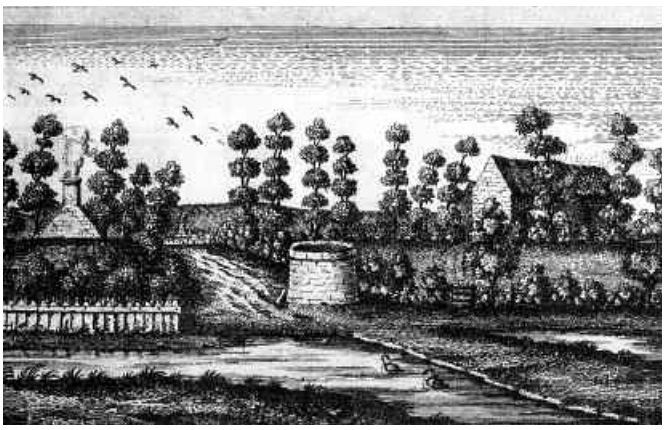

Figure 1. *Nottington well in about 1786. Frontispiece in Crane (c.1787).*

Yet a third local physician attempted to launch the spa water some years later. Dr J.D. Pickford was a resident physician in Weymouth and his pamphlet consists largely of examples of the great healing properties of the water, particularly its success at curing scorbutic [relating to scurvy] affections (Pickford, 1822). He recommended drinking a quart a day fresh from the spring. Pickford's treatise is undated but according to some Weymouth guidebooks (e.g. Anon, *c.*1845) was published in 1822. Unfortunately little information is given on the condition of the well but it would appear that little had changed from the time of Graves and that facilities for bathing were still largely non-existent.

Author	Graves	Viator	Phillips	Phillips	Edmunds et al	Osborn
Date	1792	1831	1833	1833	1967	1979
	Nottington Spring	Nottington Spa	Nottington Spa	Radipole Spa	Nottington Spa	Nottington Spa
Species						
Ca	70	77	128	186	181	114
Mg	15	34	16	28	4	6
Na	103	35	64	73	116	335
K					10	6
HCO_3	304	244	413	423	470	610
Cl	110	103	85	115	148	228
SO_4	46	48	55	185	130	110
SiO_2			20	9	11	10
Fe			1		trace	0.33
Ca + Mg	51%	81%	74%	77%	64%	29%
Na + K	49%	19%	26%	23%	36%	72%
HCO_3	55%	50%	66%	49%	53%	54%
Cl	34%	37%	23%	23%	29%	34%
SO_4	11%	13%	11%	28%	18%	12%

Table 1. *Hydrochemical analyses of Weymouth spa waters, concentrations in mg/l and percentages in terms of meq/l. The first four analyses are recalculated from old analyses originally published in terms of hypothetical compounds.*

By 1829 significant developments had taken place. According to Dr Ellis, a local surgeon 'The usual source from whence the public have been supplied was from a well surrounded by a stone wall, the water so procured, being either drank on the spot, or conveyed for use, in bottles or jars; this has been lately altered, the well covered over and the water conducted through tubes to a house in the vicinity….' (Ellis, 1829 p.252). Probably it was, at last, possible to both drink the water and to bathe in it. However, this came at a cost as it appears that after enclosure the well was secured with a lock and key and the general public were deprived of its use, except on the '….condition of making a pecuniary remuneration….' (Viator, 1831 p.386).

Nottington and Radipole spas

Ellis' book also includes the comment that on a spot near the spring but closer to the River Wey '… there has been very recently discovered traces of another spring of a medicinal nature, which bids fair soon to out-rival the former…' (Ellis, 1829 p.253). An unknown correspondent, writing under the pseudonym of 'Viator' [Traveller] continues the story in a letter to the *Mechanics' Magazine*. Apparently a local farmer and miller, Thomas Shore, had organised the repair of the bank of the River Wey near his home. 'In the progress of the work, and within a few feet north of the original spring, between it and the river, the workmen accidentally discovered another spring.' (Viator, 1831 p.386).

Analysis by Alexander Barry, Professor of Chemistry and Natural Philosophy at Guy's Hospital, London, proved that the water possessed properties very similar to the original spring (Table 1). Shore, sensing a commercial opportunity, rapidly erected a range of buildings including an 'Octangular Spa-House' over the spring. The spa house included a pump room together with 'warm, cold, vapour and shower marble baths, with appropriate and suitably-connected apartments, sitting, and bed-rooms for invalids, open to the public on exceedingly moderate terms' (Viator, 1831 p.387). The spa was opened to the public in April 1831 (Commins, 1836) and pumping the amount of water necessary to satisfy demand rapidly dried up the original spring.

In the autumn of 1830, another source was discovered at Radipole, about 2.5 km north of Weymouth and 1.7 km south east of Nottington. This was on land belonging to John Henning, a Weymouth solicitor who seems to have had a business connection with the Shore family (Hembry, 1997). The water came from a shallow well and was discovered by accident, perhaps in the course of a construction project, and proved to be similar in its geochemistry to that at Nottington, but with a greater concentration of hydrogen sulphide (Anon, *c.*1845). The pump room was '…a pretty octangular building, tastefully turreted and ornamentally surmounted…' in the Gothic style, with a view to the south over the tidal Radipole Lake (Anon, *c.*1845). The buildings must have gone up rapidly as the spa opened for business in 1831, the same year as Nottington.

In 1833 the analytical chemist Richard Phillips, one of the founders of the Geological Society, and at that time Professor of Chemistry at St Thomas' Hospital in London, reported on analyses of the two springs near Weymouth which he had been commissioned to carry out (Table 1). He noted the low total dissolved solids concentration in both spring waters commenting that '…those who wish to avail themselves merely of the sulphuretted hydrogen, may take them in larger quantity than if they were active in other respects.' (Phillips, 1833 p.158). He also confirmed that the Radipole water always contained a higher proportion of hydrogen sulphide and a higher concentration of total dissolved solids.

For the first few years both spas seem to have enjoyed a period of modest success. Unfortunately, in the summer of 1832 cholera came to the West Country. Although Weymouth claimed immunity it was ringed by outbreaks and the spas must have suffered a drop in the number of clients. In June 1832, another letter by 'Viator' was published in the *Mechanics' Magazine* extolling the virtues of the sulphureous vapour bath at Nottington as a remedy to check the progress of cholera. Acting as both a disinfectant and a gentle stimulant the water was considered to '….fortify the constitution against many depressing causes that might render it susceptible of cholera' (Viator, 1832 p.137).

In September 1832 a pamphlet was published upholding the medical properties of the Nottington water and a revised version was reissued in 1836 (Commins, 1836) when new buildings were added to the complex. A chalybeate spring is now mentioned as being available but no further information is given. The pamphlet gives details of the costs of the various treatments offered at the spa. Terms for drinking started from 2d for a single pint to 21/- for one person for a year. Bathing was charged at 1/- for a cold shower, 1/6 for a hot shower and

Figure 2. *Road signs around the site of Radipole Spa, photographed in 2006.*

Figure 3. *Nottington Spa House, photographed in 2007.*

3/- for a hot bath. The presence of an attendant resulted in a further charge of 6d (Commins, 1836).

Throughout the 1830s coverage in local papers and guidebooks suggests that both of the small spas were in full operation, with baths, showers and pump rooms in use by both day visitors and residents (Reeby, 1995). However, even at the height of their popularity Nottington and Radipole were minor local spas with no national significance. The fashionable London doctor Augustus Bozzi Granville visited Weymouth, probably in 1840, as part of his tour of the inland spas and sea-bathing places of England. Amongst other distinctions Granville was a Fellow of the Geological Society (elected in 1815) and a keen and critical observer. During his time in Weymouth, 'The existence neither of Radipole nor of Nottington Spas had ever come to my notice….' (Granville, 1841 p.506) and it was only after he returned to London that he received an account of them and a water analysis.

Decline set in during the early 1840s and is largely undocumented (Reeby, 1995). The buildings of Radipole Spa seem to have already disappeared by 1898 and a factory-sized laundry was built on the site. In the first years of the twentieth century the redundant sulphur well was probably simply filled in and built over. At Nottington a writer, in the *Sanitary Record* of 1875, records that '….the spa of Nottington has been shut for the last two years….' (Hart, 1875 p.160), although Reeby (1995), considered that the use of the baths ceased somewhat earlier, soon after 1860. A hand laundry was established in the 1870s but it did not use the mineral water. Soon after 1900 the spa buildings probably assumed their present residential use.

Time has treated the two spa sites very differently. Radipole has been swallowed up by Weymouth's suburbs and the old well now lies beneath a block of flats at the junction of Spa Road and Queens Road. However, its location is recorded in the local street names; Spa Road, Spa Avenue and Spa View (Figure 2), as well as in the Famous Old Spa Hotel on the corner of Spa Road and Dorchester Road. In contrast the Spa House at Nottington looks much as it must have done in the nineteenth century (Figure 3). Other houses to the east, which provided ancillary accommodation, have been considerably altered but the whole still forms a distinct group of buildings which are of historic significance (Royal Commission on Historical Monuments, 1970). The original hand pump remains in the basement but an electric pump is also now installed (Figure 4).

Figure 4. *Old hand pump and modern electric pump above the spa well in the cellar of Nottington Spa House, photographed in 2007.*

GEOLOGY

Although the original Nottington source was a spring, which discharged at the surface forming a pond, the sources of both commercial spas were dug wells. There is little contemporary information on the geological environment surrounding these wells. At Nottington, Crane (*c.*1787) states that 'The stones in the vicinity of the well apparently resemble common stones, and the neighbouring springs do not differ at all from common simple springs.' (Crane, *c.*1787 p.9). One hundred years later Groves (1896 p.141) wrote that there were numerous sulphur springs in the neighbourhood of Weymouth '….issuing from shaley beds strongly impregnated with pyrites….the most considerable, though not perhaps the most potent, being that of Nottington….'.

In 1830, William Buckland and Henry de la Beche read a paper on the geology of the Weymouth district to the Fellows of the Geological Society. Prior to the paper's publication in 1835 analyses of the two Weymouth spas had appeared (Phillips, 1833). In a note, added to their paper at proof stage, Buckland and De la Beche (1835, note to the explanation of Plate III) commented that the two sulphureous springs '….issue from near the junction of the lower beds of the Oxford Clay with the Cornbrash or upper beds of the Forest Marble Formation.' Since this paper a number of authors have commented on the source of the spa waters. Whitaker and Edwards (1926) considered that '….the water appears to come from the Forest Marble'. Edmunds *et al.* (1969) referred the Nottington

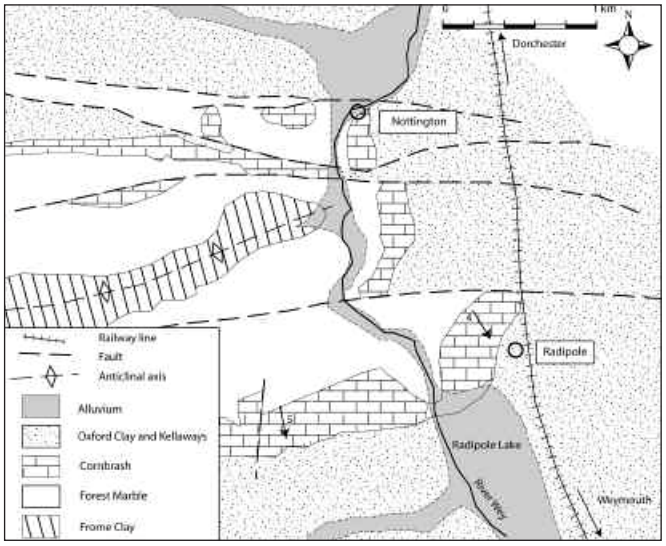

Figure 5. *Geological sketch map of the area around the spas (from British Geological Survey, 2000).*

source to the Inferior Oolite and Osborn (1978), following the advice of scientists from the Institute of Geological Sciences (now the British Geological Survey), concluded that it arises from alluvium overlying either Oxford Clay, Cornbrash or Forest Marble.

The Weymouth area was resurveyed at the 1:10 000 scale between 1995 and 1996 and a revised map was published in 2000 (BGS, 2000) from which Figure 5 has been derived. The stratigraphic succession in the district surrounding the spas is detailed in Table 2. The modern mapping suggests that the well at Nottington Spa was sunk through river alluvium into the

Formation	Member	Description
Oxford Clay (StWe)	Stewartby Wemouth members	Grey shelly mudstones (up to 110 m)
Oxford Clay (Pet)	Peterborough Member	Brown shelly mudstones (25-58 m)
Kellaways (KyS)	-	Sandy mudstones (42-50 m)
Cornbrash (Cb)	-	Shelly limestone (9-19 m)
Forest Marble (FMb)	-	Limestones and sandy mudstones (69-75 m)
Frome Clay (FC)	-	Grey mudstones (67-76 m)

Table 2. *Stratigraphic succession of the rocks in the area around the spas (after British Geological Survey, 2000).*

shelly limestones of the Cornbrash Formation and that the original spring, some metres to the south, arose at the alluvium/Cornbrash junction. The well at Radipole Spa was sunk into the mudstones of the Kellaways Formation some 120 m east of its contact with the underlying Cornbrash.

Structurally both spas are found in the nose of the Weymouth anticline which plunges towards the east with a dip of a few degrees. The steeper northern limb of the anticline is dissected by a series of east/west faults, one of which, the Nottington Village Fault, is about 100 m north of Nottington Spa (BGS, 2000 and Figure 5).

HYDROCHEMISTRY

Available analyses of the Weymouth spa waters are listed in Table 1. The historic analyses, already referenced earlier in this paper, were originally reported as a hypothetical mixture of compounds. They have been recalculated in terms of the individual ions which exist in aqueous solution. There are two modern analyses, reported by Edmunds *et al.* (1969) and Osborn (1979). Osborn reports that the well was first pumped until the water ran clear and then for a further 10 minutes before a sample was collected. Edmunds *et al.* (1969) give no details of the sampling procedure used. A pH value of 7.3 and a sulphide concentration of 4.8 mg/l are reported by Osborn (1979).

Nottington Spa has long been recognised as having a unique composition in comparison to other British mineral waters. As early as 1757 John Rutty placed this water in a separate class of "nitro-sulphureous waters" the only one of its kind described from England. The subdivision of United Kingdom mineral and thermal waters carried out by Edmunds *et al.* (1969) showed that the water was indeed unique in that it was the only one of 80 analyses which plotted in the (Ca, Mg, HCO_3) sub-field within the upper diamond-shaped field of the Piper diagram (Edmunds *et al.*, 1969 p.148).

The absence of nitrate and the presence of sulphide both indicate a reduced groundwater. The special character of the Nottington water is that the dominant anion is bicarbonate, rather than the chloride and/or sulphate anions which dominant most reduced mineral waters. It is also less mineralised which meant that those who believed that they benefited from the hydrogen sulphide could drink the water in larger volumes than at most other spas. The absence of significant concentrations of the strongly-tasting chloride anion probably accounts for the claim in some guide books that it was the 'only pure sulphureous water in England' (e.g. Commins, 1836).

At first glance there seems to be little consistency between the hydrochemical analyses quoted in Table 1 with, for example, a variation in bicarbonate concentration from 244 to 610 mg/l. However, recalculation of the analyses to millequivalents per litre (meq/l), to enable chemically equivalent quantities to be compared, and the expression of these in terms of the percentages of the different anions and cations shows a more consistent picture (Table 1). In the case of the anions the percentages of the 3 major anions in the Nottington Spa analyses are comparable and, remarkably, the percentages in the 1792 and 1979 analyses, made almost 200 years apart, are almost identical despite the differences in overall mineralisation between the two waters. The Radipole Spa water contains more sulphate than that from Nottington but compositionally the two waters are related. The anionic chemistry at Nottington can be interpreted in terms of a source water, similar in composition to that analysed by Osborn (1979), diluted by varying amounts of rainwater.

The cation compositions are more difficult to interpret. The older analyses show higher concentrations of magnesium than the modern analyses and do not provide data for potassium. For these reasons magnesium is included with the other divalent cation, calcium, in Table 1 and potassium with the other monovalent cation, sodium. Overall, the picture is reasonably consistent with divalent cation concentrations higher than those for the monovalent ions. However, the 1979 analysis is exceptional as monovalent cation concentrations are much higher suggesting that cation exchange has occurred with sodium replacing calcium in solution. The sample on which this analysis was carried out was obtained after prolonged pumping, suggesting that this ion-exchanged water is more characteristic of the deeper groundwater at Nottington.

SOURCE OF THE SPA WATERS

Modern mapping suggests that the water at Nottington originates from the Cornbrash, whereas that at Radipole comes from the Kellaways Formation. However, in contrast the hydrochemistry suggests that they both originate from a similar geological source.

There is a considerable amount of data available on the chemistry of groundwaters in the poorly permeable Kellaways Formation, particularly from Bedfordshire (Woodward and Thompson, 1909; Halliday *et al.*, 1997). The chemistry of the Weymouth spa waters is not comparable with these data, which have significantly higher concentrations of chloride and sulphate and significantly lower concentrations of bicarbonate. Locally, historic brickyards in the Kellaways beds exposed clays and sandy clays containing selenite (Arkell, 1947) and there is no reason to suppose that their groundwaters should differ significantly from the chloride/sulphate dominated groundwaters found in the Kellaways Formation elsewhere. Hence the geochemical evidence suggests that the Kellaways Formation is not the source of the spa waters.

The most likely source of the Nottington Spa water is the Cornbrash. The original spring was thrown out at the junction of the Cornbrash and river alluvium some metres to the south of the River Wey. Repairs to the river bank exposed the water table where groundwater of similar quality was found. Pumping rapidly dried up the original source. The absence of nitrate, the presence of sulphide, and evidence of cation exchange in pumped samples, all suggest a mature groundwater which has been derived from prolonged water/rock interaction involving an original bicarbonate-dominated source. The land rises to a height of 25 m above river level to the south and the mineralised water is likely to represent baseflow discharge into the river with topographically generated higher heads resulting in longer and deeper flowpaths from the more distant parts of the recharge area.

The geochemical similarities suggest that the Radipole Spa water is also derived from the Cornbrash. The mineral water source was discovered during construction work about 120 m west of the mapped Cornbrash/Kellaways junction in the nose of the gently plunging Weymouth anticline. It seems probable that excavation intercepted groundwater in the Cornbrash, confined beneath poorly permeable Kellaways clays. The confined nature of the water would account for its mature chemistry and the presence of hydrogen sulphide. The higher concentrations of sulphate and sulphide may reflect the contribution of some water from the Kellaways Formation.

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