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Subterranea

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In This Issue

The Newsletter of Subterranea Britannica and The Cold War Research Study Group.
www.subbrit.org.uk

Subterranea Britannica is a society devoted to the study of man-made and man-used, underground structures and the archaeology of the Cold War. The main focus of interest is on abandoned and forgotten structures and, in the case of Cold War structures, studies are entirely confined to declassified and decommissioned structures.
The society is open to all and its membership includes all walks of life. Members are invited to contribute to this newsletter even if this just means sending very welcome snippets from newspapers and magazines.

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Contents

Front Cover Photo - The scout mine This picture shows the view in the Council chamber. Two Nissan huts were assembled to provide shelter and chalk heaped on top to provide increased protection. All the wooden remains in the foreground are old tea chests that were used for storage. Over the years these are continuing to rot away. During the early 1990's it was possible to read scraps of paper that had not been removed. Most of these scraps were just a few inches across and fell apart if you tried to pick them up. photo by Nick Catford

News

OBITUARIES

David Bick (c. 1932 - 2006)

The death of David Bick on 19 January 2006, aged 74, has been announced. He was a founder and leading personality in the Welsh Mines Society, assisted with the formation of the Welsh Mines Preservation Trust, and a prolific author on mining and railway topics.

Source: ANON, 2006, Stop press: David Bick. *Industrial Archaeology News* 136, page 15.

Stuart Chrystall (1937 - 2005)

Rodney Stuart Benjamin Chrystall grew up in Newcastle, and died unexpectedly aged 68 on 13 August 2005 during a walking holiday in Austria.
Stuart, having retired from his post as a chemistry lecturer at the University of Surrey in 2002, was a recently enrolled member of Subterranea Britannica and joined our 2005 long weekend in France in May. He had a life-long interest in railways and industrial archaeology, at least from his student days (Gonville & Caius) when he was an active member of the Cambridge University Railway Club. He was also an active member of the Association for Industrial Archaeology, Historical Metallurgy Society, Railway and Canal Historical Society and the Surrey Industrial History Group. He was a committee member and treasurer of the Surrey group.

Source: CHRYSTALL, Rodney Stuart Benjamin [1937 - 2005], Obituary. *Bull. Railway and Canal Historical Society* 399, page 2.

NEWS - ARCHAEOLOGY

Late Quaternary - Mesolithic sediments and artefacts at Aveline's Hole, Burrington Combe, north Somerset

A complete issue of the *Proceedings of the University of Bristol Spelaeological Society* is devoted to three papers on the Quaternary stratigraphy and archaeology of cave sediments excavated in Aveline's Hole, a natural cave in Burrington Combe on the north side of the Mendip Hills.

Sources: D.T. Donovan, 2005, Aveline's Hole, Burrington Combe, north Somerset: stratigraphy and problems. *Proc. University of Bristol Spelaeological Soc.* 23(3), 159 - 170; R.M. Jacobi, 2005, Some observations on the lithic artefacts from Aveline's Hole, Burrington Combe, north Somerset. *Proc. University of Bristol Spelaeological Soc.* 23(3), 267 - 295; R.J. Schulting, 2005, 'Pursuing a rabbit in Burrington Combe': new research on the early Mesolithic burial cave of Aveline's Hole. *Proc. University of Bristol Spelaeological Soc.* 23(3), 267 - 295.

New prehistoric cave art discovery reported from the Vilhonneur Forest near Angoulême, France

An amateur caver, 63-year-old Gerard Jourdy, has claimed to have found prehistoric human remains and cave art in a cave in the Vilhonneur forest, 12 miles east of Angoulême, in western France. The finds were reported in November 2005, but have been kept confidential and the site sealed to allow expert examination. If accepted as genuine, these remains are thought to date from around 27,000 years ago - several thousand years older than those of Lascaux.

Source: Kim WILLSHER, 2006, Prehistoric cave art discovered. *The Guardian*, 8 February 2006, page 18.

Archaeological excavation of 14th to 17th century materials from an infilled masonry tower and well at Thon (Belgium)

Excavations at the remains of fortifications overlooking the Meuse near Thon, some 22 kilometres east of Namur, are reported in the latest issue (61) of *Subterranea Belgica*, published by the Société Belge de Recherche et d'Étude des Souterrains. A masonry tower about 12 metres high, built against a cliff, and above an 11 or 12 metres deep well had been infilled with demolition rubble and other materials following the dismantling of the remainder of the fortifications at the end of the 17th century. The excavation of 94 tons of masonry blocks and other materials to a total depth of over 25 metres is reported, and the finds dating from the 14th to the 17th centuries illustrated.

Source: Guy DE BLOCK, 2005, La fouille de la Tour Lapidon, 1988 - 1998. Château de Samson à Thon / Andenne (Province de Namur.) *Subterranea Belgica* 61: 67pp.

Old and new tunnels in Turkey

Istanbul (population about 12 million) is a Turkish city, part in Europe and part in Asia, divided by the narrow Bosphorus seaway between the Black Sea and the Sea of Marmara. This stretch of water, at its narrowest, is 640 metres wide. The road bridge connections are almost permanently gridlocked. Work has commenced on a high speed and suburban railway tunnel to link the two parts of the city, and indeed to link Europe to Asia. This would incorporate

News

the biggest railway station in Turkey, and the first tunnel under the Bosphorus - the deepest under-sea tunnel in the world if or when completed, and built to withstand earthquakes rated at 9.0 on the Richter scale.

Istanbul was until 1930 known as Constantinople, and had been founded by Constantine I in AD 330 on the site of the ancient Byzantium, which dated back to c. 660 BC. This was, for some time, the capital of the Roman Empire. Parts of the city are designated a World Heritage Site. Preliminary site investigations at Yenikapi (on the European shore) have revealed an immensely important archaeological site, the former harbour of the ancient city, with both Byzantine and Roman remains. The intended new railway tunnel may be delayed or even diverted to allow the excavation and preservation of the site, which includes a 'maze of dams, jetties, and platforms' and an enigmatic tunnel. The ancient tunnel, 1.5 metres by 1.8 metres, seems too large to have been a sewer or aqueduct, and is of unknown function. The harbour is thought to have been the Byzantine Portus Theodosiacus, in use from the 4th to the 7th centuries.

Source: Ian TRAYNOR, 2006, Lost treasures of Constantinople test Turkey's 21st-century ambition. *The Guardian*, 25 January 2006, page 17.

63rd tomb discovered in the Valley of the Kings, Egypt

American archaeologists have discovered the first new tomb to come to light in the Valley of the Kings since the discovery of that of Tutankhamun in 1922. It dates from the 18th dynasty, and contains five mummies in intact sarchophagi, and more than 20 large storage jars bearing intact pharaonic seals. The site, about four metres below rubble and stones, is about five metres from Tutankhamun's tomb. It is a single chamber, probably intended for a single burial but later used for further interments over a period of 200 to 400 years.

Source: Lee KEATH, 2006, Archaeologists uncover first Valley of the Kings tomb since 1922 Tutankhamun find. *The Guardian*, ?? February 2006.

NEWS - MILITARY

World War II Nazi bunker re-discovered in Normandy

A forgotten German bunker dating from World War II has been re-discovered by Gary Sterne, a Briton resident in Normandy and Manchester after buying a 1940s German army map from an American soldier. The entrance was hidden by brambles near his French home, leading to what has been described as 'a labyrinth of bunker and control rooms' containing abandoned equipment. Included are 'an office, a supplies warehouse, general quarters, a radio room, other blocks, and even an underground hospital.' Boot soles, bottles, and spectacles were found. The complex is at Grandcamp-Naisy, near Omaha Beach, which came under attack on 5 June 1944, the day before the Normandy landings, and was finally overwhelmed on 9 June. The complex is said to be 'as big as the impressive German coastal battery at Pointe du Hoc.' Mr. Sterne, who has now purchased the site, plans to open the tunnels as a tourist attraction.

Grandcamp-Maisy is on the coast, north-east of Isigny-sur-Mer; Pointe-du-Hoc is some four kilometres further east.

Source: Kim Willsher, 2006, Briton unearths Nazi bunker lost for 60 years. *The Guardian*, 24 January 2006, page 14.

Israel's secret underground nuclear reactor

An article in *The Guardian* of 4 August 2005 noted Israel's 'secret underground reactor' at Dimona in the Negev desert. An accompanying air photograph of the site is captioned 'Satellite pictures of Israel's secret Dimona nuclear plant in the Negev desert taken in 2000. The heavy water sold by Britain in the 1960s went to an underground reactor and was crucial in allowing Israel to develop its first nuclear weapons.'

The UK had purchased the heavy water from Norway, where this material is relatively inexpensive to isolate as a result of that country's cheap hydro-electric power. The Dimona complex had been started in 1958 'for a top-secret French team to start constructing what France was later to claim it believed to be a small "research reactor." ' France supplied four tons of heavy water.

Larger quantities were required for a reactor capable of producing weapons plutonium, and in September 1958 Israel negotiated the purchase of a further 25 tons of Norwegian heavy water via the UK. Israel 'is now believed to have a secret stockpile of up to 130 nuclear weapons.'

Source: David LEIGH, 2005, How the UK gave Israel the bomb + US kept in the dark as secret nuclear deal was struck *The Guardian*, 4 August 2005, page 8.

News

NEWS - MINING

UK mines and other sub-surface mineral extraction sites (other than water wells) at work in 2005

Paul W. SOWAN

The latest (seventh) edition of the British Geological Survey's *Directory of mines and quarries,* issued in 2005, includes entries for about 2,400 mineral extraction sites, including 47 mines, 74 natural gas and oil extraction points, and three brine-wells in England, Wales, Scotland, Northern Ireland, the Channel Islands, and the Isle of Man, operated by about 1,000 companies.

Energy resources (coal, oil, natural gas, and peat) dominate, accounting for £ 22,818m by value of products, followed by aggregates and construction minerals (£ 1,966m) and industrial minerals (£ 657m), with metalliferous minerals trailing at less than £ 0.2m.

The 47 straightforward mines listed are for the following products:

Product	Nature of product	No
Anhydrite	calcium sulphate	1
Barytes	barium sulphate	1
Coal (deep-mined)	coal	17
Fireclay	aluminium oxide	1
Fluorspar	calcium fluoride	1
Gold	gold	3
Gypsum	calcium sulphate 2-hydrate	5
Iron ore (hematite)	iron III oxide	1
Limestone	calcium carbonate	8*
Potash	potassium chloride	1
Salt (rock-salt)	sodium chloride	3
Silica sand	silicon dioxide	1
Slate	slate	3

* including Middleton mine at Wirksworth, which closed during 2005.

The mines, in the traditional sense of the word, are as follows, listed by products:

Product	Mine	Location	
Anhydrite	Newbiggin/Kirby Thore	Appleby, Cumbria	
Coal	Aberpergwm	Glynneath, Neath	
Coal	Blaentillery no. 2	Blaenavon, Torfaen	
Coal	Daw Hill	Arley, Warwicks	
Coal	Eckington / Westthorpe	Eckington,Derbys	
Coal	Gleision	Ystalyfera, Neath	
Coal	Harworth	Bircotes, Notts	
Coal	Hatfield	Stainforth, Doncaster	
Coal	Hay Royds	Clayton West, Kirklees	
Coal	Kellingley	Knottingley, N. Yorks	
Coal	Maltby	Maltby, Rotherham	
Coal	Monument/Haynes	Bailey Coleford, Gloucs	
Coal	Nant-Hir no. 2 / Nanthir	Seven Sisters, Neath	
Coal	Rossington	Rossington, Doncaste	
Coal	Thoresby	Edwinstowe, Notts	
Coal	Tower	Hirwaun, Rhondda	
Coal	Tower Drift	Hirwaun, Rhondda	
Coal	Welbeck	Mansfield, Notts	
Fireclay	Shibden no. 2 / Springfield no. 2	Halifax, Calderdale	
Fluorspar	Rogerley	Frosterley, Durham	
Gold	Clogau St. David's / Llechfraith	Bontddu, Snowdonia	
Gold	North Maestryfer / Cambrian	Dolgellau, Snowdonia	
Gold	South Maestryfer / Cambrian	Dolgellau, Snowdonia	
Gypsum	Barrow upon Soar	Barrow, Leics	
Gypsum	Birkshead / Kirby Thore	Appleby, Cumbria	
Gypsum	Brightling / Robertsbridge	Robertsbridge, E Sx.	
Gypsum	Fauld	Tutbury, Staffs	
Gypsum	Marblaegis / East Leake Hotchley	East Leake, Notts	
Iron ore	Florence / Ullcoats no 1	Egremont, Cumbria	
Limestone	Bowers	Portland, Dorset	
Limestone	Elm Park	Corsham, Wilts	
Limestone	Middleton *	Wirksworth, Derbys	*closed during 2005.
Limestone	Monks Park	Corsham, Wilts	
Limestone	Stoke Hill / Hayes Wood	Limpley Stoke, Bath	
Limestone	Stonehills	Portland, Dorset	
Limestone	Teffont / Chilmark	Chilmark, Wilts	
Limestone	Westwood	Bradford on Avon, Wilts	
Potash	Boulby	Loftus, N Yorks	
Salt (rocksalt)	Boulby	Loftus, N Yorks	
Salt (rocksalt)	Kilroot	Carrickfergus, NI	
Salt (rocksalt)	Winsford / Meadowbank	Winsford, Cheshire	
Silica sand	Loch Aline	Loch Aline, Highland	
Slate	Aberlleffeni	Machynlleth, Gwynedd	
Slate	Honister / Kimberley Adit	Borrowdale, Lakes	

News

Notes

A number of mines effectively 'balance the books' by running tourist operations as well as mineral extraction, including the Florence ironstone mine at Egremont (Cumbria), the Llechwedd slate mines at Blaenau Ffestiniog (North Wales) and probably at least one of the gold mines in Wales.

A number of minerals once worked underground are now extracted only from opencast pits, including ball clay, calcite, and fullers' earth. Until about the First World War, even chalk was commonly mined. The evaporite minerals anhydrite, gypsum, potash, and rock-salt can only be mined as, being soluble in water, they do not outcrop at surface. Most of the UK's salt, however, is extracted by 'solution mining' and pumped to the surface via the three brine wells in Cheshire. Rock-salt, primarily if not exclusively for de-icing roads, is mined at Kilroot mine at Carrickfergus in Northern Ireland, and at Meadowbank mine at Winsford in Cheshire. It is also produced, as a by-product, by the Boulby potash mine in the Cleveland area. Limestone, for use as dimension stone, is still mined or quarried underground at several locations in Somerset and Wiltshire, with two new underground quarries opened recently on the Isle of Portland, Dorset. Underground working for this material continues as building limestones of the best qualities are extracted from below the near-surface beds deteriorated by Ice Age and later deep weathering; and also (on Portland) to conserve the surface landscape value. The silica sand mine at Loch Aline, in the Highland Region of Scotland, sends high purity sand for glass-making out by sea to works in and around Lancashire.

Although there are now only 17 deep coal mines listed, much more is of course worked from opencast pits. Methane is extracted for sale from 15 abandoned or active colliery sites, as well as from gas- and oil-fields at 16 sites. Oil is pumped from 43 sites.

Source: D.G. CAMERON, E.L. BARTLETT, D.E. HIGHLEY, G.K. LOTT, and A.J. HILL, 2005, *Directory of mines and quarries, 2005. 7th edition*. Keyworth: British Geological Survey: (ii) + xix + 114 + 44 + 53pp.

Continuing or even expanding use of coal in the United Kingdom as an energy source

Methane has long been a source of danger in UK coal mines, and continues to be responsible for far too many underground explosions at collieries worldwide. It is for this reason that, at least in the western world, efficient coal-mine ventilation has long had a very high priority. This, effectively, has simply discharged colliery workings methane to atmosphere, where it forms one of the most important gases responsible for global warming. Another sources, as is well-known, is flatulent cows!

In view of the rapid run-down of oil and natural gas resources, and increasing fuel prices, it has been realised that, for immediate economic reasons as well as any concern about the 'greenhouse effect' on the world's climate, it would make sense to collect and make use of this natural gas from the world's coal-fields.

According to a recent publication (Gayer & Harris, 1997) resources of coalbed methane contained within our remaining coal seams 'may be as high as' 250 million million cubic metres worldwide - 'many times greater than the collective reserves of all the known conventional gas fields.'

Exploitation of this energy resource has been pioneered in the USA, and has now been taken up in the UK. Exploitable coalbed methane is divided into three categories:

(1) **Abandoned mine methane**. This, obviously enough, is methane tapped from mines abandoned for coal extraction, which of course implies the retention of methane plants at surface after all the other pithead installations are removed. In 2005 there were methane plants in operation at seven abandoned British collieries - Markham at Bolsover and Shirebook (Derbyshire); Annesley-Bentinck at Kirby in Ashfield (Nottinghamshire); Barnsley and Hickleton (Barnsley Borough Council district); Wheldale at Castleford (Wakefield); and Llay Main at Wrexham.

(2) **Coal mine methane (or mine drainage gas.)** This is methane now extracted from air pumped from seven of the 16 deep coal mines still working, these in 2005 being Harworth, Thoresby and Welbeck (Nottinghamshire); Rossington (Doncaster); Kellingley (at Knottingley, North Yorkshire); Maltby (Rotherham): and Tower colliery at Hirwaun (Rhondda Cynon Taf CBC.)

(3) **Coalbed methane**. Methane is also tapped from unworked seams in the Airth gasfield near Falkirk, Scotland.

Source: D.G. CAMERON, E.L. BARTLETT, J.S. COATS, D.E. HIGHLEY, G.K. LOTT, D. FLIGHT, J. HILLIER, and J. HARRISON, 2002, *Directory of*

News

mines and quarries, 2002 6th edition. Keyworth: British Geological Survey: xx + 101 + 39 + 50pp [ISBN 0-85272-445-4]

Source: D.G. CAMERON, E.L. BARTLETT, D.E. HIGHLEY, G.K. LOTT, and A.J. HILL, 2005, *Directory of mines and quarries, 2005. 7th edition.* Keyworth: British Geological Survey: (ii) + xix + 114 + 44 + 53pp.

Source: R. GAYER and I. HARRIS (edrs), 1996, Coalbed methane and coal geology. London: *Geological Society Special Publication* 109: viii + 344 [ISBN 1-897799-56-X]

Russians to control British coal?

The Siberian company Kuzbassrazrezugol (KRU), Russia's second biggest coal-mining concern, has secured the services of Richard Budge, a former chief executive of UK Coal when it was called RJB Mining, by buying a 51% stake in his company Powerfuel. Powerfuel was established to re-commence mining at the Hatfield colliery in South Yorkshire, where it has plans for a 'near zero emissions' electricity generating station. It has been suggested that KRU may also seek to take an interest in UK Coal, which currently struggles to keep its deep pits open and make a profit.

Source: Terry MACALISTER, 2006, UK Coal braced for Russian bid after £ 1bn deal with ex-chief. *The Guardian*, 21 March 2006, page 26.

Closure of chemical-grade limestone mines at Hopton and Wirksworth, Derbyshire

In 1959 a firm called Derbyshire Stone opened two underground mines at Hopton Wood and Middleton quarries. This was to facilitate the mining of chemical grade limestone, from which hitherto considerable thicknesses of less valuable overburden had had to be removed. Adits were driven into the working faces at both opencast quarries some 1.5 km apart, it being at first intended that they should eventually serve a single large mine. Difficulties with faulting were encountered at the Hopton mine, and this was abandoned although it is still accessible. At the now separately developed Middleton mine working continued until the mine was closed in 2005. The main heading was 40 feet wide and 20 feet high, reducing to 30 feet by 20 feet further in. Pillar and stall working was employed. Eventually four additional levels up to 30 feet high were worked, below the original mine, using the same pillar positions on each level. From time to time the levels were joined vertically, resulting in caverns 60 or even 100 feet high. The last limestone was taken from the mine in August 2005.

In 1975 a major collapse occurred, which affected about five acres of the land surface above the mine. The collapsed surface, a depression up to 25 feet deep, was 'suitably landscaped!' On one occasion, subsequent to this event, the limestone mining operations intersected a much older lead-mining level in which possibly 19th-century 'jubilee' type trucks remained standing on track. These have been photographed and recorded.

The Middleton mine eventually extended almost completely to and surrounded the abandoned Hopton Wood mine, although no physical connection to it was ever made, and comprised some 30 miles of galleries.

When first worked, the mine was operated with hand-held drill rigs worked from a scaffold on the back of an old dumper truck. Three 19RB rope-operated quarry face shovels loaded limestone into Foden dumpers. And roof-scaling was done from a ladder on an old fire engine. In more recent years, modern hydraulic plant has been used.

The operating company have allowed the Peak District Mines Historical Society to store large historically interesting artefacts in the mine. Future access to and use of the mine have yet to be clarified.

The now-abandoned mine galleries have been used in connection with geological research by Trevor Ford, who has recently published observations made from within the mine galleries, and a description of the mine. The mine, developed from 1959 onwards, exploiting the Bee Low Limestone (formerly called the Hopton Wood Limestone), with eight metre high galleries on several levels separated by an intervening four metres of unworked stone. Pillars of unworked stone 10 metres square were left to support the roof. The workings extended east - west some 1.5 kilometres between open quarries at Hopton and Middleton. Three panels of pillar-and-stall workings have been developed between four faults trending WNW - ESE, each having a downthrow to the SW of from 10 to 36 metres. The subject of Trevor Ford's research was the 17 earth-filled solution pipes with diameters of one to 10 metres and observable heights of up to 30 metres, some being seen in both lower and upper mine galleries. The material in these pipes, some of which has fallen into the galleries, naturally compromised the quality of the otherwise chemically very pure limestone extracted. Nine of the pipes are recognised by Ford as having formed during the last glaciation; the other eight have been interpreted as fossil cenotes, analogous to the 'Blue Holes' of the Bahamas.

Source: Ivor J. BROWN, 2006, End of an era -

News

Middleton limestone mine 1959 - 2005. *Newsletter Peak District Mines Historical Society* 117, page 11.

Source: Trevor D. FORD, 2006, Possible fossil cenotes or blue holes in the Carboniferous Limestone of the Derbyshire Peak District, UK. *Cave and Karst Science* 32(1), 13 - 18 [Includes data from and a small-scale outline plan of the Middleton limestone mine at Wirksworth]

New Briars School at Hatfield (Hertfordshire) closed as a result of supposed chalk mine subsidence

Six hundred children were evacuated from New Briars School, Hatfield, early in December 2005 after large holes opened up in the ground nearby. The pupils were to be taught at a nearby Youth Centre during investigations. Experts reportedly found the school to be 'sitting on a 15 metre deep maze of tunnels.'

Source: www.bbc.co.uk (7 December 2005)

Further chalk mining subsidence at Reading, Berkshire

Further investigations in the Castle Hill / Coley district of western Reading suggest the presence of a hitherto unknown chalk mine below a block of flats at Coley Place. Residents will be moving out, temporarily at least, while boreholes are drilled from within the ground floor flats to search for possible cavities.

Source: Anna DAVIS, 2005, Survey: tenants are facing evacuation. Mine fears at flats in Coley. *Reading Weekend Post*, 16 December 2005.

Source: Steve STILL, 2005, Evacuation alert as mine is found under flats. *Reading Chronicle*, 15 December 2005.

Coal-mining-induced fault reactivation

Geological faults, or dislocations of the strata, are of various kinds, the blocks of beds on either side of the fracture moving, relative to each other, laterally or vertically, or being torn apart or pushed together by ground movements. Such faults occur naturally, and some (famously the 950 km long San Andreas fault in California) continue to move from time to time, resulting in severe earthquake damage. British faults are generally much smaller, and more stable. However, sub-surface mining operations, and changes in mines after their abandonment, can lead to renewed movement (reactivation) on old fault lines. At the ground surface, this can produce new fault escarpments up to four metres high and four kilometres long, resulting at times in serious damage to buildings, engineering structures, and infrastructure. The most serious problems have resulted from coal-mining, which has often exploited several flat-lying seams one above another, below areas now built-up or industrialised. Metalliferous mines for vein minerals, in which steeply dipping veins have been worked to great depth, are less of a problem, as the voids underlie less extensive areas of the surface, and for other reasons.

Reactivation of faults may result from mining operations, in which the loading in some areas is reduced (by removal of mineral) or changed, by transporting and re-depositing worthless material underground, or by re-directing underground waterflows, or removal of water by pumping. After abandonment, loadings on the rock in some area may be increased again by the accumulation of mine-water on cessation of pumping, or by the increased density of rock once more saturated with water. Changed water flows, too, can lubricate old fault-planes, resulting in a greater likelihood of further movement.

L.J. Donnelly has studied the surviving records for 227 cases of fault re-activation (as he points out, almost certainly a fraction of the actual events) recorded during the last 150 years or so. These are tabulated, with dates and descriptions as available, for the Durham and Northumberland, Lancashire, Midland Valley of Scotland, North Derbyshire, North Staffordshire, Nottinghamshire, South Derbyshire and Leicestershire, South Staffordshire, South Wales, Warwickshire, and Yorkshire coalfields. No cases are reported from the Bristol and Somerset, Forest of Dean, Kent, North Wales, Pembrokeshire, Shropshire, or Solway and Cumbria coalfields, although he cautions against any assumptions that the problem can safely be ignored in those locations. His paper includes a number of illustrations of reactivated fault escarpments and damage at the surface.

Source: L.J. DONNELLY, 2006, A review of coal mining induced fault reactivation in Great Britain. *Q. Jl. Engineering Geology and Hydrogeology* 39(1), 5 - 50.

Thirteen men trapped by explosion in Sago coal mine, West Virginia, USA - 12 died

Thirteen coalminers were reported to be trapped 80 metres below ground after an explosion at the Sago drift mine in West Virginia, USA. The mine, owned by the International Coal group, had been cited for 46 alleged violations of federal safety regulations during

News

an eleven-week review period which ended on 22 December 2005. All but one, when reached, were found to have died of carbon monoxide poisoning.

By an appalling and appallingly handled muddle in communications at the mine, it was at first announced that 12 men had survived. Overwhelming grief and anger resulted when the management, aware of this blunder within 45 minutes, did not publicly acknowledge the true state of affairs until after relatives had been celebrating for almost three hours.

Source: Suzanne GOLDENBERG, 2006, Explosion in US coal mine leaves 13 trapped. *The Guardian*, 3 January 2006; Hopes fade for trapped miners as air quality falls. *The Guardian*, 4 January 2006, page 14; Jamie WILSON, 2005, It was a mistake, families told, after hailing news of miners' survival. *The Guardian*, 5 January 2006, page 15; Jamie Wilson, 2006, Dying miners left behind notes to reassure grieving relatives. *The Guardian*, 6 January 2006, page 21 [USA: West Virginia: Sago mine]

Russia to open a helium 3 mine on the Moon?

Russian proposals to extract the rare stable helium isotope He^3 from rock on the moon and freight it back to earth for use in thermonuclear fusion powered power stations were noticed in *The Independent* on 27 January. Kaye and Laby's *Tables of physical and chemical constants* (14th edn.) state the abundance of He^3 on earth to be 0.00013%, the balance being the normal He^4 Two further isotopes, He^6 and He^8 are also listed but, both being radioactive and having very short half-lives (0.8 seconds and 0.122 seconds) do not occur naturally. Presumably lunar helium contains much the same proportion of He^3 as terrestrial, so apart from the question of extracting natural helium from the rock (by heating it) there would also need to be a moon-based plant to separate the He^3 from the He^4.

The technology to exploit He^3 is 'still under development' according to the article. But it is seen, it is said, as the 'ideal fuel of the future.' Lunar reserves of He^3 are stated to be of the order of 500 million tons, largely in the Sea of Tranquillity. Presumably this is helium released by the radioactive decay of heavier radio-nuclides in lunar rock. This is the source of most terrestrial helium. One ton of He^3 would yield as much energy as 14 million tons of oil; ten tons would suffice to meet the energy needs of the whole of Russia for a year. The plans are, it seems, for the Russians to build a permanent base on the Moon by 2015, with industrial scale production of He^3 by 2020. Maybe the large quantities of left-over He^4 will be used for blowing up party balloons? It is further reported that the Americans are also more than interested in this scheme, as one shuttle-load of He^3 would meet USA electrical energy demand for a year. The puzzle is that as the earth is rather larger than the moon, and as it possesses itself almost certainly more helium than the moon, why it might be worthwhile going to the moon for it?

Source: Andrew OSBORN, 2006, Russia plans to put a mine on the Moon to help boost energy supply. *The Independent*, 27 January 2006, page 22.

NEWS - MISCELLANEOUS

42 mile tunnelling project to take 5,600 years?

An Austrian artist, Muhammad Müller, has begun a 'long-term cultural project' - digging a 42 mile tunnel which, it is estimated, will take two people with shovels about 5,600 years to complete.

Source: ANON, 2004, Artist puts life in perspective. *The Guardian*, 8 November 2004.

Restoration of underground air-raid shelter below grounds of King Edward VII Upper School, Sheffield

An underground air-raid shelter below the grounds of the King Edward VII Upper School in Sheffield is to be restored with the help of a £ 10,000 grant from the Heritage Lottery Fund. A newspaper report suggests that the 'labyrinth of passages' is thought to include 'four rooms designed as a City Council nerve centre.' The proposal is to make this site a 'living history classroom' for Sheffield pupils. When re-entered by the school's archaeology teacher, Dr. Caroline Hamilton, access to the shelter was via a ladder below a manhole cover, as the original entrance stairways have been sealed. Dr. Hamilton describes the system as 'complex and sophisticated.' The supposed Council 'nerve centre' is blocked off from the accessible tunnels reported in 2005.

Source: Lesley DRAPER, 2005, Wartime's hidden secret. *Sheffield Telegraph*, 22 July 2005 [Thanks to Derek Bayliss for sending in this item]

UK nuclear test in the Nevada Desert, USA

The UK conducted its 'first nuclear test for four years' 1,000 feet below the Nevada Desert on 23 February, 2006. The test is described as 'sub-critical' so not designed to produce a full-scale thermo-nuclear explosion, but has led to allegations that it is a part of a programme to design new and more advanced nuclear weapons. The Ministry of Defence, in response, has described it as an 'experiment by a responsible government insuring [*sic*] the safety and reliability of the existing nuclear warhead stockpile.' It

News

was designed, according to a spokesman, to examine the effects of ageing, and 'in no sense' linked to any possible successor to the Trident nuclear force.'

The essential materials at the heart of a fission or fusion explosive device are inherently unstable, and liable to react with atmospheric moisture and oxygen, so it is essential to monitor their condition during storage, each warhead having effectively a 'shelf-life' or 'best-before' date. The recent Nevada test was, it is claimed, concerned with the evaluation of storage and condition assessment methods, not with the development of an improved warhead as such.

However, there is suspicion in some quarters that improved warhead design is also an objective. There is strong American interest in developing 'robust nuclear earth penetrators' or 'bunker-busters' which can penetrate the ground to significant depths before exploding, the objective being to destroy hitherto safe deep bunker systems.

Source: Richard NORTON-TAYLOR, 2006, UK nuclear test prompts claim of new bomb plan. *The Guardian*, 23 February, 2006, page 5; Ian SAMPLE, 2006, Is Britain conducting nuclear tests? *The Guardian*, 25 February, 2006, page 13.

Experimental hydroponic farming in a Tokyo bank vault, Japan

A heavily fortified bank vault below the financial district of Tokyo, owned by Pasona, was converted in 2004 for use as an airtight experimental hydroponic farm. Crops of basil, lettuces, and tomatoes have been raised successfully. Growing rice was at first a failure, until the microclimatic conditions were adjusted, but the first crop of 60 kg of Koshihikari rice has now been harvested. It was discovered that simulated wind, using electric fans, and rain were required for success with rice. The underground microclimate is closely controlled, with infra-red and ultra-violet lighting, and if required raised oxygen levels. It has been suggested that rice might be grown commercially in such conditions, as without the climatic fluctuations resulting from the changing seasons, four crops per annum could be raised.

SOURCE: Leo LEWIS, 2006, Farmers bank on the rice harvest grown in a vault. *The Times*, 12 January 2006, page 44.

Seedbank to be established in a vault excavated inside a mountain in Svalbard (Spitzbergen), Norway

An artificial rock-cut vault is to be excavated inside a mountain near the small coal-mining town Longyearbyen, on Svalbard (Spitzbergen.) The vault, five metres by five metres by fifteen metres, is expected to be ready to store two million seeds by September 2007. 'The idea is to safeguard the world's food supply against threats such as nuclear war, asteroid impact, terror attack, climate change, and rising sea levels.' Seeds will be stored at minus 10 to minus 20° C.

Source: James RANDERSON, 2006, Deep inside an Arctic mountain, the Noah's ark of seeds that will survive a catastrophe. *The Guardian*, 12 January 2006, page 15.

NEWS - PUBLICATIONS

Anti-invasion landscapes of England in World War II

A substantial volume recently published by the Council for British Archaeology presents the results of a two-year project funded by English Heritage to examine and document the 1940/41 anti-invasion landscapes of England. The study combines fieldwork with archival research, includes numerous detailed maps and photographs of 67 key defence areas, and numerous references to archival sources. The various anti-invasion devices are related to the local topography at each area: natural features were used to give strength and concealment to the several works. Three major themes are reported - coastal defence, inland stop-lines, and area defence. There is also an introductory overview of the entire subject.

The defence areas featured are as follows:

Coastal defence: Abbotsbury (Dorset), Atwick (East Yorkshire), Barrow Island (Cumbria), Bawdsey Point (Suffolk), Cayton Bay (North Yorkshire), Cuckmere Haven (East Sussex), Druridge (Northumberland), Dunster Beach (Somerset), Freistone Shore (Lincolnshire), Freshwater Bay (Isle of Wight), Hollicombe Beach, Torbay (Devon), Lawyers' Creek, Holbeach (Lincolnshire), Porthcurnow (Cornwall), St. Michael's Mount (Cornwall), Saltfleetby (Lincolnshire), Speeton (North Yorkshire), Studland Bay (Dorset), Walberswick (Suffolk), Weybourne (Norfolk), and Winterton-on-Sea (Norfolk) Interestingly, major defensive centre such as Dover are not featured.

Stop-line defence areas: Audley End (Essex), Avening (Gloucestershire), Barcombe Mills (East Sussex), Bramling - Ickham - Wickhambreaux (Kent), Chequers Bridge (Hampshire), Cheshunt (Hertfordshire), Deangate Ridge, Hoo (Kent), Dorking Gap (Surrey), Drift Bridge (Surrey), Dumill Lock

News

(Berkshire), Farthingloe, Dover (Kent), Frilford - Fyfield (Oxfordshire), Godney (Somerset), Hartford End (Essex), Hogwood (Bath & NE Somerset), Hopwas Bridge (Staffordshire), Leeds & Liverpool Canal, Burscough (Lancashire), Littleport (Cambridgeshire), Old Lodge Warren (East Sussex), Pawlett Hill (Somerset), Penshurst (Kent), River Brue: Cripp's Bridge (Somerset), River Lark, Jude's Ferry Bridge (Suffolk), River Medway (Maidstone) (Kent), the Royal Military Canal (Bilsington - Ruckinges) (Kent), Semington - Whaddon (Wiltshire), Sidlow Bridge (Surrey), Sudbury (Suffolk), Sulham Valley (Berkshire), Wadbrook (Devon), Wakes Colne Viaduct (Essex), Waverley Abbey (Surrey), and Weycroft (Devon)

Area defence: Acle (Norfolk), Breamore Mill (Hampshire), Bromborough Pool (Cheshire), Canewdon (Essex), Cripp's Corner (East Sussex), Ewshot (Hampshire), Greatham Creek (Stockton-on-Tees), Ilton (Somerset), Kirkleatham (Redcar & Cleveland), Ludham Bridge (Norfolk), Pershore Bridges (Worcestershire), Pevensey Castle (East Sussex), Sarre (Kent), and Wooler (Northumberland)

Reference: William FOOT, 2006, Beaches, fields, streets, and hills ... anti-invasion landscapes of England, 1940. *Research Report Council for British Archaeology* 144: xxxvi + 658pp [ISBN 1-902771-53-2] [This volume can be ordered from Central Books at 99 Wallis Road, LONDON E9 5LN [Email orders to orders@centralbooks.com] at £ 27.95 inclusive of postage and packing]

The origins of stratigraphy 1719 - 1801

A long-winded title might put potential purchasers off investing £5 in John Fuller's new guidebook to the geology and economic geology of the Bath area. This is essentially a guide for those wishing to visit and understand some of the classic sites, of tremendous importance in the history of geology as a science, associated with John Strachey [1671 - 1743] and William Smith [1769 - 1839] and deals, *inter alia*, with their interests in coal mines and underground Bath stone quarries in this area.

In his introduction, Fuller writes:

> Knowledge of stratified rocks in England sprang directly from the industrial experience of artisan workmen employed as miners, colliers, quarrymen, well-borers, wallers, stonemasons, and salters. From the earliest days to the beginning of the nineteenth century three mineral commodities - coal, iron-ore, and building-stone - embraced virtually all practical knowledge of stratified rocks. This came about because experience of mining coal, quarrying stone, and digging ore had taught working men hard facts about the nature of strata, facts such as their variations of quality, substance, thickness and structural attitude. Miners underground were acutely aware of abrupt and unforeseen dislocations and terminations of strata, cutting off working seams, and sometimes lives. Searching for, and producing any mineral commodity required a particular set of skills that could be learned only by practice, not least the skill to judge between a mineral's economic worth and the hazards of getting it.
>
> Observations on the economy of coal-working and salt-extraction were being gathered in England as long ago as the 1540s, when King Henry VIII commissioned John Leland to 'peruse the secrets of antiquity' and to compile a country-wide survey that would embrace everything from monastic libraries to mineral deposits. Leland journeyed for several years through most of England and Wales, noting among the thousands of facts recorded in his collected *Itinerary* the presence or absence of stone-quarrying, salt-working, and coal-pits. He even commented on the likely continuation of a coal-stratum beneath Durham Cathedral.
>
> All geological information in Leland's great work was obtained either directly from workmen or from his own observation, establishing him as the first major figure in England to bridge the gap between compilers of book-learning and artisans of industry. Through the 17th and 18th centuries, authors of geological works were commonly unaware of artisan experience, chiefly because artisans kept their secrets to themselves, and did not reveal to strangers knowledge that was the source and support of their livelihood. Even in modern times this disjunction persists, separating academic scholars from the operating technicians of industry.
>
> Minerals of economic worth were generally worked underground, so somewhat unexpectedly the geology of rocks at surface outcrop did not become important in scientific thinking until the regularity of strata and their ordered arrangement underground had been already realized. Through the 1600s, records of strata, along with their various

News

properties and characteristics, were commonly made in the form of lists or tables, mostly constructed from the results of subsurface operations.

This excellent booklet continues with examples and illustrations of 18th century geological sections and plans made by Strachey and Smith. There follows a practical guide for those wishing to visit some of the key sites studied by them in and around Bath, including Mearns colliery, and relics of the Somerset Coal Canal. Interesting details are given of William Smith's Batheaston coal trial of 1804 - 13. Illustrations include several historic views of the canal, buildings associated with Strachey and Smith, and aerial photographs. There is a short but scholarly list of sources and suggestions for further reading.

This work is highly recommended for anybody seriously interested in the history of mines and quarries.

Source: John FULLER, 2004, The origins of stratigraphy 1719 - 1801: an historical guidebook to the early days of stratigraphical geology near Bath, Somerset, as seen in the works of John Strachey and William Smith, *Geologists' Association Guide* 65: iii + 53pp [ISBN 0-900717-55-6]

Guide to the industrial archaeology of Derbyshire

The Association for Industrial Archaeology publishes a gazetteer of sites for the location of each of its annual conferences, that for 2005 having been held in Derbyshire. The sixty page 2005 guide includes numerous sites with underground elements, and thus of interest to Subterranea Britannica members. Amongst the ten or so tunnels briefly described are those on canals (the Butterley Canal tunnel), tramways (the Ticknall Tramway), and branch and main line railways (obviously including the Cowburn, Dore & Totley, and Woodhead tunnels.) Mines and mining sites noticed include the Ashford black marble mines, and numerous coal and lead mines and associated buildings. The entries for each site are brief, but generally include location details, brief descriptions, and dates.

For details of availability contact the AIA Liaison Officer, c/o School of Archaeological Studies, University of Leicester, LEICESTER LE1 7RH.

Reference: Dudley FOWKES, Mark SISSONS, and Ian MITCHELL, 2005, *A guide to the industrial archaeology of Derbyshire*. Association for Industrial Archaeology: 60pp [ISBN 0-9528930-8-8]

BRITISH MINING 78 (2005)

The latest issue of the *Memoirs* of the Northern Mine Research Society, *British Mining*, was published in December 2005. It contains the following papers:

BRIDGES (nee PAULL), Shelagh J.R., 2005, William Paull and Joseph Michell Paull, moor masters of Alston Moor, Cumbria, 1845 - 1875. *British Mining* 78, 131 - 138.

BULLEN, L.J., 2005, Wheal Naweth (the New Mine.) *British Mining* 78, 43 - 48 [Cornwall]

CALLENDER, R.M., 2005, A camera for a dangerous adit. *British Mining* 78, 49 - 53 [North Wales: Glogau gold mine]

CHAPMAN, Nigel A., 2005, Thornley and Wheatley Hill collieries. *British Mining* 78, 23 - 42 [Durham]

CUCKSON, A.S., 2005, Snailbeach mine: pumping and winding machinery c. 1782 - 1856. *British Mining* 78, 118 - 130 [Shropshire]

GOODCHILD, John, 2005, The Earl Fitzwilliam's Elsecar Colliery in the 1850s. *British Mining* 78, 5 - 22 [Yorkshire]

LUKE, Yvonne, 2005, Forgotten 'clouds' and mining landscapes of the 1st millennium A.D.. *British Mining* 78, 149 - 180.

Wilkinson, Jeremy S., 2005, Iron ore mining in Caernarfonshire. *British Mining* 78, 68 - 117.

Reference: Northern Mine Research Society: *British Mining* 78: 184 pp [Available from NMRS, 38 Main Street, Sutton-in-Craven, KEIGHLEY, Yorkshire BD20 7HD / email martgill@legend.co.uk]

SUBTERRANEA 135 (2005)

We have received from our sister society, the Société Francaise d'Étude des Souterrains, issue 135 of their journal *Subterranea*. This includes the following:

ANON, 2005, Mysterieuse cavité a Vollore-Ville. *Subterranea* 135, page 80 [Reproduced from a newspaper dated 12 October 2005]

FERRARI, Bertrand, 2005, Ma visite à l'Orent. *Subterranea* 135, 73 - 75.

KAHN, Claude, 2005, Le XXVIIIe Congrès de la Société Francaise d'Étude des Souterrains, Souzay - Champigny (49) 23 et 24 juillet 2005. *Subterranea* 135, 55 - 72 [Annual Conference of SFES near

News

Saumer on the Loire]

McCarthy, J.P. Max, 2005, Le souterrain de Dunisky (Comté de Cork, Irlande): est-il un souterrain refuge? *Subterranea* 135, 81 - 96 [Ireland: County Cork]

STEVENS, Luc, 2005, Assemblée Géneral de la Société Francaise d'Étude des Souterrains tenue à Souzay - Champigny le 24 juillet 2005. *Subterranea* 135, 76 - 79.

Source: La Société Francaise d'Étude des Souterrains: *Subterranea* 135.

NEWS - TUNNELS, TUNNELLING AND RAILWAY TUNNELS

City Airport - Woolwich Arsenal extension

The London City Airport extension of the Docklands Light Railway has now been opened for business, from 6 December 2005. A report announcing this contains a map shewing the proposed extension of the line through King George V Dock Station and a new under-Thames tunnel to join up with the North Kent Line at Woolwich Arsenal Station.

Source: John SULLY, 2005, City Airport line opens on time and on budget. *Modern Railways* 63(688), page 8.

Docklands Light Railway extension to Woolwich Arsenal: tunnelling under the Thames commenced

The Docklands Light Railway is being extended in a pair of 2.5 km tunnels to connect London City Airport with Woolwich Arsenal. The first tunnel is being driven southbound under the river. The tunnel boring machine (TBM) was lowered into its launch chamber on 1 March 2006. On reaching the south bank, it will be re-launched to drive northbound back to North Woolwich. The tunnels and extension are expected to open for public services in February 2009.

Source: AMEC, 2006, AMEC prepares to bore DLR Woolwich tunnels. *Modern Railways* 63(691), page 13.

St. Pancras Thameslink Station box to be fitted-out and opened to passengers in 2007

The concrete box already built (and having trains running through it) for the replacement for the awkwardly sited Kings Cross Thameslink Station is to be fitted out and opened for passenger use some time in 2007, hopefully in time to serve arriving and departing passengers on Eurostar's Brussels and Paris services when these have been diverted from Waterloo International to the new terminus at St. Pancras. The UK Government has recently agreed to release or sanction the requisite funds, perhaps better known as a hap'orth of tar! Does any other country build instant ghost-stations?

Source: ANON, 2005, Green light for St. Pancras Thameslink *Modern Railways* 63(688), page 6 [The January 2006 issue actually published in December 2005]; and 63(690), page 7 (2006)

Proposed re-use of abandoned Jubilee Line station tunnels at Charing Cross Station, London

The Jubilee Line station tunnels at Charing Cross, by-passed and abandoned as a result of the extension of the line to Stratford, may be brought back into use as a West End terminus for a westerly extension of the Docklands Light Railway. The station tunnels complexes on sub-surface railway lines are always significantly more expensive than driving straightforward running tunnels, and the existence of a ready-made station at Charing Cross makes a DLR West End extension a better economic prospect than if an entirely new station had to be built.

Source: James ABBOTT, 2006, DLR aims for Charing Cross. *Modern Railways* 63(690), 54 - 59.

London Crossrail Bill in Parliament

Plans for Crossrail, a main line loading-gauge railway tunnel below London linking the Western Region main lines at Paddington with lines eastwards from Liverpool Street, entered the Select Committee stage in Parliament on 17th January 2006, with Government sponsorship.

If eventually passed as an Act, statutory authority for the work will possibly be in place by the summer of 2007, followed by construction work taking some six years, and the first services running in 2017 or 2018. Services, rather like those of the present Thameslink, would encompass through stopping services, and regional semi-fast services, rather than long-distance main-line expresses.

The proposals are hotly debated, although current argument is more about service patterns, routes, frequencies, and termini than about the need for the tunnel itself.

Sources: James ABBOTT, 2006, Select Committee scrutiny for Crossrail. *Modern Railways* 63(689), 48 - 49; Chris STOKES, 2006, Crossrail - argument is vital! *Modern Railways* 63(689), 50 - 51.

News

Sir Adrian Montague, chairman of Crossrail, considering purchase of the Channel Tunnel Rail Link

The 'serial business troubleshooter' Sir Adrian Montague is 'putting together a takeover offer' for London & Continental Railways, the co-owners of Eurostar and builders of the Channel Tunnel Rail Link. The Link is nearing completion, with the final section into London St. Pancras due to open next year (2007), when trains to and from Brussels and Paris will arrive at and depart from that station instead of, as now, Waterloo.

Source: Andrew CLARK, 2006, Crossrail chairman Montague in talks to buy Channel tunnel rail link. *The Guardian*, 15 February 2006, page 26.

Channel Tunnel Rail Link and British part of Eurostar 'nationalised'

The Channel Tunnel Rail Link (CTRL), from the English portal to London St. Pancras, and the British part of the Eurostar passenger trains operation on the London to Brussels and Paris routes have effectively been nationalised as a result of a ruling by the Office of National Statistics that they are under Government control. The parent company of the two businesses, London & Continental Railways (LCR), has been re-classified as a 'public non-financial corporation' (a status also enjoyed by Royal Mail and London Underground) as a result of the Government's influence on the company's policy and finance. The Government will decide on whether a takeover bid for LCR by Sir Adrian Montague can go ahead - 'irrespective of the views of management or private sector shareholders.' The Government's guarantee for £ 3.7bn of LCR's borrowing is held to gives ministers the power to force the sale and appropriate 90% of the proceeds. The ruling means that 11 of LCR's 31 Eurostar trains are now owned by the British Government, the remainder by Belgian and French interests. Completion of the last section of the CTRL into St. Pancras is expected in 2007, when Eurostar trains will terminate there instead of as now at Waterloo.

Source: Andrew CLARK and Ashley SEAGER, 2006, Debt-laden Channel tunnel rail link is 'nationalised.' *The Guardian*, 21 February 2006, page 24.

Croydon HT cable tunnels to be made by Morgan East

Morgan East have been awarded the contract to construct a new National Power high tension cable tunnel from Bromley to Sutton, passing below Croydon. Construction is scheduled to commence after August 2006, with completion in January 2011.

Source: ANON, 2006, Electricity works should mean minimal disruption. *Croydon Guardian*, 1 February 2006, page 11.

Gotthard high-level tunnel may close on the opening of the base tunnel, Switzerland

The historic road from Switzerland to Italy through the St. Gotthard Pass (at an altitude of 6,929 feet) was, for many purposes, by-passed by the 15,003 metre St. Gotthard railway tunnel driven in 1872 - 80, on the main line from Zurich to Milan. This is now in course of being by-passed itself by the new 57,000 metres St. Gotthard Base Tunnel, much longer and at a much lower elevation. The new tunnel, proposed to be opened to traffic in 2010, will result in much improved transit times for long-distance international passenger and freight trains between the two countries (although the old tunnel itself is entirely within Switzerland) as severe gradients and tight curves will be avoided. The old high-level line might to retained for local traffic, although closure has been proposed. There is currently a move to advocate the designation of the 19th century tunnel as a World Heritage Site, in view of its importance as one of the earliest very long tunnels under the Alps.

Source: ANON, 2006, Gotthard to close? *Modern Railways* 63(690), page 72.

High-speed railways in France and Spain to be linked by a tunnel now under construction under the eastern Pyrenees

Two tunnel-boring machines (TBMs) are driving parallel bores northwards from Spain into France as a part of the first high speed rail link between the two countries. The 44.5 km rail link, from Perpignan (France) to Figueres (Spain) runs parallel with the existing A7 road, and is expected to take much freight off that route.

The two bores, started in July 2005 from Spain, each have an internal diameter of 8.5m, and will be 8.3 km long. Only the first kilometre of the tunnels will be in Spanish territory, the longer part in France. Poor tunnelling conditions are anticipated about midway through the intended bores, where there is unstable schist and faulted granite. An access adit is being driven by drill-and-blast techniques from the mountainside above, and will run between the two bores and facilitate ground consolidation by grouting before the TBMs reach this point. The 1.1 km 'treatment gallery' will have a cross-sectional area of 40 m^2. Approaches to the tunnel portals, visible from

News

the parallel road, will includes lengthy viaducts.

Source: Andrew BOLTON, 2005, Making the connection. *New Civil Engineer*, 24 November 2005, 24 - 25.

Cross-Paris TGV railway tunnel proposed

A five kilometre tunnel below central Paris is proposed, to link the Gare du Nord with the Gare de Lyon, and allow high-speed trains (TGVs) from the north to continue southwards from the city. Many passengers at present have to change trains and use the Metro between the two main line termini. A new low-level city-centre station on this line is also proposed at République.

Such a new line would accommodate serious European loading gauge long-distance expresses to cater for long distance rail travel demand, the existing RER lines, catering for outer-suburban movements, not having sufficient spare capacity. Belgium has had such a link for through long distance expresses running through Brussels between the Midi / Zuid and Nord Stations since the 1950s (and a city-centre station at Centrale.) London is far behind in this sort of thing, with nothing better than Thameslink trains, hardly long-distance or express, crawling through Farringdon between London Bridge and King's Cross!

Source: ANON, 2005, Cross-Paris TGV lines? *Modern Railways* 63(688), page 78 [The January 2006 issue actually published in December 2005]

Phased construction and opening for the Lötschberg base tunnel (Switzerland)

Long-distance through expresses and freight trains between Bern and Milan currently cross below the Lötschberg mountain barrier via a tortuous route between Kanderstegg and Goppenstein which includes hairpin bends and a high-level tunnel. This traffic will in future be better provided for by a lower-level route through a much longer tunnel between Frutigen and Visp. The new Lötschberg tunnel is currently under construction, with much track already laid. The construction and opening will be phased, the southernmost third of the tunnel being of two single-track bores; the central section will also have two bores, although at first track will be laid in only one bore; and for the time being the northern section will be a single track single bore.

Source: ANON, 2005, 2007 opening for base tunnel under Lötschberg mountains *Modern Railways* 63 (688), page 80 [The January 2006 issue actually published in December 2005]

Leipzig railway termini to be linked by tunnelling below the city

Like many another major European city, Leipzig was at first served by a number of independent railway companies, each with a terminus on the city centre periphery. At one time there were six such termini, although now as a result of line rationalisations only Leipzig Hauptbahnhof and Leipzig Bayrishen Hauptbahnhof accommodate all the rail traffic. Cross-city connections are now to be improved by a new railway tunnel linking the lines into the two remaining termini, serving low-level stations at those locations, and new low-level city-centre stations at Markt and Wilhelm Leuschner Platz. Driving the new 3.9 km tunnel commenced in 2003, with completion expected in 2009.

Source: Richard MALINS, 2006, Leipzig - the last S-Bahn? *Modern Railways* 63(691), 62 - 63.

The Gaustaban military railway inside a mountain in southern Norway

An extraordinary narrow gauge (800 mm) military railway was tunnelled into Gaustatoppen, southern Norway's highest mountain, by the armed forces in the years 1954 - 58, to serve a NATO installation on the summit. The tunnel travels 850 metres into the mountain, and is then linked to the summit by a funicular, with ascending and descending cars on cables on two parallel tracks. The first section is operated by a Levahn locomotive. In 2004 this line was opened to visitors 'on a trial basis' on certain days in April, May, and August, and proposed to open likewise in 2005, with 280 tickets (350 NKr) available on each day. The mountain is near Rjukan.

[This item, forwarded to SB by Derek Bayliss, is credited to Philip Racey (with thanks to Jonathan Rowse) and cites the following web site: http:// www.funiculars.net/line.php?id=224]

Source: Philip RACEY, 2004, Gaustaban. *Narrow Gauge News* 263, July 2004, page 24.

An unfortunate event on the Moscow underground railway

Workmen driving a concrete post into the ground above one of the Moscow subway lines, perhaps a little over-enthusiastically, drove it right through the tunnel ceiling and the roof of a moving train that just happened to be passing at the time, causing a fire on board. Fortunately, none of the passengers were hurt. The driver saw the post penetrate the tunnel ceiling, but was unable to stop in time to avoid damage to the train. It was suggested that the

News

workmen at the surface were erecting an un-authorised advertising hoarding, and perhaps were not even aware that they had selected a site immediately over a tunnel.

Source: ANON, 2006, Russia: builders drive pillar into roof of moving train. *The Guardian*, 20 March 2006, page 22.

Fibre network in London's Sewers

A fibre network that was built in London's sewers is being opened again for business following its mothballing 3 years ago.

The so-called Urband network will provide businesses with dark fibre on which they can run their own services. Thames Water and the National Grid created the network in 2002 by running throughout the London sewer system in a project which was then thought to herald the transition of utilities into telecoms provision. Around 80km of network was built. But with no customers signed up for the service, the network was abandoned in 2003.

Now the network is due to be resurrected, following the purchase of the assets by Geo which runs a nationwide backbone network. The existing network stretches from Paddington to Docklands and Geo plan to expand it further.

Source: ANON, Communications News, February 2006.

Last signal for Unst radar base

The Royal Air Force has ended its near 50-year association with the Shetland community of Unst after closing its radar base. More than 100 jobs have been lost at the Saxa Vord early warning station after the need for it diminished following the end of the Cold War. The departure of service personnel and their families will see the island's population drop by a quarter to 500.

An RAF Nimrod made a flypast to mark the occasion. In a response to the jobs blow, renewable energy projects are up and running and the island's fish farming businesses are expanding.

There are also plans to build a whisky distillery at the base. The station's flag was lowered for the last time on Wednesday afternoon, ending the RAF's special relationship with the UK's most northerly community. RAF spokesman Michael Mulford described the base's closure as "the end of an era". The station will be placed on a care-and-maintenance basis, meaning it is effectively closed but that the operational part of the site could be reactivated if required. The decision to mothball the base is part of the MoD's modernisation plans for the armed forces.

Story from BBC NEWS

Sub Brit Autumn 2006 Day Conference.

The 2006 Autumn Day Conference will take place on Saturday 30th September at BCUC, High Wycombe, Buckinghamshire.

As usual we will have a variety of top class speakers and a film on a subterranean topic. Booking forms will be issued to members later in the year.

Andrew Smith

AOL Mailing list problem

On 13th March 2006 we received an automatic email from AOL, warning that they were about to start rejecting emails from subbrit.org.uk because of an unspecified "spam" problem.

This was discussed at length by the mailing list administrators. The consensus was that AOL is in the wrong. On the 14th May, for the first time, the AOL system blocked a message sent to an AOL subscriber who is on one of the mailing lists.

It is possible that AOL is now blocking all subbrit.org.uk emails sent to AOL subscribers.

The only advice we can give is for AOL customers who wish to continue to receive Sub Brit email should Complain to AOL about their spam filtering approach, which is widely considered to be of fundamentally poor design; and/or Change to a different ISP with a more rational and standards-based approach to the spam problem.

Footnote:

AOL appears to be blocking a large number of organisations' email. This may be an attempt to create a market for a scheme whereby they charge senders a fee to process email sent to their subscribers. More about this can be found at:

http://www.eff.org/news archives/2006_03.php#004461

Underground in Ethiopia

Julian Allason plumbed hidden depths with explorer Steve Turner in search of the Ark of the Covenant.

The mediaeval town of Lalibela, named after Ethiopia's great king and priest, clings to a high ridge above the valley of the river Jordan, echoing ancient links to the Hebrew promised land that predate Christianity by centuries. Up to the last great famine of 1991 the Falasha, the 'lost tribe of Juda', survived in Ethiopia until airlifted to Israel, where they were accepted as true Jews. It is from the balcony of the Jerusalem Guest House, as the first rays of the sun emerge from behind the mountains, that I catch a strange sound echoing through the hillside.

It comes from beneath the earth. Picking my way through the dawn I approach a chasm with some care. The moaning resolves into arrhythmic chant emanating from Bet Giorgis, the underground church of St George rising out of the abyss. Cruciform in shape, its flat roof bears the triple cross device of the Orthodox . From 11th century basilicas to tiny chapels the churches of Lalibela are carved from the living rock. Porticos, cloisters, roofs, all are cut from a single monolith of stone, surrounded by deep trenches shriven with connecting tunnels.

A shadow materialises from a hole in the trench wall. Gathering his thin muslin cloak about him the hermit genuflects towards the sanctuary door of Bet Medhane Alem before disappearing within. The darkness of the interior is attenuated by guttering candles, casting an uncertain light

over soaring columns and the veiled holy-of-holies. From this sacred place emerges the priestly guardian bearing Ethiopia's most precious treasure, the 800-year old solid gold cross of King Lalibela, recently stolen and now recovered.

At the centre of the complex is what is believed to be King Lalibela's palace. So secret was the location of the escape tunnel from it that knowledge of the entrance was entrusted to a single monk who on his deathbed would pass it to his successor. Alas, in an episode worthy of Monty Python, the last guardian managed only to whisper to his successor, "The portal is by the . . .argh!", before breathing his last. Its whereabouts have yet to be unearthed.

At Bet Maryam a pillar engraved in the ancient language of Ge'ez tells the story of the beginning and end of the world: it remains permanently shrouded. What of the 'tabot' reserved within? Deeply reverenced, certainly, but not, the priest confesses, the true Ark of the Covenant. To quest for so holy a relic one must follow the pilgrim road. The next station upon that route, it seems, is the monastery of Yimrehana Kirstos.

Steve Turner was waiting with a four-wheel drive vehicle. We would need it for the journey ahead. After ninety minutes negotiating mountain passes the rough road petered out by a waterfall. It was time to climb on foot, our progress mocked by the calls of yellow fronted parrots. At 9000 feet we entered groves of juniper and African wild olive, an indication of the monastery's proximity. Above us yawned the mouth of a vast cavern, within it the 11th century palace of King Yimrehana Kirstos and the domed shrine.

From a chandelier above the altar a bat hangs, enfolded in leathery wings. "Tread softly, for you tread upon our pilgrims," murmurs Abba Birham Silase, the Chief Priest. Beneath our feet the ground was paved with the polished skulls of 10,740 pilgrims, Ethiopians who had returned on foot from as far as Palestine and Egypt to die in this hallowed spot. The devotion of fifty generations hangs heavy in the moist air, but it is not the resting place of the Ark. "You are ascending the ladder of sanctity," says Abba Birham softly. "There is a city that is the holiest place in Ethiopia. It is called Axum . . .", and he bows towards the north.

A week earlier Steve and I had been in Addis Ababa, visiting the Cathedral of the Holy Trinity where Emperor Haile Selassie, murdered by the Dergue plotters, was reinterred in 2000, an event that annoyed the small Rastafarian community ("He no dead, man, he immortal"). About it

are encamped the faithful in anticipation of the great

Underground in Ethiopia

feast of Timkat, the Epiphany. Most of Ethiopia adheres devoutly to the Orthodox Church, coexisting peacefully with the Muslim minority in the south.

A horn sounds, bringing brocaded deacons to the sanctuary door. The slow rhythm of drums draws the people too, and in ever greater numbers. With a rasp the massive doors swing open and a procession emerges, sheltered from the sun by a forest of velvet umbrellas. To the front patrol thurifyers, swinging clouds of frankincense up into the morning air. In the shade of the parasols moves the stately figure of the high priest, his noble head crowned by a veiled object the size of a tea-tray. "He bears the Tabot," whispers Steve. "The Ark?" I ask in astonishment. Steve inclines his head uncertainly. In a moment the procession is swept away from us on a flood of devotion.

Could this really be the Ark of the Covenant, the sacred chest containing the stone tablets upon which God inscribed the Ten Commandments? From its presentation to Moses on Mount Sinai the Bible records the Ark's deployment as the Israelite weapon of mass destruction, smiting the Philistines and razing the walls of Jericho. Little doubt is left ruins as to its central position in Old Testament Judaism as the moral heart of the Universe - or of its fearful power. The Ark is brought up to Jerusalem by King David. Yet, after its installation by his son, King Solomon, in the first Temple around 955 BC, this, the most important object in the universe, vanishes from the Biblical account - and from history. Little wonder that kings and crusaders, scholars and treasure hunters have scoured the Middle East for it.

Nor has the sacred relic lost its hold upon the popular imagination. In the 1981 Hollywood fantasy, 'Raiders of the Lost Ark', Harvard archaeologist Indiana Jones defeats a Nazi expedition to discover and seize the Ark. The plot is not completely far-fetched, given the Fuhrer's obsession with occult power and Mussolini's plunder of Ethiopian relics. For this is where, in the words of the Bradt Guide, the ancient world and Africa meet.

Finally I am on my way to Axum, supposed seat of the Ark, where the a deep pit is under construction to receive the great obelisk looted by Mussolini seventy years ago, the return of which is expected imminently. We are escorted through dusty lanes to a large compound, in which ancient ruins lie in the shade of Eucalyptus trees. The enclosure is dominated by the castellated cathedral of Tsion Maryam, dedicated to the Virgin Mary, but into which women are forbidden to set foot. Between cathedral and the vaults of Aksum's original 4th century church stands an austere chapel within a garden enclosed by a low blue fence. This small, windowless building of grey stone is the Chapel of the Tablet, its crypt the final sanctuary, Ethiopians believe, of the true Ark.

From within emerges the tall, spare figure of the Guardian. Grey of beard and swathed in white with black cap of the professed, Girma Wolda Giorgis was chosen for his purity and humility. He has not left the Ark since his appointment twelve years ago. Nor has the Ark departed its sepulchre in that time. No one else may enter, not even the Patriarch. Its presence is too sublime to disturb, and, he says, too dangerous. Were an impure person to draw near they would die. Although the Ark is covered at all times, the monk approaches it only through a cloud of incense in the ritual prescribed by Moses. Even so his two predecessors suffered increasing blindness.

But the Ark has the power not only to harm but to heal, still performing miracles after millennia, the most frequently reported being the restoration of sight to blind pilgrims and the bestowal of fertility upon the barren. The faithful at Axum have also seen its ancient power exercised in their own history, Ethiopia remaining free, its Church flourishing, as the rest of Africa fell to European colonisers.

Behind me there is a metallic click. A PPsh-41 submachine gun peeps out from the robes of one of the temple guards. But who would threaten the Ark? "An impolite man who climbed the railings is in gaol," says the Neburaid. "Next time the response will be more . . . severe." Indeed precautions are in place to thwart any attempt to hijack the Ark following an apparent reconnaissance by Israelis. One glance at the temple guards suggests that overwhelming force would be required to overcome the resistance of men ready to die for their faith, and for a chest that may still contain the law of God written with his own finger.

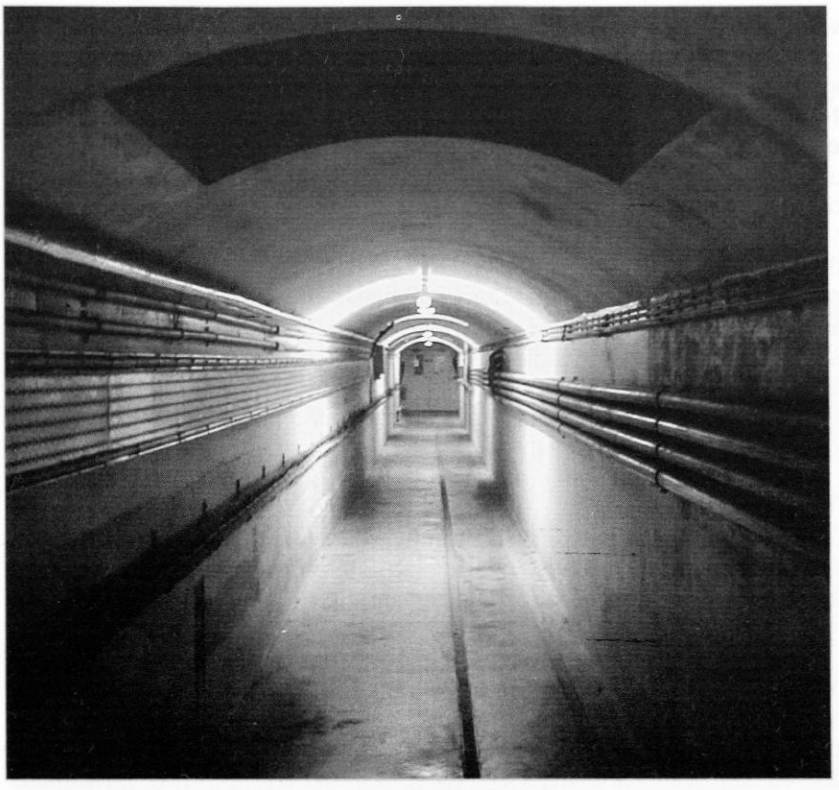
Is the Ark authentic? The two leading scholars, Grierson and Munro Hay, agree that it conforms to the biblical accounts and retains its ancient ceremonial office as the hidden heart of a rich and devout culture. "The more the Biblical account of the Ark is exposed to critical enquiry the less extravagant the Ethiopian claims begin to seem," they conclude. To visit Ethiopia is akin to entering the pages of the Old Testament, the story of the Ark of Zion its national epic.

The Guardian stands in the garden of the Ark scanning the heavens as the sound of a large aircraft echoes through the hills encircling Axum. Is this the one returning the lost obelisk? Perhaps it will be followed by visitors - and pilgrims come in search of the law given to mankind so long ago on Mount Sinai that now rests in its forbidden sepulchre.

British Airways (0870 850 9 850 *www.ba.com*) fly from London to Addis Ababa. Julian travelled inside Ethiopia with Origins Safaris (+254 20 312137 *www.originsafaris.info*).

Steppes Travel (01285 650011 *www.steppesafrica.co.uk*) offer a seven-night full board package arranged by Origins staying at the Sheraton Addis Ababa and the Jerusalem Guest House, Lalibela, including British Airways flights from London and internal private charter flights to Axum, Lalibela, and Harar.

Subterranea Bodleiana



The Tunnel Photo by Ian Walker

Last year, during the Oxford Literary Festival I went on a very interesting tour of the Bodleian Library. As this included the tunnel that connects the Radcliffe Camera to the New Bodleian, I thought this might be of interest to readers of Subterranea. The following notes are taken from an information sheet given to us at the time of the tour and I think it describes the buildings far better that I could.

One of the particularly interesting things I noticed were the Lamson tubes that run through the tunnel. You can see these in the photograph of the tunnel with a terminal station on the right of the book transporter. This facility was used to order books for many years until modern computer networking took over.

THE RADCLIFFE CAMERA

This is the first rotunda library to be built in Britain. The original idea came from Sir Christopher Wren, who in 1676 proposed a circular plan library for Trinity College Cambridge (on the model of Palladio's Villa Rotunda at Vicenza). This idea was developed by Nicholas Hawksmoor for the library to be built as a memorial to the wealthy physician John Radcliffe, and after Hawksmoor's death was achieved in its present form by James Gibbs between 1736 and 1747.

In the 1850s Oxford was in a ferment of reform, and two interrelated tendencies now coincided to make the Radcliffe Library an annex of the Bodleian. In 1850 Parliament set up a Royal Commission on the University, and academic witnesses complained that the Bodleian was comparatively useless to them because it allowed no borrowing, and, because it had no lighting, was open only for very limited hours. At the same time, Dr (later Sir) Henry Acland, librarian of the Radcliffe Library, and later Regius Professor of Medicine, was promoting the introduction into the Oxford curriculum of natural history. As part of this movement, he set up, with his friend John Ruskin, the University Museum of Natural History, which was to be the first phase of the development of science teaching. He suggested that the Radcliffe Library collections, by now predominantly scientific, should be moved to the new Museum to form the nucleus of what is now the Radcliffe Science Library, and that the Camera (as it was to be known henceforth), at this time lit by gas, should be leased to the Bodleian as a general reading room which could be open in the evenings.

THE CAMERA UPPER READING ROOM

The architectural splendour of the interior, restored in 1969 to its original colour scheme, speaks for itself. A life-size statue of Dr Radcliffe by Michael Rysbrack stands in a niche over the door. When incorporated into the Bodleian it served as a general reading room, holding what was named the 'Select Library', but since 1945 has become increasingly specialised, primarily as a Modern History reading room for undergraduates. There are also collections on Art History and Education.

THE CAMERA LOWER READING ROOM

In Gibbs's design this was an open under croft or ambulatory, as libraries were not then built on ground floors. However, the Bodleian enclosed the space and fitted it out as a book stack. The more comprehensive implementation of legal deposit from about 1860 onwards led to a much more rapid increase of the collections, and a crisis of overcrowding by 1895. E W B Nicholson persuaded the University to undertake an underground extension, to which we now descend from the reading room.

THE UNDERGROUND BOOKSTORE

This opened in 1913 and was then claimed to be the

Subterranea Bodleiana

largest underground stack in the world, with a capacity of about a million volumes. It is remarkable for the innovatory system of rolling bookcases, manufactured in Oxford on a plan first suggested to Nicholson in 1887 by W E Gladstone. Gladstone's interest in libraries was manifested during a visit to the Bodleian, where he drew for Nicholson a sketch of his proposed system, and he later published an article in *The Nineteenth Century* entitled 'On books and the housing of them' which elaborates this. The two floors are now as densely packed as possible with books in the old Nicholson classification, now closed.

THE TUNNEL

Already in 1860 Sir Henry Acland had proposed a walkway to link the Old Library and the Camera, which (happily in the view of the present writer) was not executed. However, his aim was achieved in 1913 by the excavation of the tunnel. Here may be seen, on the floor, the remains of a railway along which wheeled boxes of books were pushed by the 'Bodley Boys' (the subjects of Nicholson's remarkable experiment in library education), and, on the walls the system of pneumatic tubes which served as an internal postal system for the delivery of book order forms until the introduction of online ordering.

THE NEW BODLEIAN

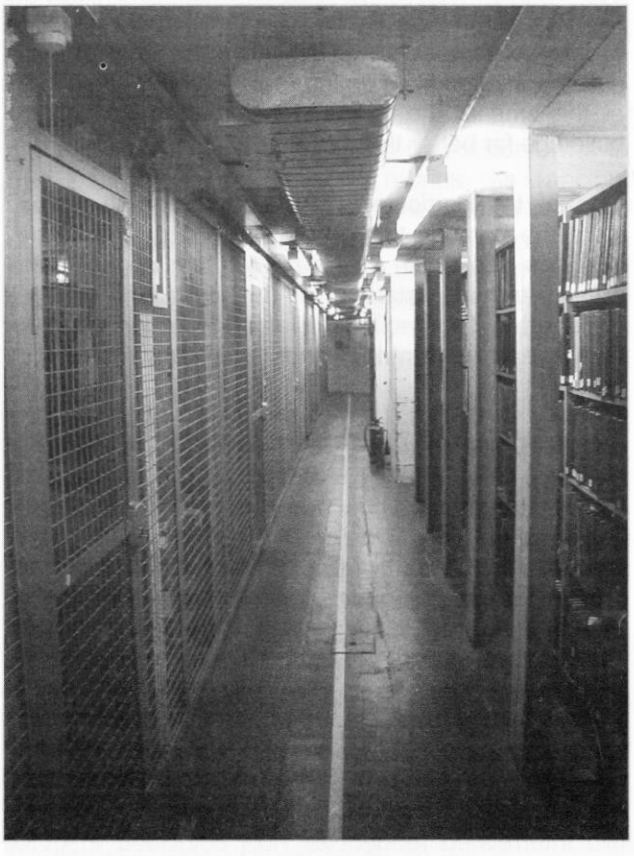
The Underground Bookstore filled up much more rapidly than had been predicted, and around 1930 a number of proposals were considered for the Bodleian's future: the building of a completely new library on a off-central site, as had been done at Cambridge; the development of remote storage; or the construction of a further central extension to the Library. This last plan was finally approved, and a major fund-raising campaign begun. The finance was assured by the Rockefeller Foundation, which contributed over 60% of the cost. In 1934 Sir Giles Gilbert Scott, who had recently designed the new Cambridge University Library, was appointed architect, and the construction of the New Library took place between 1936 and 1940. To enable the new building to function with the Old Library and the Camera as a unit, the tunnel was extended and fitted out with a mechanical conveyor system for the transport of books between the new stacks and the Old Library reading rooms.

Although the New Library was virtually ready on the outbreak of the Second World War in September 1939, its intended opening by King George VI in June 1940 was postponed until 1946, and the building was requisitioned by the Government, like many others in Oxford, for war purposes. The stacks were used partly as an air raid shelter, and for the housing of collections felt to be endangered elsewhere, such as the King's Library from the British Museum. A diversity of war-related activities was carried on in the outside rooms, such as the photographic division of Naval Intelligence, a Red Cross Prisoner of War Library Service supporting the so-called 'barbed wire universities' in Germany, a blood transfusion service, etc.

The New Library consists of a central core of eleven floors of stack (the three below ground level being air-conditioned), surrounded by three outer floors on which corridors give access to reading rooms, acquisitions and cataloguing departments, janitorial services, the Conservation department, Photographic Studio etc.

Finally, visitors may wish to note that the Library's holdings of English literature, in addition to the comprehensive coverage of Britain ensured by Bodley's agreement with the Stationers (and retrospective collection), are strong in American and Commonwealth literature; and that there are extensive manuscript collections, including writers such as Gerard Manley Hopkins, P B and Mary Shelley, CS Lewis, J R R Tolkien, T E Lawrence, Louis MacNeice, Barbara Pyrn, Brian Aldiss, Michael Moorcock and Philip Larkin.

From: Ian Walker



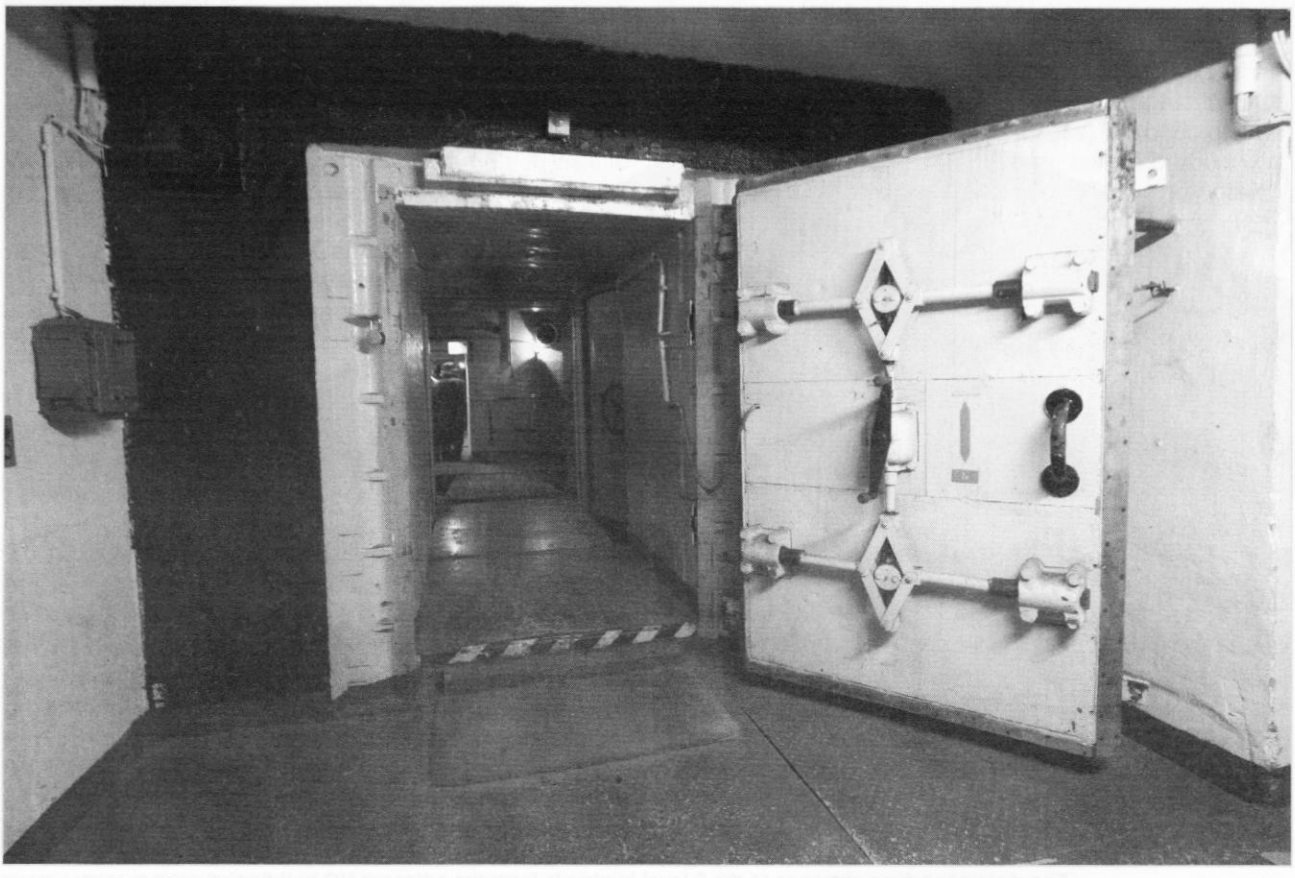
One of the "Stacks" Photo by Ian Walker

HARNEKOP -Objekt-Nummer: 16/102

The main peacetime entrance to the 3 level bunker is from the adjacent HQ building

The bunker located at Harnekop served as the main command post for the former East German Defence Ministry and General Staff. It is located 30 miles north east of Berlin in an area with a relatively high density of other former EGER / NVA bunkers and protected structures. Within 30 miles there are the sites of 5001, 5005, Strausberg EGER MOD, Wollenberg tropospheric scatter site etc etc. 2 miles away was located the Air Defence facility for the site, the 4122 SAM battalion (see details). Construction for the Harnekop bunker started in 1971 amidst the usual Soviet secrecy and was finally completed in 1976 after many alterations to the plans and arguments about costs and budget allocations, for example - there were delays due to arguments over the fact that a wooden panelled room had been constructed despite the fact that wood wasn't allowed in such facilities due to the risk of flying splinters in the event of a "near miss" strike. The final cost was estimated to be 125 million Marks – approximately £45 million. The site occupies 265 hectares / 655 acres in total, of which 30 Ha / 75 acres are dedicated to the inner Parkzone or 'facilities' area, this Parkzone was surrounded by a high voltage fence over 1 mile long designed to deter or eliminate intruders. It is not uncommon to find these fences at such sites, others can be found at facilities such as 5001, 5005, Wollenberg, air defence sites etc, etc. They are designed to start at a relatively low voltage but then quickly ramp up to much higher fatal voltages. There are few surface features which give away the location and status of the Harnekop bunker. The bunker is built into the side of a hill and immediately surrounded on 2 sides by trees. There are a few nondescript camouflaged buildings located directly on top, these resemble large tin sheds and contain external ventilation equipment, pressure and radiation sensors and external service equipment. The large machinery access/assembly shaft building is partly covered by trees. The main peacetime entrance to the 3 level bunker is from the adjacent HQ building.This 2 storey building looks not unlike a camouflaged office block from the outside but once through the main door you descend down 2 flights of stairs, through a short length of tunnel and then pass through a blast door into the bunker, which, at this depth, is about 10.5 metres below ground level. The bunker extends to about 21 metres below ground. It consists of a 4.6 metre thick blast cap, then an air space containing a gravel bed. This air gap served to dampen any effects of concrete spalling off the underside of the blast cap caused by a large external explosion or ground shear. This feature has been utilised in several NVA bunkers and it is possible to

HARNEKOP -Objekt-Nummer: 16/102



This first blast door gives you access directly into the bunker and would have been used during peacetime.

examine this protecting space at 5001. The blast cap also extends approximately 15 metres beyond the sides of the bunker to provide a protective apron to help to prevent direct strikes by ground penetrating missiles. The whole bunker is surrounded by a continuous jacket of steel – this served two purposes: it provided a former for use during the concrete pouring stage of bunker construction and it also mitigated the effects of an EMP (electromagnetic pulse). Internally, the bunker has 7 thick load bearing walls running the width of the structure and 2 load bearing walls running longitudinally as well as countless thinner walls which make up all the office and technical rooms. Many of these rooms also have sprung and damped floors to help absorb any shockwaves caused by nearby explosions: they were capable of absorbing a 7.5G vertical load and a 2.5G horizontal load. These floors can be made to move by jumping on them – the floors would deflect up and down whilst the walls and ceiling would stay still, a small skirt attached to the bottom of the walls would cover any exposed gap between wall and floor. Located in the corner of many of these rooms was a rudimentary 3+ metre tall screw jack which could be used to wind the floor back into place should an excessive shockwave dislocate the floor upwards. One of the side effects of these sprung floors was that any equipment or furniture used in these rooms had to be securely fixed to the floor at all times and also had to be constructed to be able to withstand such violent movements. As a precaution, the bunker stores contained many times the usual number of spare parts that you would normally find in such a site. The bunker was designed to function under wartime conditions for a maximum of 4 weeks before food and fuel etc began to run out. It was capable of being run for 36 hours in a hermetically sealed condition with a maximum of approximately 500 staff – in this scenario it would only run on internally recirculated air, which would have been partially refreshed by the RDU air regeneration units. These yellow units work by chemically binding the exhaled CO2 and releasing oxygen into the air – they would be put into use only if the CO2 levels rose above 0.8% concentration. It is one such unit which contributed to the loss of the Kursk submarine when one of the chemically laden plates used in the process was accidentally dropped into water and caused a violent explosion. Internally, the bunker covers approximately 4930 square metres and contains 220 rooms. There are 56 operational rooms, 160 three-tier bunks hanging on sprung fixings distributed over 10 restrooms, 6 medical rooms, 32 rooms in the airlock system, a communications area

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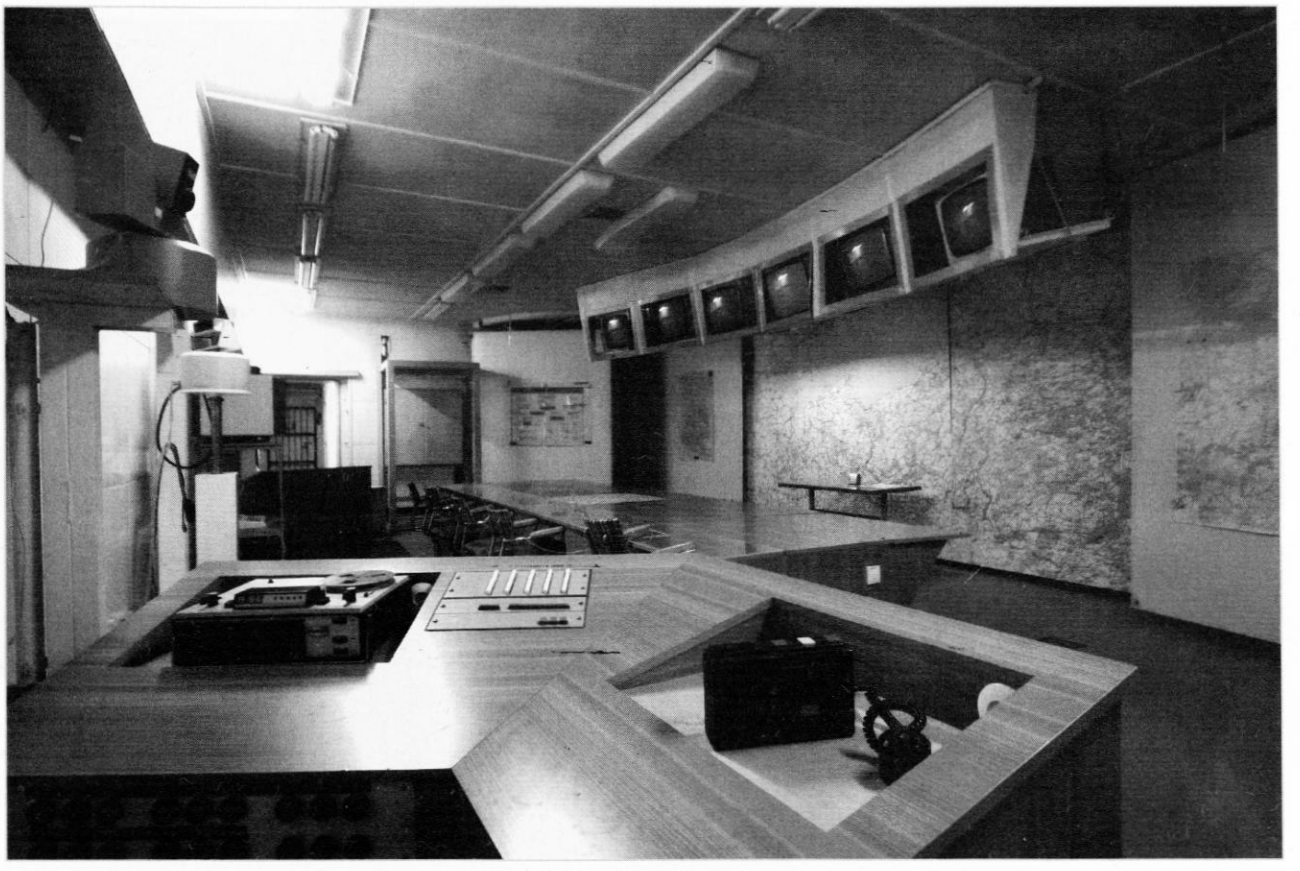


The single storey main operations room

of 21 rooms, a data processing facility of 13 rooms, including two large computer rooms, 52 rooms dedicated to technical services plus kitchen, stores and sanitary areas. Back-up power was provided by four 570 hp diesel generators which could provide up to 460 kvA. Fuel was stored in six concrete tanks each holding up to 110 cubic metres of diesel, while water could be supplied via a borehole. On entering the bunker during peacetime you would pass along a narrow section of tunnel, passing the machinery access shaft and stores area on the way, finally coming to the first of many blast doors. This first blast door gives you access directly into the bunker and would have been used during peacetime. During wartime, access would have been through a different entrance, this would have involved going through a succession of varying sizes of blast doors and reception areas until you arrived at the decontamination zone where you would normally have to wait until there were enough of you to proceed through as a group. This was desirable because the bunker was run at an overpressure and the dispatcher (technician in charge of the building management) would wish to minimize the opening of blast and pressure doors to reduce the loss of valuable internal air pressure. There were 2 routes through the entrance/decontamination process – clean and dirty, these were marked with colour coded arrows on the floor which you would be instructed to follow. The upper floor (level –1) contained medical rooms, consisting of examination beds, stores, surgical and recuperation rooms. On this floor there were also located offices, map rooms (still containing maps of Europe with text in Cyrillic) and general service areas. The single storey main operations room contains a long 5-seat desk which faces a large moveable map wall, above this wall and suspended from the ceiling are a bank of 6 television screens all on sprung hangers designed to help absorb any movement in the bunker caused by any large nearby – possibly nuclear – explosions. Behind the desk, and facing the map wall and televisions, are several remotely controlled video cameras with full pan, tilt and zoom functions. These were used to monitor the map wall, situation board and general progress in the ops room and to relay the pictures to other ops rooms in the bunker. A pneumatic tube message handling system (identical to a Lamson Tube system) was used to pass messages throughout the bunker. The Minister's room was also located on this level. Level -2 housed the majority of the restrooms and sleeping accommodation. The canteen area contained the ubiquitous large picture on the wall of a delightful pastoral scene which served to remind the serving personnel either of what they were fighting for or what they were missing, but also had the

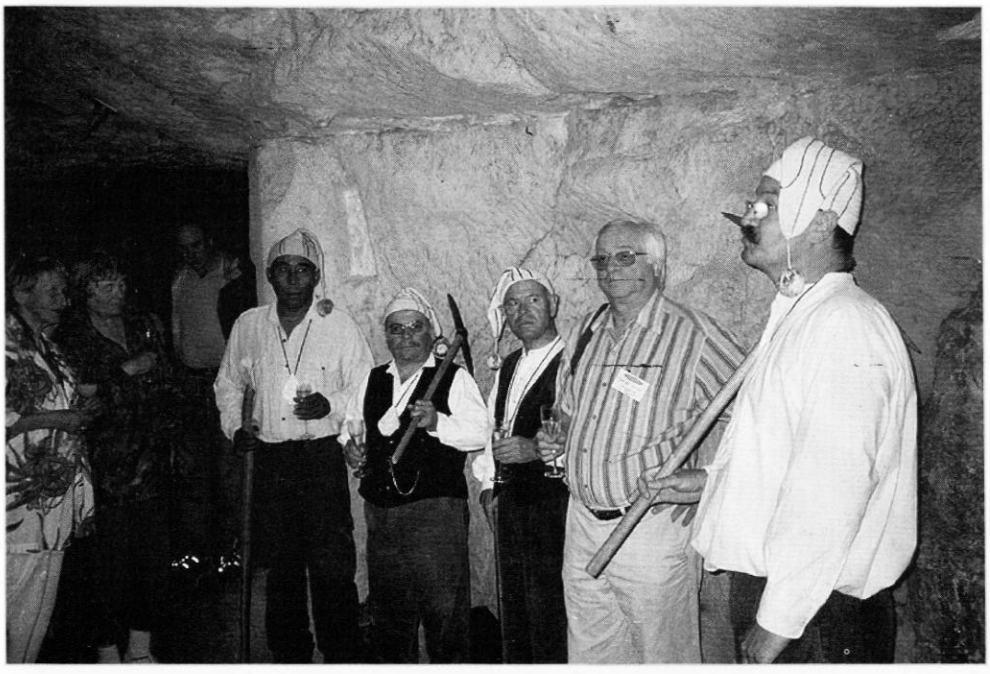
HARNEKOP -Objekt-Nummer: 16/102

The computer and data centre

psychological purpose of creating a "relaxed" atmosphere inside the bunker. The kitchen area contained ovens, hobs, preparation tables, stores and, unusually, a sprung suspended walk-in freezer. Level –3 contained the diesel generators, dispatcher's room and computer data centre as well as more of the building management equipment. The computer and data centre was spread over several rooms and contained dozens of upright reel-to-reel data handling computers, 100 meg hard drives the size of Mini car wheels with each one fitting into a reader/writer the size of very large modern upright domestic fridge, printers capable of handling large format track fed paper, punch card readers and writers, computer terminals and associated paraphernalia. Many of these items were direct copies of Western equipment and have been given the nickname IBMski. The dispatcher's room was the main control room for the overall functioning of the bunker. From here the dispatcher could control access to the bunker through the blast doors by remotely opening or, more importantly, locking the doors. Control of environmental conditions, for example ventilation, could be carried out from here as well as implementing building alarms and regulating the distribution of power supplies. A large red lever adjacent to the dispatcher's desk could cut the power to the bunker instantly. Although the bunker had its own on-site transmitter and communications aerials these would not have been used under normal conditions as the site could have been DF'd and, importantly, more could have been learnt of its capabilities by eavesdropping on transmissions. Instead, it used its own remote transmitter site at Kunersdorf (17/448) located 7 miles to the east to contact other military units, the two military districts and other major facilities, including their Soviet comrades. There was also a mobile transmitter site at Beerbaum to the east as well as the tropospheric site at Wollenberg, which was one of the three NVA stations forming the western most element of the Warsaw Pact BARS forward scatter network akin to the ACE High tropospheric network operated by Nato. The BARS network had stations in most of the Warsaw Pact countries (Romania was a major exception) and linked the member-states with Moscow. There are no exact figures for staffing levels available but approximate figures are: 60 service, 25 kitchen and medical, 120 communications, 30 IT, and 200 operations personnel. The site was manned continuously throughout its 12 year life but primarily only by the 20 strong maintenance staff.

Text Nick Catford - Photo's Robin Ware

The Souterrains of the Loire



Welcome by the local mining group in a former quarry underneath Souzay church

We knew we were in for a good weekend when the local guidebook to Saumur listed no fewer than eighteen underground sites open to the public. We were in Souzay, a few miles outside Saumur in the Loire Valley for the annual study weekend of SFES (Societe Francais d'Etude des Souterrains) – the French underground society with which Subterranea Britannica maintains a close relationship. SFES has a particular interest in underground dwellings and refuges and it was on these that the weekend was to be focused. Most of the 75 or so attendees were French but there were also delegates from Belgium, Germany, Italy and Monaco and of course ourselves. The sites visited were all above (not literally!) and beyond the aforementioned public sites, leaving lots to see on a return visit.

The weekend's structure was a morning of lectures and talks (limited to 30 minutes each) followed by an afternoon of visits. These two elements were separated by plenty to eat and drink, and the opportunity to meet old friends and make new ones. There was also an extensive exhibition area covering many aspects of underground exploration; from plans of local sites to Roman wells in Southern France and bat protection. We mounted a small Subterranea Britannica display featuring our mobile stand, copies of 'Subterranea' and information on our own recent trips to Northern France and Paris. A small bookstall completed the set-up. An excellent guide to the local sites was priced at a puzzling 24.39 Euros – equating to 160 Francs at the exchange rate when the Euro was introduced!

The formal morning presentations were varied, including local sites and speakers and those from further afield. Raymond Delavigne – a long time friend and member of SubBrit – gave an extensive presentation of underground symbolism based on the devil. Examples covered every continent and the general thesis was that the carvings and graffiti were there to act as protection in these underground spaces. Luc Stevens (who helped us arrange the Sub Brit trip to Belgium a few years ago) gave a superbly illustrated talk on the underground aspects of two Chateaux in Northern France. Italian delegates showed a wide and intriguing selection of underground 'Colommbards' or 'Pigonniers' – Dovecotes to English speakers. As Italians talk as much with their hands as their mouth, aspects of the presentation were lost as the hand-held microphone was waved about adding emphasis to the unheard words.

One characteristic of SFES members' research is detailed surveying of sites being studied. Daniel Vivier exemplified this with his talk on La Tourette, a very clear multimedia presentation of three phases of a large underground quarry dating back over a thousand years. Local groups gave talks on sites to be visited and the protection of our underground heritage. An entertaining interlude was presented when the bulb on the overhead projector failed. "How many Frenchmen does it take to change a lightbulb?". Based on observation, at least six. Denis Montagne, responsible for the underground quarries in Laon, finalised the formal presentations with a 'hands on' display of recently discovered Roman vessels and artefacts from underneath his hometown.

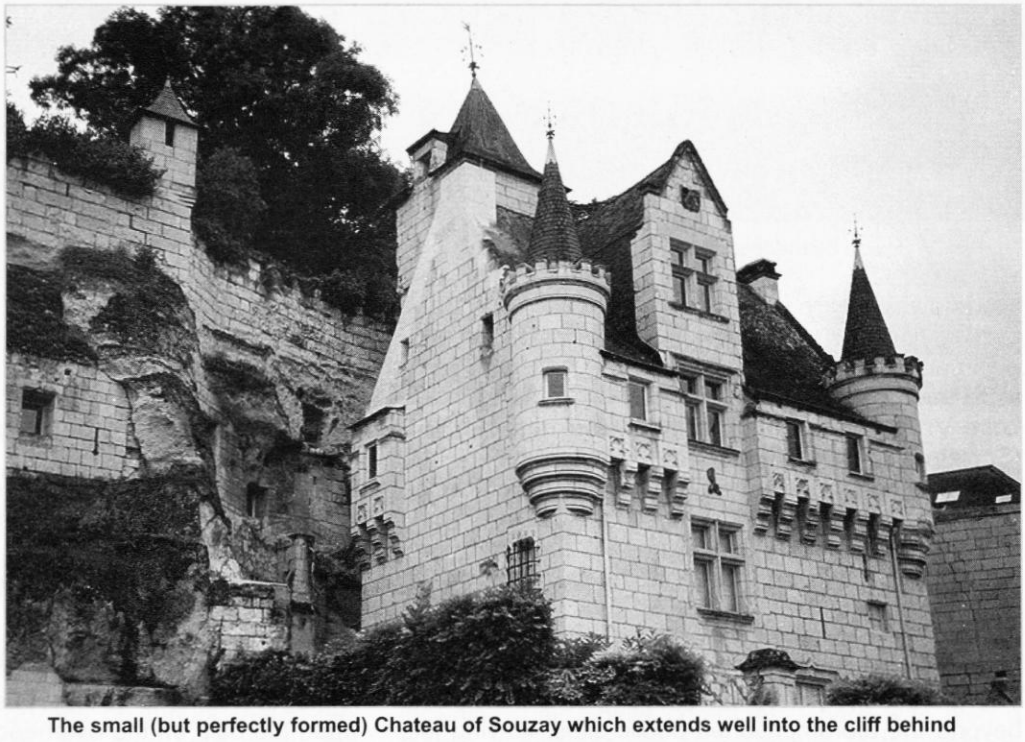
After the relaxed morning lectures, we retired (or more accurately, descended) beneath the adjacent church. Originally the quarry from which the 12th century church was built, the space was used until recently as an underground wine press and wine storage cave. Chutes that fed grapes into the presses from above still descend from directly outside the choir of the church. As well as exploring this most convenient underground site, we were hosted to drinks here on both Saturday and Sunday. Members of the local press attended part of the conference and these more formal sessions and gave the conference a good write-up.

On Saturday the Mayor of Saumur gave a speech of

The Souterrains of the Loire

welcome to the conference. On Sunday the 'Confrere des Amateux et Respecteux du Monde Souterrain' (Brotherhood of Love and Respect for the Underground World) greeted us dressed in miners outfits and regaled us with a song. Linda restrained me from responding with "Hi Ho, Hi Ho, it's off to work we go...". We were treated to the local sparking wines – Saumur and Cremant de Loire. Both are produced in exactly the same way as Champagne but because of strict geographical limits, can only describe themselves as 'Methode Traditionelle'. A very refreshing aperitif at 1145 each day to set us up for the lunch which followed and lasted to 1500.

Saturday's site visits were particularly relaxed as they were all found on a two mile walk from the Conference site itself. The walking tour (Balade in French) also had three dogs in attendance (above and below ground) which was a novel experience in itself. We first visited Rue du Commerce – a street which suddenly dips completely underground and is the site of several shops. Sadly they are now all closed but were presumably built there to offer protection for foodstuffs from the midday sun. Venturing on, we explored various quarries dating back to mediaeval times. Recent consolidation and protection has tried to provide support without destroying the original structure; a lesson that could well be learned by British authorities in places such as Bath and Reading.



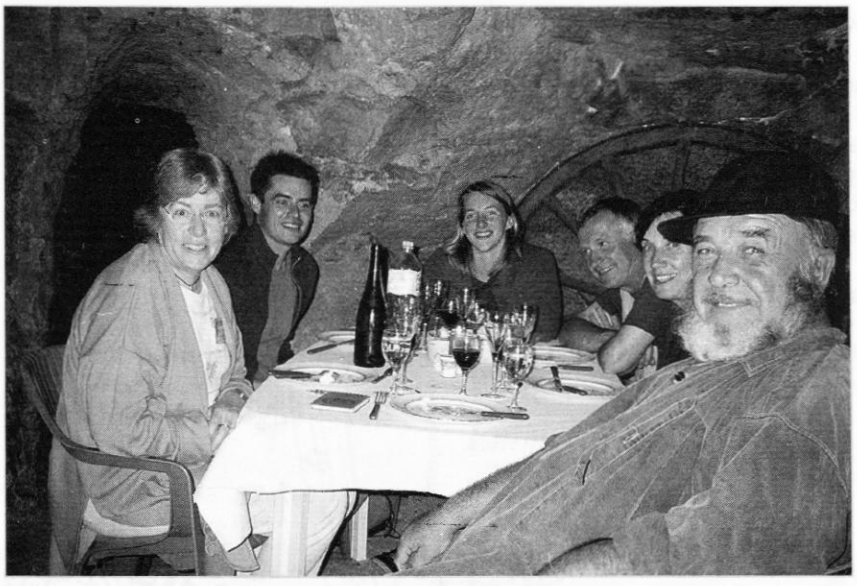
The small (but perfectly formed) Chateau of Souzay which extends well into the cliff behind

By kind permission of Monsieur Letellier, we then explored underneath the Chateau of Souzay. This compact but impressive Chateau was rebuilt in the 19th Century but is undermined by extensive and much earlier chambers. These now offer living and storage space as well as holding the obligatory wine presses. Our next visit was to sample the products of the vine and we had a wine tasting in the vaults of the 'La Petite Chapelle', housed in a large former quarry. We continued our journey to an underground house owned and occupied by Claude Kahn, one of the organisers of the weekend. An adjacent but as yet un-restored dwelling is destined to be Claude's library. The whole experience felt like being part of Tales of the Riverbank, almost expecting Ratty to pop up at any minute. At this point we had the only rain of the weekend – to make our British friends feel at home according to our hosts. We were staying exactly on the Greenwich Meridian which may have been a contributing factor.

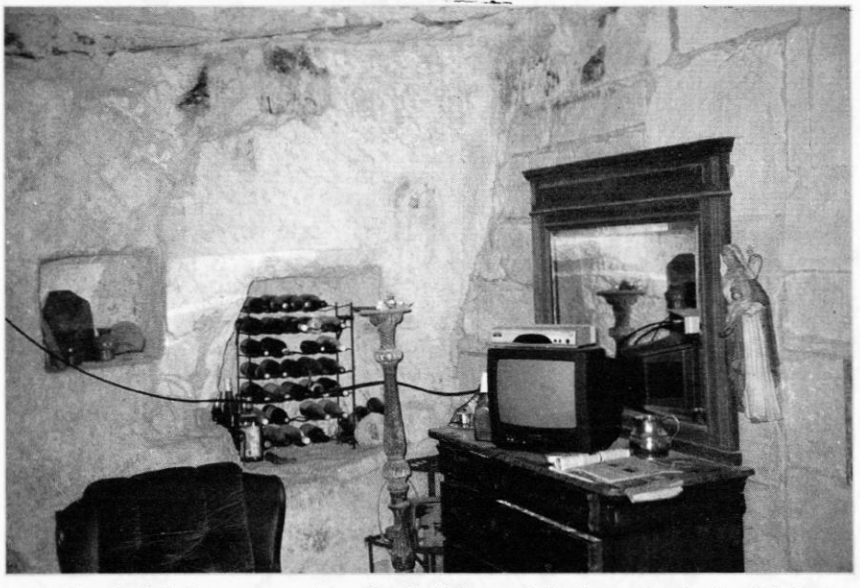
Saturday night we ate in the nearby village of St Cyr en Bourg. It goes without saying that the meal was underground. The meal was the local speciality 'Fouaces', consisting of small pieces of bread baked in a large 'pizza' oven with a large variety of dips and sauces. We finished off with baked pears, also cooked in the large oven and drizzled with chocolate. We were entertained by a 'Colporteur'- a recreation of the centuries-old local travelling salesman/tinker/ barber/ storyteller. I even managed to translate a couple of his jokes into English but by no means all. As you can see from the photo, it's a role that MC Black might well slip into!

After the Sunday morning lectures it was time for SFES to hold their AGM and we explored more of the village. We looked at the local windmill – Moulin a Cavier – which is situated over an old quarry and had its grindstone and grain silos located underground. We then sampled some more wine at the aptly named 'Domaine des Haute Troglodytes'. To get to the wine cellar, we followed the owner on a track that suddenly dived underground and then weaved its way underground for several hundred yards along a

The Souterrains of the Loire



Underground meal with local " Colporteur" (story teller)



Troglodytic house owned by Claude Kahn - publications director for SFES

twisting track which dodged between the pillars of a huge former quarry.

After lunch we visited two sites on Sunday afternoon by coach, both about 30 minutes drive away. The first was an underground shelter underneath the Chateau of Roche-Clermaut. A twisting network of passages in the tuffeau led to a chamber with graffiti and coffin shaped holes in the floor. The graffiti included a life-size man holding bread and wine, the signs of the communion, suggesting a religious purpose or belief. We then moved on to the underground Chapel of Sainte Radegonde, dating back to the 11th Century. This had behind it an underground hermitage believed to go back to the 6th Century and which housed, by repute, an English Hermit. Still deeper in the complex were steps down to a marvellously clear underground well. The Chapel itself had extensive traces of mediaeval wall paintings.

On Sunday evening we ventured into nearby Saumur for our last group meal. Saumur itself has a stunning chateau, painted by Turner in 1826. Although we said farewell to many of the other attendees, we had two more treats in store. On Monday a group of about 20 visited an underground shelter under the hamlet of Quellay. Discovered in the 1950s, this site is beneath a group of three large farms. A network of passages led to a handful of underground rooms, each with traces of seating and animal troughs. There were also airshafts for ventilation and a rather sudden (though mapped) plummeting underground well. A side passage led off for perhaps 20 metres before a steep descent and crawl (so tight in fact that I could only fit through by twisting diagonally, my modest hips being too wide for the narrow opening!). The crawl led to a single room of no particular merit other than being able to turn round for the return trip.

On returning to the surface, we declined yet another wine tasting and said goodbye to our remaining colleagues. After a picnic on the banks of the Loire Linda and I visited Chateau Breze, an impressive enough building on the surface but built over monumental underground features. These include food storage silos, defensive bastions, light wells, stables, wine presses, kitchens, stables, an ice well and on and on. All built in and around the deepest dry moat in Europe. This was a splendid site to finish our visit and one that I would emphatically recommend to anyone visiting the region.

All in all this was a fascinating weekend, helping us look at a wide range of sites unlike most found in the UK. Quite a number of the delegates spoke English so there was almost always someone around to help with translations. Accommodation in the local hotel was from 25 Euros (£18) for a double room so we didn't break the bank either. The 2006 SFES Conference is being held in the Massif Central (between Clermont-Ferraud and St Etienne). If you're tempted, see you there!

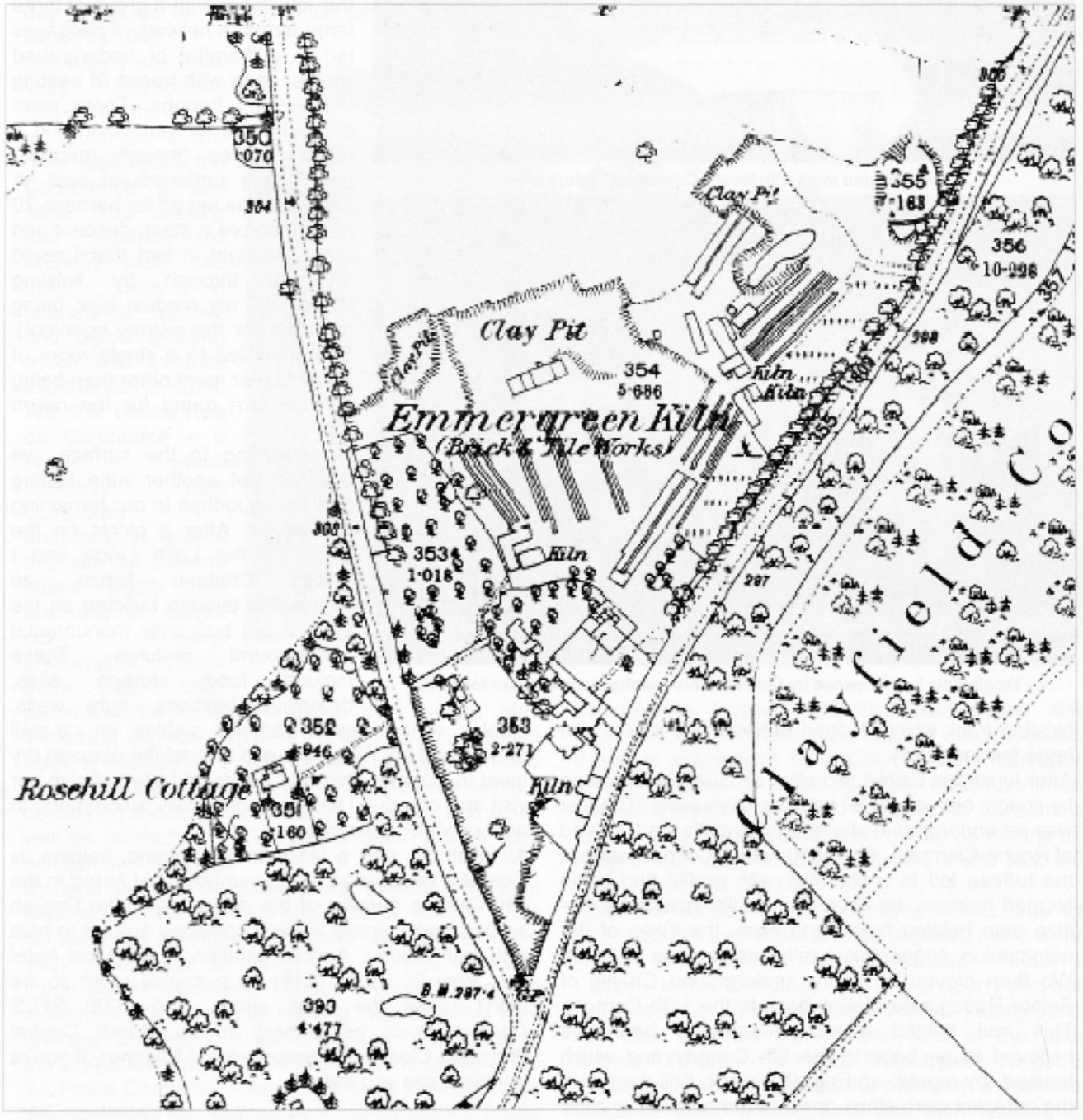
Photos and Text from Martin Dixon

Emmer Green Brick Works and Chalk Mines.

The chalk mines are situated below the old brick works at Emmer Green where Kiln Road splits off from the Peppard Road. This is approximately three miles north of Reading and situated on the Chiltern Hills as they rise north of the River Thames. The Chilterns are chalk with a clay cap of various thicknesses. In the old brick works the covering above the chalk is approximately 35 feet.

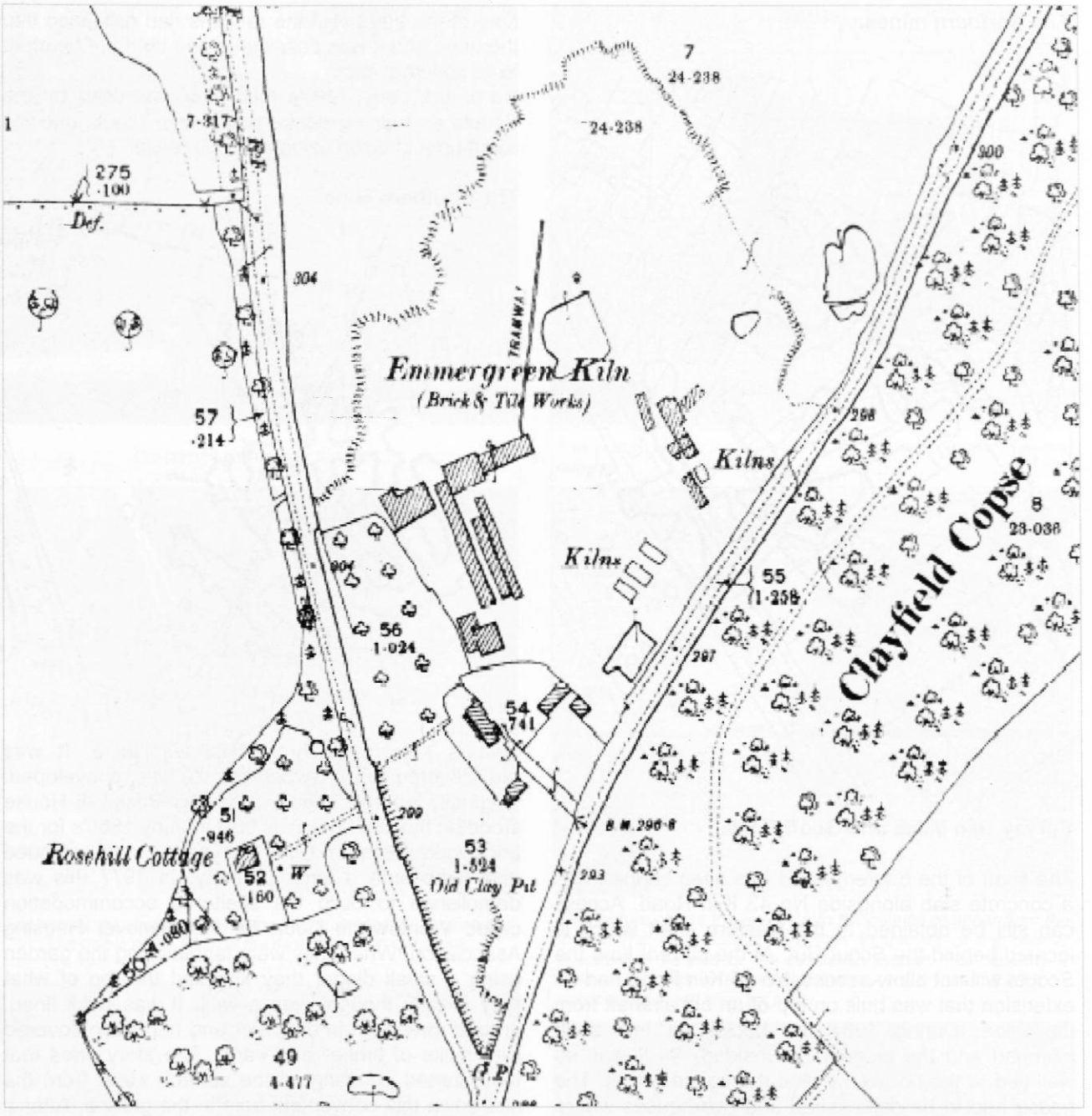
The brick works have been operating at Emmer Green for a long time. The first brick works date from 1654 and they finally closed in 1947. The suspicion would be that operations stopped in 1939 and never restarted again. During the latter part of the 1800's and the early 1900's the brick works were in full operation. The 1881 census list numerous workers and some chalk diggers. The chalk was cooked in the lime kilns to make lime mortar and it has been suggested that a small percentage of chalk was added to the brick clay to make a lighter and stronger brick which was less inclined to crack during the firing process.

Having extracted the clay and revealed the chalk



The Map of 1879 shows the woks well established with many buildings and several Kilns.

Emmer Green Brick Works and Chalk Mines.



The map of 1898 shows that the brick works is moving north. The clay at the southern end of the site had been exhausted and clay is now being extracted north of the buildings and moved into the works on a narrow gauge tramway. This northern pit continued to supply the brick works until its closure. It has now been built over and has become Russet Glade.

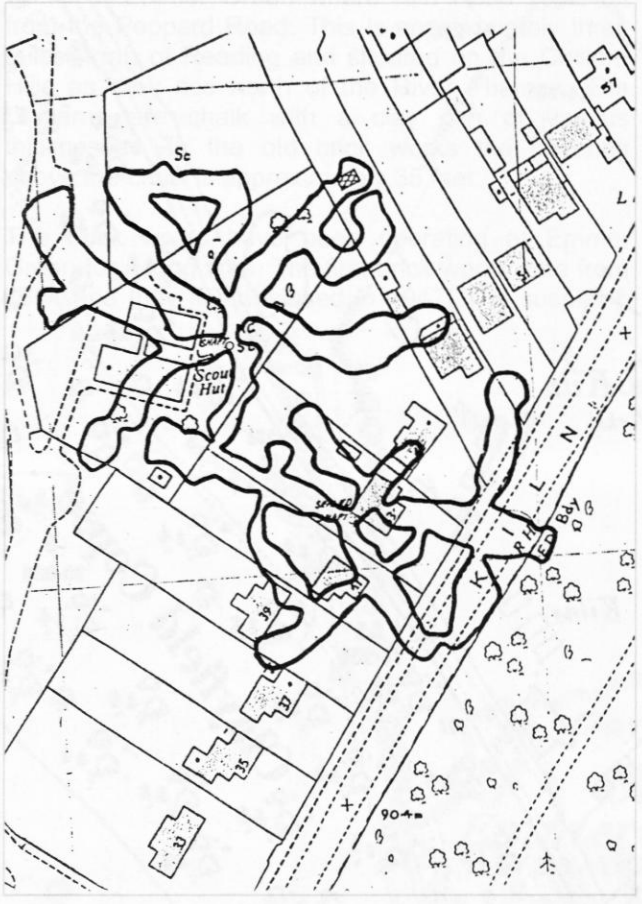
below it presumably became easier to dig out the chalk in daylight and transport it in the tramway cars rather than dig it underground in the dark and haul it to the surface. It is interesting to note that the 1881 Census lists the workers as chalk diggers and not chalk miners. The last dates in the Southern mines are 1844 and by 1903 the northern mines were being used by three mushroom growers. This suggests that chalk mining stopped in the late 1800's.

There are currently three known chalk mines under the site. Two of these northern mines are close together and have been known about for many years. At some point in the past they have been joined underground.

The third southern mine was lost and was rediscovered in 1977 when the site was redeveloped.

Emmer Green Brick Works and Chalk Mines.

The Northern mines.



Survey Dan Miles and Geoff Beale.

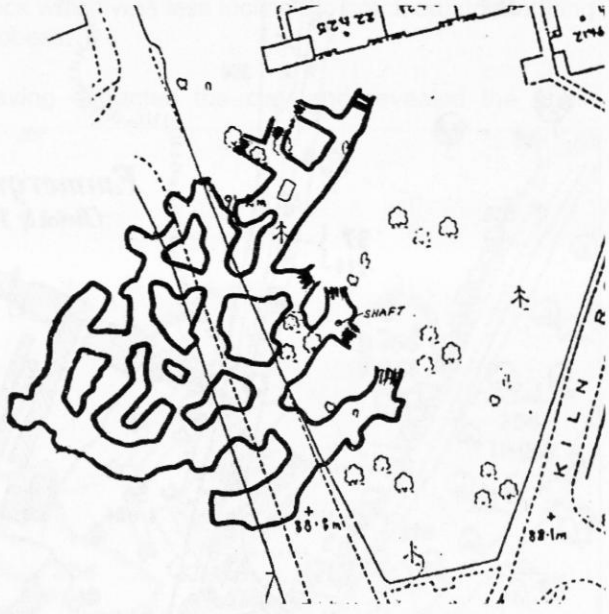
The shaft of the Easterly mine has been capped with a concrete slab alongside No 43 Kiln Road. Access can still be obtained to the western shaft which is located behind the Scout Hut. At the current time the Scouts will not allow access. No 45 Kiln Road had an extension that was built on top of an old airshaft from the mine. During 1987 the backfill in this shaft slumped and the extension subsided. As it was so well tied to the house it pulled the house with it. The house had to be demolished and two houses where built in the garden away from the shaft.

These mines are as you would expect a mine to be. They both have a main vertical shaft some 7 feet in diameter and some 70 feet deep. The shaft is brick lined at the top where the shaft goes through the clay but stops once the shaft has descended to the chalk. The passages radiate out from the bottom of the shaft and the floor is mostly level. As at best they would be moving chalk in a wheelbarrow it makes sense to have a level floor.

During the WWII the mine was used by Reading Council to store documents and other valuables from the museum. Staging was built across the Eastern shaft and descent was via ladders. During the early 1990's this staging was still in the shaft but by the time of the 2003 visit the remains had collapsed into the mine and it was possible to see right up the shaft to its concrete cap.

Up to the early 1990's this mine was used by the Scouts as training centre and many Scouts used to climb up and down using a caving ladder.

The Southern Mine.



This is known locally as Hanover mine. It was rediscovered in 1977 when the site was redeveloped. Originally a large house known as Brickwall House stood on the site. This was built in early 1800's for the brickworks foreman. Over the years it was extended until it became a large property. In 1977 this was demolished to build the sheltered accommodation called Wordsworth Court for the Hanover Housing Association. When they were landscaping the garden using a small digger they knocked the top of what they initially thought was a well. It was brick lined, around three feet in diameter and had been covered with bulks of timber and earth. The story goes that they started pumping all the surface water from the site down this convenient hole in the ground. After a few days of pumping and with no sign of water at the bottom, one of the hod carriers on site lashed some builders ladders together and went down the shaft. At the bottom he discovered an extensive chalk mine.

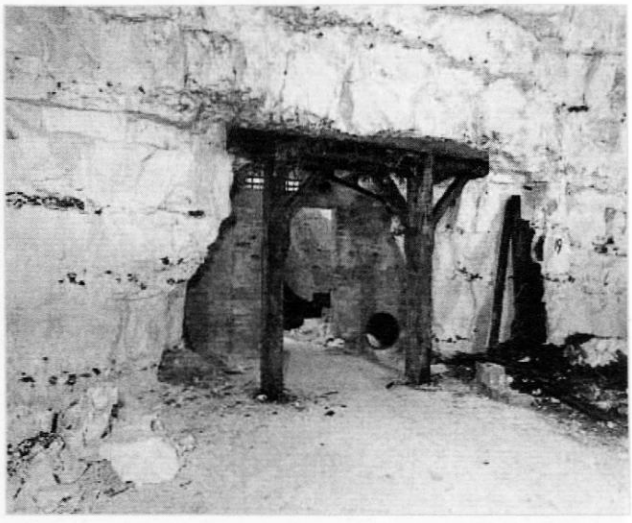
A survey indicated that the mine went under the Peppard road and the gardens of the houses opposite and a small part went under the corner of the newly constructed Wordsworth court. This section under Wordsworth court was blocked of by sandbags and pumped full of concrete.

Around 1980 Reading Council employed Wimpy Geotech to spray shotcrete over that part of the roof of the mine that was under the Peppard road. They fitted a steel liner and a fixed ladder to the shaft.

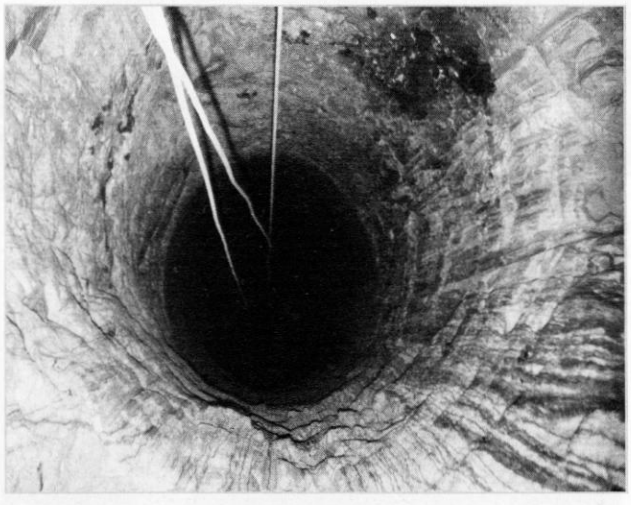
Hanover mine is frankly a mess. Its floor levels vary

Emmer Green Brick Works and Chalk Mines.

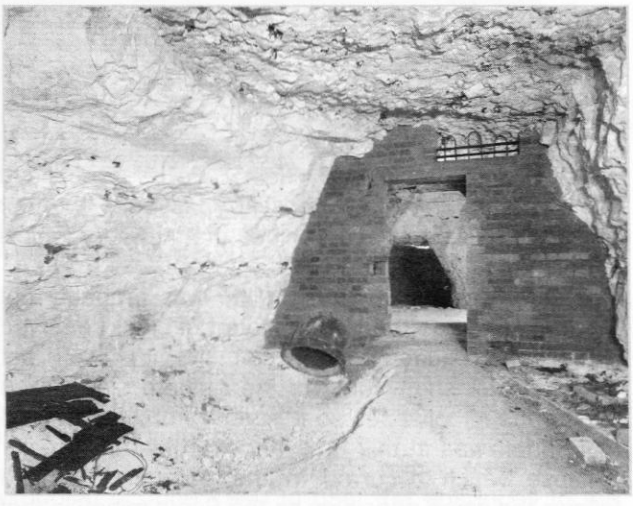
The current entrance to the mine.



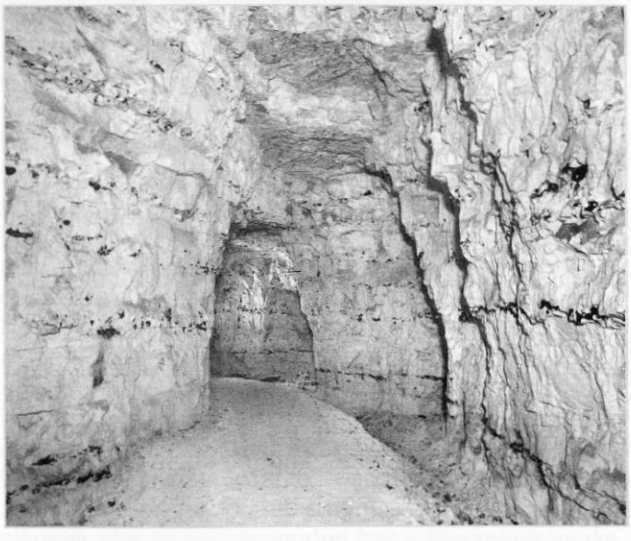
This picture shows the entrance to the Council chamber from the outside.



Looking up the shaft from the bottom. The start of the brickwork is just visible at the limits of the flash. Photo: Geoff Beale.



This picture shows the entrance to the council chamber from the inside. The large earthenware pipe to the left of the door is assumed to be part of the ventilation system. The humidity is always very high in the chalk mines and any material such as wood or paper will soon rot away.

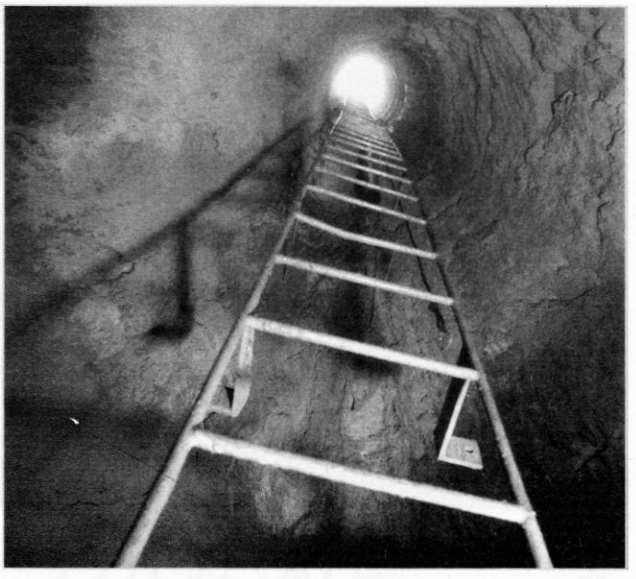


Passage in the mine. All the passages are a similar size of 12 to 15 feet high. They are all very stable with no sign of collapse.

This picture shows the inside of one of the Nissan huts. The steel work is still in very good condition considering that it is approximately 65 years old.

Emmer Green Brick Works and Chalk Mines.

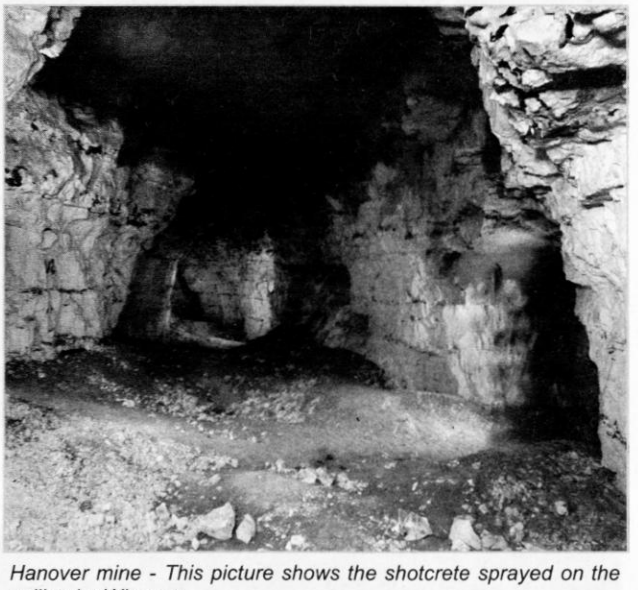
This picture shows the old stove at the bottom of the western shaft. Its chimney used to run up the shaft to the open air. The trays piled on the left of the stove were used to place the small tins of silica gel on, so that they could be placed in the oven. The silica gel was used to keep the documents dry.



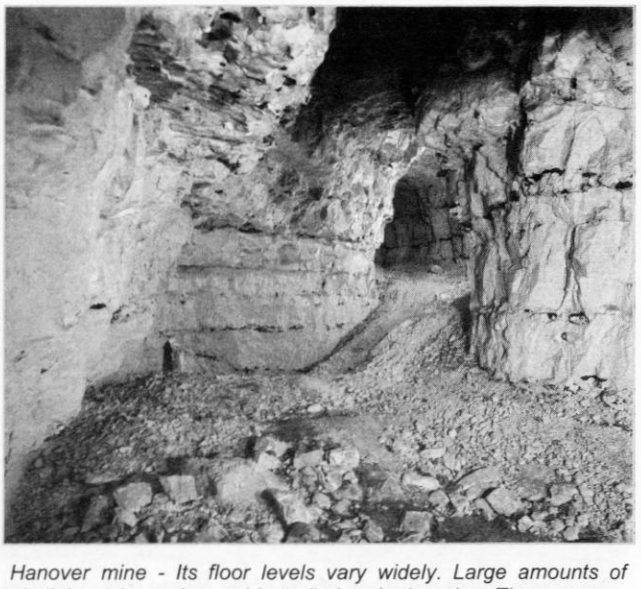
Hanover mine - Looking up the shaft showing the fixed ladder fitted by Wimpy.

widely. Large amounts of chalk have been dug and just piled up in the mine. The passages wonder aimlessly unlike the Scout mines that are very logical in their layout.

The current entrance to the mine was probably not the main shaft as the large amount of chalk removed would have required a larger diameter, it is likely that it was an air shaft. Most of the eastern side of the mine ends in collapses so it is very probable that the main shaft was in this area and was lost in a major collapse which occurred in the past. If the mine follows the same principles as the Scout mines in that the shaft is positioned in the centre of the mine than what remains of Hanover must be a small percentage of the original mine.



Hanover mine - This picture shows the shotcrete sprayed on the ceiling by Wimpey



Hanover mine - Its floor levels vary widely. Large amounts of chalk have been dug and just piled up in the mine. The passages wonder aimlessly unlike the Scout mines that are very logical in their layout.

We know from the maps of the late 1800's that clay was excavated from the southern end of the site and that the pits were above the mine workings. It is likely that these disused pits were filled with rubbish and possibly rain water until the roof of the mine collapsed.

One of the collapse faces in the mine has revealed broken bricks and tiles that can only have come from the surface. It is likely that the mine was abandoned when it lost its main shaft and the dates suggest this was around the mid 1800's.

From Graham Old Photo's By Nick Catford

Shelter in the East

Photographs of the Westdown and Gainsborough shelters have proved impossible to trace but this linocut drawn in 1941 by N.H. Johnson gives a vivid impression of the Gainsborough Bridge Tunnel. The proportions are not quite right for a 12ft diameter running tunnel, however, and the picture gives an impression of space that could never have existed. [*Vestry House Museum*]

The purpose-built deep civilian shelters built during World War Two were concentrated mainly in north and south London but no provision of this kind was made on the eastern side of the city. At the height of the blitz in 1940 local authorities the unopened stations and running tunnels of the Central Line tube extension, construction of which had stopped because of the war, could provide valuable protection underground for the population.

A little background on this project may help readers put this work into context. Before the war the Central Line was much shorter than today, with its eastern terminus at Liverpool Street (in the west it went no further than Ealing; the Ruislip line had not been built). Under the 1935-40 New Works plan (described in Chapter 2 of the book *London's Secret Tubes*) new tunnels to the east of Liverpool Street would extend the line to Leyton, at which point tube trains would run over existing suburban lines of the LNER company to Woodford, Epping, Hainault and Newbury Park. The main tunnelling works had been completed by early 1940, but the stations were unfinished and only a small proportion of the tracks had been laid when further tracklaying activity ceased in May 1940. This was the situation when bombing became a serious threat to London's East End and in June it was agreed with the Ministry of Transport that all work should be suspended bar a few minor works that could not be left unfinished. Some track already laid was even lifted for use elsewhere.

Stratford's shelter

In May 1940 the Regional Technical Adviser of the London Civil Defence Region visited the unfinished works of the Central Line extension and afterwards invited local authority engineers to consider their use as shelters. Leyton Borough Council presented its proposal in June 1940 to use "the entrances to the railway" and a month later a proposition was received from West Ham Corporation. Three public air raid shelters were created as a result in the Stratford and Leytonstone areas.

The first two shelters used the untracked westbound tunnel between Stratford and Leyton stations (the eastbound tunnel contained a working railway track). The ¾-mile tunnel provided two separate shelters operated by different local authorities under separate leasing arrangements with the London Passenger Transport Board. The boundary or division point was a London Transport working site on the east side of Queen Street next to the junction with Henniker Street, where an access and eventual air shaft had been dug to the running tunnels below. West Ham Corporation took over the southern half (425ft) as the 'Stratford tunnel' and created an entrance near Stratford station, reached by a wooden footbridge from the west end of William Street. From there a ramped wooden walkway was constructed between railway tracks down to a 12ft square tunnel 60 yards long that led into the main tunnel. Leyton Borough Council occupied the northern section (the 'Queen

Shelter in the East

Entrance to the Bethnal Green shelter

Street tunnel', 'Westdown Shelter' or 'Drapers Field Shelter') and created an entrance at Drapers Fields adjoining Westdown Road and a temporary depot used by London Transport for storing tunnel lining segments and other materials of the new railway (its last traces were erased in early 1947). To reach the tunnel portal the council created fenced asphalt footpaths across the railway depot from High Road Leyton and from Westdown Road; these led to a footbridge over the railway with steps down to the tunnel mouth from there.

Occupation of the shelters began in September 1940 and although the original intention was to use only part of the tunnel, the public effectively gatecrashed the entire length. Bunks were eventually fitted along the length of the tunnel, with sleeping accommodation for 2,800 people in the Leyton section and for 2,136 persons in West Ham. Canteens were also provided in both sections, with ventilation supplied by the shaft at the mid-point below Queen Street (slightly south of the actual municipal boundary). At this spot a timber and wire mesh barrier with a wicket gate was erected. To be opened only in emergency, its purpose was to create a line of demarcation between each borough's residents but in fact it led to a source of some irritation. To serve a most basic human function, latrines were provided but whereas Leyton's tunnel had these places of convenience set out at convenient intervals, West Ham's 20 cubicles were sited less conveniently all together at the Stratford entrance. For some West Ham shelterers this meant a walk of up to 600yds to answer the call of nature—so they used the nearer facilities 'across the border' in Leyton.

Needless to say, the Leytonians were none too pleased to suffer longer queues for the loos. It became such a bone of contention in fact that the police had to intervene and have West Ham install additional toilets. To add to the displeasure the latrines had only Hessian 'doors' and partitions, many of which were 'torn and soiled'. Litter bins and candle lights were being stolen constantly, so life in the tunnels must have been quite disagreeable.

Grief at Gainsborough

Displeasure of another kind was felt at another shelter operated by Leyton Borough Council, the next northerly use of the tubes dug for the Central Line to be. Known variously as the Gainsborough, Gainsborough Bridge or Leytonstone Shelter, it was another tunnel entrance shelter. The new tunnels heading off towards Wanstead and Redbridge diverge either side of the original Epping line and enter tunnels north of Leytonstone station close to where Gainsborough Road bridge crosses the line. It was a portion of this new tunnel section that Leyton Borough Council agreed to lease from London Transport in July 1940.

The agreement related to both tube tunnel bores for a distance of 350ft north-east of the Gainsborough Road tunnel portal, at the far end of which a wire mesh barrier was erected. The tunnels beyond here were reserved for the Ministry of Aircraft Production (MAP) for use as an underground factory (described next) and this soon became a source of strife. In September, when air raids on London became intense, shelterers swelled in numbers, broke through the barrier (later replaced by a more substantial screen and picket gate) and occupied the MAP section of the tunnel. Since this was not required immediately for production the shelterers were allowed to stay put until the engineers required the tunnels to install machinery (they were, however, warned this was a temporary concession).

On 25th February 1941 London Transport, on instruction from the MAP, gave one month's notice that the 640ft 'illicitly' occupied section of tube tunnels would have to be cleared and on 14th March signs were posted in the shelter saying it would close on

Shelter in the East

This photograph, showing bunks constructed at Liverpool Street or Bethnal Green, indicates that a standard design was followed. [*Railway Gazette*]

the 28th. Five days later letters of protest reached the Ministry of Home Security (MoHS) and a major argument broke out in the newspapers, not to mention a row between the two ministries. Complaints by the Shelter Committee led to the Member of Parliament for Leytonstone, Mr M. Leigh, berating the government. "The callous decision to close major portions of Gainsborough Bridge tunnel shelter in favour of a company on war work is nothing less that a crime against humanity," he asserted on 23rd March 1941. A few days later two Labour Members, Reginald (later Lord) Sorensen (Leyton West) and Valentine (later Baron) McEntee (Walthamstow West), raised Parliamentary Questions on the subject. Newspapers ran campaigns too. The Minister of Home Security blustered that steps would be taken to provide alternative accommodation for the shelterers but this was clearly impossible and eventually it was agreed not to move them (in this respect they were more fortunate than their fellows in Redbridge, where a public shelter at the unopened Redbridge station was displaced by the Plessey works, described in *London's Secret Tubes,* chapter 12).

"Petition Saves Shelter," ran the headline of the *Daily Express* on 4th April, which gave no pleasure to the government. "The plain fact is that we have to choose between shelter and aeroplanes, and there can be no doubt as to the choice," wrote a Civil Service adviser at the MoHS, noting that bunked accommodation in trench shelters was standing idle while people occupied the railway tunnel. It was remarkable too, the file also noted, that 5,000 people signed the petition to retain the shelter, even though nightly attendance was normally just 700, rising in mid-March to 1,000 when air raid activity became more intense. In the event political expediency won the day.

Access to the shelter was by temporary staircases from the south side of the bridge where Gainsborough Road crossed the railway cutting and with no other way out, it was realised that a safety hazard existed. A potential alternative exit would have been through the tunnel bulkhead into the adjoining tunnels used for the Plessey factory but the door here was locked on account of the secrecy of the works. A 5ft diameter escape shaft to the surface was proposed in August 1941 but nothing came of it.

Rebellion at Redbridge

Redbridge, the next point east on the Central Line tunnel, was another location opened initially as a public shelter and then assigned to aircraft production. As a shelter it offered rather little protection, probably less than the Morrison and Anderson shelters that its users had forsaken, simply because it was only just below ground level. In fact the station was built immediately below the surface, so close in fact that stairs and no escalators were required to reach the station platforms.

Nonetheless, the unfinished station provided a refuge of sorts and one that shelterers were unhappy about leaving. Hundreds of people flocked there as soon as the night raids began in September 1940, causing some animosity, as most of them were not local residents. The condition of trench shelters in council parks was not enticing either; they were extremely damp, forcing people to spend the night on wet concrete floors. The station made a barely more satisfactory shelter; there was no sanitation and people had to sleep on the platform or the rail-less trackbed. When the premises were requisitioned for factory use the shelterers were given notice to quit.

Shelter in the East

Bethnal Green, one of the unopened tube station in east London that was converted into a shelter. Note the wooden trestles for bedding on the tracks.

Although the station was not closed until an alternative shelter had been constructed and equipped, the shelterers were still not satisfied and a deputation of them was received by the MoHS, supported by a Parliamentary Question on 6th February 1941 by the M.P. for Ilford North, Mr T.E. Groves, regarding "the decision to discontinue the use of the Redbridge tube station air-raid shelter". This time, however, the MAP was not deflected and the shelterers were obliged to vacate their underground quarters to make way for factory workers.

Their departure was not without incident, however, and when they showed signs of refusing to leave, the mayor of Ilford, Alderman C. A. Parman, went accompanied by the Borough Engineer and Chief Warden to reason with them. The shelterers became "extremely threatening" and advanced on the peacemakers with sticks. The Borough Engineer laid out the nearest attacker but others made for the Mayor's car and attempted to overturn it. It is said that only the frosty ground on which the car slid thwarted this effort. A retreat was possible when the Chief Warden arranged a diversion and the Mayor's driver stated that if the crowd would get back a little, the Mayor would like to talk to them. But this was a deceit; when the crowd backed off the chauffeur manoeuvred the car out and away to safety. Afterwards the shelterers transferred to their new quarters without further incident.

Gants Hill and Newbury Park

Further east at Gants Hill a pedestrian subway system and a booking hall for the future station had been built beneath the large (seven-ways) roundabout that had formed a landmark here since the early 1930s. The access tunnels (but not the circulating area that gave access to the Plessey factory) served as a public refuge from air raids and were known as the Gants Hill Subway Shelter. Operated by Ilford Council, it was noted in use in MoHS files dated 1943 and 1944 but not in May 1945. A reminiscence by Sheila West, now in Australia, states, "We were driving home from London one night in 1940/41, before my father went into the army, and it got so bad we had to take cover there. I remember thinking it was great fun!" A police report of August 1944 confirms it was frequently used by casual passers-by and had 250 users nightly then. At the eastern end of the new tunnel, south of Newbury Park station, an unofficial air raid shelter was also established. This did not last, as long-term

Shelter in the East

local resident Peter Shorer recalls.

The tunnels, with no barriers to stop entry, appeared to be attractive to those having access to them and were used as an air raid shelter. After several daylight and night time raids about 1939, this was brought to a halt one Sunday morning when, as usual the locals who had access to the track through the fences of their back gardens assembled some way inside the tunnel. My mum and dad had followed, believing it to be safer under some thickness of ground rather than on the surface in the Anderson shelter or in the house 'under the stairs'. While the neighbours were talking among themselves there was a disturbance at the entrance and in walked a police officer with several constables.

The officer walked straight up to my dad and said in a penetrating voice, "I want you to get your people out of here! It is very dangerous! If a bomb bursts at the entrance it will kill all of you by its blast!" My dad replied they were not his people and he was not responsible for what they did.

But the senior policeman became very imperious and told him, "You will get them out back to their homes and safety at once!" His loud voice convinced many people to move out, so a confrontation was averted and this was the end of the use of the tunnels for that purpose.

This was not the last excitement for people living alongside the railway here, as Peter continues. In about 1941 or 1942 the railway line between Ilford and Hainault was used for firing a large rail-mounted anti--aircraft gun during the night. This was probably to discourage raiders from attacking the fighter airfield at Fairlop. "It would stop at irregular intervals to fire, sometimes outside our house and the sound was dreadful, particularly if you had been asleep! We had got used to the noise of the trains running during sleep times but these guns were something quite different," he declares.

From Andrew Emmerson

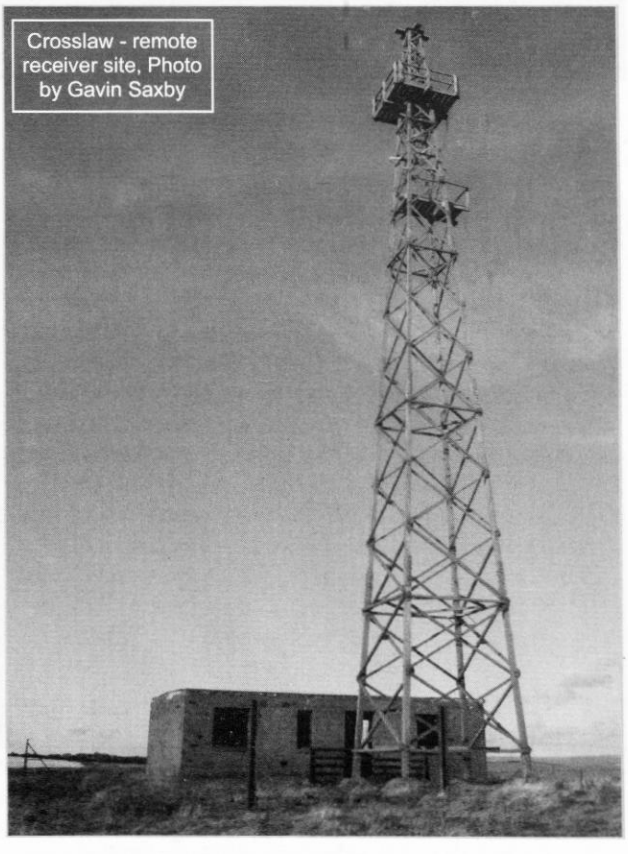
The History of Crosslaw

In the early 1950's Crosslaw was chosen to participate in the ROTOR project as a Chain Home Extra Low 'A' (CHEL'A') to replace the old WW2 CHEL station at Cockburnspath. It opened in late 1954 and at the same time the Chain Home station at Drone Hill was placed on care and maintenance, the latter closing in March 1955.

It is an R2 single level operations room serving a single Type 14 radar head which was located on a 25' gantry above the bunker; the site of the radar is now occupied by a NATS (National Air Traffic Services) VOR (variable omni-directional radar) beacon.

There was a reserve site allocated for a mobile CHEL if the station was off air, this was to be on Coldingham Moor although the exact designated site is not known. The standby set house (generator) was located on the domestic site at Coldingham village. Although the standby set house has been demolished some buildings, including the MT shed, still survive within a holiday home village and the adjacent married quarters are now in private occupation.

In order to provide communication between the controllers in the R2 bunkerat RAF Crosslaw and the intercepting aircraft, two VHF/UHF multi-channel radio transmitter and receiver blocks were at built at



Crosslaw - remote receiver site, Photo by Gavin Saxby

The History of Crosslaw

Front of Crosslaw guardhouse before conversion. From owner's archive

Rear of Crosslaw guardhouse before conversion. From owner's archive

Front of Crosslaw guardhouse after conversion. Photo by Nick Catford

remote sites at Haud Yauds. The blocks were remotely sited to stop interference and swamping of the radio signals by the radar transmissions.

Each site consisted of two buildings, the operations building and a standby set house. The transmitter building was located on the north side of the A1107 at NT82956875 and comprised the transmitter hall, mechanical and electrical room, store, workshop, staff room and toilet. The building still stands within a small compound alongside the road. It has been stripped of all original fittings and has been put to agricultural use.

The smaller receiver building is located on the east side of Dolaw Road at NT83456835 and comprises a receiver room, mechanical and electrical room, store, workshop, staff room and toilet. Again the building remains intact although derelict and gutted. Unusually the wooden aerial tower also survives alongside, one of only two Rotor radio masts still surviving; its future is uncertain

The station had a short life, it is listed as being operative in 1956 parented by RAF Turnhouse but by 1958 it was surplus to requirements and closed.

In 1962 it was proposed to move the ROC Caledonian sector control from Barnton Quarry to the bunker at Crosslaw. However the distance crews would have to travel from Edinburgh group was a problem so they selected School Hill near Aberdeen instead with Caledonian Sector Control being relocated in the former Chain Home transmitter block and manned by local volunteers from the Aberdeen ROC Group Control.

The Crosslaw site was purchased by the Civil Aviation Authority in about 1965 as part of the ongoing improvements to civil navigation. The guardhouse was used as engineers' accommodation when on site but the bunker remained unused.

In 1990 the estate was sold to a private owner and the ROTOR guardhouse was tastefully extended to make a larger house. These pictures clearly show the changes that were made:

The water tanks that would have been in the roof void were removed An extra section was added in the middle at the rear of the house for the new staircase to the first floor.

Another extra section was added at the rear right of the house to extend the kitchen and master bedroom The fake dormer window in the roof was opened and extended almost the full length of the roof to allow light into the new bedrooms. The sealed window in the entrance stairwell was opened and glazed. The veranda was sealed at both ends and windows added at the front to make an entrance vestibule and allow the dining room and lounge to be extended into the veranda.

A seperate garage was built at the right hand side of the house. The entrance staircase was carpetted and the area at the bottom of the stairs was converted

The History of Crosslaw

into a snug. A wooden door to the entrance tunnel was added. The top few metres of the entrance tunnel became a small utility room.

Crosslaw Today:

When friends and colleagues find out that I am interested in bunkers and underground places they will either say that I must be a little eccentric or accuse me of being barking mad. As I stood at the top of the entrance tunnel into the R2 bunker at Crosslaw, I wondered if they might be right...

Laid out before me was a smooth expanse of water stretching off into the darkness. The ceiling mounted corridor lights were perfectly reflected in the the water until they disappeared under the surface as the tunnel sloped down.

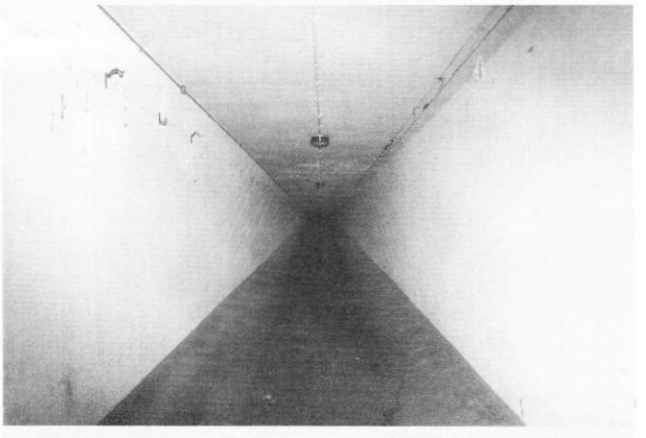
The day before our first visit to the site I was informed that the water level in the bunker might be higher than anticipated. The last time the bunker had been visited, the water was lapping at the underside of the joists that would have supported the teak flooring. To step through the door at the top of the entrance tunnel and see the sight I described above was a blow to say the least. It was clear that the high level of water in the entrance tunnel was on the brink of causing the snug to become flooded. Something had to be done! In the following weeks I liased with the contractor the owner had employed to do the work, taking him through the finer points of R2 design and explaining the techniques that had been used to great effect during the pump out at Wartling. I was also able to pass on advice gleaned from some of the learned members of Sub-Brit.

There were a number of options available for getting the water out of the bunker. These ranged from breaking through the concrete cap above the cable exit shaft and lowering a pump on a rope through to core drilling through the roof of the entrance tunnel and installing a standpipe. In the end it was decided to use a single submersible pump with a float switch and a very long 2" hose routed up the entrance tunnel and through the window at ground level. A pane of glass was removed from the window and a wooden board with a hole cut in it was used to keep the guardhouse secure.

The pump was moved down the tunnel as the water level dropped. I visited the site a week after the pumping started and despite my worries about how slowly the water would be moved with the amount of vertical height, the water was now halfway down the tunnel and I could see the wooden door at the bottom.

While driving down to Crosslaw for my third visit I began to feel quite excited. How far would the water have dropped? Was I going to be able to see inside? After being let in by the housekeeper I was pleased to discover that the water was now down to just over

Rear of Crosslaw guardhouse after conversion. Photo by Gavin Saxby



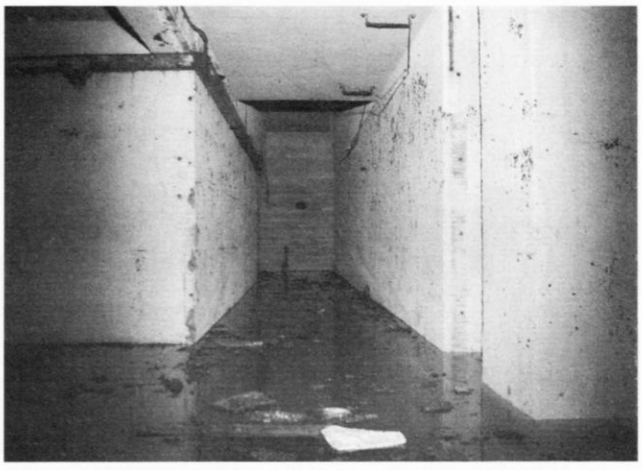
The entrance tunnel before pumping started. Photo by Gavin Saxby

The entrance tunnel halfway through pumping. Photo by Gavin Saxby

2' at the bottom of the tunnel. The pump was sitting idle a few metres up the corridor in front of the wooden door.

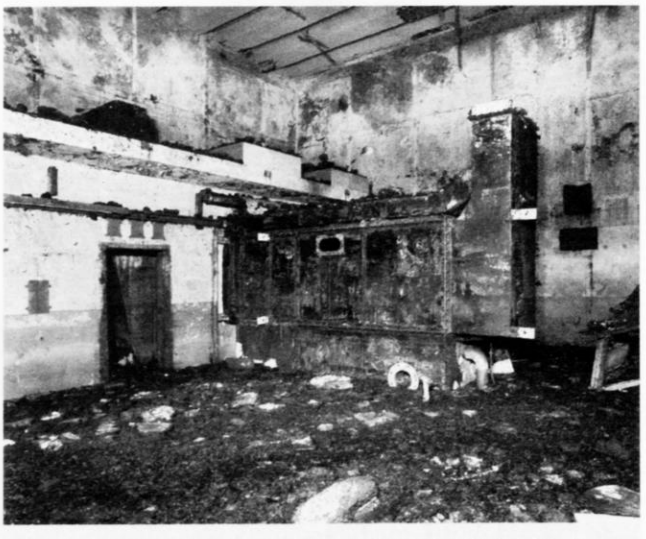
With the aid of my trusty waders I was able to make the left turn into the dogleg and see the recess for the transformer on the left and the bottom of the cable exit shaft on the right. There was a lot of cork and pieces of wood floating on the surface, but the water was clear enough to see that a section of wooden

The History of Crosslaw



The entrance dogleg and transformer bay. Photo by Gavin Saxby

The operations rooms. Photo by Nick Catford



The Air Conditioning plant room. Photo by Nick Catford

flooring was missing right in front of the transformer recess. I was able to walk across a small brick wall that would have supported the floor.
Moving further down the dogleg I was able to peer around the corner and into the main northwest to southeast spine corridor, this was it! At this point I decided that discretion was the better part of valour because my companion was only wearing wellingtons and would find it difficult to come to my aid if necessary. Coming back along the dogleg proved to be a little more tricky. My movement had stirred up the water into a murky brown soup which completed obscured the little wall I had to walk over. After some probing with my monopod I was able to relocate the wall and walk out. Before leaving I lowered the pump into the cable void and it started to run again.
In the weeks before my next visit, the hose for the pump had been removed from the entrance tunnel and had been dropped down the cable exit shaft. The concrete shaft cap had been core drilled to allow the hose to go through. The pump itself stayed beneath the secondary flooring by the transformer bay.
By the time of my next expedition into the bunker the water was down to a depth of 6" and well below the secondary flooring. This meant it was possible to move around without even having to use wellingtons.
This time I was able to see exactly what I had been treading on while walking down the entrance dogleg. On the right hand side of the corridor were rolls of cracked brown lino and bundles of a white fibrous substance that I was happy to leave well alone. On the outward side of the dogleg were heavy steel blast doors and on the inward side wooden swing doors, both sets of doors have been removed.
Originally there would have been four rooms on the left hand side of the spine corridor. These were from the north west, the radar office, the track telling room, the workshop and the air conditioning plant room. The partitions that would have seperated them had collapsed into the water leaving one long room. All that remained in the first three rooms was ventilation trunking on the walls and ceiling.
The AC plant room had also been largely stripped although part of the air handling plant still remained on its concrete plinth in the centre of the room. At the back of the room there were three small rooms with brick partitions, these still contain the filters. The AC plant room never had a secondary teak floor, just concrete steps down from the corridor to true floor level.
On the right hand side of the spine corridor, the partition between the first two rooms (intercept recorder and technical office) had also collapsed.
Moving further down the spine corridor and walking gingerly over more gaps in the floor I found that the remaining rooms on the right had solid floors and could all be entered. The next room on the right was the RAF (male) toilet which still retains its WC's, beyond this was a storage area where there was originally a ladder up to the technical stores above the rest rooms, the ladder had gone. After that came the WRAF (female) rest room with a small serving

The History of Crosslaw

hatch from the kitchen and access to the WRAF toilet which again had its WC's and wash basin intact. The kitchen had been completely stripped apart from the extractor hood. The RAF rest room next door is also empty; this too had a serving hatch into the kitchen. The final two rooms on the right hand side of the corridor were the GPO room and the low voltage switchgear room, again both were empty.

I crossed another section of missing floor the end of the corridor and entered another dog leg passage to the right. The wooden swing doors and the steel blast doors that would have been here had been removed. I then moved through into the final section of corridor towards the emergency exit stairs. There were two recesses on the left, one for the forced-air water coolers (cooled water being piped back into the AC Plant), the second recess was for air filtration plant; these recesses were empty.

At this point there was a long section of missing floor, necessitating a precarious balancing act across a small brick wall. After this there was a small room on the right that would have contained a compressor for the 'Shone' sewage ejectors' contained in the sump below, but these had been removed.

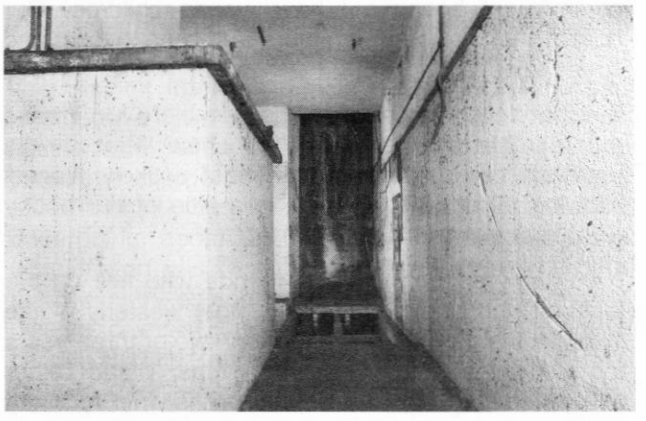
The emergency stairs had been removed from the end of this corridor, but the outlines of them could clearly be seen on the wall. Looking up to the very top of the stairwell I observed large chunks of masonry which had been used to fill the passageway leading out to the emergency exit. The back wall of the emergency stairwell was covered in mud and grass and there was a large evil-smelling heap of it piled at the bottom. It was clear that water had been slowly running down the wall from the surface, bringing mud down with it. There was a very clear line of dried brown grass high up on all the walls of this plant area which shows how high the water reached.

In general the bunker was very messy, large chunks of cork had come away from the ventilation ducts and floated on the surface of the water. A lot of the spraycrete had come off the ceiling and lay on the floor coating the soles of your boots with white powder. Most of the metalwork was very rusty and the red rust stains on my boilersuit have resisted several attempts to wash them out.

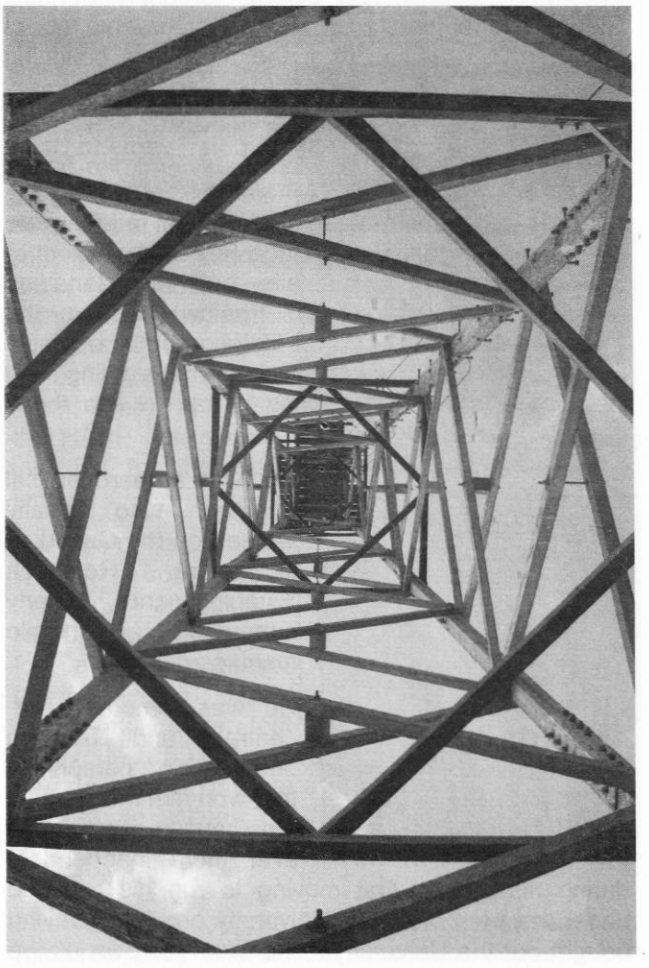
A final visit was arranged a few weeks later to allow a proper photographic survey to be carried out. In the meantime the hose had fallen back down the cable exit shaft and the pump had been switched off. The water level had risen quite quickly and was close below the secondary flooring. Fortunately, this didn't present a great problem to us.

Looking to the future, the owner is investigating leaving a pump in the bunker permanently so that the house will not be threatened again and hopefully the condition of the bunker will remain stable.

I would like to extend my thanks to the owner and the housekeeper for allowing me to visit and assist in the pump out. Please respect the owner's privacy, the site is used as a family home. No more visits will be allowed.



The emergency exit. Photo by Gavin Saxby



The wooden aerial tower, one of only two Rotor radio masts still surviving; its future is uncertain. Photo by Gavin Saxby

From Gavin Saxby

Sun, Sea and Space Race

Subterranea often features the extended trips taken by some members to see some of the long-forgotten military remnants scattered around Europe. While these trips look appealing, I can't make this sort of commitment because I have young children. Our holidays tend to be of the more traditional bucket and spade variety.

But that doesn't mean that I don't explore too. I have put together this little story to show what a little research can turn up in the most unlikely places, allowing all of us to indulge in a little of our hobby when we're away.

I am lucky enough to have friends who live on the lovely island of Barbados, the most westerly of the West Indies. I go there once every two or three years for a fortnight and, after three trips, I had rather exhausted the tiny island's diversions. To look out some more esoteric attractions I did a little web-crawling and soon came across a site put together by local photographer and blogger Stephen Mendes. Steve's site features a complete photographic tour of the island's coastline from the air. While scanning these images I came across something very surprising, quite the biggest gun I have ever seen, nestled on a cliff top near the airport. I wrote to Steve straight away to find out more.

He told me that the gun (several of them in fact) were the remains of the High Altitude Research Project or HARP, an experimental site built by Canadian ballistics expert Gerald Bull (below) back in the sixties as the first step in his lifelong pursuit of viable method for launching objects into space using very large modified artillery pieces. I had to see these guns for myself.

Bull was an aeronautical engineer who initially worked on the Canadian Armament Research Establishment's early supersonic missile fuselage designs.

He was famously self-centred and had a bombastic personality that won him few friends. This caused him to grow ever more independent during his career, first moving to run his own lab under the wing of McGill University and later, having bought out the University's share, on his own as the head of the grandly titled Space Research Corporation.

In his early supersonic research, Bull used large, smooth-bore guns to test fly his designs. The models were carried up the barrel safely in wooden 'sabots' (literally shoes) that fell away as the projectile left the muzzle

This was to be the first of Bull's big ideas, and helped foster his lifelong belief in the advantages of using guns over rocketry. In this belief Bull was not alone, although he was the first practical user of the idea. Isaac Newton himself discussed the use of a cannon to escape gravity and attain orbit in his seminal *Principia Mathematica* of 1687 - the very book that defined classical physics and provided the theoretical basis for space travel and rocketry. Jules Verne also used a 'moon gun' in his 1865 novel *From the Earth to the Moon.* Let's look at the first real moon gun, the HARP gun.

After impressive small-scale trials on his firing range (cum house) in Quebec, Bull set out in 1962 to find a suitable site to set up a big gun and start building up his altitudes. This search led him to Barbados.

Just 13 degrees north of the equator, Barbados is ideal for satellite launches. At this latitude, the spin of the earth is greatest and this centrifugal effect can actually fling objects out, helping them to break free of the Earth's gravity. The site also allowed for several thousands of miles of downrange area over the Atlantic Ocean for the safe impact of projectiles and was also visible by radar at Cape Canaveral

HARP jointly funded by the US Army and Bull's alma mater McGill University. On the Army's part it was a subtle attempt to stay involved in the Space Race after Strategic Air Command and USAF were given sole rights to develop rocketry.

In 1964 the US Army and Navy were actually forbidden from conducting or funding any rocket launches above 100,000 feet. This had no effect on HARP, which was in full swing by this time and regularly breaking 350,000 feet – the US Army just hid the money it was sending to fund HARP.

The Government of Barbados, and especially its forward-thinking president Grantley Adams, was very happy to host HARP: it gave valuable work to over 60 of the island's most educated citizens; it provided much-needed foreign investment; and it had the potential to change the country's image from that of a Caribbean backwater to a player in the high-tech age. In 1968 Barbados even issued a series of four postage stamps commemorating HARP.

Just getting the guts of the gun onto the island was a trial. The giant 16.7" barrel - weighing in at 125 tonnes and nicknamed "BETSY" - and its ancilliary equipment were secured on flat-bed rail cars and then loaded onto the tank landing ship the USS John D Page. The Page then set sail from the US Navy Gun Forge at Norfolk Virginia, ready for what would soon become the world's largest ever 'over the beach' landing.

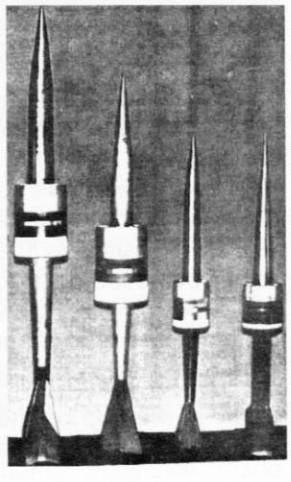
Sun, Sea and Space Race

The rough coastline and difficult terrain at the range site itself meant that the barrel had to be landed about seven kilometres up the coast at Foul Bay. From there they were transported to the gun site by laying a temporary railway track and tractoring the rail cars along. With only 450 meters of track available the US Army Corps of Engineers team had to lift and lay continuously for nearly six weeks.

Once the barrel was mated with its new mounting, breach housing and dampers on the cliff top, the final preparation of the barrel commenced. The team used a field rig to hone the barrel in situ. Soon the gun was ready to prove itself.

The driving concept behind the HARP gun's theoretically huge lobbing power, rested on two ideas: 'gearing' the explosive power of the propellant by firing a comparatively tiny shot; and developing a far more aerodynamically efficient shell.

To achieve both of these aims, Bull developed a distinctive, non-rotating projectile which he named the 'Martlet' missile in homage to the bird depicted in McGill University's crest. The Martlet went through several evolutions during the HARP project, four of these are illustrated below. The blocky central section of each missile is actually the sabot, a simple four-part wooden plug that allows the sub-calibre missile to seal the bore effectively and to ride it true. The sabot falls away as the missile leaves the muzzle.

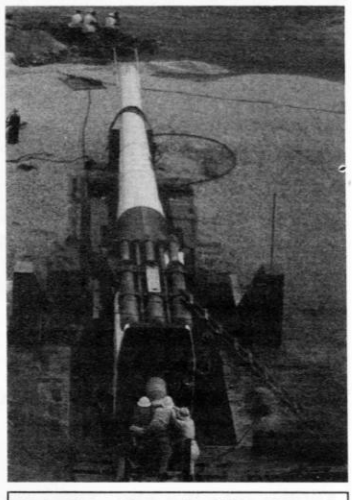


But the Martlet wasn't just a well streamlined dumb shell. To reduce air resistance in flight, each round had a 'bleeder charge' embedded between its tail fins. This slow-burning chemical charge pushed out a steady stream of gas into the missile's slip stream. This gas helps fill the vacuum formed behind the shell as it punches its way through the atmosphere, filling the 'hole' and so reducing drag. Later versions evolved this theme into full-on rocket assistance as they neared the apex of their flight.

The astonishing launch speed of the Martlet was down to the fact that the entire payload was about ten times lighter than the regular 16-inch shell the gun would have fired in normal service. The ferocious acceleration of a Martlet riding such a huge propellant charge drives the missile out of the barrel at six to eight times the speed of a conventional shell, undergoing about 25,000G in the process. This acceleration was so violent that all electric circuits for the telemetry equipment had to be encased in solid plastic to resist the great forces. Some of these circuits still litter the site today.

Activity on the site was frantic leading up to the first test shot on 20th January 1963. This first shot presented many unknowns such as how such a big gun would behave when firing vertically into the air, and whether the barrel would split.

Set up tests in the afternoon uncovered leaks in the oil-filled recoil dampers above the breach. This delayed the first shot - with Grantley Adams and a host of dignitaries from both sponsor organizations – for several hours. Then, finally, at 18:20 the HARP gun roared into life for the first time.



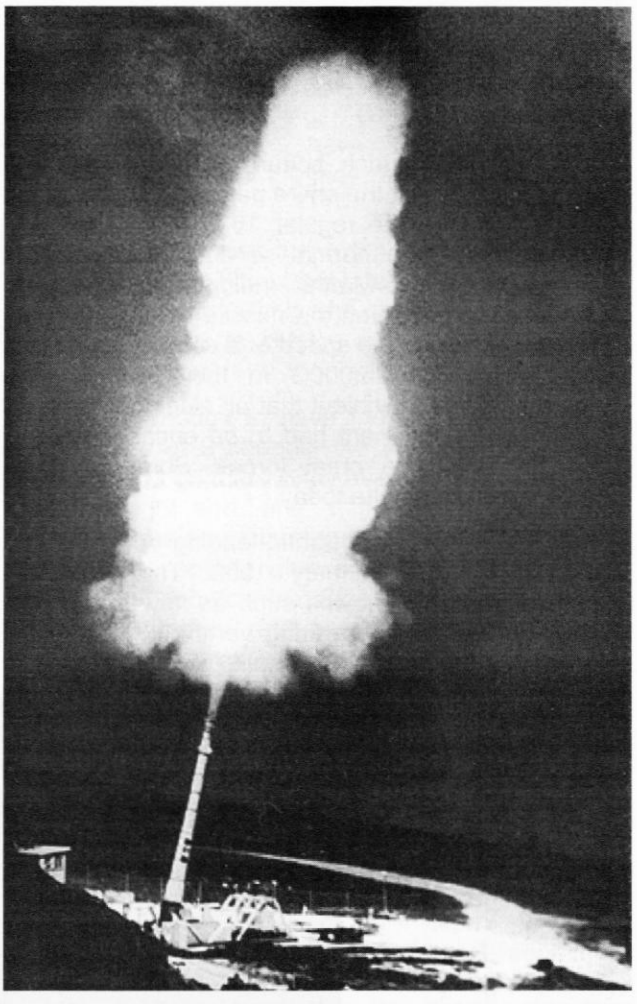
Scientists from McGill university push the first test slug into the breach, pith helmets were issued as part of the HARP uniform in what now looks like a comical colonial touch

A plume of flames and smoke from one thousand pounds of M8M propellant shot forth and the very earth of the island shook. The 315kg wooden test slug rode a 60,000psi wave of hot gas, leaving the muzzle at over one km a second. The wooden slug rose to an altitude of 3000 meters before coming down a kilometre off shore. The flight had lasted just 58 seconds.

The very next day, the first Martlet missile was fired (pictured p42) and in the four shot series to 1st February a new altitude record of 112km was set. For the next five years, its sisters roared ever higher into the atmosphere, setting new records with alarming regularity.

The peak altitude was extended (by 6000 metres) by

Sun, Sea and Space Race



pumping out most of the air in the gun barrel before the shot. When the cannon fired--its loud bang was heard all over Barbados and the airtight cover over the muzzle was blown away.

In 1966 Bull set a world record for shooting a Martlet 180km into the sky. The record would stand for more than 25 years until the Chinese reached 225 km in 1989.

Bull's long-term goal for HARP was to create a low-cost method of launching small satellites into space. He calculated it could be done for one-fifth the cost of traditional methods.

In 1967 the Canadian government stopped funding the project, citing concerns about the drawbacks of a gun-launch system. The U.S. Army dropped out soon after because of their growing focus on the war in Vietnam. By 1968 Bull had withdrawn all research back to his own facility in Quebec as Space Research Corporation where he continued.

Long after HARP died, Bull continued to pursue his dream of gun-launching a satellite. In the mid-1980's he was contracted by Iraq to construct a satellite launching gun system. The Babylon Gun or so-called Iraqi Supergun. This was a massive one metre bore, 156 metre long device.

Despite the fact that its size would make it ineffective as a weapon The Babylon gun was seen as a threat by Iraq's neighbours and Bull was targeted for assassination after he refused to be swayed by overt threats.

On the evening March 22 1990, at the age of 62, Gerald Bull approached his apartment door in Brussels. He was shot six times in the back of the head. The assassin was reported to be Mossad but this was never proven.

Bull's last Supergun was cut up and scrapped by the UN at the end of the first Gulf war. It was never assembled or fired.

Further reading/viewing

The definitive book on the life and work of Gerald Bull is *Arms and the Man: Dr. Gerald Bull, Iraq, and the Supergun* by William Lowther (Presidio, Novato, 1991)

James Adams, Bull's Eye: The Assassination and Life of Supergun Inventor Gerald Bull (Times Books, New York, 1992) is less detailed and a bit of a livelier read.

There is a selection of contemporary newsreels of the HARP Gun in action on the Canadian Broadcasting Company's archive site at *http://archives.cbc.ca/IDD-1-74-626/people/gerald_bull/*. They make fascinating viewing, including interviews with Bull and firing footage if you have the patience to wait for the downloads.

The Site Today

The big HARP gun, plus several smaller variants, control bunkers and technical buildings all persist today. This is thanks in part to the no vandalism culture of the West Indies and in part to the fact that the site now lies at the bottom of the Caribbean Defence Force's firing range which is used on a daily basis. Nothing like heavy machine gun fire to dissuade casual visitors is there?

Although you can climb up to the site from Paragon Bay beach, that's not the way I do things so I wrote to the C in C of the Force before leaving home. Sadly I didn't get a response so, while I was there I called in at the guard room of the barracks that now straddles the old entrance to the site. A quick chat with the rather bemused Squaddie got me a phone call with the Officer in Charge who said I'd be welcome to come back on the Saturday when the range is open for the Barbados Rifle Club's meeting.

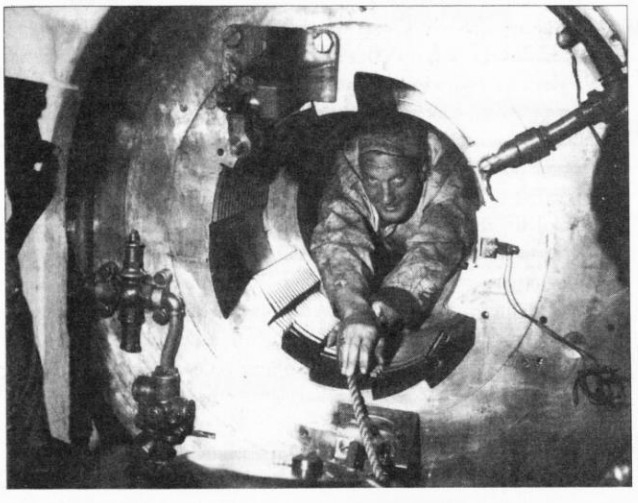
I duly bowled up on the day, complete with my wife and small children. We had a delightful couple of

Sun, Sea and Space Race

hours exploring the site in the sunshine. The level of preservation is frankly amazing against European standards, we even found some old telemetry equipment, but the heat and the rain of a tropical climate play merry hell with the steel of the guns. Nature is claiming back its quiet cliff top once more…

The HARP gun as it stands today, now 40 metres long compared to the 21 metre version first installed in 1962. The search for more altitude meant that the gun was modified constantly through the five years of the project. Eight adjustable drawbars were installed so the gun could be aligned at any angle of elevation if it sagged under its own colossal weight.

Barbados gun the biggest operational artillery piece in the world. A record broken by Bull himself at his 'home' range in Quebec in 1977



This contemporary picture of a similar gun on a lathe bench at the US Navy Gun Forge at Norfolk Viginia shows just how big a 16" bore is. This gentleman has just been pulled through (note rope) the freshly turned smooth bore to check for any defects before honing.

The gun was extended with a second barrel in 1966. The extra length, and greater propellant charges required 25 tons of these weldments to stiffen the two-barrel assembly. The barrel extension made

From John Smiles

Subterranea Britannica - Summary Report 2005

Income & Expenditure Account for the Year Ended 31st December, 2005

			Year ended 31 Dec 2005	Year ended 31 Dec 2004
			£	£
INCOME/EXPENSE				
INCOME				
	Membership Subscriptions	12,650.02		11,812.44
	Publications	165.80		24.02
	Donations	18.00		90.00
TOTAL INCOME			12,833.82	11,926.46
EXPENSES				
	Affiliation Fees	113.00		121.00
	Bank Charges			11.50
	Paypal Charges	141.38		39.39
	Insurance	198.00		2,100.00
	Miscellaneous expenses	63.20		40.50
	Post, Packing & Staty, Phone & Copying	1,292.57		2,576.21
	Printing (Including Subterranea)	9,266.79		11,358.20
	Publicity Items			843.38
	Web Fees	881.15		810.85
	Depreciation - Web Server & Mac	348.46		291.79
TOTAL EXPENSES			12,304.55	18,192.82
NET INCOME (EXPENSES)			529.27	(6,266.36)
SELF-FINANCING ACTIVITIES				
	Income from Conferences	3,885.75		4,401.00
	Outgoings from Conferences	(2,783.28)		(3,751.46)
	Income from Study Weekend			4,344.50
	Outgoings from Study Weekend			(4,072.94)
	Income from other Events	1,911.00		2,045.00
	Outgoings from other Events	(1,911.00)		(1,682.94)
TOTAL SELF-FINANCING			1,102.47	1,283.16
SURPLUS (DEFICIT) FOR THE YEAR			£1,631.74	-£4,983.20

Subterranea Britannica - Summary Report 2005

Statement of Affairs, as at 31st December, 2005

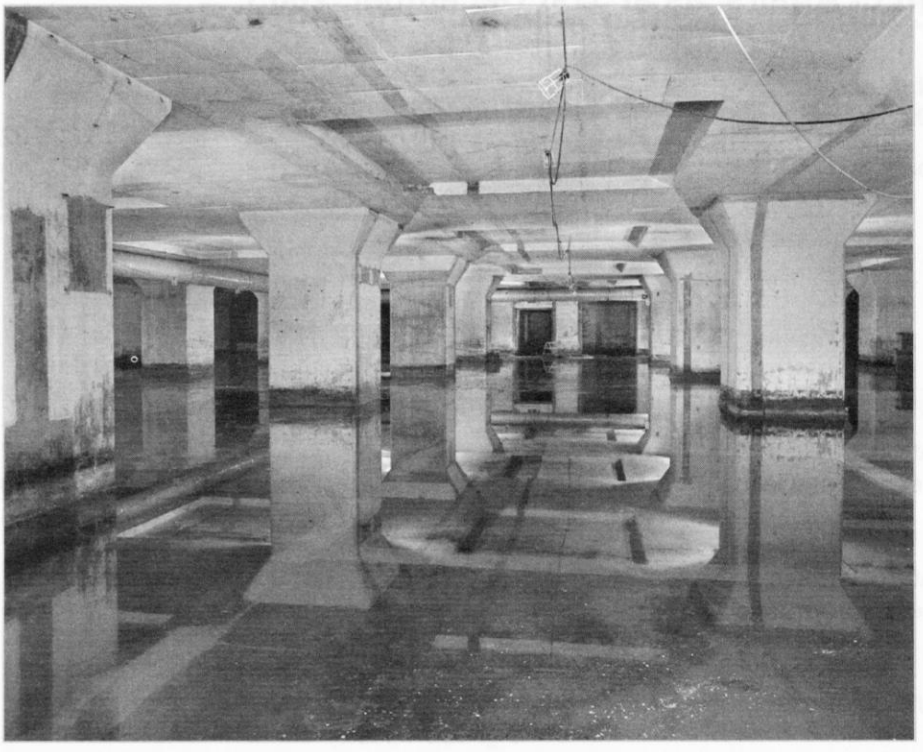
			31 Dec 2005 £	31 Dec 2004 £
ACCUMULATED FUND				
Brought Forward			10,641.82	15,625.02
Surplus for the Year			1,631.74	(4,983.20)
			£12,273.56	£10,641.82
REPRESENTED BY:				
FIXED ASSETS				
COMPUTER EQUIPMENT				
WEB SERVER				
	At Cost	875.37		875.37
	Less: Depreciation	(583.58)		(291.79)
		291.79		583.58
MAC				
	At Cost	170.00		
	Less: Depreciation	(56.67)		
		113.33		
NET BOOK VALUE			405.12	
CURRENT ASSETS				
CASH				
	Unity Trust Bank	14,316.02		13,427.05
	Paypal	2,158.85		254.03
	GiroBank	-		1,994.65
	Cash Floats	-	16,474.87	1.00
PAYMENTS IN ADVANCE				
	Spring Conference Deposit	282.50		465.00
	Other Prepayments	81.00		56.00
			363.50	
DEBTORS				
	Conference & Study Weekend fees Due	-		34.00
RECEIPTS IN ADVANCE				
	Subscriptions		(545.00)	(763.42)
CREDITORS				
	Printing	(3,533.78)		(5,021.50)
	Web Fees	(352.50)		(387.85)
	Expense Account Balance	(75.00)		(0.72)
	Other Creditors	(463.65)	(4424.93)	-
			£12,273.56	£10,641.82

Sue Monsell, Treasurer (2005) **February, 2006**

I confirm that I have examined the books of account and find the above statements in accordance with those books.

D.A.Kozubska, FCA

Station Z



The sub-basement. All internal partirion walls have been removed leaving an open plan area with 25 supporting pillars. Photo by Nick Catford

No sooner had the First World War ended than the Government started to worry about what might happen if there was another war. From 1924 Britain had committees of officials examining ARP questions and this examination intensified after Hitler came to power in Germany in 1933 and as the conviction grew, based on experience of the Spanish Civil War where the view was that the bomber would 'always get through'. It was assumed, naturally enough, that the main target for enemy air raids would be central London.

It was decided early in 1936 to appoint a Minister for the Coordination of Defence and to launch an expanded five-year programme of rearmament. France ratified a bilateral pact with Soviet Russia and on 7 March Hitler sent his troops into the Rhineland in defiance of the Versailles and Locarno treaties. The Cabinet now called for contingency plans to be devised for coping with a potentially dangerous situation and among new sub-committees set up under the Committee of Imperial Defence was one on 'the location and accommodation of staffs of Government Departments on the outbreak of war'.

Chaired by Sir Warren Fisher (Head of the Civil Service), the 5-man sub-committee reported early in 1937 with a suggestion that an alternative centre of government should be planned in the London area where Ministers and possibly Parliament could be relocated if Whitehall were to become unusable. After endorsement by the Cabinet in February 1937, this work was further developed in great secrecy by a new 5-man sub-committee under Sir James Rae and resulted in two alternative schemes, one of which was for accommodating not only civil servants but also Ministers and Parliament in London's northwest suburbs; if however, this short retreat were to prove insufficient, a further withdrawal should be made to prepared accommodation in the western counties.

For the 'fighting' Departments work on bomb-proof underground citadels was to be continued, including one for the Admiralty at Oxgate in Cricklewood and one for the Air Ministry at Harrow

When this suburban scheme was examined further in the autumn of 1938, after the Munich crisis, it was decided that the construction of four underground citadels would go ahead: one each for the three Services and a fourth which became the bomb-proof Emergency War Headquarters at Dollis Hill.

The Emergency War Headquarters (Paddock) and the Air Ministry and Admiralty Citadels were built as planned but that for the army at Kneller Hall in Twickenham was abandoned before work started. As with Paddock and the Admiralty Citadel at Oxgate chosen site was within an existing government site, HM Stationary Office where a vacant plot of land was selected.

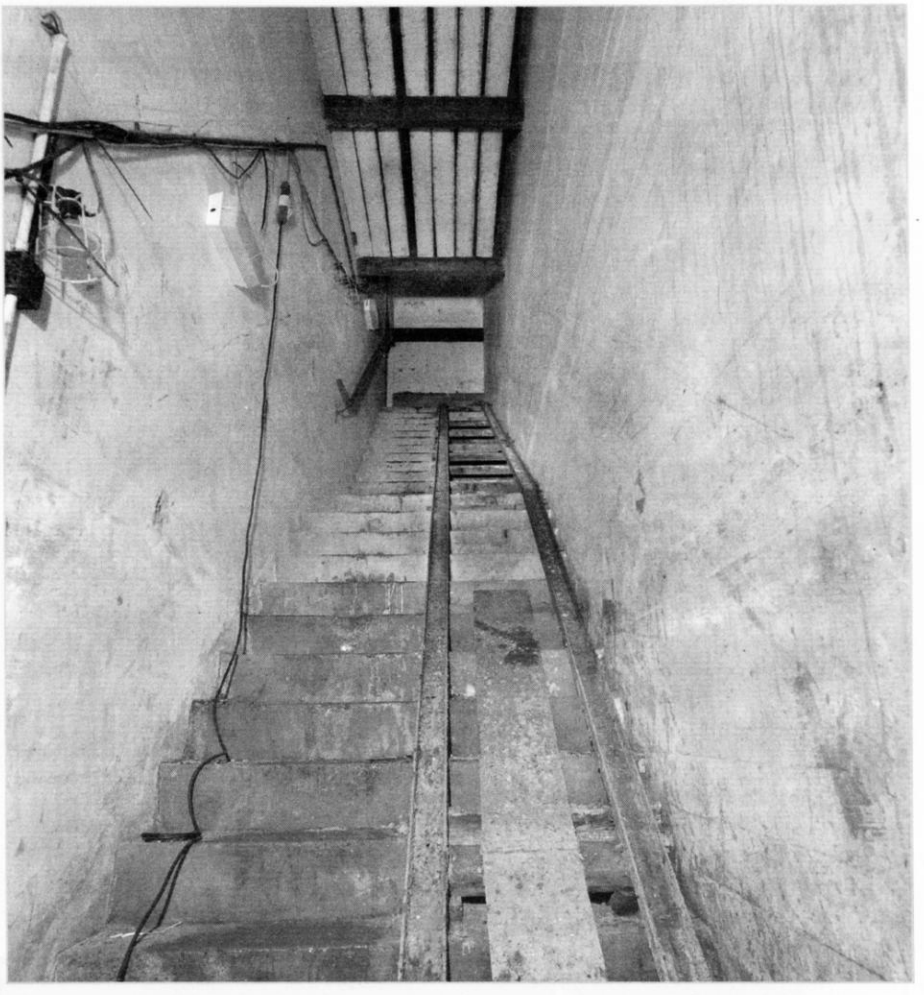
In line with the original 1938 plan the Air Ministry citadel consisted of a three storey above ground surface block with an inner court yard. Below the sire was a basement roofed over by 3½ feet of reinforced concrete and below it a sub-basement protected by another 6 feet of concrete (probably in two layers); with comparable protection at the sides, the sub-basement was considered to be entirely bomb-proof. The building was almost identical to the Admiralty citadel in Oxgate Lane, Cricklewood.

The new Air Ministry site was ready for occupation by October 1940 as detailed in a minute sent to the Deputy Under Secretary of State for Air on 11.10.1940 (National Archive ref: Air 19/190)

"The Air Ministry Citadel is situated at the rear of HM Stationary Office premises (HMSO Printing Works) Headstone Drive, Wealdstone, Middlesex. It is known for the sake of anonymity as Z or the Stationery Office Annexe.

Station Z

If a move to Z were ordered the whole of the staff of the Air Ministry Whitehall would be involved but those divisions in the (Air Ministry) Kingsway Area would not be affected. The Whitehall Group comprises:
Secretary of State (for Air), Under Secretary of State, Permanent Under Secretary and part of the departments of the Permanent Under Secretary, the Chief of the Air Staff and the department of the Chief of the Air Staff (i.e. Directorate of Signals, Directorate of Intelligence, Directorate of Operations (Home), Directorate of Operations Naval Co-operation, Directorate of Operations (Overseas), Directorate of Plans, Directorate of Public Relations, Directorate of Operations Requirements and Directorate of Ground Defence.
(They would all be relocating from the new protected Government Office in Whitehall adjacent to the cabinet war room.)
Communications: The Air ministry Citadel may be obtained on the telephone from the Cabinet Offices in Richmond Terrace or Paddock by the following means:
i} On the Federal system by asking for Station Z
ii) On the normal 'black' line system by asking for Federal Exchange and the proceeding as at i
iii) On the 'green' line system by asking for Station Z
iv) On the public telephone system by ringing Harrow 4269
In addition there is a direct tie line from Richmond Terrace to Z on the 'black' tie line system
A small Insurance Party is in permanent occupation of the citadel. Apart from police and guards the sections actually manned and operating are: War Room, Telephone Exchange, Teleprinter and Communications
The Air Ministry citadel is ready for immediate occupation. Rooms have been furnished and allocated to staff, telephone and teleprinters have been installed and telephone directories prepared. The war room records are maintained up to date and domestic services are arranged."



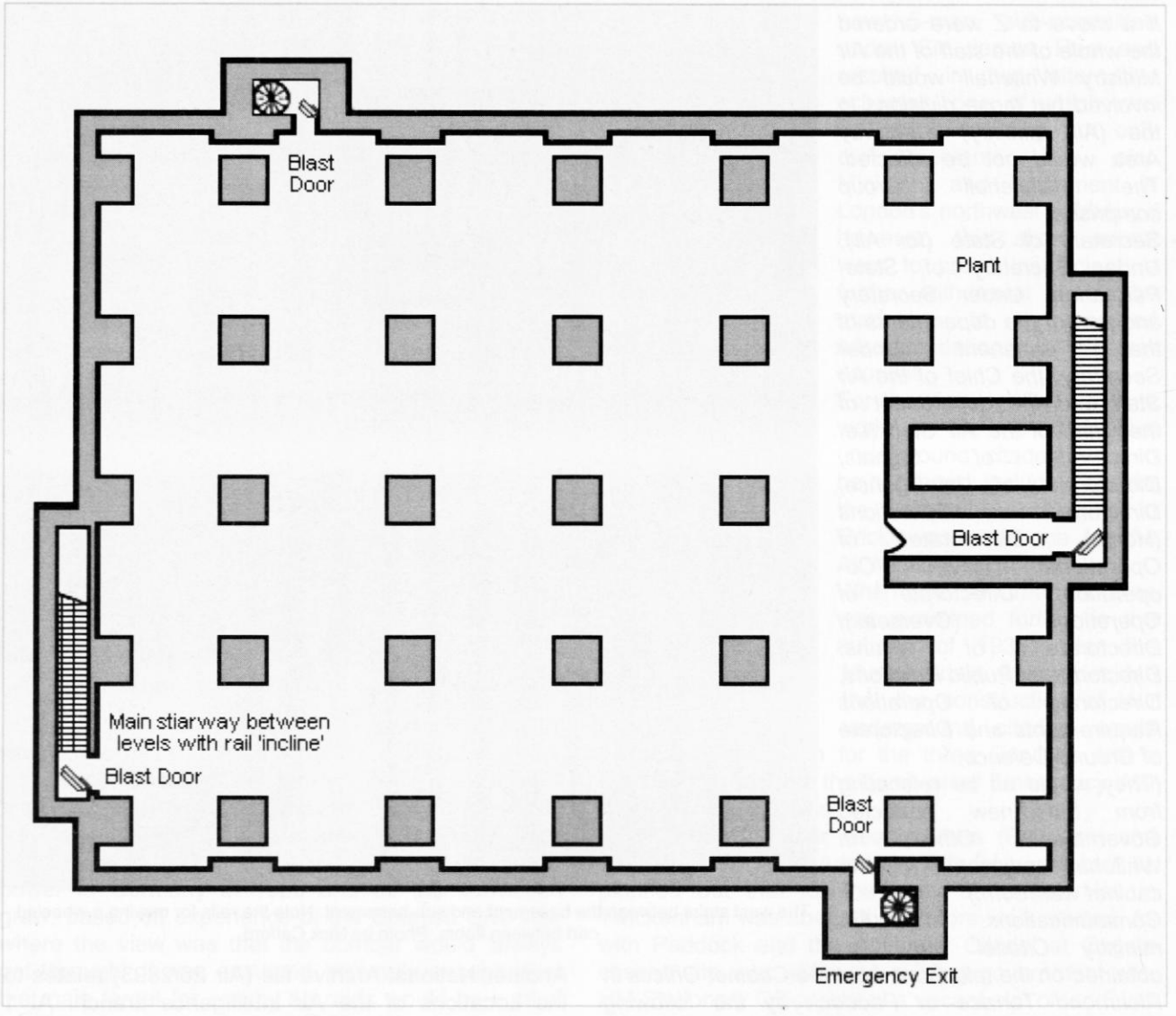
The west stairs between the basement and sub-basement. Note the rails for moving a wheeled cart between floors. Photo by Nick Catford

Another National Archive file (Air 20/2893) relates to the Locations of the Air Intelligence branch. AI 1 (Intelligence Civil Clerical Staff Administrative Section) goes part to White Hall and part to Harrow and AI 1 (A) Intelligence RAF Staff Administrative Section go to Harrow:

Other departments relocating to Harrow include: AI 1 (G) Technical Intelligence & Crashed Enemy Aircraft examination section. (HQ is at Harrow with a regional organisation covering the rest of the UK, Northern Ireland and the Middle East.), AI 1S Security Section, AI 1 T Translation Section and ADI Supply of maps to the RAF.

After WW2 the Air Ministry continued to occupy 28 office sites in UK, notably in London these included the steel framed building at the Marsham Street rotunda site. Station Z still housed some Air Ministry departments and was still earmarked as a wartime dispersal for administration staff until 1955.
By 1955 some of the Air Ministry's accommodation problems had been resolved and the building was

Station Z



Station Z lower floor plan. Drawn by Nick Catford

vacated by peacetime staff although the site remained available as possible wartime office accommodation although this may not have included the bunker.

In 1955 the Home Office Directorate of Telecommunications moved into the surface offices which became their headquarters for the maintenance of the Home Office radio network for civil defence, the police and the fire service. It also ran the Hilltop Radio system (as detailed by Duncan Campbell in War Plan UK). For this service large steel lattice radio mast was erected in the courtyard. It was also the regional depot for Civil Defence Region 5 until that was divided up in late 1950's

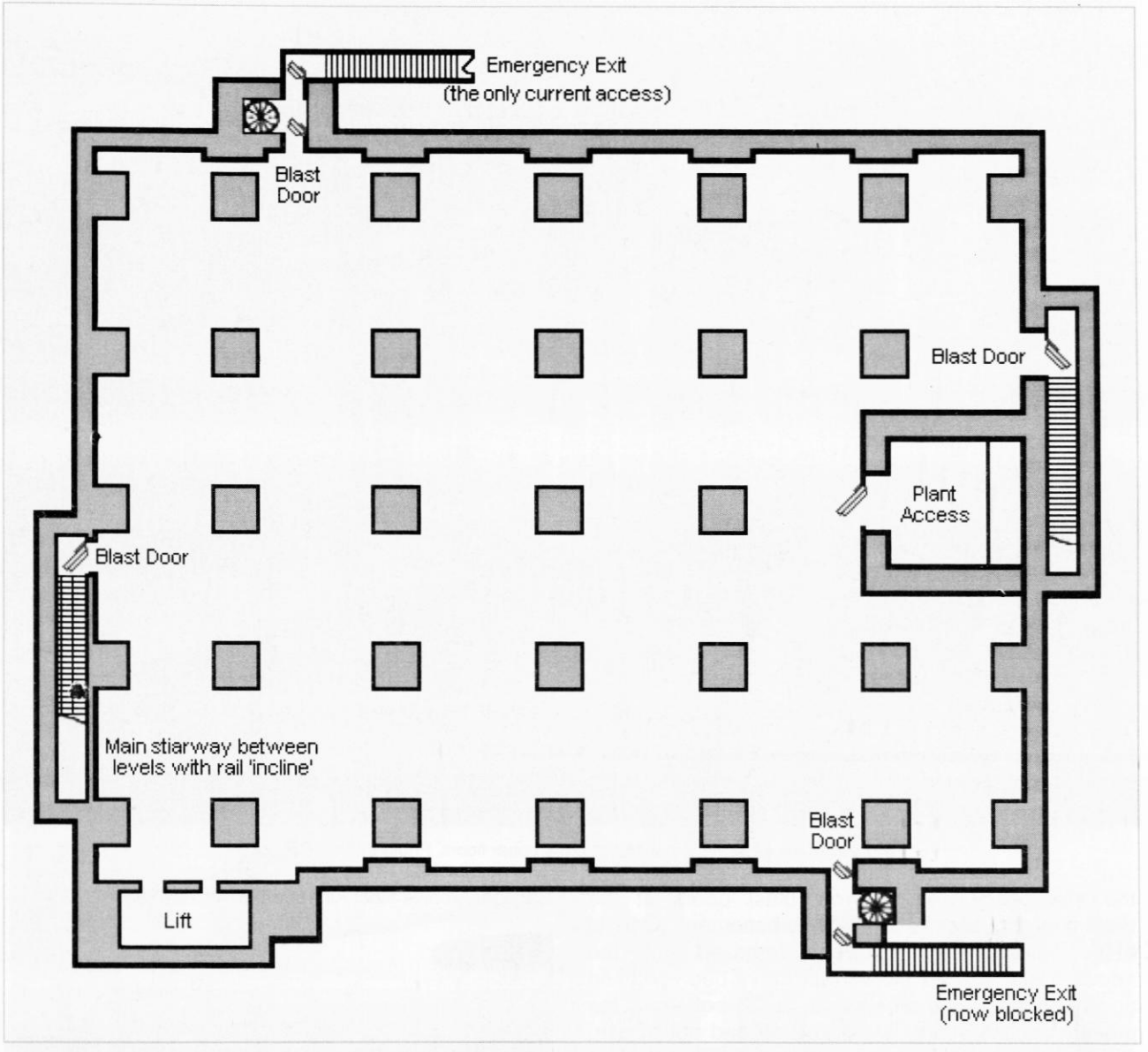
In 1966 the underground accommodation was designated as a short term location for Sub Regional Control 6.2 covering Berkshire, Buckinghamshire, north and west London. The longer term plan was to upgrade the old RSG at Warren Row. By 1971 this function had disappeared following the reduction in planned SRC's and the disbanding of Civil Defence in 1968. No work had been carried out at the site in connection with this proposed use.

By 1980 it once again acted as the Region 5 radio depot, as that region had been reformed in 1971. This function was retained until c.1992 when the site was vacated by Home Office. It then became a store for the adjoining HMSO print works.

nce the HMSO works closed, Kodak brought the site for expansion of their large adjoining complex and the surface office block was demolished in 1996.

Access to the bunker was maintained via one of the emergency exits but the bunker was allowed to flood. Until recently, the sub-basement was flooded to a depth of several feet but the water has now been pumped out with only a little standing water remaining. The pumps are still in place to ensure that the flooding does not reoccur and new ventilation

Station Z



Station Z upper floor plan. Drawn by Nick Catford

trunking has been installed to ensure a supply of fresh air throughout the bunker. Kodak has no planned use for the site.

Station Z today

All trace of the three storey surface building has been cleared leaving a flat gravel area with a small entrance blockhouse and a stairway down to the upper basement utilising one of the original emergency exit doorways.

The upper basement level has been stripped of all original fixtures and fittings including all internal partition walls leaving one large 'open plan' room with 25 supporting pillars evenly spaced in five lines. On the east side the original plant entrance, loading bay and east stairway are enclosed within a walled area. The stairs have been removed and the main plant access hatch has been slabbed over but a personnel access hatch has been retained and there is a wooden ladder against the wall if access is required, this now acts as an emergency exit from the bunker. Originally there would have been heavy blast doors at all entrance and exit points but these have also been removed although the 8" thick steel door frames are still in place to indicate their position and size. The basement was originally served by a lift from the upper floors, the lift shaft is still there but the lift and all the lift machinery has been removed.

There are four stairways down to the protected lower level or sub-basement. Two of these are wide concrete stairways with door frames at the bottom where the blast doors have been removed. There were originally two spiral staircases which acted as

Station Z

Access to the lift from the basement to the upper floors. Photo by Nick Catford

the emergency exits; narrow blast doors at the bottom giving access to the sub-basement. One of these spirals has now been removed and the adjacent stairs up to the surface have been blocked at ground level. The otherspiral, at the bottom of the present access stairs, is blocked off and out of use. On the west stairway there are two rails mounted on the steps, these were used for moving a wheeled cart between levels. The cart can still be found in the upper basement, it is unclear if this is an original feature or was added post war.

The sub basement is similar to the basement with 25 pillars directly beneath those in the basement. Again all internal partition walls have been removed with the exception of a small block extending into the room from the east wall. Here there is one separate room and an adjacent short corridor leading to the east stairs. A number of concrete plinths in the north east corner indicated where the ventilation plant and standby generator were located.

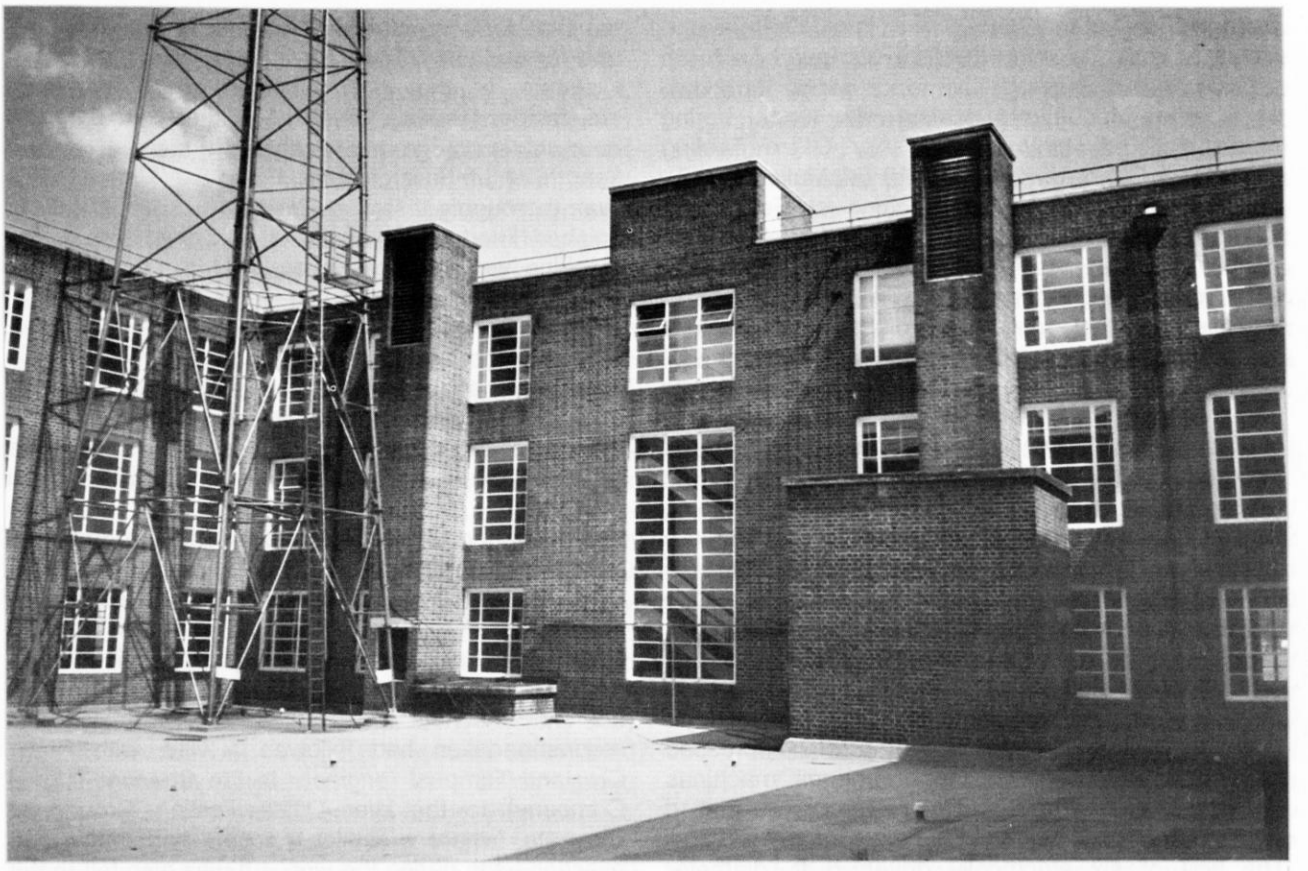
Sources:
Bob Jenner
Keith Ward
Ken Valentine (Willesden at War Volume 2)
ISBN 0 9514258 6 2

National Archive files: Air 19/190 & Air 20/2893

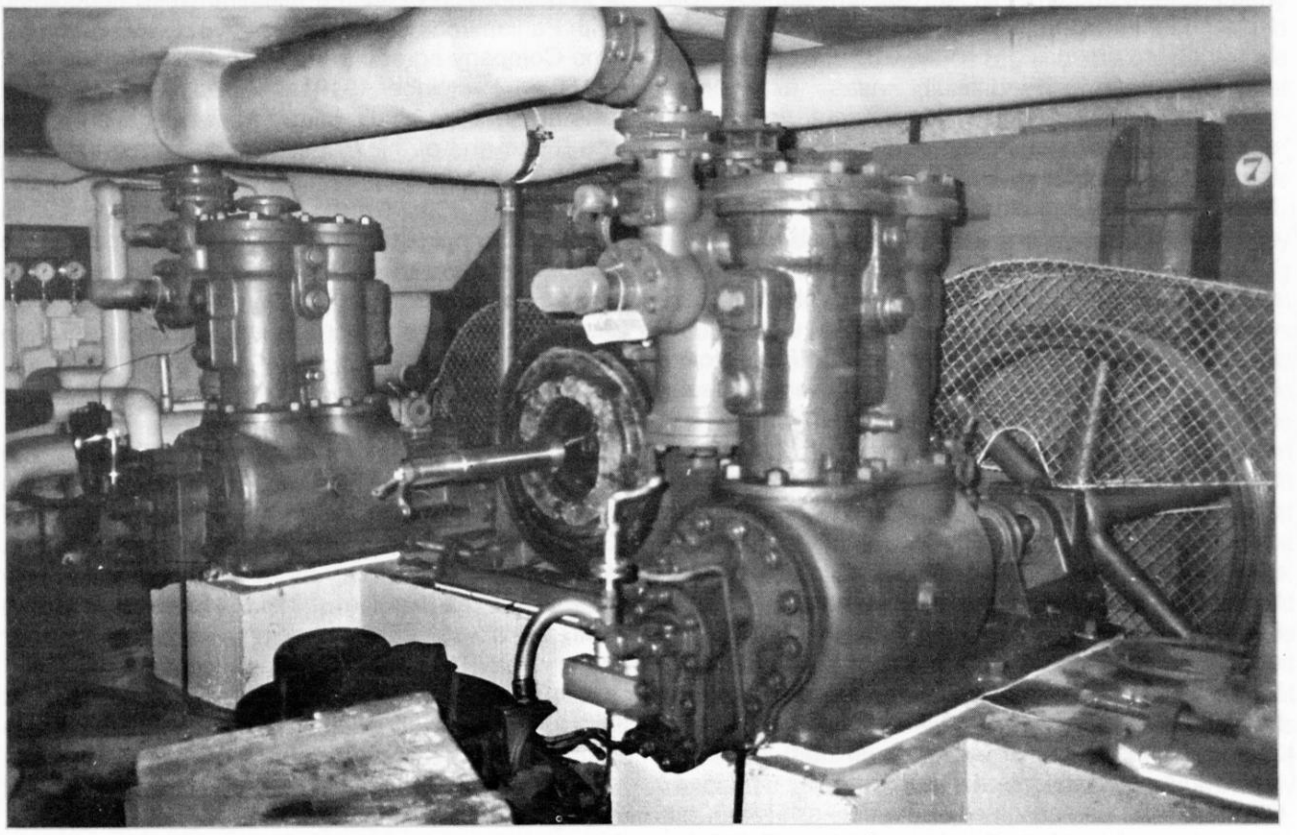
Aerial view of the surface building in the 1980's - Photo from Kodak Ltd.

From Nick Catford

Station Z



The courtyard - the bunker is beneath the courtyard and the building that surround it. Note the two ventilation towers. The radio mast was erected in the 1955 for the Home Office Hilltop Radio System. Photo by Dr. James Fox from Historic RAF Holmpton photo archive



Part of the ventilation plant which was still in use in the mid 1980's Photo by Dr. James Fox from Historic RAF Holmpton photo archive

The World War I War Office Testing Ground at Claygate, Surrey

Introduction

Some time in the early 1980s I borrowed from the archives of a leading civil engineering firm two unpublished documents dealing with tunnel boring machine (TBM) trials at the 'War Office Testing Ground' at Claygate, 1916 - 1919 (McMullen, 1919), and a trial tunnel boring machine at Folkestone Warren (Adams, c. 1960) I published a short note about these (Sowan, 1985) in the hope that somebody would research the Claygate site further, establish an exact location, and discover more details of the establishment and its operations. So far as I am aware, my published note resulted in no further enquiries specifically relating to this site being made or results published, although there are several references to it in a recently published paper (Varley) which, oddly, suggests it is in Kent. In the intervening years I have gradually pieced together a little more information, reported below, and now submit the following, again in the hope of stimulating someone to undertake more research.

McMullen's report on TBM trialling at Claygate

From the Claygate document, and from Paul Varley's research, it is evident that a number of compressed air or electrically driven tunnel borings machines (TBMs), of several different diameters, were trialled at Claygate.

The first of six electrically driven 5 ft. diameter machines (developed from plans by Messrs. Mott, Price and Markhams by a Captain Sankey, Col. Norton-Griffiths, and Captain Hird) was 'put through a fair trial' commencing on the 15th April 1916 at Claygate. Much difficulty was experienced particularly in keeping to a straight line, either vertically or horizontally. An earlier model had been found to be 'unsteerable' and did not go far. Messrs. Markhams had meanwhile produced a similar machine driven by compressed air which also had a 'thorough trial', though whether or not at Claygate is not clear. The electrical model was preferred. This was 'finally got into the condition when it would do 40 ft. a day,' and after a trial to which the Inspector of Mines sent two representatives, it was sent overseas on 9th January 1917, and a second machine was completed as spare.

Several further designs and trials (some at Chatham) culminated in a machine which 'shewed a capability of doing 60 ft. in a day and the Inspector of Mines after a full trial had it sent overseas and put to work in the Ypres salient .. [but] .. the performance at the front was disappointing .. The tunnel was run at about 125 ft. from the surface in a strata [sic] of very hard clay .. [which] .. fell in before the tubbing could be fixed.' This machine 'cut very well, advancing 2" [two inches] a minute and proved that, in ground that would stand up, great speed could be obtained.' General HQ then decided to order a 5 ft 6 ins diameter machine for offensive mining, a 7 ft 2 ins machine for communication tunnels, and an 8 ft 2 ins one for dugouts. The first of these was 'tried out at Claygate at the end of 1917, and gave very satisfactory results .. 60 ft. of finished tunnel per 24 hour day in any ground which would stand up for 2 ft [length] of 5 ft 6 ins diameter.' The 8 ft 2 ins machine 'was thoroughly tested at Claygate .. and 123 ft. of finished lined tunnel was cut in 51½ hours. The machine was sent to France and did a little work before hostilities ceased.

Adams' report on Channel Tunnel TBM trials

The first Channel Tunnel trial headings (at least two of which, between Folkestone and Dover, have been entered and photographed in recent years, and one of which is still accessible) were machine-bored in the 1880s. Sir Douglas Fox & Partners recommended on 11 September 1919 the purchase of a 'Whitaker tunnelling excavator' manufactured by Douglas Whitaker of Union Street, Leicester, in conjunction with Sir William Arrol & Co. Ltd, of Parkhead, Glasgow. The quotation received from Whitaker on 27th August 1919 refers to a 12 ft diameter machine for £ 6,150. Fox and Partners' recommendation had followed a visit, with Percy Crosland Tempest (engineer to the Channel Tunnel Company) to the War Office Testing Ground at Claygate, 'where a similar machine had undergone exacting tests during the war .. It was also felt that it would strengthen the hand of the Channel Tunnel Co. if in possession of such a machine when negotiating with Parliament.'

The Company agreed to buy the 12 ft. machine for £ 6,150 on 3rd October 1919, and used it to drive 480 ft. of trial tunnel in chalk, inland from a location above the Dover end of the Martello main line rail tunnel at Folkestone, during the period 18th June 1922 and 26th September 1923. On the cancellation of the 1920s Channel Tunnel plans, this TBM was left blocking the collapsed outer end of the trial bore, from which site is was rescued in 1990, renovated, and placed on display at the now closed Channel Tunnel Exhibition Centre at Cheriton.

Offensive military tunnelling

The use of offensive military tunnelling on the Western Front in World War I commenced, at the instigation of John Norton-Griffiths [1871 - 1930] of Griffiths & Co., public works contractors, in 1915, when nine British military tunnelling companies were raised. At the peak of mine warfare the following year, there were 25 Allied companies accounting for some 25,000 men. The Germans were similarly employed, having started a year earlier, in 1915. At first tunnelling was done manually, by a technique known as 'clay kicking.' There were soon proposals to speed up mine tunnelling progress by using tunnel boring machines, drawing on experience gained at, for example, the aborted Channel Tunnel borings

The World War I War Office Testing Ground at Claygate, Surrey

made on the coasts of England and France during the 1880s. The World War I TBMs were to be electrically powered, but were not entirely successful. By far the greater part of the 7,600 metres of British military tunnels on the Western Front were in fact dug by hand. It was essential that the tunnelling should as far as possible be noiseless, as the other side would be listening for any signs of underground activity, and would seek to destroy offensive tunnels coming towards them by driving their own tunnels nearby and blowing them up. Another problem was keeping the TBM boring in the right direction - they tended to 'dive' rather than stay on the intended level course. One tunneller cited by Varley commented that 'We never discovered why, but this machine showed a distinct disinclination to proceed towards Germany, but preferred to head to Australia by the most direct route.'
And although the machines would cut through clay reasonably satisfactorily they would, if left idle for any length of time, be trapped and immovable as ground pressure gripped them like a vice. Blown fuses and burnt-out motors could result from attempting to re-start machines so trapped, and on occasions they had to be dug out. At least one was abandoned underground in Belgium or France. Using barbed wire to replace blown fuses was found, in practice, a good way to wreck a TBM!
of course there was the usual problem of the disposal of tunnelling spoil in such a way that the nature of the operations in hand could not be deduced from aerial reconnaissance by the enemy.

The War Office Testing Ground at Claygate

It was clearly desirable to have a site on home territory where prototype TBMs could be tested in conditions as close as possible to those on the Western Front where, as in the London Basin, Lower London Tertiary beds overlie the Chalk. One of John R. Sims' clay pits at his brickworks on the eastern side of Oaken Lane at Claygate was selected for the testing ground. This was at TQ 1564, to the north-east of Claygate Station. Published geological records indicate that this pit exposed a section variously stated as from 50 to 70 feet of strata, with (in one such account) 12 feet of Bagshot Sand overlying 50 feet of Claygate Beds below which was the uppermost eight feet of the London Clay. The Claygate beds are sandy clays intermediate in character between those above and below them. The London Clay / Claygate Beds interface would have been best avoided, as it forms a spring line at which 'The water bubbles up carrying with it "running sand" .. The constant drain of sand from below leads to the gradual slipping of the ground, and, where aided by the slope, landslides occur, large slabs of land gliding down the slippery clay slopes.'
Presumably the tunnel machine bores were driven into the London Clay at the base of the pit, well below the junction with the Claygate Beds. The most likely mode of operation would seem to have been the digging of vertical shafts in the pit floor, communicating with launch chambers from which the cylindrical TBMs could be driven into the London Clay (pushed forwards by screw jacks.) Varley indeed has published a sketch shewing such a shaft and launch chamber for another device (a horizontally acting pile-pusher) below the floor of an unidentified brickfield pit floor (probably in fact Claygate.) He writes of a shaft 2.86m wide, sunk to a depth of about 4.8m below the pit floor for this device.

Barbara Stack (1982) records that:

> *During the war the Royal Engineers had carried out rigorous tests on a Whitaker machine at the War Office testing ground in Claygate. Apparently this machine was inspected by Sir Percy [Tempest] and by Sir Douglas Fox and partners, and as a result of the favourable recommendations made by Sir Douglas Fox and partners, Sir Percy persuaded the directors of the Channel Tunnel Company to purchase one. The argument put forward being that possession of such a machine would 'strengthen the hand of the Channel Tunnel Company.*

It is not clear if the machine, which the Company purchased, was already at Claygate, and trialled there, although it was certainly put to work in the Chalk at Folkestone in 1922, where it drove 480 feet inland from the cliffs before being abandoned.

What might have been the nature of the Claygate site?

Reading between the lines, and speculating, we may imagine a number of vertical shafts, communicating with launch chambers, sunk in the pit floor, from which approximately horizontal bored trial tunnels (almost certainly lined) of various diameters and lengths were driven. The shafts and chambers were perhaps timber-lined, so over the years since the 1920s have almost certainly fallen in and / or been back-filled, although their remains may be at least notionally available for archaeological inspection at some time in the future. The tunnels, if brick-lined (it was after all a brickworks site), may survive. However, for military purposes on the Western Front brick-lining would have been inappropriate, as the tunnels were intended only for short lives to be ended by the successful detonation of explosives placed at their inner ends below enemy lines. Timbered linings or steel tubbing seem more likely, so it is to be expected than any tunnels will now be in a seriously distorted if not entirely collapsed state. I have,

The World War I War Office Testing Ground at Claygate, Surrey

however, found no mentions of collapses holing through or disturbing the ground surface. Assuming the trial tunnels to have been driven towards and beyond the clay pit face, they would lie 85 feet or so below ground level. It seems unlikely that the tunnels would have been driven at shallow depth outwards below the pit floor, as this would potentially have endangered any mobile or stationary plant there.

One must assume that there were more or less substantial surface installations at the Testing Ground. Workshops for assembling and maintaining heavy machinery, at the least, and arrangements for a substantial electrical power supply.

Substantial quantities of excavated London Clay spoil would of course have been produced by the tunnelling. This may simply have gone into the brickmaking plant, as was done with spoil from the London Underground Northern Line to Morden, and the Victoria Line. It may otherwise have been employed merely filling-in the worked out pit in due course.

TBM trials in Chalk

Although at first the military tunnelling on the Western Front was in the Flanders Clay, later tunnels were driven at greater depths in the underlying Chalk. Varley and others mention TBM trialling also at Chatham, and from a chalk pit at Cuxton, in Kent. And there are also some mentions in early documents on 1880s TBM trials near Snodland in the Medway Valley. The Chalk is almost certainly too far down (several hundred feet) at Claygate to have been accessible for TBM trialling at that site.

The subsequent history of John Sims' Oaken Lane clay pits

According to Peebles (1983) the older pit on the western side of Oaken Lane is now occupied by the Oaken Lane Garden Centre. The eastern pit, opposite the junction of Oaken Lane with Manor Road South, appears from Ordnance Survey maps to have gone out of use by 1932. I have not yet had the opportunity to visit the site, but assume it is landfilled and / or built over.

Further research

Although there is a substantial, if scattered, published literature concerning military tunnelling and underground warfare in the First World War, mentions of the Testing Ground are few and far between, and lacking in detail. I have found nothing specifically relating to the site and its equipment and facilities during the War, and a search of the National Archives catalogue (available on line) resulted in only a handful of War Office files relating to Claygate none of which contain relevant details. Probably the most fruitful line of enquiry will be the Royal Engineers at Chatham. A substantial part of the files of the Channel Tunnel Company Ltd was evidently destroyed as a result of enemy action in World War II, although what survives would be worth searching.

Although traces of collapsed shafts, launch chambers, and flimsily lined tunnels will almost certainly remain below ground at Claygate, they seem likely to be at such a depth as to put them beyond archaeological investigation.

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From Paul Sowan

NAMHO 2005: the view from Juniper Hall

The National Association of Mining History Organisations' 2005 Conference was hosted by the Wealden Cave and Mine Society, assisted by the Kent Underground Research Group, the Chelsea Spelaeological Society, and Subterranea Britannica, at Juniper Hall Field Studies Centre, Mickleham, near Dorking, Friday 8th - Sunday 10th July. There was a supplementary programme of two surface walks on Monday 11th July. There was a very full programme of underground visits and, running parallel, lectures on the Saturday and Sunday.

Bedlams Bank (No.3), Rockshaw Road, Merstham, Surrey. 09-Jul-2005 - *Setting off on a NAMHO field trip...* © Andy Belcher WCMS

Your correspondent, representing Subterranea Britannica on the organising committee, stayed above ground all weekend, organising the lecture programme, and leading the two surface walks. This report, therefore, deals only with the above-ground aspects of the Conference.

Attendance

Bookings were very slow coming in, and until quite late in the planning it was feared we might have to cancel, or run at a loss. However, in the event we had 50 or 60 people over the weekend, and made a profit. The hoped-for Belgians, Dutch, and French, a faithful band your reporter meets at international gatherings all over Europe, sadly did not book. We had hoped, being in the south-east, to make this an international gathering. One Portuguese lady came to deliver a lecture, as did a man from Ireland, and Anna and Irina Kompaniyets from Ukraine arrived at the last minute. Several people failed to arrive, including a lecturer from Paris, as a consequence of travel difficulties via London, in the wake of four terrorist bombings on a bus and the underground the day before the Conference opened.

Juniper Hall

Juniper Hall, an 18th century mansion with extensive Victorian additions, in a superbly scenic setting (marred only by parked cars), proved an excellent choice of venue. It is run as a field studies centre by the Field Studies Council, and thus has something of a Youth Hostel feel about it (especially the décor), but we enjoyed a splendid Conference Dinner, and adequate breakfasts. There was some hilarity caused by our being solemnly advised that on Health & Safety grounds we were on no account to operate the electric toaster ourselves! This was not quite so daft as it first appeared, as the Hall's smoke-detection and fire alarm system are apparently very easily triggered by burnt toast fumes! We arranged for two barrels of real ale, which ran out appropriately enough late on the Sunday evening. The trouble with buying-in real ale is what to do if it runs out too early, or if there is half a barrel unsold and left over.

The lecture programme

Malcolm Tadd, President of the Wealden Cave and Mine Society, and past-Secretary and an Honorary Member of Subterranea Britannica, formally welcomed everybody on the Friday evening, and introduced Harry Pearman (another SB Honorary Member) who gave an illustrated introductory talk on the south-eastern underground, based on his 40 or so years experience of exploring and cataloguing man-made cavities in the region.

The main advertised lecture programme was as follows. With the exceptions noted, all lecturers sent abstracts in advance, attended, and delivered their lectures. Arrangements were made to cover for those who did not attend.

Juniper Hall Field Studies Centre, Mickleham, Nr Dorking, Surrey. 09-Jul-2005 *The conference dinner...*© Matthew Clark WCMS

ALVES, Helena (Portugal) - Some aspects of the Portuguese mining history: British mining interests and mining companies operating in Portugal for the last two centuries.

BAKER, Ross (Surrey Bat group), and Peter

NAMHO 2005: the view from Juniper Hall

SCRIMSHAW (Kent Bat Group) - The ecology and conservation of bats underground.

BURGESS, Peter M. (Wealden Cave and Mine Society) - The historical development of the Quarry Farm area, Merstham, and its relationship to the Croydon, Merstham & Godstone Iron Railway.

CEBADA, Juan Diego Pérez (Spain) - Copper mining and environmental conflicts in Europe at the end of the 19th century [Abstract received, but lecture not delivered / lecturer did not attend]

CLARK, Matthew (Wealden Cave and Mine Society) - Diving discoveries in the flooded Merstham quarries.

CLAUGHTON, Peter F. (National Association of Mining History Organisations) - Men, minerals, and money: crossing borders in European mining.

CLEWS, Stephen (Radstock Museum) - Memories of mining and cultural identity in Europe.

CRITCHLEY, Martin (Ireland) - Europamines.

GLINEC, Frédéric (France) - Old quarries below Paris [No abstract received / lecturer did not attend. Brad Whible stood in for him and spoke on the same topic]

GROOM, Deanna (Wessex Archaeological Unit) - The Princess Channel wreck - iron ingots from the Wealden iron-mining district lost in the Thames estuary.

HODGKINSON, Jeremy (Wealden Iron Research Group) - The Wealden iron industry: the history of iron extraction in the Weald with special reference to the mining of ore.

KOMPANIYETS, Anna, and Irina KOMPANIYETS (Ukraine) - Verteba: the Pompeii of the Dnister [Complete paper by Michailo SOKHACKIY and Anna KOMPANIYETS received for publication, but lecture not delivered on account of timetabling constraints]

PEARMAN, Harry (Chelsea Speleological Society) - A mole's-eye view of the south-east.

SMILES, John (Wealden Cave and Mine Society) - Wartime miners [No abstract received, lecture not delivered, lecturer did not attend]

SOWAN, Paul W. (Subterranea Britannica) - Mining silver sand at Reigate Castle.

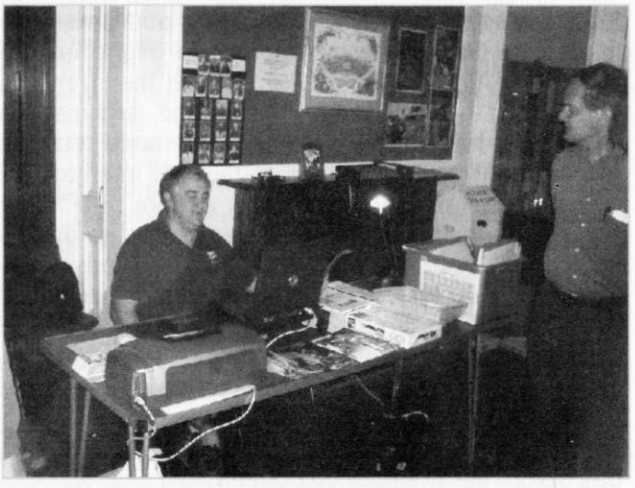
SOWAN, Paul W. (Subterranea Britannica) - Refractories and mineral pigment - working hearthstones and hearthstone underground.

SOWAN, Paul W. (Subterranea Britannica) - The interpretation of primary sources for mining history in east Surrey: some case studies [replacing John Smiles]

Croydon, Merstham and Godstone Iron Railway, Merstham, Surrey. 11-Jul-2005 *Delegates inspecting the Croydon, Merstham and Godstone Iron Railway cutting North of Merstham on the Monday morning surface walk...* © Matthew Clark WCMS

The field walks

Two field walks, led by Paul Sowan on the Monday, visited (1) the area of the southern terminus of the Croydon, Merstham & Godstone Iron Railway, which served underground quarries and a limeworks here from 1805 to 1838; and (2) the 19th / 20th century hearthstone mines and limeworks surface features at Betchworth and Brockham, both sites having recently been Scheduled as Ancient Monuments.



Juniper Hall Field Studies Centre, Mickleham, Nr Dorking, Surrey. 09-Jul-2005 *At the conference reception desk...*© Matthew Clark WCMS

From Paul Sowan

SUBTERRANEA SHOP - PRICE LIST AND ORDER FORM

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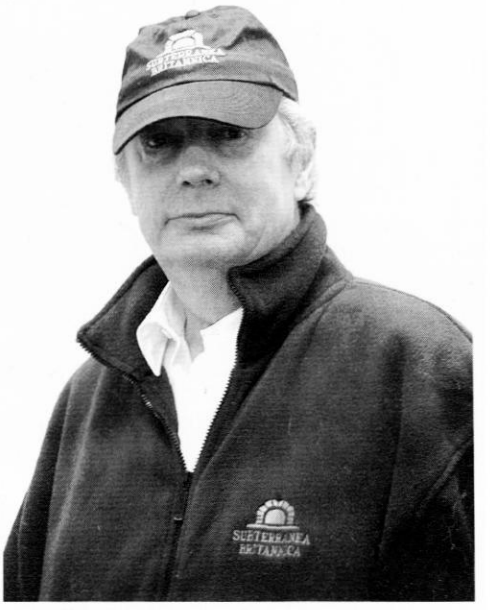

All items are in Navy Blue with the Subterranea Britannica logo and name in light blue.

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Rear Cover Photo's - Emmer Green Chalk Mines -Top: the inside of one of the Nissan huts. The steel work is still in very good condition considering that it is approximately 65 years old. Bottom: Passages in the mines. All the passages are a similar size of 12 to 15 feet high.