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# W. Henry Penning: a 19th-century applied geologist

Multi-Hazard and Resilience Programme

Open Report OR/20/058







BRITISH GEOLOGICAL SURVEY

MULTI-HAZARD AND RESILIENCE PROGRAMME

OPEN REPORT OR/20/058

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# W. Henry Penning: a 19th-century applied geologist

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M G Culshaw & A Forster

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Official photograph of William  
Henry Penning, 1863.

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*British Geological Survey offices*

**Nicker Hill, Keyworth,  
Nottingham NG12 5GG**

Tel 0115 936 3100

**BGS Central Enquiries Desk**

Tel 0115 936 3143

email [enquiries@bgs.ac.uk](mailto:enquiries@bgs.ac.uk)

**BGS Sales**

Tel 0115 936 3241

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**The Lyell Centre, Research Avenue South,  
Edinburgh EH14 4AP**

Tel 0131 667 1000

email [scotsales@bgs.ac.uk](mailto:scotsales@bgs.ac.uk)

**Natural History Museum, Cromwell Road,  
London SW7 5BD**

Tel 020 7589 4090

Tel 020 7942 5344/45

email [bgslondon@bgs.ac.uk](mailto:bgslondon@bgs.ac.uk)

**Cardiff University, Main Building, Park Place,  
Cardiff CF10 3AT**

Tel 029 2167 4280

**Maclean Building, Crowmarsh Gifford,  
Wallingford OX10 8BB**

Tel 01491 838800

**Geological Survey of Northern Ireland, Department of  
Enterprise, Trade & Investment, Dundonald House,  
Upper Newtownards Road, Ballymiscaw,  
Belfast, BT4 3SB**

Tel 01232 666595

[www.bgs.ac.uk/gsni/](http://www.bgs.ac.uk/gsni/)

**Natural Environment Research Council, Polaris House,  
North Star Avenue, Swindon SN2 1EU**

Tel 01793 411500

Fax 01793 411501

[www.nerc.ac.uk](http://www.nerc.ac.uk)

**UK Research and Innovation, Polaris House,  
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# Foreword

This report has been prepared by Honorary Research Associate and former staff engineering geologist, M G Culshaw, and former staff engineering geologist, A Forster. The report does not relate directly to official BGS scientific activities but provides a biography of an applied geologist and former staff member who wrote the first text book on engineering geology.

# Acknowledgements

The authors would like to thank Allen Hatheway who first brought to their attention Henry Penning's book on engineering geology and started their researches. The assistance of Andrew Morrison (Archivist at the British Geological Survey, Keyworth, Nottingham) with regard to unpublished 19th century Survey papers, and David Bate (British Geological Survey historian) has been of great value. Steve Culshaw's efforts in digging out much previously unidentified material from the British Library are greatly appreciated. We acknowledge the help of Wendy Cawthorne at the Geological Society of London in providing details of Henry Penning's membership of the Society and in helping to identify South African references to Penning, of Evelyn Watson, Head of Archive of the Royal Society of Arts, London for passing on details of his membership of that organisation and of Louise Neep of the British Geological Survey, Keyworth for information about Henry Penning's donation of fossils. We thank Linda Rhodes for her comments on the relationship between Henry Penning and Cecil Rhodes' family that are published with her permission and for bringing to our attention Penning's poem, "Sea spray". We are also grateful to Pat Sampson, who is married to Peter, a great grandson of Phillipina Sampson, Henry Penning's step-daughter. She has given us access to the South African sketch by Phillipina's husband, Lewis Dod Sampson and to a notebook of Henry Penning's poems, as well as providing additional information about Penning's family. The framed copy of "Sea-spray" is reproduced with Pat and Peter Sampson's permission. The assistance and advice of staff at the libraries of the British Geological Survey (particularly Paul Carter) and the Institution of Civil Engineers, London, at Special Collections at the University of Reading, and at the National Archives, Kew, London, are also gratefully acknowledged.

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# Summary

This paper gives an insight into the career of an applied geologist in the latter part of the 19th century. Over more than 30 years, William Henry Penning worked in England as an agent for a railway contractor, as a mapping geologist and, in South Africa, as a consultant geologist for gold, diamond and coal mining opportunities. Although not an academic, he published, frequently, on the geology of eastern England, on engineering geology and the geology of South Africa. Probably his greatest achievement, a book entitled *Engineering Geology* published in 1880, was still quoted until at least the 1930s. Yet, today, he is almost completely unknown.

Penning's publications fall into three categories: Geological Survey memoirs, maps and sections and associated papers on the geology of eastern England; books and articles on building and engineering geology; and books, articles and papers on the geology of South Africa. His book on engineering geology was based on a series of articles published in *The Engineer* in 1879. The first of these contains the earliest usage, so far discovered, of the term 'engineering geology' in the UK and possibly the world. The book contains guidance still valid today. For this, he might be considered as the 'Founder of Engineering Geology' as a discipline. Whilst he did not establish any geological principles, he consistently published papers and books useful to applied geologists active in three principal fields of applied geology — geological mapping, mineral exploration and engineering geology. For this, he deserves to be remembered.

# 1 Introduction

In the UK, engineering geology was an important part of applied geology from the time of William Smith (Forster & Reeves 2008) and was implicitly included in the brief of the Geological Survey from its founding in 1835 (Lyell 1836). A small number of scientific papers were written in the mid to late 19th century that had what would now be seen as engineering geological content (Fookes *et al.* 2005), though none of them used the term 'engineering geology'. The great Russian engineering geologist Evgenii Mikhailovich Sergeev noted that: "In Russia geologists were involved in engineering investigations in connection with constructing railways (1842)" (Sergeev 1974). However, he later stated that the first time the words 'engineering' and 'geology' were used together in Russia was in 1885 (Sergeev 1984). Sergeev thought that the term 'engineering geology' had certainly been in regular use since about 1925, pointing out that the Russian engineering geologist I. V. Popov recalled that the term was used by Russians in the 1920s: "it was floating in the air" (Sergeev 1974). In the USA, Reis & Watson (1914) published a text book entitled *Engineering Geology*, so the term must have been in common use some time before that. However, on the basis of evidence identified so far, W (William) Henry Penning, a geological surveyor at the Geological Survey of England and Wales, was the first person to use the term in a publication when the first of a series of articles for *The Engineer* magazine was published on the 10 January 1879 (Penning 1879a – i). This contention is supported by Hatheway (1990).

William Henry Penning is hardly remembered today by engineering geologists, even though he amalgamated his articles in *The Engineer*, with chapters on geological mapping summarised from his earlier book on the subject (Penning 1876a), to form a short book entitled *Engineering Geology* (Penning 1880a). Kiersch (1955) described the book as possibly "the earliest attempt in English to describe the significance of geologic features and conditions on engineering structures..." He also noted that Penning's discussion of geology in tunnelling cited many of the geological principles still regarded as good practice. Penning's book was mentioned by Herbert Lapworth in the published version of two lectures that he gave to students at the Institution of Civil Engineers in 1907–8 (Lapworth 1908). De Freitas & Rosenbaum (2008) have pointed out that in the latter part of the 19th century there was a group of applied geologists based in London that included Penning, Lapworth and another Geological Survey geologist called Herbert Woodward. The latter had written a memoir on the 'Soils and subsoils' of London (Woodward 1897) which included a map, which Culshaw (2004) considered to be an early British example of an engineering geological map. The memoir was so popular that a slightly expanded second edition was produced (Woodward 1906). As Penning also worked for the Geological Survey (joining on the same day as Woodward—see below) the question arises as to whether the Geological Survey specifically sought to recruit applied geologists. However, it seems that the recruitment of two applied geologists was not a deliberate act by the Survey and it is perhaps significant that none of Penning's books were published by the Survey itself. Further, it would be interesting to know why Penning wrote *Engineering Geology* in the first place. To try and answer these questions it is useful to consider Penning's development as an applied geologist and the early influences upon him.

## 2. A short biography of William Henry Penning

### 2.1 FAMILY BACKGROUND

William Henry Penning (apparently known as 'Henry') was born at Eye, Suffolk, in eastern England on 9 March 1838. The 1841 census return shows Henry Penning, then aged 3, living in Lambseth Street, Eye, Suffolk (Table 1) with his parents Daniel (age 35) and Jane (née Hewitt; age 32), sister Jane (4) and Susan Penning (age 33: relationship unknown but could be his father's sister). Daniel Penning's occupation was 'Builder'. A trade directory by Pigot (1823/4) listed Roe (Robert?) Penning and son, Carpenters and Wheelwrights of Eye; possibly this relates

to Daniel and his father. Since that time, Daniel had expanded his father's business to encompass building as a whole.

No direct record of Henry Penning's early life has been found but much can be inferred from other sources. The 1851 census return shows William Henry Penning, then aged 13, still living in Lambseth Street, Eye, Suffolk with his parents and their growing family: his sisters Jane, Kate and brothers Edward and Charles. Also living there was a house servant called Mary Flatt. Daniel's occupation was still given as a builder, but now one who employed 19 men.

It would appear that Daniel Penning had become a builder of some importance. Reference to the Suffolk trade directories of this time show that he was listed not only as a builder (Robson 1839, White 1855, Kelly 1869) but also as 'bricklayer, carpenter' (Pigot 1839), 'bell and paperhanger' (White 1844), joiner (White 1844, 1855), a surveyor (White 1855, Kelly 1869), a councillor (White 1844, 1855, Kelly 1869) and an agent for the Imperial Fire and Life Assurance Company (White 1855, Kelly 1869).

The Suffolk Records Office contains several papers relating to the building works carried out by Daniel's building company including the building of chapels and entrance gates for the new burial ground at Eye which was laid out in 1846, schools at Rudham, Weasenham and South Creake, and rectories at Mellis and Rickinghall (all in eastern England). Thus, it would appear that Henry Penning was a member of a prosperous, emerging middle-class family.

## 2.2 EDUCATION

Nothing is known of Henry Penning's education other than, at the age of 13, he was recorded as a "scholar" in the 1851 census. However, it is clear that Eye was exceptionally well supplied with schools that he might have attended. It is probable that as the eldest son of an aspiring Victorian middle-class family he would have been encouraged to study and better himself. White (1844) described Eye as "an ancient borough and irregular market town" with a population, in 1841, of only 2493. However, it contained "several Boarding Schools; a large National School, for both sexes, built about six years ago by Sir E. Kerrison and chiefly supported by him; and an endowed Grammar School."

Table 1. Penning's places of residence

<b>Date</b>	<b>Penning's Location</b>	<b>British Address</b>	<b>Comments</b>
1837–1850s	GB	Lambseth Street, Eye, Suffolk	Birth details; 1841, 1851 censuses
1861	GB	High Street, Pewsey, Wiltshire	1861 census
1865	GB	High Street, Marlborough, Wiltshire (business address?)	Harrod's Directory (Anon. 1865a)
1867	GB	West Hill Lodge, Dartford, Kent	Geological Survey application letter
1868	GB	West Hill Lodge, Dartford, Kent	Electoral register
11 January 1869	GB	Bishops Stortford	Patent application
1871	GB	The Parsonage, Stansted Road, Bishops Stortford, Cambridgeshire	1871 census

1873	GB	Caldecote Rectory, Cambridgeshire (wrongly given as "Oxon")	Land Registry record for Wiltshire which showed a W H Penning owning 14 acres, 3 rods and 12 perches in Wiltshire
24 June 1874	GB	Caldecote Rectory, Cambridgeshire	Marlborough Times 4 July 1874. Wedding of step-daughter Rebecca Porter to Charles John Paddison of Wood Hall, Bishops Stortford
August 1876	GB	Caldecote, Cambridgeshire	Foreword to book
1878	GB	Caldecote, Cambridgeshire	Birth place of step-granddaughter
1878	GB	Granville Lodge, Queens Road, Finsbury Park, London	Kelly (1878)
May 1879	GB	Granville House, Finsbury Park, London	Witness at step-daughter's wedding
November 1879	GB	Granville House, Finsbury Park, London	Book dedication
1880	GB	Granville House, Finsbury Park, London	Preface of 'Engineering Geology'
15 March 1880	GB	Granville House, Finsbury Park, London	Nomination to membership of the Society of Arts, London
1880	GB	Redhill, Surrey	Birth place of step-grandson
1881	GB	9 Alexandra Villas, Seven Sisters Road, Finsbury Park, London	Electoral Register
1881	GB	Linkfield Road, Reigate, Surrey	1881 census
7 April 1882	SA	Kimberley, South Africa	Geological Survey resignation letter
February 1883	SA	Pretoria, South Africa	Foreword to book
July 1883	GB	Haywards Heath, East Sussex	Advert in Times for work to inspect mines. He is "about to leave for South Africa" <i>The Times</i> 18 July 1883.
March 1884	GB	?	Lecture at the Geological Society
May 1885	GB	?	Lecture at the Geological Society
September/October/November 1885	SA	Transvaal, South Africa	Negotiating with Transvaal Government conditions under which he would be prepared to investigate the

			presence of diamonds and precious metals. Seeking appointment as state mineralogist – failed ( <a href="http://www.s2a3.org.za/bio/Biograph_final.php?serial=2162">www.s2a3.org.za/bio/Biograph_final.php?serial=2162</a> )
1886	?	Haywards Heath, East Sussex	Birth place of step-grandson
March 1886	GB	Haywards Heath, East Sussex	Letter to Rev J Mackenzie re lecture at Society of Arts
April 1887	GB	In GB	Old Bailey court record
November 1887	SA	In South Africa	Old Bailey court record
July 1888	GB	Haywards Heath, East Sussex	Advert in The Times
August 1888	SA	In South Africa	Poem 'Sea-spray' won 1st prize on RMS 'Moor'
February 1891	GB	GB	Lecture at the Geological Society
1891	SA	Summerfield, Cuckfield, Haywards Heath, East Sussex	1891 census
June 1894	GB	The Parsonage, Henfield, Sussex	Letter from publisher
August 1895	SA	Left Southampton for South Africa on the RMS 'Scot'	Ship manifest
May 1896	SA	The Parsonage, Henfield, Sussex	Death record of step-daughter Phillipina
September 1896	GB	Left Capetown, South Africa for GB on the RMS 'Nile'	Ship manifest
26 April 1898	GB	GB	Exhibition at the Anthropological Institute, London
February 1899	GB?	Ifield Park, Ifield, West Sussex	Advert of Havering Cottage to let in the <i>Marlborough Times</i> 25th Feb 1899
1901	GB	Ifield Park, Ifield, West Sussex	1901 census
June 1901	GB	Ifield Park, Ifield, West Sussex	Letter from publisher
January 1902	GB	Crawley (probably Ifield Park)	Letter from publisher
1902	GB	Pembroke House, Redhill, Surrey	Will; death notice in the <i>Surrey Mirror</i> , 25 April 1902
[1906 (wife)]	GB	19 Birdhurst Road, South Croydon	Probate record]

## 2.3 OTHER EARLY INFLUENCES

Eye is only 5 km south west of Hoxne, which was a place where the antiquarian John Frere first recognised that flints discarded from a brick pit on the road from Hoxne to Eye had been shaped by the hand of man. He reported his find in a letter to the Society of Antiquaries in 1797: “They are, I think, evidently weapons of war, fabricated and used by a people who had not the use of metals” and from “... a very remote period indeed” (Wymer & West 1999). In his early life Henry Penning may well have come across flint tools in the area around Eye, which may have sparked an interest in matters antiquarian and geological. The short paper that he published later supports this supposition: 'Notes upon a few stone implements found in South Africa' in which he drew attention to their similarity to those from Hoxne (Penning 1887).

## 2.4 ADULT LIFE

The census return for 1861 shows that William Henry Penning, aged 23, had left home and was living in a boarding house run by a widow, Mrs Sarah Adelaide Kerr and her family in High Street, Pewsey, Wiltshire, in the south west of England. Also in the house were three other boarders, Harriet Stagg, Sarah Howell, both of whom were “dress makers” and Mary Jane Nutland who was an “apprentice.” There was also a domestic servant Jane Amos. Henry Penning must have achieved a good standard of education and, presumably, practical experience from his father because his occupation was given as a “Railway Contractor's Agent.”

Henry Penning (“architect and surveyor” [sic]) was married to Mary Ann Somerset in Pewsey by the Rev G H Waterfall on 14 May 1862. Her name varies somewhat but 'Mary Ann' is used here because this is what appears in her baptismal record and on her first husband's will. However, Penning spelt her name as Marianne in a book dedication to her (see below). She had been born in Kintbury, Berkshire but had moved to Milton Libourne, Wiltshire after her first marriage to Edmund Thomas Somerset in 1842. Edmund was a successful farmer of 100 acres at Wooton Rivers. Edmund died in 1860 leaving Mary Ann a reasonably well-off widow who moved, with her children, to Pewsey where, at the time of the 1861 census, she was living comfortably in the High Street, not far from Henry Penning's lodgings, with her four children, a visitor and two domestic servants. Her occupation was described as “Landed proprietor.” In the summer of 1863, Penning was offering a six-bedroom house on the High Street with stable, coach house and office, for rent (*Devizes and Wiltshire Gazette*, 4 June, 23 July, 6 August 1863). At the time of their wedding Mary Ann was 43 and Henry was 23. Such a large age difference may be seen as unusual by modern conventions but within the laws and customs of mid-Victorian England it may be more understandable.

Henry was following a profession in railway construction and geology (see below). He may have been away from home when working in more remote parts of the railway (see below) and would have benefited from a stable home base to which he could return and, if he had no strong desire for children that a marriage to a younger woman would have implied, he may have been well-satisfied with this arrangement. Mary Ann was a relatively well-off widow and the status of having a suitable, sometimes absent, husband may well have given her greater freedom to manage her affairs and avoid the attention of fortune seekers.

Henry Penning's career moved from railway construction, and building, to geology when he joined the Geological Survey of England in 1867. The transition from engineering to geology was not as difficult as it might appear today. William Smith had also started as a surveyor and engineer, having been tutored in surveying in its broadest sense, and had learnt geology while surveying routes for canals and prospects for coal mines. Perhaps Henry Penning had had similar training and experience but on the railways.

His new employment as an Assistant Geologist (Fig. 1) at the Geological Survey of England appears to have been largely focused in eastern England and this may have required a move to a more convenient address as the Survey insisted that field staff lived in their mapping area (and without expenses). In the 1871 census Henry Penning and his wife were living with their extended family in Bishops Stortford (Table 1), with three of Mary Ann's children by her first marriage, Phillipina, Rebecca and Edward Somerset. Also living with them were Henry's niece Frances M. Penning, and Mary Ann's cousin Jenner Gale Hillier whose occupation was given as

“Undergraduate, Downing College, Cambridge.” There were also two resident domestic servants, Ellen Hawkins (the cook) and Elizabeth Speller (the housemaid). It is interesting to note that Mary Ann's occupation was given as “Wife – landowner;” she had apparently maintained her independence successfully.

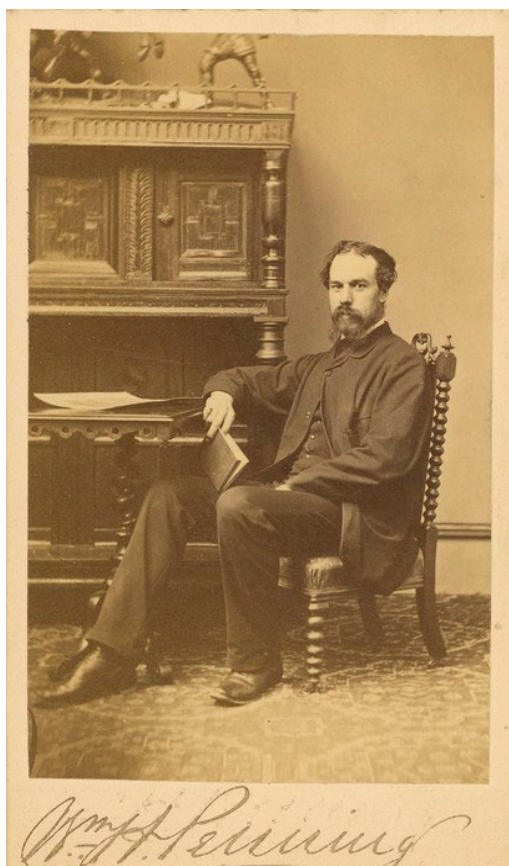


Figure 1. Official Geological Survey photograph of Henry Penning (undated, but probably early in his career). Photograph P545377

In 1876, by which time Penning and family were living in Caldecote, Cambridgeshire, he published his book *Field Geology* (Penning 1876a) and the very personal dedication to “Marianne” (Mary Ann, his wife) was unusual for a serious textbook but perhaps acknowledged the support that she had given during his absences in the field. The preface to the 2nd edition of Penning's book *Field Geology* (Penning 1879j) was dated November 1879 and gave an address in Finsbury Park, London where he also appears on the 1881 electoral list (Table 1). It seems reasonable to assume that this was his London residence.

Towards the end of 1880 Henry's health apparently began to deteriorate, leading to his retirement from the Geological Survey. It would appear from correspondence in the archives of the British Geological Survey that the retirement was not entirely in accord with his wishes. His doctor claimed that, although he suffered from a minor and curable physical illness that would not have impinged on the satisfactory performance of his duties, he was also affected by a long-term mental or behavioural condition that was incurable and rendered him unsuitable for employment in a government department and, perhaps by implication, unacceptable to Victorian Society at that time (see Appendix 1).

Penning moved his geological activities to Southern Africa. Indeed, he had gone to South Africa before his formal retirement from the Geological Survey as his final letter of resignation (on the grounds of ill-health), dated 7 April 1882, came from an address in Kimberley, South Africa. In his Preface to *A Guide to the Goldfields of South Africa* (Penning 1883) written in Pretoria, Henry noted that he had often been asked to write the book “In the course of his rambles, extending

over a period of two years, in search of health in South Africa” a reference to the illness that had led to his retirement from the Geological Survey. In the preface to a revised second edition of his book *Field Geology* dated February 1894 (Penning 1894), Henry referred to “A long residence in South Africa.”

In Henry Penning's absence, the head of the Penning household was Mary Ann Penning who, in the 1881 census, was resident in Reigate, Surrey (south of London) (Table 1) with her daughter Phillipina (now Sampson), who had married a naval officer, and their young children Constance and Arthur. Also present was another grandchild Cecil J Somerset (and three resident servants Ann Webster (cook), Emily Monk (maid) and Alice Easton (nurse)).



Figure 2. Ifield Park (Photograph 2010. © M G Culshaw)

The 1891 census return also indicated that Henry was working away from home. The head of the household was again Mary Ann Penning who was resident in Haywards Heath, East Sussex (southern England) (Table 1). Her occupation was “geologist's wife.” Living with her were her son-in-law, Lewis Sampson who was a commander in the Royal Navy, her daughter (his wife), Phillipina Sampson, and their children Constance, Arthur, Ernest and Herbert. Two servants were living in the household: Rachel Colly (cook) and Annie Penfold (housemaid).

The census return for 1901 shows that Henry Penning had retired as a geologist and returned from Africa to live with his wife in a substantial house and grounds, Ifield Park, West Sussex (in southern England) (Fig. 2). The household comprised Henry, Mary Ann and four grandchildren from Mary Ann's daughter Phillipina's marriage – Constance, Arthur, Ernest and Herbert. Both Phillipina and her husband were dead by this time. A servant, Alice Hall (housemaid), was living in the house together with Rose Hillier (possibly a relative of Mary Ann's cousin Jenner Gale Hillier, see above); Albert James Comins (the groom and gardener), who lived in Ifield Park's Lodge, is also listed.





Figure 3a. William Henry Penning's grave in Reigate Cemetery (the white horizontal gravestone in the centre of the photograph) (Photograph 2013. © M G Culshaw)



Figure 3b. William Henry Penning's gravestone, a 'white' medium-grained granite, in Reigate Cemetery. The inscription is on the left-hand, long side of the gravestone. (Photograph 2013. © M G Culshaw)

Sadly, William Henry Penning's retirement did not last long, as he died aged 64 on 20 April 1902 at Pembroke House, Redhill, Surrey (according to his will and a death notice in the *Surrey Mirror* local newspaper of 25 April 1902). The immediate cause of death was laryngitis according to an obituary in the same edition of the *Surrey Mirror*. Despite his substantial home at Ifield Park, he was not particularly wealthy at his death leaving just £896 18s 6d in his will (to his wife). This is roughly the equivalent of £111 000 when inflated to today's prices (2019) using the Bank of England inflation calculator. He was buried in Reigate Cemetery (grave reference: Section P 5560a) on 25 April 1902. On his grave is the inscription: "In loving memory of William Henry Penning F.G.S. Born 9<sup>th</sup> March 1838. Died 20<sup>th</sup> April 1902. *Requiescat in pace.*" His grave is capped with a stone of a 'white' medium-grained granite (Fig. 3a and b). His wife was buried in London South Metropolitan Cemetery (now West Norwood Cemetery) (grave number 7064 sq. 3) on 20 July 1906 along with her first husband (Edward/Edmund Thomas Somerset, buried 22 June 1860) and their daughters Phillipina (buried on 3 June 1896) and Rebecca Porter Paddon (buried on 11 August 1915). In the cemetery records, Mary Ann's age is given as 78. She was actually about 87 years old but in various censi over the decades had gradually reduced her age, probably to try to reduce the large age gap between herself and Henry Penning. She successfully maintained the fiction to the very end!

## 3. Henry Penning's career

### 3.1 AS A BUILDER

While Penning received a formal school education, it is likely that, in his teens and possibly his early twenties, he worked with his father on building projects. Indirect confirmation for this is indicated by the completion certificate for the boys and girls school and Master's schoolhouse of the Pewsey National School issued on 3 July 1863, with Penning being named as the builder (Document 782/82 in the Wilts and Swindon Archives) though building probably started the year before, as the new school was formally dedicated on 30 September 1862 (Bouverie 1890) (Fig. 4). According to the *Devizes and Wiltshire Gazette* of 2 October 1862, the contract was worth close to £800 (around £98 000 today – Bank of England inflation calculator). According to Beresford (1993) this was a Junior School built on land purchased in 1862 on the south side of Pewsey. Between mid-1862 and the end of 1863, Penning was also responsible for the erection of the station (Fig. 5) and other buildings on the Berks and Hants Extension Railway (B&HER) (see below) and, possibly, the gas works at Pewsey for which he was the “architect and surveyor” (sic) (*Devizes and Wiltshire Gazette*, 15 May 1862). No other records have come to light of other building projects, though his interest in architecture may be indicated by one of the few drawings in his Geological Survey notebooks of a church doorway at “Wenden Church” (probably St Dunstan's at Wenden Lofts, Essex) and dated 13 April 1869 (Page 50 reverse, Notebook 1063, Table 5) (Fig. 6) showing detailing around the doorway (Penning attributed the doorway to Saxon age but it is more likely Norman). Similarly, he commented on the architecture of Ickleton Church (Page 1 reverse, Notebook 1065, Table 5) and Chigwell Church, Essex (dated 29 August 1867) (Notebook 1063, Table 5).



Figure 4. Pewsey National School and Schoolhouse (Photograph 2012. © M G Culshaw)

### 3.2 AS A CIVIL ENGINEER/SURVEYOR

By 1861 Penning was living in Pewsey, Wiltshire, SW England and working on the construction of a railway, presumably in the area. During this time, he may have had contact with Charles Hutton Gregory whose mentoring he acknowledged in the dedication of his book *Engineering Geology* (Penning 1880a):

AS A SLIGHT TRIBUTE OF ESTEEM  
THIS WORK  
IS INSCRIBED WITH THE NAME OF  
CHARLES HUTTON GREGORY, C.M.G.,  
(Past President of the Institution of Civil Engineers),  
UNDER WHOM THE AUTHOR WAS PRIVILEGED TO  
OBTAIN HIS EARLIER EXPERIENCES  
IN ENGINEERING.



Figure 5. Pewsey Station booking office (Photograph 2012. © M G Culshaw)

This is confirmed in two of Penning's obituaries: "After pursuing a course of engineering under Mr C. H. Gregory,..." (Anon. 1902a); "Mr. Penning, who joined the Geological Survey in 1867, had in previous years qualified as an engineer under the late C. H. Gregory." (Anon 1902b). Gregory was an important railway engineer (both civil and mechanical) who, himself, worked under Robert Stephenson on the Manchester and Birmingham Railway and subsequently, as Chief Engineer on the construction of a number of railways in the West Country and overseas. A listing of these railways was provided by Chrimes (2008) (Table 2). However, though Gregory worked on railways in south west England, he was not the engineer for the B&HER. The consulting engineer for this line from its inception to completion and beyond was R J Ward of Westbury, Wiltshire (National Archives files Rail 29/1, 29/2 and 29/7).

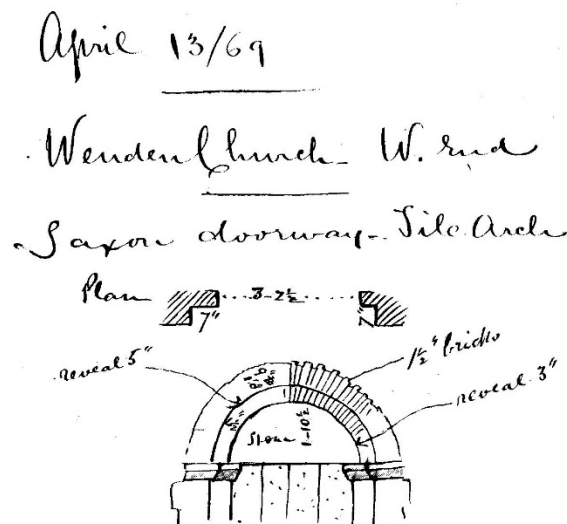


Figure 6. Sketch of Saxon doorway with a tile arch at Wenden Church. Page 50 reverse, of Penning's British Geological Survey field notebook No. 1063, 13 April 1869

Table 2. Railways worked on by Sir Charles Hutton Gregory (after Chrimes 2008).

Year(s)	Railway
1852–54	Somerset Central Railway
1855	Glastonbury and Bristol
1856–60	Dorset Central Railway
1858	Somerset Central Railway
1859	Shepton Mallet
1860–62	Dorset Central Railway
1861–66	Chard and Taunton Railway
1861–66	Lake Fucino, drainage
1863	Somerset and Dorset Railway
1864–69	Cheddar Valley and Yatton
1865	Bridgwater Railway

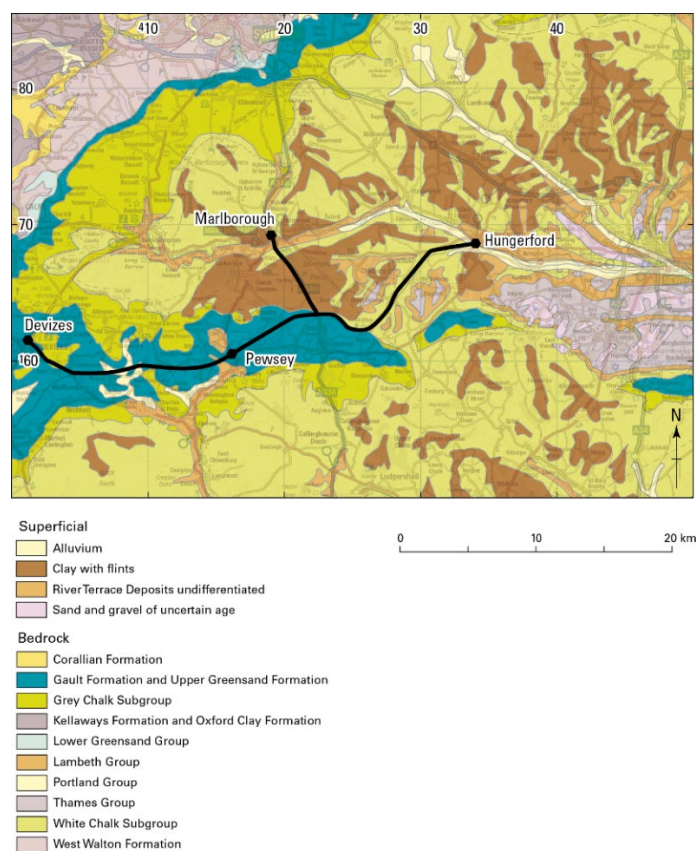


Figure 7. Geological map of the area around Pewsey, showing the approximate line of the Berkshire and Hampshire Extension Railway (BHER) and the Marlborough branch line. The geological line-work is taken from British Geological Survey 1:50 000 scale geological map sheets nos. 266 (Marlborough), 267 (Newbury) and 282 (Devizes). Contains Ordnance Survey data © Crown copyright and database rights 2020. Ordnance Survey Licence No. 100021290 EUL

Assuming that Penning was unlikely to have moved to Pewsey before the age of 16 (about 1854) and that he had embarked on a school-building project in Pewsey in 1863, it is likely that his railway construction experience was gained between 1854 and 1863. Given Gregory's projects in that period, the most obvious railways on which Penning might have worked were the Somerset Central and the Dorset Central. Indeed, these two railway companies merged in 1862 to form the Somerset and Dorset Joint Railway (S&DJR - the 'Slow and Dirty'). However, this line, which runs south west from Bath to Shepton Mallet and then approximately north-south to Poole (and then east to Bournemouth) lies nearly 50 km to the west of Pewsey where Penning can be assumed to have lived at least between 1861 (at the time of the census) and his wedding in May 1862. Therefore, it is questionable whether Penning would have worked on the S&DJR and have lived a long distance (at the time) away. As a result, how Penning met Gregory remains unknown.

It seems more likely that Penning worked for the contractor of the Berks and Hants Extension Railway (B&HER), Smith and Knight (National Archives file Rail 29/1). This line, as the name implies, was an extension of the Berks and Hants Railway that originally terminated at Hungerford (in Berkshire) (Fig. 7). The line was to run from Hungerford to Devizes (in Wiltshire). Pewsey lies approximately half way along the line (Fig. 7). The company to build the Extension was incorporated on 13 August 1859 and the awarding of the contract to construct the line to Smith and Knight was agreed at a Company Board meeting on 3 July 1860, though construction did not actually start till later, commencement being acknowledged in the Board minutes of 18 January 1861 (National Archives file Rail 29/1). The ceremony of the turning of the first sod took place on 7 August 1860 at Great Bedwyn to the accompaniment of a band, singers and a feast (National Archive file Rail 29/16). The line was opened to traffic on 11 November 1862. In the 1861 census, Penning described himself as a "Railway Contractor's Agent." This implies that either, he worked for Smith and Knight (the B&HER contractor) or, he worked for Smith and Knight's agents Baldwin & Co. However, no confirmation has been found. During the building of the railway there was a long-running dispute between Baldwin & Co and Smith and Knight which was not resolved till August 1863.

He may also have worked for the contractor (also John Knight of Newbury, one of the principals of Smith and Knight [Mitchell & Smith 2001]) of a branch line that ran 5½ miles from Savernake (on the B&HER) to Marlborough (Fig. 7). Construction began early in 1863 and the line was opened to traffic on 14 April 1864.

Towards the end of 1862, Mr Knight of Smith and Knight reported to the B&HER Company Directors that construction work on the railway would be finished by 1 November 1862. Whoever Penning worked for as a contractor's agent, this job was coming to an end. However, Penning found new employment related to the railway as the builder of the stations and other buildings. At the half-yearly shareholders' meeting of 29 September 1862 it was reported that "The erection of the stations on this Railway was submitted to public competition and tenders were received from several eminent Contractors. Mr W H Penning, *a local builder* (authors' emphasis), was selected to execute the whole Station Works, and your Directors are glad to be able to report that he is proceeding with the execution of his contract in a satisfactory manner." (National Archives file Rail 29/1). It is likely that Penning was responsible for the erection of Bedwyn, Savernake, Pewsey and Woodborough station buildings. Photographs of these stations (Mitchell & Smith 2001) show similarities in their design and, particularly, decorative brickwork on the station walls (also Fig. 5). Adjacent stations at either end of the B&HER (Hungerford to the east and Patney & Chirton to the west) have completely different designs. Penning received a series of payments that are recorded in the minutes of Directors' meetings held monthly between August 1862 and May 1863. The last payment, which also accompanied the final certificate for the station contract, was recorded in the minutes of the 15 January 1864 Directors' meeting. In total, for stations and other buildings, Penning was paid almost £6400. This would be worth around £773 000 in 2017 (using the Bank of England inflation calculator). It is interesting to note that some of the payments were made to H W Penning. This confusion probably arose because Penning was known by his second name, Henry.

The geology of the B&HER was recorded by Thomas Codrington (who was an engineer but also a Fellow of the Geological Society [Anon. 1865b]). In 1862 (while the railway was being constructed) he drew a series of geological sections, at least some of which were along the line

of part of the railway (Wiltshire Heritage Museum, Devizes records DZSWS: 1982.1872-77). Later he wrote a paper on the geology of the B&HER and the Marlborough branch line which included many of these sections (Codrington 1865). As Penning worked on the B&HER he almost certainly would have been aware of this work and it may have stimulated his interest in geology. Also, it is worth noting that in 1862 Henry Bristow and William Whitaker were carrying out field work for the Geological Survey in “Berks and Hants” (Guppy 2000).

The completion of the B&HER in late 1862 may explain why he sought the station building contract (completed in early 1864), the school building contract (completed in mid-1863) and the gas works contract referred to above. By 1865, Penning was advertising himself in Harrod's Directory as an “architect and surveyor” based at High Street, Marlborough (Anon. 1865a). Clearly, Penning was using his experience and ability to try to make a living as best he may. However, nothing has been found to explain how, when or where, Penning met Charles Gregory. Penning's obituary (Anon. 1902b) indicates that they met before Penning joined the Geological Survey in 1867. So, perhaps Penning trained under Gregory before he began work on the B&HER.

### 3.3 AS A GEOLOGICAL SURVEYOR

Penning's letter of application to the Geological Survey was sent from an address in Dartford in mid-1867 (Table 1) but no evidence of what he was doing there has emerged, or of when he moved from Pewsey (sometime after the advert mentioned above appeared in Harrod's Directory in 1865). He arrived at the Geological Survey at a time of expansion. To get in, he was examined by local Directors to test that he was qualified in geology and, then, he had to pass a Civil Service examination, which covered writing (handwriting and orthography), arithmetic (including vulgar and decimal fractions), English composition, drawing (copying part of a geological section), Euclid (Book 1) and the use of common mathematical instruments (BGS archive GSM1/8, paper 489/90, 19 June 1867). This he obviously did but he was fortunate, perhaps, that 1867 was the year in which the Director, Sir Roderick Murchison, greatly increased the size of the Survey, partly as a result of the findings of a Royal Commission in 1866 into matters relating to coal. Nineteen assistant surveyors were appointed in 1867 and another fourteen in 1868. Flett (1937) noted that there were “*numerous failures at the first examination in 1867.*” So, there is no evidence that Penning was selected to join the Geological Survey because of any particular skills or experience. He simply was good enough to pass the interview and examination.

While Bailey (1952) noted that “*there were a few misfits among the newcomers*” he identified ten of the nineteen who joined in 1867 as making names for themselves in geology. Penning is not one of the ten! However, in 1876 Bristow successfully recommended to the Director General, Ramsay, that Penning be promoted as he was “*one of the Seniors of the Assistant Geologists*” and that “*During a long service, extending over nearly nine years, Mr Penning has done excellent work which has given every satisfaction, and I feel every confidence in recommending him for promotion.*” (BGS Archive 1/38, paper 241, 5 May 1876). Later, following Penning's departure from the Geological Survey, Bristow, in a discussion about extending Penning's sick leave, noted that Penning “*... has always proved himself to be a zealous, active and efficient Geologist and has done his work to my satisfaction ...*” (BGS archive 1/38, paper 469, 11 May 1881).

Penning was elected to Fellowship of the Geological Society of London in 1868 (No. 2471). He was proposed by Andrew Ramsay, Henry W. Bristow, William Whitaker and Roderick I. Murchison, all eminent geologists of the time and all employed by the Geological Survey. He remained a Fellow till his death (Wendy Cawthorne, The Geological Society, pers. comm.) He was also a Member of the Society of Arts (the Royal Society of Arts from 1908 – Fellowship was introduced in 1914), being nominated on 15 March 1880 and accepted on 18 April 1880. No record of who proposed him survives. He remained a Member till his death in 1902 (Evelyn Watson, The Royal Society of Arts, pers. comm.)

On arrival at the Geological Survey, Penning was set to work on a series of horizontal geological sections. These, together with vertical sections, were published separately from the maps and supplemented them. Flett (1937) described how they were made: “*The Horizontal Sections were regarded at that period as a valuable addition to the information shown on the one inch maps. They were drawn on the scale of 6 inches to a mile. The line taken across country was very*

*carefully surveyed and the heights measured by level or by barometer.*” Penning's experience on the B&HER in Wiltshire no doubt came in useful. Flett went on: “*At the same time complete notes were made of the geology traversed and as much detail was shown as the scale of the drawing would allow. The time spent on this work was justified by the precision attained, which was far higher than was possible on a one-inch map.*” The preparation of horizontal geological sections, begun in 1845, ceased in 1894 when six-inch topographic maps became better contoured and so levelling was no longer necessary. Penning was involved in the preparation of eight sections, though for three of them he seems to have been responsible only for the levelling (Table 3a). Brief explanations of 55 of the 148 sections were published but only one (No. 140) related to a section upon which Penning had worked (Table 3b). The reference in this explanation is unusual in that, like the titles of horizontal sections 83, 120, 122, 124, it mentions the name of the person who had done the levelling (Penning). No other sections indicated the name of the person who carried out the levelling. Penning also worked on other sections that are mentioned in his notebooks (Table 5).

Table 3a. List of horizontal geological sections worked on by W H Penning.

Horizontal Section No.	Horizontal Section Title	Authors	Publication date
83	Section from the Warwick and Leamington Railway, south-east of Kenilworth to the River Anker, 1/2 mile SSE of Arkhall, near Tamworth Staffordshire	H. H. Howell F.G.S. The outline of the ground levelled by W. H. Penning F.G.S.	October 1870
84	Section across the London Basin from the North Downs near Boxley, Kent across the Medway, the Hundred of Hoo, and the Thames through Hadleigh Castle and Rayleigh, across the River Crouch and through Danbury to the River Chelmer 1/2 mile east of Little Baddow in Essex (in continuation of Sheet 78)	H. W. Bristow F.R.S. William Whitaker B.A. and W. H. Penning F.G.S.	March 1875
120	Section of the London Basin from south to north from the Chalk SE of Farningham, Kent across the Tertiary Outlier of Swanscombe, Park Wood and the Valley of the Thames below Greenhithe; through Essex, from West Thurrock, across the Bagshot Outlier of Warley Common, the Valley of the Roding and the Valley of the Stort above Roydon; into Hertfordshire, to the outcrop of the Chalk in the Valley of the Ash at Widford.	W. Whitaker B.A., F.G.S. and W. H. Penning F.G.S. The levelling by W. H. Penning	April 1877
121	Section across the Chalk of Hertfordshire, from 3 miles eastward of Ware, through the Tertiary Outliers of Sacomb and Cutting Hill, by Baldock; across the Gault and Lower Greensand of Bedfordshire (E of Biggleswade and W of Potton) to Everton, and across the Oxford Clay to a point 4 miles NW of Kimbolton (continued from Sheet 120)	W. H. Penning under the superintendence of W. Whitaker	April 1878

122	Section from the Three Shire Stone 4 miles NW of Kimbolton (Hunts) through Thrapston, Rockingham Forest (Northamptonshire) Uppingham (Rutland) and across Burrow Hill to the River Eye West of Melton Mowbray (Leicestershire)	William H. Holloway F.G.S. Levelled by W. H. Penning F.G.S.	December 1879
124	Section from Buddon Wood across Mount Sorrel, Burrow Hill (Leicestershire) the Vale of Catmos, through Oakham and Ketton (Rutland) to the Fenland at Peterborough, Northamptonshire	William H. Holloway F.G.S. Levelled by W. H. Penning F.G.S.	December 1887
126	Section across the Tertiary Beds, and the Chalk of the London Basin from the River Chelmer (4 miles below Chelmsford) by Felstead, Radwinter, Barrington Hill, and Wandlebury to the Gault at Cambridge and Madingley Park	W. H. Penning F.G.S. and W. H. Dalton F.G.S. under the superintendence of W. Whitaker B.A. F.G.S.	?July 1882
140	Section from Bishopstone near Hartwell, through the Oolites and Lias of Buckinghamshire and Northamptonshire (near Buckingham and Daventry), and through the Lias and New Red Marl of Warwickshire, from Rugby to near Wibtoff (5 miles SSE of Hinkley)	A. H. Green, H. B. Woodward and W. H. Penning F.G.S.	December 1888

Table 3b. Details of Horizontal Section explanation 140.

Horizontal Section No.	Horizontal Section Explanation Title	Authors	Publication date	Comment
140	Explanation of horizontal section, sheet 140	Horace B. Woodward	Pre 1891	The opening paragraph of the Explanation states: <i>"This section is a continuation of Horizontal Section Sheet 74 and illustrates portions of the following Geological Survey maps: Sheets 46SW, 45SE and NE, 53 SE and NE, 53NW and 63SW. It was constructed by Mr W. H. Penning, the Geological details from Bishopstone to near Braunston were inserted by Prof A. H. Green F.R.S., and those from Braunston northwards by the writer."</i> This explanation is unusual in that it is the only one for which the person who <i>"constructed"</i> the section is named.

Penning is named on five geological map sheets (sometimes these were split into quarter sheets): Nos. 1 (NE & NW), 47, 51 (NW, SW & SE), 70 and 83 (Table 4). It is interesting to note that Penning remains a contributor to a 'modern' 1:50 000 scale New Series geological map number 102 (Market Rasen). This is because this map is termed by the BGS as part of the "Provisional series." Given that the BGS appears to have stopped systematic geological mapping, Penning is likely to remain as a contributor to this map sheet in perpetuity. Penning is also a co-author of the



memoirs that accompany three of these map sheets (Whitaker *et al.* 1868 [No. 1NW], Whitaker *et al.* 1878 [No. 47] and Penning & Jukes-Browne 1881 [No. 51SW]). He is not a co-author for the memoir for map sheet 70 but Jukes-Browne (1885) includes several extracts on the Lias, on Limestone Gravels and on the River Trent Alluvium, from Penning's notebooks. However, Penning also contributed to the mapping of a number of other sheets. The geological memoirs for these sheets record Penning's contributions by quoting from his notebooks. For sheet 83 (country around Lincoln) (Ussher *et al.* 1888) Penning's notes on the Middle and Upper Lias, the Inferior Oolite, the Great Oolite, the Cornbrash and post-glacial Ancient Gravels are referred to more than 20 times. Indeed, the memoir states that: "*The survey of Sheet 83 was commenced by Messrs Penning and Holloway, who examined a portion of the country lying around and south of Lincoln. The area, however, was far from completed at the time of the retirement of the former and the death of the latter.*" From his work on the 'Ancient Gravels (Quartzite Gravels)' Penning is acknowledged to have developed a "*theory*" on their distribution, proposing that they were laid down by an ancient River Trent (Jukes-Browne 1883).

For sheet 84 (East Lincolnshire) Jukes-Browne (1887) recorded that Penning mapped small areas near Mablethorpe and some of Penning's notes are published in the memoirs for sheets 51NE (parts of Cambridgeshire and Suffolk) (Whitaker *et al.* 1891) and 51SE (Bury St. Edmunds and Newmarket) (Bennett & Blake 1886). Penning seems to have been an industrious geologist and the Geological Survey Annual Reports for 1878, 1879 and 1880 quantify his mapping output in terms of area and boundary length mapped as:

1878	178 square miles (461 square km)	-
1879	167 square miles (433 square km)	395 miles (632 km) of boundary
1880	326.5 square miles (846 square km)	670 miles (1072 km) of boundary

Penning was also a co-author of two maps of the geology of "London and its environs" (drift, Bristow *et al.* 1873a; solid, Bristow *et al.* 1873b). These maps were accompanied by a text entitled *Guide to the geology of London and the neighbourhood*. These maps can be considered to be the forerunners of the applied/engineering geological maps of the London area published around the end of the century (Woodward 1897, 1906; Culshaw 2004), particularly as Woodward was also a co-author of the two 1873 maps.

Table 4. Details of map sheets for which Penning was a co-author. (Note: The map sheets did not have geographical locations printed as a title).

Map sheet number	Authors	Publication date
1NW	Geologically surveyed W part by W Whitaker and W H Penning, the E part W B Dawkins, W H Penning, Horace B Woodward and F J Bennett	Solid: December 1868 Drift: March 1876
1NE	Geologically surveyed, south of the River Crouch by Henry W Bristow F.R.S., the rest by W Boyd Dawkins F.R.S. (with additions by H B Woodward 1870). Drifts surveyed, in the eastern half by W Boyd Dawkins and W H Penning; in the western part by W Boyd Dawkins and Horace B Woodward.	December 1868
47	Geologically surveyed by W Whitaker (SW and NE corner), W H Penning (greater part), W H Dalton, and F J Bennett under the supervision of W Whitaker.	Solid: February 1881 Drift: October 1884
51NW	Geologically surveyed the SW part by W H Penning and A J Jukes-Browne under the superintendence of W Whitaker, the NE part by S B J Skertchly (Upware by H B Woodward)	December 1882

51SW	Geologically surveyed by W H Penning and A J Jukes-Browne under the superintendence of W Whitaker	March 1881
51SE	Geologically surveyed by W H Penning, F J Bennett and J H Blake under the superintendence of W Whitaker	No date
70	Geologically surveyed by W H Holloway (greater part of the map), S B J Skertchly (Fens and SW part), W H Penning, J W Judd, W H Dalton and A J Jukes-Browne	December 1886
83	Geologically surveyed by W H Penning, W H Dalton, A C G Cameron, W A E Ussher, A J Jukes-Browne and A Strahan	December 1886

Eight of Penning's field notebooks are preserved in the BGS archives (Table 5). The first of these records that on 5 August 1867 (shortly after he joined the Survey at the start of the month) he received the following tools:

- 1 box with six colors [*sic*], 2 brushes, 2 coloured pencils
- 1 prismatic compass (old)
- 1 clinometer (boxwood)
- 1 ivory protractor (old)
- 1 small hammer
- 1 notebook
- 1 map case (folding)
- 1 map case (round)
- 1 ordnance survey map No 1 SE
- 1 ordnance survey map No 1 NW
- 1 small magnifier
- 1 lot of forms

It is interesting to note that these items are very similar to those received by the authors of this paper on their joining the Survey around 100 years later!

Table 5. Penning's Geological Survey field notebooks.

Number	Dates	Comment
1063	August 1867 – June 1870	First entry: at a pit near High Halstow Church, Essex, 10 August 1867 First cross section and sketch map 3 December 1869
1064	July 1870 – October 1873	Includes section drawings and fossil lists
1065	November 1873 – October 1876	First entry 20 November 1873. W Whitaker still his superintendent.
1066	March 1868 – April 1877	Sections: 20 March 1868: Sandown Bay to Nettleston Point, Isle of Wight. 23 March & 3 April 1868: Poole Harbour to Chippenham. 30 March 1868: Chilmark Down to Ebbesbourne Wake. 1 April 1868: Fifield, Berkshire to Chiltern, Bedfordshire. 27 January 1870: NE of Salisbury to Marlborough Downs, Wiltshire.

1067	November 1868 – March 1873	Section taken in Nov 1868 and February 1873. Danbury (Essex) to River Thames; River Thames to Widford (Hertfordshire); Eynesford (Kent) to River Thames; Bexley (Kent) to River Thames; Llanbury (?) to River Thames; Widford to Hurapstone (?)
1068	1869, 1876, 1880	Sections in Buckinghamshire, Northamptonshire and Warwickshire, August 1869. From Oxhill north to near Grendon, Warwickshire. Sections, begun 29 November 1876, to illustrate memoirs for sheets 47 and 51SW from Ashdown, NE of Saffron Walden by Bartlow, Linton and Hildersham to Cambridge. 19 March 1880: From Old Workhouse in Dunmow to Braintree, Essex.
1069	1873	Continuation of section from near Widford (Hertfordshire) railway station to near Nottingham beginning 10 March 1873. On 8 and 9 April 1873 Penning was surveying around Stanton, Bradmore, Plumtree and Ruddington close to today's headquarters of the BGS! 14 April 1873 continuation of a section from Newport Pagnall to NW of Leicester.
1070	1873	1 April 1873: section from Mt Sorrel (Leicestershire) eastwards through Peterborough to Whittlesea and Eastrea, Cambridgeshire. 5 November 1877: Newport Pagnell, Buckinghamshire to NW Leicestershire.

These notebooks record where Penning was working during much of his career, though there is something of a lack of information after 1877. Some of the sections referred to in the notebooks can be linked to published sections on which Penning is known to have worked. However, it is likely that he worked on more sections than he is credited with. As one might expect of a professional geologist, the notebooks are light on extraneous information. However, Penning does attribute a joke to his then supervisor William Whitaker. The Fox and Hounds in Hunsdon, Hertfordshire (now a gastropub and the only Michelin BIB Gourmand restaurant in the county) had a notice near the bar:

*"No smoking allowed over the Board.  
No beer to be sat on the Board.  
No gambling for money"*

To which Whitaker added the comment: *"By order of the Board."*

Despite the claim in the obituary in the *Surrey Mirror* (25 April 1902), Penning donated few palaeontological samples to the Geological Survey, apart from those collected as part of his geological mapping duties. Undated records at the BGS note that he donated three mammoth teeth from around Crayford in Kent (an area that Penning did not map). These are numbered GSM 117009, 117010 and 117013.

Penning resigned from the Geological Survey on 7 April 1882, after 15 months of sick leave, from an address in South Africa. While no reference to Penning's engineering knowledge has been found in the BGS archives, it is interesting that, in a note to the Director General (four months after Penning's resignation), Bristow observed that his replacement as a Geologist, R. Russell (who had been appointed as an Assistant Geologist on the same day as Penning) had knowledge

of engineering and suitability as a “teacher of engineering”. This could imply that Penning had previously fulfilled such a role (BGS archive 1/38, paper 507, 21 September 1882) and that while Penning’s engineering knowledge was not the reason for his appointment, it was recognised that having staff with such knowledge was important.

### 3.4 AS A GOLD AND DIAMONDS CONSULTANT

It is interesting to speculate about why Penning left the Geological Survey. On the face of it, he left because of ill-health (Appendix 1). Additionally, in 1880, Penning had spent a long time in the field, mapping nearly twice as much ground as in the previous two years (see above). However, there seems to be a contradiction between Penning being too ill to work, and being given sick leave, and his almost immediate departure (probably in early 1881) to South Africa to work in the goldfields. He must have been quite active in South Africa as in the foreword to his *Guide to the Goldfields of South Africa* dated 22 February 1883 (Penning 1883), he referred to two years of rambling round South Africa. There is further reason to believe that Penning may have gone to South Africa for reasons other than his health. In the whole time of his employment at the Geological Survey he received no pay rise. In a letter from Bristow to Ramsay (BGS archive 1/38, paper 460, 23 June 1880) it was pointed out that there had been no rise for 22 years! In 1867 pay had been set by Murchison’s regulations at: Assistant Geologists 7 to 12 shillings per day, Geologists £230 to £350 per annum (£17 900 – £27 200 revalued by the Retail Prices Index). Furthermore, as mentioned earlier, field geologists were expected to live in the areas in which they were working, with their families and no field expenses were paid. Pay only increased in 1885 when Assistant Geologists were paid 7 to 14 shillings per day and Geologists £275 to £400 per annum (£23 200 – £33 700) (Wilson 1985). Perhaps the opportunity to enrich himself was too great an attraction.

Linda Rhodes (pers. comm.), a distant relative of Penning’s wife’s first husband’s family, made the following observations that offer a possible explanation as to why Penning went to South Africa:

*“The family moved to Bishops Stortford (renting the Parsonage) (before the 1871 census), and here begins an interesting series of connections with South Africa:*

*“The Pennings became friendly with Henry Paddison and his family, who lived in some style at Wood Hall, Arkesden. The Paddisons had lived for many years in Colesberg, Cape Colony, which from 1867 onwards was of course the centre of the Diamond Rush. Henry Paddison’s son Charles married W. H. Penning’s step-daughter Rebecca Somerset in 1874 and they had a son, Cecil John Paddison, the following year. Charles Paddison was declared bankrupt soon afterwards, promptly fled back to South Africa and was then divorced by Rebecca in his absence on the grounds of adultery and cruelty.*

*“W. H. Penning’s stepson Edmund Thomas Somerset attended Bishops Stortford Grammar School with Cecil Rhodes (also born in 1853). The two families became close: Cecil was godfather to Cecil John Paddison, and two of his sisters were bridesmaids when Phillipina Carrington Somerset married Lieut Lewis Dod Sampson RN in 1876. Cecil Rhodes followed his brother Herbert to South Africa in 1870, came back to England then returned to SA in 1874, taking his friend Edmund Thomas Somerset with him. Somerset made a lot of money from gold and diamond mining, and settled in Johannesburg where he lived to be 98.*

*“Following her divorce from Paddison, Rebecca Somerset married Samuel Wreford Paddon in 1879. Paddon became a dealer in South African diamonds (and the subject of J. M. Whistler’s pamphlet ‘The Paddon Papers’). Rebecca’s son by her marriage to Paddison became known as Cecil John Paddon. At 16 he ran away from home in London to join his godfather Cecil Rhodes in South Africa. Cecil Paddon then became the youngest member of the 1893 Pioneer Column, among the first settlers in what became Rhodesia. The suburb of Paddonhurst in Bulawayo is named after him.”*

In addition, Commander Lewis Dod Sampson had visited South Africa, at least in 1872 when he sketched the diamond fields at Colesberg Koppie (Fig. 8). The sketch is now owned by a direct descendent of Lewis and Phillipina, Peter Sampson and his wife, Pat Colesberg is also where the

Paddison family had lived for some years; Charles Paddison was the first husband of Phillipina's sister, Rebecca. Commander Sampson may have discussed his experiences in South Africa with Penning.

So, Penning must have been aware of the potential financial opportunities available in South Africa and it is possible that his resignation from the Geological Survey was, in part, motivated by them. He is known to have visited South Africa on at least six separate occasions between 1881 and 1896 (Table 1), though it is likely that he was there more frequently. Visits seem to have lasted as much as a year, or more. During this time, Penning was involved in providing geological advice in relation to the potential for exploitation of gold resources. He wrote reports (Table 6) but also became a shareholder and even a company director. He seems to have invested, also, in at least one Australian gold mining company but no record has been discovered of his ever having visited the country.

Publications by Penning during this part of his career such as *The Kalahari Desert* (Penning 1893a) and Stanford's map of the Transvaal goldfields, with the geology of the southern part of the Transvaal (cartographic material by Penning [1883]) showed that he worked extensively in South Africa, particularly with regard to gold, diamonds and coal. Although he spent most of his time abroad he did return to England occasionally, during which visits he presented papers to the Geological Society in 1884, 1885 and 1891 and to the Society of Arts in 1884 and 1888.

Other than his publications, little else is known about Penning's work in South Africa. It has been suggested to the authors that in 1884 he was made a member of a Government Commission with regard to gold digging in the South African Republic. Unfortunately, the authors have been unable to find a record of this. However, everything did not go smoothly. Penning is mentioned in the record of a libel trial at the Old Bailey in which the owner of the Rae Transvaal Gold Mining Company (Harry H Marks) sued the author of a pamphlet (George W Butterfield). Penning was a director of the company, a shareholder and the person who wrote the geological report on the site of the proposed mine. The company was revealed as a fraud (Johnson 2000) and the libel case was lost. Fortunately for Penning, he was in South Africa at the time of the trial as, on the face of it, he was heavily involved in the company (if not the fraud). However, his reputation could not have suffered irrevocably as he continued to publish, lectured at the Geological Society and provided an exhibition of stone implements from South Africa at the Anthropological Institute (Penning 1898). By the time of the 1901 census he described himself as a "retired geologist."

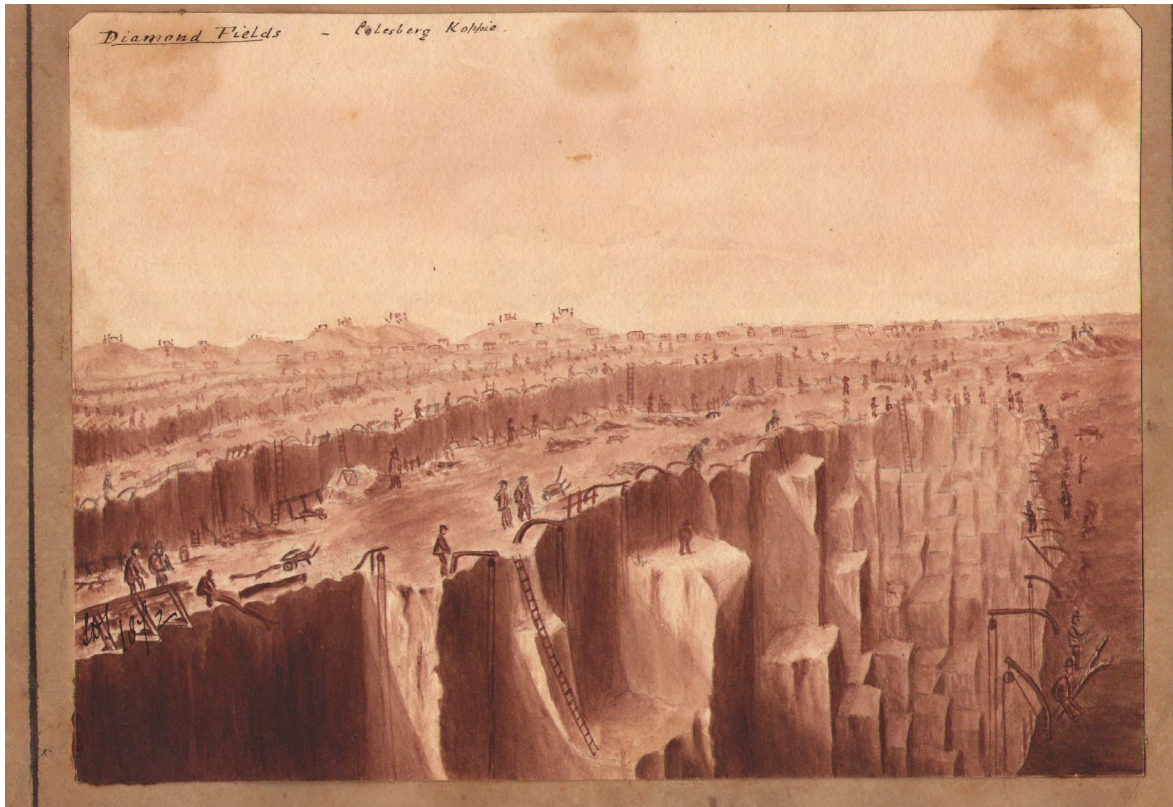


Figure 8. 1872 sketch of the diamond fields at Colesberg Koppie, South Africa by Commander Lewis Dod Sampson (Reproduced with the permission of Pat and Peter Sampson).

Table 6. Penning's involvement with gold prospecting companies.

Date of Launch	Company and mineral	Mine Location	Role	Evidence
January 1889	The First Netherlands Transvaal Gold Mining Company	Oakley, Witwatersrand, South Africa. 14 miles from Johannesburg; 40 miles from Pretoria	Geological report	Launch of company. <i>The Times</i> , 12 January 1889
Early 1887	West Moodies Mining Company Gold	De Kaaps District, Transvaal South Africa	Company Director	Announcement of legal winding up of the company. <i>The Economist</i> , 9 March 1889
?1887	Rae (Transvaal) Gold Mining Company	Transvaal, South Africa	Geological report Shareholder Company Director	Libel case about 'overselling' of the company to attract shareholders. <i>The Times</i> , 12 December 1890
February 1895	The Cardiff Castle Gold Mines	Coolgardie District, Western Australia. 1 mile west of Lake Lefroy; 45 miles SE of Coolgardie	Company Director	Launch of company. <i>The Economist</i> , 9 February 1895 £40 000 of shares issued 19 February recorded in <i>The Queenslander</i> 23 February 1895 S W Paddon, the husband of Penning's step daughter, Rebecca is another director

### 3.5 GAPS IN OUR KNOWLEDGE OF HENRY PENNING

From the dedication in *Engineering Geology* (Penning 1880a) we know that Penning met and was mentored by Charles Gregory (see above). However, we do not know when and under what circumstances they came into contact. Records for the Berks and Hants Extension Railway Company in the UK National Archive in Kew do not mention Gregory at all and no personal papers for either Penning or Gregory have been found. Gregory worked on a number of railway building projects in western England between 1852 and 1869 (Table 2) It is possible that they met prior to Penning beginning work in Pewsey on the railway. That would probably mean prior to about the autumn of 1860 when construction on the B&HER began. Alternatively, they might have met during Penning's time in Pewsey (1860? to 1865) or, in the period from 1866 to 1867 when he joined the Geological Survey of England and Wales. However, on balance, it is likely that Penning and Gregory met before the former went to work on the B&HER in about 1860. Otherwise, why would Penning be given a significant job on the building of a railway at all? The contact with Gregory was important because it gave Penning his training in engineering and surveying.

Penning applied to the Geological Survey for a position from an address in Dartford. We have no knowledge of when he left Pewsey nor why. Given that he was well established socially in Pewsey (the *Devizes and Wiltshire Gazette* for 20 November 1862 refers to an attempted burglary at his residence on the High Street, Pewsey; that of 19 May 1864 refers to his subscription to the Dover Lifeboat Fund; that of 14 June 1864 mentions him being a steward for a “town and country ball at the New Hall, Chippenham” and for another ball at the Town Hall, Marlborough; that of 29 June 1865 mentions his involvement with the Art-Union of London – an organisation that sought to foster interest in the arts) his departure sometime after the middle of 1865 is surprising. No reference to what Penning may have been doing in Dartford has been found.

Apart from the personal communication from Linda Rhodes (see above) we can only guess at why Penning left the Geological Survey and began a new career in relation to gold and diamond exploration and mining in South Africa. His resignation on the grounds of ill-health does not ring true, particularly as he seemed to have worked quite strenuously in South Africa. A financial motive seems a more likely explanation. Or maybe he got bored with mapping the relatively unchallenging geology of eastern England!

Finally, and most interestingly from the authors' point of view, we do not know what motivated him to write *Engineering Geology* (Penning 1880a).

## 4. Henry Penning's publications

### 4.1 INTRODUCTION

Henry Penning was not an academic; rather, he was a practical man and would be called an applied geologist today. He had expertise in building, engineering and surveying, in railway construction, in geological mapping and in mineral exploration. However, the range of his publications indicates that he had a strong desire to communicate his knowledge and his thoughts on a range of matters, not all necessarily in the mainstream of geology. In the mid-1870s he wrote three interesting discussion articles in a popular literary magazine (*Tinsley's Magazine*). The first of these was on 'Darwinism' (Penning 1876g) in which he compared the public response to Darwin's theory with the way that the young science of geology had been treated in its early days and also discussed how Darwinism made some question the existence of God. The second article was entitled 'Hidden Treasure' (Penning 1877a). This article was concerned with natural minerals 'buried' in the ground and how geologists located them. He endeavours to show that these minerals are not found by chance or by use of divining rods: "*The limits in which gold can occur, whether in the reef or in the silty bed of an old river, can readily be defined by those who are able to wield the staff (or hammer) of geological knowledge, which may aptly be called the 'divining-rod of science.'*" The article discusses a number of minerals: gold, silver, iron, diamonds, phosphate of lime and, particularly, coal. It emphasises the size of the coal reserves of the UK (then estimated at around 300 years' worth) and how coal could be burnt more efficiently than on an open fire. Finally, Penning discussed the value of clean groundwater both as a source of drinking water and the use of it as a way to reduce disease and concluding that it was "...our greatest hidden treasure." Penning's third article was called 'Science' (Penning 1877b). The article begins by trying to define 'science.' It starts with a short discussion of how others have defined it and then Penning's own version: "...a knowledge of Nature, of natural laws, their actions and results, this knowledge bearing the same relation to Art as the mind bears to the body." The article goes on to discuss the evolution of 'Art' and 'Science' as civilisation advances through time. He concludes by extolling the value of applied science: "...although science is eminently worthy of cultivation for its own sake, men should extend their knowledge if they would increase their material happiness;" Penning also published at least two poems in *Tinsley's Magazine* (see below). Indeed, an obituary in the *Surrey Mirror* of 25 April 1902 describes him as a "popular contributor."

He wrote poetry. Fig. 9 is the text of a poem "Sea spray" dated April 1900 and accompanied by Penning's signature (compare it with the signature below his official Geological Survey photograph [Fig. 1]). However, a printed version of the poem is headlined "First prize. – R.M.S. 'Moor,' August, 1888." The text of the poem is given in Appendix 2. Penning wrote at least sixteen other poems (also given in full in Appendix 2) that are preserved in a notebook compiled by Penning's step-granddaughter, Constance. The notebook is now owned by Constance's grandson, Peter Sampson (see above) and his wife, Pat. At least two of these poems were published, 'An Invocation' and 'A snow-storm in spring' appearing in *Tinsley's Magazine* (Penning 1876h, 1877c). In Constance's notebook the two poems consist of cuttings that are identical, in the way that they are typeset, to the poems as published in *Tinsley's Magazine* and so are probably cuttings from this magazine. The notebook also contains cuttings of 'Sea Spray' and 'Twilight,' (both in the same printing style as 'An Invocation'), 'The Cape,' an un-named poem and 'To Anthea.' It is possible that the first two of these printed poems were also published in *Tinsley's Magazine*. Many of Penning's poems are romantic relating to his wife and also to his mother. However, the saddest poem is called 'One less.' This two-verse poem refers to a small grave upon which Penning (and, presumably, his wife) were mourning for "our darling," who had a very brief life. It could be assumed that the baby was the child of Henry and Mary Ann Penning. As Mary Ann was 43 when she and Henry married, it is reasonable to assume that the baby was born during the 1860s.



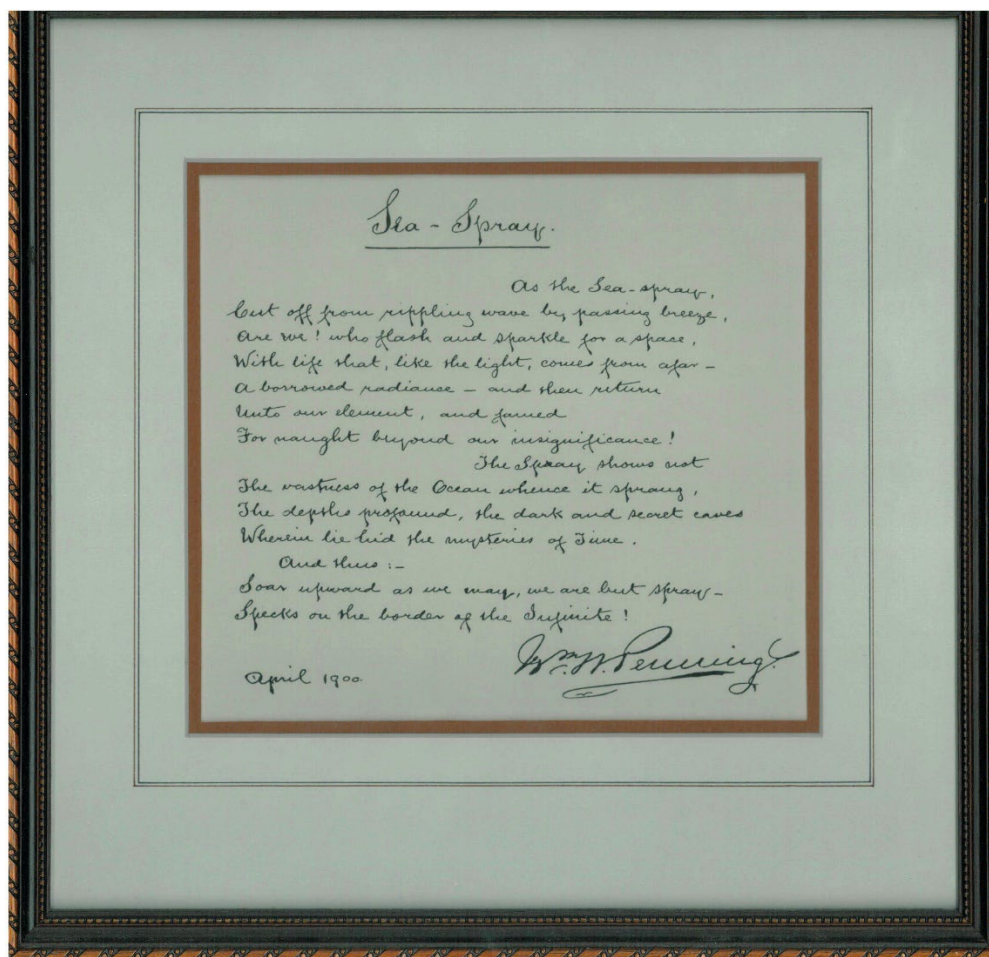


Figure 9. Hand written poem "Sea spray" dated April 1900 and accompanied by Penning's signature (Reproduced with the permission of Pat and Peter Sampson).

His articles on engineering geology (Penning 1879a–i, 1880a) have been referred to above, but his first two known publications were concerned with public health. He wrote a geological note and produced a map for a report on an epidemic of typhoid fever at Wicken Bonant in Essex, eastern England (Penning 1870). This was followed by a thirty-two-page treatise on problems for houses associated with poor drainage and other unhealthy conditions, with practical hints for their detection and cure (Penning 1872). His knowledge on this topic probably related back to his earlier years when he may have worked for his father's building business in Eye, Suffolk and his own building business in Pewsey. However, before these two publications, Penning submitted a provisional patent application on 11 January 1869 to the London Patent Office (Anon. 1869). The application, which received provisional protection only, concerned a compressed air device that could be used for transmitting signals and suitable for "houses, buildings and public places, on carriages, on board ships, steam ships and boats, and especially applicable as a means of intercommunication between the passengers, guards, and drivers of railway trains." It is not known whether Penning ever took patenting of the device further or commercialised it.

During his time at the Geological Survey he published a wide range of short articles and letters relating to a wide range of topics: physical geology of east Anglia during the Glacial Period (Penning 1876b), concretions (Penning 1876c), apparent and true dip (Penning 1876d, e), marine erosion (Penning 1876f), divining rods (Penning 1878) and diatoms in the London Clay (Penning 1880b). These were in addition to the three editions of his book on field geology (Penning 1876a, 1879j, 1894) and his contributions to geological memoirs (Penning & Jukes-Browne 1881; Whitaker *et al.* 1868, 1878).

His South African work resulted in a number of publications on goldfields and coal and diamond districts (Penning 1881, 1884a, b, 1885, 1887, 1888, 1890, 1891, 1893a, b, c and 1901). According to the Biographical Database of Southern African Science ([www.s2a3.org.za/bio/Biograph\\_final.php?serial=2162](http://www.s2a3.org.za/bio/Biograph_final.php?serial=2162)) Penning also wrote two newspaper articles in 1883 – for *De*

*Volksstem* (Pretoria) on 27 January 1883 (dealing with geological and mining aspects of the De Kaap Valley) and for the *Diamond Fields Advertiser* (Kimberley) on 9 February 1883 (dealing with the future prospects of the Transvaal and its gold deposits).

It is likely that he wrote to other professionals, though only one letter has been found (Penning 1886). In this, he wrote to the Reverend John MacKenzie (a member of the London Missionary Society and a Special Commissioner in Bechuanaland (now Botswana) who supported indigenous communities and opposed some of Cecil Rhodes' ideas) congratulating him on a paper on Bechuanaland, read to the Society of Arts, and enclosing a paper of his own of South African interest.

Most of Penning's books and pamphlets were published by Baillière, Tindall and Cox (London). Reference to some of his books is to be found in the publisher's archive held in the Special Collections at the University of Reading. This archive is incomplete but includes letters to Penning with regard to his early publication (1872) on "nuisances, drains and dwellings," on the first two of his books on field geology (1876a, 1879j) and on his last book on gold and diamonds in South Africa (1901). This last book did not sell well and the publisher suggested that Penning should pay for more advertising (Baillière, Tindall and Cox Archive, University of Reading, Box 11 Volume 1901–1902 Item 161 – publisher to Penning, 28 January 1902). As Penning died less than three months later, this was, presumably, never done. The poor sales were despite the original book on diamonds being broadened to include gold (Box 7 Volume 1900 Item 911 – publisher to Penning, 8 November 1900). It is also interesting to note that in publishing his second book on field geology in 1879, Penning tried to copyright the term 'field geology,' presumably to prevent it being used in the book by Archibald Geikie (Geikie 1879) (Box 5 Volume 1877–1879 Item 403 – publisher to Penning, 16th April 1879). However, he did succeed in getting Geikie to change his original title (Box 5 Volume 1877–1879 Item 141 – publisher to Penning, 23rd December 1878)!

#### **4.2 WILLIAM HENRY PENNING'S CONTRIBUTION TO ENGINEERING GEOLOGY AND THE GEOLOGY OF SOUTH AFRICA**

Henry Penning had two significant geological achievements. First was the publication of his book *Engineering Geology* (Penning 1880a) (and the articles from which it was derived [Penning 1879a-i]). These articles record one of the earliest uses of the term 'engineering geology,' possibly the first (Koszela & Koszela-Marek 2009). That he understood the importance of geology to building, construction and mining is apparent from the opening paragraph of the first of the series of papers on engineering geology in *The Engineer* (Penning 1879a) that were combined in the book (Penning 1880a): "*In the execution of engineering works, however scientific in design and clever in workmanship, failure has frequently usurped the place of success, because due attention has not been paid to geological phenomena. The same may be said of building operations; whilst it is notorious that vast sums of money have been thrown away in mining speculations which would at once have been characterised as hopeless by anyone possessing the slightest acquaintance with geology.*" In addition, Penning stressed the importance of understanding the geology both of the district through which a linear structure (such as a railway) passed but also "...for a considerable distance below; their relationship to each other, and the consequent influence they will exert over the works in contemplation." Here he was describing the 3D geological model! He felt that "trail-pits" were too shallow and that, in most cases, "borings" were too expensive. He stressed the importance of field-geology: "One cannot fail to perceive how differently placed or constructed would have been many of the most important works ... had those who designed them been acquainted with the principles, methods, and results of field geology; or how much capital might have been usefully instead of fruitlessly expended, or how many catastrophes would have been averted." He then goes on to describe geological strata in terms of what they are, their relationship to one another and how they impact on engineering works.

This theme was continued in the second article in *The Engineer* (Penning 1879b). Here he explained that more information was required for tunnelling than for cuttings. The cost of the former was much larger and so the savings that could be made would be potentially greater. He goes on to discuss superficial deposits and problems created by buried valleys as well as the variability of "drift gravels." He then discusses potential value of rock and soil mineral resources though he says that peat is of little agricultural value because of the high vegetable matter content!

He notes the varying agricultural value of different soils because of their chemistry. He finishes this article with a discussion of the drainage capability of different soils.

In the third article (Penning 1879c) he discusses drainage, drawing attention to spring lines in cuttings that might *“cause serious slips unless means be taken for their prevention.”* He also points out the increased danger if the dip is into the cutting. He then noted that knowledge of geological structure is more important with regard to tunnelling. He indicates how a knowledge of the rock structure can be obtained by geological mapping at the surface. Penning then turns his attention to embankments. He warns that the embankment loading on a slope may cause slipping. It is interesting to note that he discusses only sedimentary rocks, probably because his experience was in southern, south eastern and eastern England. He indicates that his comments may also apply to reservoir embankments and canals. His final discussion in this article is with regard to water supply and how an understanding of the depth to the water table is important. He notes, also, that *“A knowledge of the undoubted relation existing between subsoil and disease must also be beneficial to those who are seeking for themselves a new home.”*

The fourth article (Penning 1879d) focusses on geological surveying methods. He identifies three operations that should be carried out: 1) determination of the character of the strata; 2) identification of the boundaries of the different rocks; 3) measurement and estimation of the dip and its subsurface continuation. These operations result in identification of the lithology and the production of geological maps and sections. These are discussed further in the article.

The fifth article (Penning 1879e) gives a relatively complicated example of geological surveying (mapping) involving: *“...the application of the methods of determination of rocks, of observation for dips, and of tracing irregular boundaries, faults, and unconformities.”* Article 6 (Penning 1879f) is relatively short and discusses geological sections.

Article 7 (Penning 1879g) moves on to *“Materials, minerals and metals of practical value and importance.”* The article covers building materials, alluvium and other Recent deposits, Tertiary or Cainozoic (actually given as Kainozoic) rocks, Upper Cretaceous (the chalk [sic]) and the Lower Cretaceous. Article 8 (Penning 1879h) continues by discussing Upper Oolites, Middle Oolites, Lower Oolites, the Lias, The Trias, the Permian, the Carboniferous, the Devonian, Old Red Sandstone, the Silurian, the Cambrian including the Lower Silurian, presumably now the Ordovician) and finally the Laurentian (Pre-Cambrian).

The final article (No. 9) (Penning 1879i) turns its attention to groundwater with sections on the nature of springs, artesian wells and absorption wells. The final section returns to the subject of building sites and the importance of geological understanding to sanitary engineering involving urban drainage, disposal of sewerage and supply of pure water.

Article 9 was published on 22 August 1879 but knowledge of the nine articles spread quite quickly. In Australia they are referred to in the November 1879 edition of a short-lived magazine called *The Australian Engineering and Building News*.

It is significant that Penning's book on engineering geology (Penning 1880a), which is based on the nine articles, strikes right at the heart of its topic by dealing with the role of geology and engineering in construction and land use in the first section; only then, in the second section, does he describe methods of geological surveying. The third section deals, at length, with geological materials as resources, water supply and lastly 'building sites'. The discussion of the most appropriate choice of locating a building site within a wider context, from a practical as well as an aesthetic point of view, is an early description of land use planning. His advice to look beyond the bounds of the footprint of the building in order to construct it in the most effective and sustainable manner is a principle of engineering geology that is fundamental to the long-term safety of the building or structure and its users. This book was one of the earliest textbooks, if not the first (at least in English), that encapsulated the complete integration of geology and civil engineering, in their widest implications, that defines the discipline of engineering geology and sets it aside from geology and geotechnical engineering. Indeed, if Penning was the first to use the term 'engineering geology' this was an important step in the development of engineering geology as a discipline. The power of a name is not to be underestimated. Other works dealing with geology and engineering have tended to start by instructing the reader in geology and only later seeking

to add engineering implications; thus, they are 'geology for engineers' rather than engineering geology texts.

Sadly, Penning seems to have left no explanation as to why he wrote his engineering geological textbook. However, unless further information comes to light, it seems reasonable to suggest that Penning was the first person to use the term 'engineering geology' and define its subject matter in print.

His second achievement, in his papers on the South African goldfields (Penning 1888, 1890), was his naming of the Witwatersrand Beds (Du Toit 1954, Kent & Hugo 1978), later renamed the Witwatersrand System by Mellor (1917): "*The thick, predominantly sedimentary succession which hosts the auriferous conglomerates of the Transvaal was named the Witwatersrand Series by W. H. Penning in 1888*" (Kent & Hugo 1978). He further discussed the stratigraphy of the Transvaal System in his papers for the Journal of the Society of Arts and the Quarterly Journal of the Geological Society (Penning 1884b, 1891). He also produced a small-scale sketch map of "Gold fields of South Africa" in his Guide to the Goldfields of South Africa (Penning 1883). The map is something of a disappointment; it has no scale or north arrow and simply shows gold field locations in relation to mountain areas, towns, roads and rivers. However, as the 'Guide' was basically a historical, geographical and, to some extent, economic description of the goldfields, rather than a geological one, the provision of an essentially topographic map is not surprising.

Rogers (1936) described the Guide to the Goldfields of South Africa as a "pamphlet" (it was privately published in South Africa) but commended the descriptions of gold discoveries in the Transvaal. However, Rogers noted that "The geological features are hardly dealt with..." Rogers also was critical of Penning's discussion of South African coal-bearing rocks (Penning 1884a) in that Penning appeared to assume that those from Natal, the Orange Free State and Transvaal were stratigraphically the same age. Rogers' discussion of Penning's publications closes with further implied criticisms of the 1891 paper on the geology of the southern Transvaal and his final publication in 1901, a booklet (77 pages) on gold and diamonds in South Africa. Hatch & Corstorphine (1909) are much less critical of Penning's work, simply stating what Penning had observed and described, and comparing his results with other workers (including Hatch). In particular, they discussed the three main theories proposed for the origin of gold in the Witwatersrand conglomerate:

- The Placer Theory – "*...the conglomerates (are) ancient marine placer deposits, of which the original pyrites has been partially, and the gold entirely, dissolved and redeposited.*"
- The Precipitation Theory – "*the gold and pyrites are chemical precipitates from the waters in which the conglomerate pebbles were laid down.*"
- The Inflation Theory – "*...the cementing material of the conglomerates is so largely composed of secondary minerals shows that the beds must have been subject to much percolation by mineralising solutions before final consolidation. The slow and repeated passage of such solutions, even if carrying only a minute quantity of gold, would gradually enrich the matrix.*"

Penning (1888) proposed the Precipitation Theory but Hatch & Corstorphine preferred the Inflation Theory, though the modified Placer Theory is more favoured now (Tucker *et al.* 2016).

Despite his contributions to the understanding of South African geology, his real motive was to make money through the provision of consultancy advice, particularly in relation to gold exploration. This is indicated by the advert he placed in his own book: *A guide to the goldfields of South Africa* (Penning 1883). The final section contains 39 adverts for businesses ranging from lawyers to shop keepers and hotels. There is only one advert from a geologist, that of Penning himself:

“W.H. Penning, &C.,  
(Late of H.M. Geological Survey of England,)

PRETORIA AND LYDENBURG

Undertakes to thoroughly examine and fully report upon Gold and Mineral Properties, to assay samples of Ore, to effect the sale of Farms, to form Companies, to provide Machinery, and generally to advise upon the utilisation of the mineral resources of the country.

*List of Farms for Sale on application.*

HIGHEST REFERENCES.”

Whilst Penning may have made only a small contribution to the understanding of the stratigraphy of Great Britain (partly because his early mapping experience was limited to stratigraphically, relatively uninteresting strata in eastern England), in South Africa he was able to apply principles of stratigraphical mapping to older rocks and this led to a more lasting contribution.

Henry Penning was not entirely forgotten following his death. His former colleague Horace Woodward mentioned him in his book on geology in relation to agriculture, estates, engineering and sanitation: “*There are also tracts of loam or brickearth over Boulder Clay, as shown here and there on the Geological Survey map; and hard yellow loam is intercalated in Boulder Clay at Wenden, as observed by W. H. Penning (1878).*” (Woodward 1912). The reference to Penning (1878) should actually be Whitaker *et al.* (1878). Woodward's book was intended to be useful “*...to students and teachers of agriculture, to those occupied in the management of estates and farms, or in sanitary or engineering works, wherein it is important to consider the geological nature of different sites for residences and other purposes.*” Penning would probably have appreciated that!

Perhaps the last non-historical reference to Henry Penning's work was by Greenly & Williams (1930) in their book on geological surveying. They refer to Penning's books on field geology (Penning 1876a, 1879j) and on engineering geology (Penning 1880a). No further reference to Penning's engineering geological work has been found until Kiersch discussed it in 1955. The next reference was by Hatheway (1990).

## 5. Conclusions

Henry Penning was an applied geologist with a background in building, construction, surveying and engineering who worked, initially, on railway construction, and for the bulk of his career on geological mapping and mineral exploration. Despite working for 15 years at the Geological Survey of England and Wales, he does not appear to have received widespread scientific recognition in his lifetime, even though he published extensively.

However, more recently, he is acknowledged to have named the Witwatersrand Series, which contains the gold-bearing strata of the Transvaal in South Africa, and to be the author of what is almost certainly the first text book on engineering geology (1880). Also, he may have coined the term 'engineering geology' itself in the first of his articles in *The Engineer* in 1879 (Penning 1879a). Indeed, it is not unreasonable to regard him as the 'Founder of Engineering Geology' as a discipline.

It is likely that his role in the development of 'engineering geology' as a modern discipline was the result of his broad background in practical subjects. His early work in his father's building business and, later, in his own business, his engineering training under the guidance of the eminent engineer Charles Henry Gregory and his survey work with the Geological Survey gave him the broad knowledge and experience essential to a modern engineering geologist. However, breadth of experience, alone, is insufficient and it is its application to solving practical problems that characterises a good engineering geologist. His meticulous approach to the construction of geological sections using his engineering surveying skills appeared to be highly regarded by his colleagues in the Survey and may be regarded as an early phase of the development of an

engineering geologist's quest for the '3D model'. That he was capable of using knowledge from diverse sources was demonstrated by his paper in which he compares stone tools from Africa with those seen in his childhood from Hoxne in Suffolk. If not a polymath, an engineering geologist must be, at least, a first rate generalist and Penning proved himself to be certainly that.

Unlike many of the more famous geologists of his time, he came from a relatively humble background and, despite 'marrying into money,' he continued in his professional career throughout his working life though, other than his salary during his time at the Survey, his remuneration may only be guessed at.

Undoubtedly, his achievements at the Geological Survey helped establish engineering geology as a key part of what national geological surveys should do and his 1880 text book on *Engineering Geology* was not rivalled until 34 years later when Ries and Watson (1914) published a text book of the same name, though it lacked the integration achieved by Penning. The efforts of 'ordinary' geologists are rarely acknowledged in the scientific literature but the work of Henry Penning reminds us that achievement in science and its application is not the sole preserve of the well-known and the well-educated!

## Appendix 1

Letter from Henry Cribb LRCP (Licentiate of the Royal College of Physicians), London, 28 November 1880 confirming Penning's illness.

"I have seen Mr William Henry Penning and hereby certify that he is suffering from decided symptoms of failing brain power, and nervous energy. I have no hesitation in saying that this has been brought on by the anxious carrying out of his professional work in connection with the Geological Survey. A severe attack of *Prolapsus Ani*, following an operation for *P/Fistula* some years ago has become chronic and rendered his work much more toilsome and harassing than it would otherwise have been. These unfavourable symptoms will undoubtedly increase unless Mr Penning speedily gives up all brain work and a long rest is absolutely necessary to produce any permanent benefit."

## Appendix 2

### POEMS

The poems below are contained in a notebook compiled by Constance Nina S Sampson, the daughter of Phillipina Sampson and the granddaughter of Mary Ann Penning. The notebook includes a wide range of poems from well-known and less well-known authors. It is now owned by Pat and Peter Sampson of Victoria B.C., Canada. Fifteen poems are identified in the notebook as being written by W H Penning either by his initials or his first two initials and his surname. Some of them are hand written and others are printed cuttings.

#### ***Sea-Spray***

*(First Prize. R.M.S. "Moor," August 1888.)*

As the Sea-spray,  
Cut off from rippling wave by passing breeze,  
Are we! Who flash and sparkle for a space,  
With life that, like the light, comes from afar -  
A borrowed radiance – and then return  
Unto our element, and fated  
For naught beyond our insignificance!

The spray shows not  
The vastness of the ocean whence it sprang,  
The depths profound, the dark and secret caves

Wherein lie hid the mysteries of Time.  
And so-  
Soar upward as we may, we are but spray -  
Specks on the border of the Infinite!

### ***A snow-storm in spring***

*Published in: Tinsley's Magazine, Vol 20, January–June 1877, page 424.*

When the earth doth smile in gladness,  
When the lark is on the wing,  
When March winds have ceased their madness,  
And soft showers their blessings bring, –  
Type of sorrow, type of sadness,  
Comes a snow-storm in the spring.

When life's cares are of the slightest,  
Beauty haloes everything;  
When its days are fairest, lightest,  
Then will clouds their shadows fling,  
Dash the hopes that seemed the brightest,  
As a snow-storm in the spring.

### ***The Cape***

*(Prize Poem. R.M.S. Moor, August 1888)*

“Capo di Diaz!” the famed De Gama cried:  
Truly a “Cape of Storms” which beat around  
Thy beetling cliffs, in force unknown, untried,  
Till thy stern bluffs were weathered – newly found –  
By those brave mariners who sought to wrest  
Grand secrets from the Southern Ocean's breast.

Thy fame no longer rests on storms of old,  
Long since subdued by Science, Will, and Power,  
But on thy wealth – nor wealth alone of gold –  
Of Nature's gift and promise; splendid dower;  
Boast thou of these, and of a lovely clime,  
Cape of Good Hope! As erst of storms sublime!

### ***A Song: Air – Kathleen Mavourneen***

*(Dated April 1874 and written in Mary Ann's handwriting and repeated in Nina Somerset Sampson/Smiley's handwriting)*

England! Dear England! Thy loved shores are fading,  
Fast, fast from the ken of my tear-moistened eye;  
The sadness of exile my spirit is shading,  
Lowly I murmur a parting “Good-Bye!”  
Thou land of my fathers! With pride do I hail thee;  
I part from thee now with a heart-broken sigh:  
Fair home of my childhood! This heart shall bewail thee;  
Farewell to thee, England; dear England, “Good-Bye!”  
My childhood's loved home where fond memories dwell;  
Farewell to thee, England! Dear England, Farewell!

Afric! Fair Afric! The day-star is shining,  
That points to a glorious future for thee.

Thy sons by adoption may cease their repining,  
E'en for their loved home that lies o'er the sea.  
The treasures thou holdest, thou giv'st on the morrow,  
Of health and of wealth, with glorious hand;  
And thy sunny clime may well lighten their sorrow,  
When memory turns to the far-distant land.  
Thou land of fair promise! My home that shall be'  
All hail to thee, Africa! All hail to thee!

### ***Dinna forget***

We canna forget, when the world smiles sae bonnie,  
The days when that world brought ye naething but strife;  
We canna forget, when the cauld blast sweeps o'er ye,  
The warm breath o'summer that gladdened your life.  
Then "Dinna forget" when the young blood doth warm ye,  
That time's rapid flight is naething but a truth;  
And "Dinna forget" when auld age shall come to ye,  
The freedom, the joy and the love o'your youth.  
We canna forget, in the home o'your childhood,  
The far-distant kindred, in woe or in weal;  
We canna forget – if stern duty should call ye  
From Albion's shores - the loved land o'the leal.  
Then "dinna forget," when we sit here together,  
The days when the mountains laid 'twixt me and thee;  
And "Dinna forget," when I'm far o'er the heather,  
Then "Dinna," ah Dinna forget" to love me.

*"To M. A. P."*

*(Presumably, M. A. P. is Mary Ann Penning)*

### ***On her birthday***

The smiles of fortune seldom shone,  
On thee my loved, my nearest;  
Few flow'ers of life have e'er been strewn,  
Upon thy pathway, dearest.

But many griefs and many woes,  
You have endured from me, love;  
Amidst false friends and open foes,  
You have been true to me, love.

And when bereavement touch'd my heart –  
Far sadder than all other –  
When cruel Death's long-dreaded dart,  
Removed my darling Mother.

You bade me think this life was fraught,  
With suffering and with pain, love;  
You cheer'd me with the blessed thought,  
Of meeting her again, love.

In time of sickness and of pain,  
In sufferings severest;  
Your self-denying love again,  
Did watch o'er me my dearest.

Then many a day and midnight drear,



You sacrificed for me, love;  
Your smile caused me to banish fear,  
And wish to live for thee, love.

And I would thus my tribute pay,  
To thy true sterling worth, love;  
Upon this day, this happy day,  
The day that saw thy birth, love.

Let my devotion dry all tears,  
My heart doth cling to thee, love;  
Oh! Many, many, happy years,  
May you be spared to me, love.

### ***Silver wedding***

*(Possibly written in 1888, 25 years after Penning's wedding to Mary Ann.)*

Sparkling eyes 'neath arching eyebrows,  
Speaking plain 'though silently;  
Cheeks in colour like the blush-rose,  
Mouth of perfect symmetry:  
Such her face, and every feature  
Dearer was then life to me:  
I adored her, sweetest creature,  
Hers the face I loved to see.

Years have rolled by, five-and-twenty,  
"Silver-wedding" day hath come,  
With grey hairs perhaps in plenty,  
And of old Time's furrows some.  
Still – the past as present deceiving –  
Memory spans the years for me,  
Sleeping, waking, thinking, dreaming,  
That's the face I always see,

### ***Mary***

Star of the morning whose pale silver ray  
Gives hope and promise of glorious day!  
Star of the evening whose gay golden light  
Heralds the advent of peace-yielding night!  
Stars of the midnight stey! Stars without end!  
Cheer ye my darling! Your loving rays send  
Rendering homage from bright worlds afar  
Unto my Mary! my own brightest Star!

### ***One less***

In silence we stood by the window,  
Without how the night-winds did rave!  
We thought of the snow that was falling,  
So softly on one little grave.

In spirit we mourned for our darling,  
Whose sojourn so brief was below: -  
He came unto us like a sunbeam,  
Then melted away like the snow!

### ***A birthday fancy***

*Dated March 9<sup>th</sup> 1871.*

Bright the morning,  
Early morning,  
Of this day in op'ning spring:  
Red the dawning,  
Fiery warning,  
Of a storm that noon would bring.

Token cheerful!  
Portent fearful!  
Mingling thus they seem'd to say:  
'Many happy,  
Some unhappy,  
Annivers'ries of this day.'

In the morning,  
Life's young morning,  
Years swept by with swiftest tread;  
But at mid-day'  
Stormy mid-day,  
Through much strife and sorrow sped.

Token truthful!  
Portent ruthful!  
While in mingling seem'd to say;  
'Many happy,  
Some unhappy,  
Annivers'ries of this day.'

But the evening,  
Welcome evening,  
Of that day in early spring;  
Was it cheery?  
Was it dreary?  
Would it joy or sorrow bring?

What was looming,  
In the glooming?  
Potent, omen, token, say!  
Many happy,  
Or unhappy,  
Annivers'ries of this day?

Lovely twilight,  
Placid twilight,  
Follow'd on the stormy scene;  
Rough winds dying,  
Gently sighing,  
All the hills and groves between.

Sweet foretoken  
Of unbroken  
Peace to close Life's rugged way!  
And of happy  
Many happy  
Annivers'ries of this day.

### ***Golden wedding***

As the rainbow, from the hollow,  
Bathed in sunlight, fades away;  
So the years that quickly follow,  
Leave no trace of their brief stay.  
Fifty years have swept with lightness,  
O'er my loved one and o'er me;  
Since the day when all was brightness,  
For this is our Jubilee.

Time has set slight marks upon her,  
I at least no change have seen;  
Since we vow'd to cherish, honour,  
And to love, - t'was yestere'en.  
Youth looks forward, hoping merely  
For that which may never be:  
We have lived, and loved right dearly;  
Hail we then our Jubilee!

### ***In memory of my mother***

Backward my glance I turn,  
Steadfastly, steadfastly;  
And how my heart doth burn,  
Earnestly, earnestly,  
Borne back on swiftest wing;  
Faithfully, faithfully,  
My fondest mem'ries cling,  
To thee, dear Mother!

After the lapse of years,  
Frequently, frequently;  
Burst forth anew my tears,  
Lovingly, lovingly;  
When with the eye of love,  
Dreamily, dreamily;  
I see thy face above,  
My dearest Mother!

When thy sweet smile I see,  
Cheering one, cheering one;  
On towards meeting thee,  
Hopefully, hopefully;  
Onwards through weal or woe,  
Fearlessly, fearlessly;  
Beckoned by thee I go,  
My dearest Mother!

As the swift years glide by,  
Silently, silently;  
And as the end draws nigh;  
Readily, readily,  
Leaving this world of sin,  
Willingly, willingly;  
Trusting my way to win,  
To thee, dear Mother!

### **Toby**

"To be or not to be," as Hamlet says,  
But Toby or not Toby's now the thing  
We seek to know. His loss for many days  
We mourned, but hoped they still him back might bring  
For Lucre's sake (if not for honest ways  
To walk in), as 'tis now the rule to fling  
Our gold unto the scamps who steal our poodles,  
As a "reward." We certainly are noodles!

He's not returned, and that which makes it sad  
Unto our minds, is his uncertain fate:  
Is he detained in durance by some cad?  
Or has he passed thro' that remorseless gate,  
Unto "the bourne whence daggies n'er return"?  
Or been the victim of some murd'rous hate?  
Whatever his lot, as dead we must him mourn.  
Convinced that he to us will n'er return.

Our Toby's coat was black, his feet were tan,  
His collar red, from which a silver bell  
Suspended was, that tinkled as he ran  
And played about us. And his tail did tell  
A tale of sadness; by some evil man  
It had been injured so it n'er got well  
But crooked still remained; a certain test  
And surely of all tell-tales 'twas the best.

Though hard upon each mouse that he could find,  
Our "manney" had few failings, virtues many;  
He'd bark at strangers – when he felt inclined –  
Of vices I much doubt if he had any.  
When lost at times for home he ever pined,  
But now his chance seems scarcely worth a penny.  
"In pace requiescat" – toll the bell –  
And call his young successor mournful (k)nell.

### **An invocation**

*Published in: Tinsley's Magazine, Vol 19, July-December 1876, page 99.*

O Time! whose mighty power  
Extends o'er all below,  
Whose every fleeting hour  
Some wondrous changes show,-  
I ask no craven blessing:  
Let Sorrow, Pain, and Care  
On me their marks impressing,  
Tenfold my rightful share,  
So that the lot be lighter  
Of her I call my own;  
The sunny spots be brighter,  
And darker ones unknown!  
O Time, thou arch-destroyer!  
This boon I crave of thee:  
Deal gently with my darling,  
And spare her long to me.

## *Twilight*

In that hour most enchanting,  
From sunset to the fall  
Of darkest shades of evening,  
And night's enshrouding pall;  
When twilight soothes the spirit,  
From care and toil set free, -  
Then think of me, my darling,  
For then I dream of thee.

When first the star of evening  
Preludes the coming night,  
And the pale moon, increasing,  
'Gins shed her silvery light;  
When, on each green bank shining,  
The glowworm's lamp we see, -  
Then think of me, my darling,  
For then I dream of thee.

When owls dart from their cover,  
And raise their plaintive cry;  
When night-hawks hover over,  
Or swiftly skim the sky;  
When from his lair is stealing  
The fox on yonder lee, -  
Then think of me, my darling,  
For then I dream of thee.

When ravens croak and mutter,  
And bats are on the wing;  
When moths around us flutter,  
And crickets loudly sing;  
When nightingales are piping  
Their love from tree to tree, -  
Then think of me, my darling,  
For then I dream of thee.

## References

British Geological Survey holds most of the references listed below, and copies may be obtained via the library service subject to copyright legislation (contact [libuser@bgs.ac.uk](mailto:libuser@bgs.ac.uk) for details). The library catalogue is available at: <https://envirolib.apps.nerc.ac.uk/olibcgj>.

ANON. 1865a. Postal and commercial directory of Wiltshire containing a brief descriptive account of each town, parish, village and hamlet followed by a directory. London: Harrod, J. G. and Co.

ANON. 1865b. Review of the paper by T Codrington on "The geology of the Berks and Hants Extension and Marlborough railways." *Geological Magazine*, Vol. 2, 504-507.

ANON. 1869. Specification of William Henry Penning – Signalling. No. 81. London: Great Seal Patent Office.

ANON. 1902a. Untitled obituary of William Henry Penning. *Nature*, 1 May, No. 1696, Vol. 66, p15.

ANON. 1902b. Obituary William Henry Penning. *Geological Magazine*, Vol. 39 (or Decade 4, Vol 9), p335.

ANON. 2006. The history of Eye Grammar School <http://www.egosa.onesuffolk.net/egs-history/> (downloaded 5 July 2013)

BAILEY, E. 1952. *Geological Survey of Great Britain*. London: Thomas Murby & Co. 278p.

- BENNETT, F. J. and BLAKE, J. H. 1886. The geology of the country between and south of Bury St Edmunds and Newmarket. *Memoir of the Geological Survey of England and Wales*. Explanation of quarter sheet 51SE. London: Her Majesty's Stationery Office.
- BERESFORD, P. 1993. *Pewsey through the ages*. Pewsey, Wiltshire: Pewsey Heritage Centre (reprinted 2002).
- BOUVERIE, B. P. 1890. *A few facts concerning the Parish of Pewsey in the County of Wilts*. Privately published by the author. Republished with permission by the Pewsey Heritage Centre, Pewsey (2008).
- BRISTOW, H. W., WHITTAKER, W., POTWHELE, T. R., TRENCH, R. DAWKINS, W. B., PENNING, W. H., WOODWARD, H. B., BENNETT, F. J., USSHER, W. A. E., BLAKE, J. H. and HAWKINS, C. E. 1873a. London and its environs. 1:63 360 scale geological map (drift). London: Geological Survey of England and Wales. (Accompanied by a text: Guide to the geology of London and the neighbourhood.)
- BRISTOW, H. W., WHITTAKER, W., POTWHELE, T. R., TRENCH, R. DAWKINS, W. B., PENNING, W. H., WOODWARD, H. B., BENNETT, F. J., USSHER, W. A. E., BLAKE, J. H. and HAWKINS, C. E. 1873b. London and its environs. 1:63 360 scale geological map (solid). London: Geological Survey of England and Wales. (Accompanied by a text: Guide to the geology of London and the neighbourhood.)
- CHRIMES, M. M. 2008. Sir Charles Hutton Gregory. 352-353 in: *Biographical dictionary of civil engineers*, Cross Rudkin, P. S. M. and Chrimes, M. M. (editors), Vol. 2: 1830-1890.
- CODRINGTON, T. 1865. The geology of the Berks and Hants extension and Marlborough railways. *Magazine of the Wiltshire Archaeological and Natural History Society*, Vol. 9, 167-193.
- CULSHAW, M. G. 2004. The first engineering geological publication in the UK? *Quarterly Journal of Engineering Geology and Hydrogeology*, Vol. 37, 227-231.
- DE FREITAS, M. H. and ROSENBAUM, M. S. 2008. Engineering geology at Imperial College London; 1907-2007. *Quarterly Journal of Engineering Geology and Hydrogeology*, Vol. 41, 223-228.
- DU TOIT, A. L. 1954. *The geology of South Africa*. 3<sup>rd</sup> Edition. Edinburgh: Oliver and Boyd.
- FLETT, J. S. 1937. *The first hundred years of the Geological Survey of Great Britain*. London: Her Majesty's Stationery Office. London. 280p.
- FOOKES, P. G., DE FREITAS, M. H. and CULSHAW, M. G. 2005. Discussion of "The first engineering geological publication in the UK?" by M. G. Culshaw in *Quarterly Journal of Engineering Geology and Hydrogeology*, Vol. 37, 227-231. *Quarterly Journal of Engineering Geology and Hydrogeology*, Vol. 38, 105-106.
- FORSTER, A. and REEVES, H. J. 2008. William Smith and the development of engineering geology in England. *Quarterly Journal of Engineering Geology and Hydrogeology*, Vol. 41, 165-170.
- GEIKIE, A. 1879. *Outlines of field geology*. (1<sup>st</sup> Edition). London: Macmillan and Co.
- GREENLY, E. & WILLIAMS, H. 1930. *Methods in geological surveying*. London: Thomas Murby & Co.
- GUPPY, E. M. 2000. BGS Archives GSM1/718, biographical notes on Geological Survey staff. British Geological Survey Technical Report WO/00/04 (Keyworth, Nottingham: British Geological Survey).
- HATCH, F. H. and CORSTORPHINE, G. S. 1909. *The geology of South Africa*. 2nd Edition. London: Macmillan and Co., London.
- HATHEWAY, A. W. 1990. Perspectives No. 5. Weak rock, poorly lithified cockroaches and snakes. *AEG News*, Vol. 33/3, July, 33-36.
- JOHNSON, P. 2000. Civilizing Mammon: laws, morals and the city in nineteenth-century England. In: *Civil histories – essays presented to Sir Keith Thomas*. Burke, P., Harrison, B. H., Slack, P. & Thomas, K. (editors). Oxford: Oxford University Press.
- JUKES-BROWNE, A. J. 1883. On the relative ages of certain river-valleys in Lincolnshire. *Quarterly Journal of the Geological Society*, Vol. 39, 896-910.
- JUKES-BROWNE, A. J. 1885. (Part by Dalton, W. H.) The geology of the SW part of Lincolnshire with parts of Leicestershire and Nottinghamshire. *Memoir of the Geological Survey of England and Wales*. Explanation of quarter sheet 70. London: Her Majesty's Stationery Office.
- JUKES-BROWNE, A. J. 1887. The geology of parts of East Lincolnshire, including the country around the towns of Louth, Alford and Spilsby. *Memoir of the Geological Survey of England and Wales*. Explanation of sheet 84. London: Her Majesty's Stationery Office.
- KELLY, E. R. (ed.) 1869. *The Post Office Directory of Cambridge, Norfolk and Suffolk*. London: Kelly & Co.
- KELLY, E. R. (ed.) 1878. *The Post Office Directory of Middlesex*. 9<sup>th</sup> Edition. London: Kelly & Co.
- KENT, L. E. and HUGO, P. J. 1978. Aspects of the revised South African stratigraphic classification and a proposal for the chronostratigraphic subdivision of the Precambrian. *Contributions to the geologic time scale*. 367-379 in: Editors: Cohee, G. V., Glaessner, M. F. & Hedberg, H. D. (editors). Papers given at the Geologic Time Scale Symposium 106.6, 25<sup>th</sup> International Geological Congress, Sydney, Australia, August 1976. *Studies in Geology*, Vol. 6, 367-379. Oklahoma: American Association of Petroleum Geologists.

- KIERSCH, G. A. 1955. Engineering geology. Historical development, scope, and utilization. *Quarterly of the Colorado School of Mines*, Vol. 50, 3, 1-123.
- KOSZELA, J. and KOSZELA-MAREK, E. 2009. Engineering and geotechnics in civil engineering. *Studia Geotechnica et Mechanica*, Vol. 31, 4, 17-23.
- LAPWORTH, H. 1908. The principles of engineering geology. Two lectures to the students of the Institution in session 1907-8. *Minutes of the Proceedings of the Institution of Civil Engineers*. Vol. 173, 298-327.
- LYELL, C. 1836. Address to the Geological Society on the 19th Feb., 1836. *Proceedings of the Geological Society of London*, Vol. 2, 44, 357-90. (Key passage is on page 358).
- MELLOR, E. T. 1917. *The geology of the Witwatersrand. An explanation of the geological map of the Witwatersrand Goldfield*. Pretoria: South African Geological Survey. 46p.
- MITCHELL, V. and SMITH, K. 2001. *Western main lines: Newbury to Westbury including the Marlborough Branch*. Midhurst, West Sussex, UK: Middleton Press.
- PENNING, W. H. 1870. Geological note and map. In *Buchanan, G., Report of an epidemic of typhoid fever at Wicken Bonant. Report of the Medical Officer of the Privy Council for 1869*, p. 72. London: Her Majesty's Stationery Office.
- PENNING, W. H. 1872. *Notes on nuisances, drains and dwellings: A short popular treatise, on the form and origin of the various nuisances arising in houses, from imperfect drains and other causes, with practical hints for their detection and cure*. London: Baillière, Tindall and Cox. 32p
- PENNING, W. H. 1876a. *Field Geology*. London: Baillière, Tindall and Cox. 227p.
- PENNING, W. H. 1876b. Notes on the physical geology of east Anglia during the Glacial Period. *Quarterly Journal of the Geological Society*, Vol. 32 Issue 1-4, 191-203 (with discussion 203-204).
- PENNING, W. H. 1876c. Concretions. *Geological Magazine*, Decade II, Vol. III, 218-220
- PENNING, W. H. 1876d. Apparent and true dip. Undated letter with three diagrams. *Geological Magazine*, Decade II Vol. III, 236-237.
- PENNING, W. H. 1876e. True and apparent dip. Letter dated 15 June 1876. *Geological Magazine*, Decade II Vol. III, 383.
- PENNING, W. H. 1876f. Waste of insular land by the sea. Undated letter with map. *Geological Magazine*, Decade II Vol. III, 282-284.
- PENNING, W. H. 1876g. Darwinism. *Tinsley's Magazine* (which was published from 1868 to 1884), Vol. 19, July-December, 515-523
- PENNING, W. H. 1876h. An Invocation. *Tinsley's Magazine*, Vol 19, July-December, 99.
- PENNING, W. H. 1877a. Hidden treasure. *Tinsley's Magazine*, Vol 20, January-June, 138-144.
- PENNING, W. H. 1877b. Science. *Tinsley's Magazine*, Vol 20, January- June, 421-424.
- PENNING, W. H. 1877c. A snow storm in spring. *Tinsley's Magazine*, Vol. 20, July-December, 424.
- PENNING, W. H. 1878. The divining rod. Letter dated 6 September 1878 with extract from the Marlborough Times. *Geological Magazine*, Decade II, Vol. V, 480.
- PENNING, W. H. 1879a. Engineering geology. Part I. *The Engineer*, Vol. 47, (part 1, Jan to June 1879), 20-21, 10 January.
- PENNING, W. H. 1879b. Engineering geology. Part II. *The Engineer*, Vol. 47, (part 1, Jan to June 1879), 93, 7 February.
- PENNING, W. H. 1879c. Engineering geology. Part III. *The Engineer*, Vol. 47, (part 1, Jan to June 1879), 168, 7 March.
- PENNING, W. H. 1879d. Engineering geology. Part IV. *The Engineer*, Vol. 47, (part 1, Jan to June 1879), 202-203, 21 March.
- PENNING, W. H. 1879e. Engineering geology. Part V. *The Engineer*, Vol. 47, (part 1, Jan to June 1879), 256, 11 April.
- PENNING, W. H. 1879f. Engineering geology. Part VI. *The Engineer*, Vol. 47, (part 1, Jan to June 1879), 404, 6 June.
- PENNING, W. H. 1879g. Engineering geology. Part VII. *The Engineer*, Vol. 47, (part 1, Jan to June 1879), 468, 27 June.
- PENNING, W. H. 1879h. Engineering geology. Part VIII. *The Engineer*, Vol. 48, (part 2, Jul to Dec 1879), 60-61, 25 July.
- PENNING, W. H. 1879i. Engineering geology. Part IX. *The Engineer*, Vol. 48, (part 2, Jul to Dec 1879), 139-140, 22 August.
- PENNING, W. H. 1879j. *Text book of Field Geology with a Section on Palaeontology by A J Jukes-Browne*. London: Baillière, Tindall and Cox. 319p. (2nd Edition of 1876 book)
- PENNING, W. H. 1880a. *Engineering geology*. London: Baillière, Tindall and Cox. 104p.
- PENNING, W. H. 1880b. Diatoms in the London Clay. Letter to the Editor. *Nature*, Vol. 21, 494 (25 March 1880)

- PENNING, W. H. 1881. *Report on gold near Pretoria*. Pretoria: Transvaal Book Almanac. 107p.
- PENNING, W. H. 1883. *A guide to the goldfields of South Africa, with map*. Printed by J F Celliers, Church Street, Pretoria.
- PENNING, W. H. 1884a. A sketch of the high-level coal-fields of South Africa. *Quarterly Journal of the Geological Society*, Vol. 40, 658-673.
- PENNING, W. H. 1884b. The Transvaal gold-fields; their past, present, and futures. *Journal of the Society of Arts*, Vol. 32, 608-621.
- PENNING, W. H. 1885. A sketch of the goldfields of Lydenburg and De Kaap, in the Transvaal, South Africa. *Quarterly Journal of the Geological Society*, Vol. 41, 569-590.
- PENNING, W. H. 1886. Letter to J Mackenzie dated 6 March. *University of Witwatersrand Historical Papers*. Letter no. 1195, Collection No. A75, Collection Index: Mackenzie Rev. John, 1854-1890, Collection Name: Rev. John Mackenzie papers. <http://www.historicalpapers.wits.ac.za/inventory.php?iid=6783> (downloaded 5 July 2013)
- PENNING, W. H. 1887. Notes upon a few stone implements found in South Africa. *The Journal of the Anthropological Institute of Great Britain and Ireland*, Vol. 16, 68-70.
- PENNING, W. H. 1888. The South African goldfields. *Journal of the Society of Arts*, Vol. 36, 433-443.
- PENNING, W. H. 1890. Geology and gold mining: On the geology of the Witwatersrand, with reference to gold mining. *Witwatersrand Mining and Metallurgical Review*, Vol. 1, part 9 (September), 11-12, continued in part 10 (October), 12-14.
- PENNING, W. H. 1891. A contribution to the geology of the Southern Transvaal. *Quarterly Journal of the Geological Society*, Vol. 47, 451-463.
- PENNING, W. H. 1893a. 'The Kalahari Desert,' *African Review*, February 1893.
- PENNING, W. H. 1893b. *Stanford's (1888) map of the Transvaal goldfields, with the geology of the southern part of the Transvaal. Scale 1 inch = 16 miles (with accompanying memoir)*. London: E. Stanford.
- PENNING, W. H. 1893c. *The geology of the southern Transvaal*. London: E. Stanford. 37p.
- PENNING, W. H. 1894. *Field geology*, 2<sup>nd</sup> edition (revised and enlarged). London: Baillière, Tindall and Cox. 325p.
- PENNING, W. H. 1898. Exhibition of stone implements from South Africa. *The Journal of the Anthropological Institute of Great Britain and Ireland*, Vol. 28, 54.
- PENNING, W. H. 1901. *Gold and diamonds*. South African facts and inferences. London: Baillière, Tindall and Cox, 77p.
- PENNING, W. H. and JUKES-BROWNE, A. J. 1881. The geology of the neighbourhood of Cambridge. *Memoir of the Geological Survey of England and Wales*. Explanation of quarter sheet 51SW (and part of sheet 51NW). London: Her Majesty's Stationery Office. 184p.
- PIGOT. 1823/4. *Pigot's Directory of Suffolk*. London and Manchester: Pigot.
- PIGOT. 1839. *Pigot's Directory of Suffolk*. London and Manchester: Pigot.
- REIS, H. and WATSON, T. L. 1914. *Engineering geology*. New York: John Wiley & Sons Inc.
- ROBSON. 1839. *Robson's Commercial Directory of the six counties forming the Norfolk circuit: viz: Beds, Bucks, Cambridgeshire, Hunts, Norfolk, and Suffolk, with Oxfordshire*. London: Robson.
- ROGERS, A. W. 1936. The pioneers in South African geology and their work. *Transactions of the Geological Society of South Africa*, Annexure to Vol. 39, 1-139.
- SERGEEV, E. M. 1974. Teaching and training in engineering geology. 1-14 in *Proceedings of the 2<sup>nd</sup> Congress of the International Association of Engineering Geology*, Vol. 1, 1-GR. (Sao Paulo: Associação Brasileira de Geologia Engenharia, Instituto de Pesquisas Tecnológicas).
- SERGEEV, E. M. 1984. Theoretical fundamentals and problems of engineering geology. 35-49 in *Proceedings of the 27<sup>th</sup> International Geological Congress*, Moscow, Vol. 17, (Utrecht: VNU Science Press).
- TUCKER R. F., VILJOEN, R. P. and VILJOEN, M. J. 2016. A review of the Witwatersrand Basin – the World's greatest goldfield. *Episodes*, Vol. 39(2), 105-133.
- USSHER, W. A. E., JUKES-BROWNE, A. J. and STRAHAN, A. 1888. The geology of the Country around Lincoln. *Memoir of the Geological Survey of England and Wales*. Explanation of Sheet 83 (in part from notes by W. H. Penning, W. H. Dalton & A. C. G. Cameron). London: Her Majesty's Stationery Office.
- WHITAKER, W., DAWKINS, W. B. and PENNING W. H. 1868. Explanation of Sheet 1NW. *Memoir of the Geological Survey of England and Wales*. London: Her Majesty's Stationery Office.
- WHITAKER, W., PENNING, W. H. and BENNETT, F. J. 1878. The geology of the North-Western part of Essex and the North Eastern parts of Cambridgeshire and Suffolk. *Memoir of the Geological Survey of England and Wales*. Explanation of Sheet 47. London: Her Majesty's Stationery Office.



- WHITAKER, W., WOODWARD, H. B., SKERTCHLY, S. B. J. and JUKES-BROWNE, A. J. 1891. The geology of parts of Cambridgeshire and Suffolk. *Memoirs of the Geological Survey of England and Wales*, Explanation of quarter sheet 51NE (with part of 51NW). London: Her Majesty's Stationery Office.
- WHITE, W. 1844. *History, gazetteer, and directory of Suffolk & the towns near its borders*. Sheffield: William White.
- WHITE, W. 1855. *History, gazetteer, and directory of Suffolk & the towns near its borders*. Sheffield: William White.
- WILSON, H. E. 1985. *Down to earth, one hundred and fifty years' of the British Geological Survey*. Edinburgh: Scottish Academic Press.
- WOODWARD, H. B. 1897. *Soils and subsoils from a sanitary point of view: with especial reference to London and its neighbourhood*. 1<sup>st</sup> Edition. London: Her Majesty's Stationery Office.
- WOODWARD, H. B. 1906. *Soils and subsoils from a sanitary point of view: with especial reference to London and its neighbourhood*. 2<sup>nd</sup> Edition. London: Her Majesty's Stationery Office.
- WOODWARD, H. B. 1912. *The geology of soils and substrata with special reference to agriculture, estates and sanitation*. Arnold's Geological Series. London: Edward Arnold.
- WYMER, J. J. and WEST R. J. 1999. A memorial to John Frere. Past, *The Newsletter of the Prehistoric Society*, 33, December edition.