History - overview

Industrialisation shaped and made possible our modern day world and global society. Cornwall and west Devon was one of the main areas where this process began. Copper and tin production was of global significance during the first half of the nineteenth century, both resources vital to the progress of industrialisation.

In response to the challenge of mining deep and often near-vertical deposits, the region developed a technologically advanced and distinctive approach to deep, hard rock mining.

The supply of tin and copper and the distribution of Cornish mining technology and practice lead the way in the export of the Industrial Revolution overseas, and thus played a key role in the growth of the global capitalist economy.

The history of mining within Cornwall and west Devon originates in prehistory when this area was uniquely-placed to supply the tin vital for the production of bronze in Britain. Likewise, the tin streams of Cornwall and Dartmoor were the basis for an industry which supplied almost all the needs of Western Europe during the medieval period. True underground mining is first documented in the Crown-operated silver mines of the Bere Alston peninsula during the late thirteenth century, but it was not until the early sixteenth century when the tin gravels of west Cornwall were approaching exhaustion that tinners were forced to turn to the parent lodes, most probably in what were to become the coastal mines of west Penwith.

The mining technologies in use during this period are documented by a number of contemporary European writers, notably Biringuccio (1540), Agricola (1555) and Ercker (1574) and show an industry that had already begun to develop sophisticated water-powered machinery, in particular for pumping, and were using extensive adits to provide natural drainage wherever possible. By 1602, however, Carew was making plain the limitations of the available technology as mines became deeper: 'For conveying away the water they pray in aid of sundry devices, as adits, pumps, and wheels driven by a stream and interchangeably filling and emptying two buckets, with many such like, all which notwithstanding, the springs begin to encroach upon these inventions as in sundry places they are driven to keep men, and somewhere horses also, at work both day and night without ceasing, and in some all this will not serve the turn.'

In Europe in the early seventeenth century, Giattambista da Porta had speculated on the application of power from a vacuum induced by steam, whilst David Ramsay had taken out a patent 'To raise Water from Lowe Pitts by Fire' in 1624; von Guericke, Papin, Boyle and Morland advanced the new science of steam power to some degree, but the first practical machine specifically for mining use was developed by the Devon engineer, Thomas Savery, in 1698. Some sources suggest that an early example of one of his mine pumps was installed at Wheal Vor, though this is a matter of some debate. Savery's machine was a vacuum pump, however, and it was not until

Thomas Newcomen combined Guericke's cylinder and piston with Savery's separate boiler that a workable machine was created. The first engine to be installed at a mine may have been at Balcoath in the first decade of the eighteenth century, though most experts contend that the first installation was not within Cornwall. The engines were rapidly taken up in the coal mines of Britain and, to a more limited degree, in Cornwall. By the time of Newcomen's death in 1729, his engines were helping to drain mines in Hungary, Sweden, France, Germany, Belgium and Spain, whilst the following decades saw Josiah Hornblower erecting the first beam engine in North America.

Despite work by the Yorkshire engineer John Smeaton which resulted in the doubling of the efficiency of the Newcomen engine, it was proving too fuel-hungry for most Cornish mines, but the development of the separate condenser by James Watt transformed the efficiency of the engine made possible efficient mine drainage. Rotative engines which could be applied to mine haulage were developed in 1781, the use of expansive steam in the following year and double-acting engines soon thereafter. The end of Watt's patent in 1801 allowed local engineers free rein to experiment with further improvements to the beam engine, the development of the Cornish boiler and high pressure working by Richard Trevithick being particularly significant and the beam engines which emerged in the early decades of the nineteenth century were to power Cornish and Devon mines for the whole of the following century.

In 1580, Ulrich Frosse had been charged with exploring the possibility of mining for copper in Cornwall, working initially at Perranporth and Illogan, though ore was also purchased from mines near St. Just and St. Ives. The venture was not a success. Within a few decades copper mining seems to have come to a halt and it was not until the last decades of the seventeenth century that production was restarted, largely as a result of the efforts of John Coster, a copper smelter who established works on the River Wye in 1680. Coster, a metallurgist and engineer, helped to develop adit drainage, made significant advances in assaying and dressing copper ore, erected one of the first horse-whims in Cornwall and developed the first true copper mine in Cornwall, at Chacewater in the early 1700s.

National demand for copper was rising rapidly and Cornwall proved rich in ore, particularly to the north of Carn Brea. By the 1720s Cornwall was producing 6000 tons of copper ore a year and in the next two decades this was to double. But deeper mines were inevitably wetter mines. Newcomen's engines were put to work on some; others developed adit systems, that begun by Sir William Lemon in 1748 to drain Poldice eventually becoming the Great County Adit and linking together dozens of mines, notably those being newly-developed in the parish of Gwennap. By 1770 Cornwall was producing nearly 30,000 tons of ore each year, but the copper ore raised from two vast opencasts on Anglesey from 1768 was to seriously challenge this growth. The only way to improve the economy of Cornish mines and make them competitive was to improve the efficiencies of their pumping engines. By the end of the century, the Anglesey mines had ceased to be a threat; copper prices were rising and the beam engine had been transformed. Cornish engineers such as Harvey, Trevithick, Woolf and West emerged during this period, new foundries and engineering works were established at sites like Perranarworthal and Hayle. Soon, new ports were being constructed to ship ore, coal and timber and tramways being laid down to serve the mining fields inland. John Taylor's Redruth and Chasewater Railway carried 50,000 tons of ore in its first year. Amongst the developments in mining machinery during these early decades of the nineteenth century were John Taylor's crushing rolls at Wheal Friendship in 1796, Trevithick's steam winder, erected at Stray Park in 1801, Woolf's steam stamps at the Carn Brea mines in 1813, the Brunton calciner at Wheal Vor in 1830, the introduction of wire rope haulage at South Frances in 1840, Michael Loam's man-engine at Tresavean in 1842 or the Brunton Belt (a forerunner of the belt vanner) at Devon Great Consols in 1844.

Cornish engineers and inventors did not solely limit their efforts to mining technology, however, and the nineteenth century also saw the emergence of a substantial gunpowder making industry, the invention of safety fuse by William Bickford, whose company was to dominate world production for decades, the expansion of Perran Foundry and Harveys of Hayle into international suppliers of mining equipment and the eventual emergence of Holmans of Camborne as world leaders in the field of rock drills and compressed air equipment. Murdoch lit his Redruth house with gas in 1795, Davy established himself as a pioneering British chemist, Goldsworthy Gurney ran a steam-driven coach from London to Bath in 1829 before turning his attention to light houses, Trevithick had trialled a practical steam carriage in 1801 and produced the first successful steam locomotive in the world. Cornwall during the late eighteenth century and during the first part of the nineteenth century was an important centre of innovation and technological development.

In 1836, the Caradon mines were discovered and in 1844, the phenomenally-rich Wheal Maria (with its sister mines, soon to become Devon Great Consols). The mines to the west of Truro had been worked extensively for half a century, however, and were showing signs of incipient exhaustion. In the 1830s Cornwall had dominated world copper production. Two decades later Chile's production far exceeded Cornwall's output, whilst the Lake Superior mines and those in South Australia were developing fast. Cornwall and Devon's peak year for production was 1855-6, when 209,305 tons of ore were mined. By the end of the decade, tin was replacing copper as the most important mineral, particularly in the western mines, and in 1866 the collapse of banking giants Overend & Gurney precipitated a disastrous crash in the copper market which Cornish copper mining could not survive. Chile, Australia, Lake Superior, Montana, and Arizona spelt the end for Cornish copper mines and, eventually, for the Welsh smelters also.

Some Cornish mining districts were fortunate in that they also possessed tin reserves, and through increasing mechanisation and the adoption of efficient ore dressing technologies their mines were able to work on for a couple of decades more, despite falling tin prices; some former copper mines found a new lease of life in working the arsenical pyrites which they had formerly discarded as waste - indeed Devon Great Consols produced a substantial proportion of the world's arsenic during the closing years of the nineteenth century. Nevertheless, the great days of Cornish mining were over and one by one, mines whose reputation had spread far beyond Cornwall were abandoned forever.

Prehistory and Romano-British Period (AD 43 - 410)

Historic production of minerals from the Cornubian Orefield: introduction

The metalliferous mineral resources of the Cornubian Orefield have been exploited for well over 3,500 years. Pebbles of 'stream tin' have been recovered from a number of prehistoric settlement sites and there is much evidence of prehistoric activity recorded from Cornish tin streamworks. Until 1700 tin was the most important metal (except for silver which was mined in the Bere Alston peninsula during the late-thirteenth and mid-fourteenth century). Cornwall and Devon was Britain's only indigenous tin resource. Its recorded production was only ever exceeded by the Erzgebirge in Eastern Europe in the early fifteenth century.

Romano-British period (AD 43 - 410)

Classical author Diodorus Siculus was a Sicilian historian who wrote about trading for tin with Cornwall prior to the Roman invasion. He refers to tin trading at Ictis; a location claimed alike by St Michael's Mount and Mount Batten in Plymouth.

Diodorus, who may have been quoting Pytheas of Massilia (300 BC), states The inhabitants of Britain who dwell about the promontory known as Belerion (Cornwall) are especially hospitable to strangers... The natives work the tin, treating the bed which bears it in an ingenious manner. The bed, being like rock, contains earthy seams, and in them the workers quarry the ore, which they melt down and cleanse of its impurities…and convey it to an island which lies off Britain and is called Ictis; for at the time of ebb-tide the space between this island and the mainland becomes dry and they can take the tin in large quantities over to the island on their wagons. On the island of Ictis the merchants purchase the tin of the natives and carry it from there across the straits of Galatia or Gaul; and finally make their way on foot through Gaul for some thirty days, they bring their wares on horseback to the mouth of the river Rhone. Cornwall was the principal source of tin for countries in northern Europe; though in the first centuries BC and AD the Mediterranean region may have obtained their supplies from Iberia. Tin production was probably the main reason that the Romans ventured into this part of Dumnonia. The nearest Roman town was Exeter but small forts have been found in Cornwall, together with Roman milestones and hoards of Roman coins. A Roman fort at Tregear (Nanstallon) near Bodmin is close to an ancient ford and some important early tin workings.

Medieval Period (AD 410 - 1500)

Early Medieval (AD 410 - 1066)

Tin was in considerable demand for manufacturing both bronze and pewter and there is strong archaeological evidence for trade between Cornwall, the eastern Mediterranean and northern Europe.

The Trewhiddle Hoard (Pentewan) of late ninth-century silver is thought to have been hidden from invading Danes in a working tin stream. An oak tinners' shovel found in Boscarne tin stream (Bodmin Moor) has been radiocarbon dated to between AD 635 and AD 1045. Church bells, whose bronze depended on Cornish tin, were widespread by AD 1000.

Later Medieval (AD 1066 - 1500)

Cornwall and Devon sustained an internationally important medieval tin industry. Shallow mining effectively mapped the major areas where tin occurred; copper at this time still being of little commercial interest.

The Stannaries

The importance of the tin industry in the medieval period was recognised by the establishment of a special legal framework. It was first enshrined in a charter from King John in 1201 that included a number of pre-existing common law practices. The charter gave privileges to the tinners, and their industry, in return for which they paid a special tax, that was calculated at the time of coinage. From the earliest records in the twelfth century through to abolition in 1838 the tax levied on tin production in Cornwall was at double the rate of that applied in Devon.

The areas of jurisdiction were defined as eight Stannaries; four in Devon and four in Cornwall. In Devon they divided Dartmoor into quadrants. In Cornwall they were: Foweymore (present-day Bodmin Moor); Blackmoor (centred on Hensbarrow Moor north of St Austell); Tywarnhayle (a triangle approximately bounded by St Agnes, Truro and Scorrier); and the united Stannaries of Penwith & Kerrier (roughly corresponding with the respective political districts of today). Each possessed at least one designated Stannary town where tinners were obliged to present their blocks of smelted tin that were tested for purity before taxes were collected. Tavistock was a Devon Stannary town.

When the Duchy of Cornwall was established in 1337 coinage formed a significant source of revenue. The Duchy was also probably the largest single mineral lord in the south-west. Most of the fundus (river-bed) of the principal rivers, and some of the estuaries, were owned by them, and considerable royalties were gained from tin-streaming activities in those areas.

In 1497 the Cornish revolted against new Stannary laws imposed by Prince Arthur, Duke of Cornwall. As a result the charters were confiscated, to be renewed by the Charter of Pardon issued in 1508 in return for a payment of £1,000. This included the right, through the Stannary Parliament, to veto any statute or proclamation which was 'to the prejudice' of the tinners. The combined Stannaries had their own Stannary regiment 1798-1913.

Medieval tin-streaming

Tin-streaming technology in Cornwall and Devon was similar to that which was used elsewhere in Europe during this period. This was documented by a number of contemporary European writers, notably Biringuccio (1540), Agricola (1555) and Ercker (1574). They show an industry that had already begun to develop sophisticated water-powered machinery, in particular for pumping small-scale shaft mines, and was using extensive adits to provide natural drainage wherever possible.

By 1602, however, Carew was making plain the limitations of the available technology as mines became deeper:

For conveying away the water they pray in aid of sundry devices, as adits, pumps, and wheels driven by a stream and interchangeably filling and emptying two buckets, with many such like, all which notwithstanding, the springs begin to encroach upon these inventions as in sundry places they are driven to keep men, and somewhere horses also, at work both day and night without ceasing, and in some all this will not serve the turn.

Tin streaming, and shallow shaft mining, provided employment and wealth far beyond that to be expected from such a remote and poor agricultural area. Countless valleys in Cornwall and west Devon were turned over for tin. There is massive evidence of tin streaming manifested in hundreds of hectares of man-made landforms on Dartmoor (Devon), Bodmin Moor, West Penwith, on Goss Moor, Breney Common and Redmoor, as well as in the wooded valleys of the region that drain the mineral rich areas. These remains are well documented and many have been surveyed in detail. The removal of millions of tonnes of overburden, together with the finely crushed waste of ore-processing resulted in the rivers and estuaries in the region becoming heavily silted. The Plym, Looe, Fowey, Fal, Carnon, Helford, Cober, Hayle and Red Rivers all have mineral detritus many metres deep. Tidal limits have been progressively pushed downriver so far that former ports were subsequently marooned amidst salt marsh. The landscape of the region's medieval tin mining industry represents the most extensive remains of pre-1700 mining in Britain.

Tin smelting in blowing houses

Tin was smelted by mixing the simple dioxide ore (cassiterite SnO^2) with carbon (usually peat or wood charcoal) and reducing it in a granite furnace blown with air by means of a water-wheel bellows. In 1198 William de Wrotham, first Warden of the Stannaries, refers to two smelting processes. The first (probably a crude smelting) took place at the mine whilst the second took place at the Stannary town for taxation purposes.

By the mid-fourteenth century this practice was succeeded by single-process blowing houses and a number of these survive, particularly on Dartmoor. Blowing houses produced the purest grade of tin (grain tin) from alluvial ore. This metal carried a premium price, above that of 'mine tin', and was favoured by the glass-making industry. It was also used in coloured glazes and in acid dyes for carpets and fabrics.

Fuel and the early mining industry

During the thirteenth and fourteenth centuries oak woodland in Cornwall and Devon was managed to make charcoal for tin-blowing. Tinners also needed timber for their shallow shaft workings. Old oak woodlands in Cornwall such as in the Luxulyan Valley or the thickly wooded banks of the river Fowey, show the multiple trunks of ancient coppiced trees and the platforms where the charcoal was made. On the moorland peat was cut to make peat charcoal. Goonhilly Downs, Bodmin Moor and Dartmoor were important sources for this fuel.

Medieval silver mining in the Bere Alston peninsula

The Bere Old Mines, together with those at Combe Martin in north Devon, dominated English silver production until the late sixteenth century. In the late thirteenth and fourteenth centuries a fundamental change took place in local mining organisation when the Crown - apparently prompted by the desire to maximise its income from silver mining - worked the Devon silver-lead mines directly by shaft mining. For the first time small-scale independent operations were replaced by a relatively large-scale capital-intensive mining organisation that laid the foundation for an entrepreneurial system - the Cornish tribute. This dominated non-ferrous metal mining, in Britain and in many overseas mining fields into the modern period.

Skilled miners were drawn from other British lead mining districts, many of whom were pressed into service. Workings were initially shallow but adit drainage was required by 1297 when output peaked. In the early fourteenth century the workings were rich but again impeded by water. Crosscut drainage adits had to be driven deeper. When the Black Death hit the South West of England in 1348/1349 the mines were reduced to the reworking of slag residues. Underground working was abandoned.

Post-Medieval Period (AD 1500 - 1700)

By the early sixteenth century many tin streams were becoming exhausted and miners were turning to the exploitation of tin and copper lodes that outcropped in cliffs and other places where hard-rock was close to the surface.

Goffen works

Much of this early mining was in the form of open-cast trenches up to 20m deep; known as 'goffen works'. The next step was to sink shafts and drive horizontal levels through the ore-ground which occurred in fissures or veins. Once the shallow ore had been mined the only way to go was deeper, progress only being possible if the workings were free of water. Workings were drained by adits and primitive pumps.

The pumps were operated by perhaps five times more pump-men than miners. From the late-seventeenth century miners used water power to drain their shafts. Waterwheel pumps were built wherever there was sufficient surface water to drive them. Man-made watercourses (leats) often brought water several kilometres to drive pumps and tin stamping machinery.

Copper mining

The earliest recorded attempts to mine Cornwall's copper ores had been in the 1580s by The Society of Mines Royal (which had first worked the Keswick deposits in Cumbria on a large scale). The Cornish mining operations took place in St Just, St Agnes, Perranzabuloe, Illogan, Marazion and St Hilary. Ulrich Fosse (a German mining expert) was sent to Cornwall to manage operations and under his direction a small smelting works was also set up at Neath in South Wales. This smelter operated under German management and copper ore was received from mines near St Ives and St Just. Carew in his *Survey of Cornwall* (1602) mentions the shipment of copper ore from St Ives to be refined in Wales: the beginnings of a long-standing relationship between Cornwall and South Wales.

These early copper mines were unsuccessful and significant exploitation did not begin until the passing of the Mines Royal Acts of 1689 and 1693. During the last years of the seventeenth century, copper production largely progressed as a result of the efforts of a copper smelter named John Coster who had established works on the River Wye, Herefordshire in 1680. He was a metallurgist and engineer who also helped to further develop adit drainage, to make significant advances in assaying and dressing copper ore, erected one of the first horse-whims in Cornwall and developed its first true copper mine at Chacewater in the early 1700s.

Gunpowder

In 1689 the Godolphins asked Thomas Epsley, who had learnt the art of 'shooting the rocks' in the Mines Royal in Somerset, to come and demonstrate the use of gunpowder

to their miners in the Breage district. Thomas Epsley died at Godophin Ball six months later but the import was quickly adopted in other districts such as the cluster of tin mines around St Agnes Beacon. The time, labour and capital required to drive adit levels and crosscuts was reduced significantly by the use of gunpowder. As a result, ore-ground could be opened up much more quickly.

Sir Francis Godolphin was highly successful with his innovations at Great Work mine and his services as a mining engineer were sought by the owners of the lead mines in Cardiganshire in Wales.

Adit Drainage

Drainage tunnels or adits (Latin: *Aditus*, an approach) had been used for centuries to drain water out of mines (e.g. the thirteenth century Bere silver mines). They were driven from the lowest convenient point the topography allowed, such as a river, the base of a cliff or a valley bottom.

These tunnels lowered the natural water table and presented a new datum to which water could be pumped up from below. However the depth at which this could be done was still limited by the primitive design of early pumps, such as the ‘rag and chain’ pump.

Gunpowder made it possible to drive adits much more rapidly along a known or towards a surmised lode. Such undertakings were costly and could take tens of years to accomplish so were often financed by mineral lords or other adventurers with significant capital. In addition to mineral revenue, further rewards were often reaped by leasing the use of the adits to other mine operators for transferring water.

The industrial mining landscape and economy, from AD 1700 - 1900, and 1900 - 1914

The World Heritage Site status for Cornwall and west Devon relates specifically to the period 1700 to 1914, the most universally significant era for Cornish mining.

From 1700 there are a number of general characteristics which distinguish this period of metalliferous mining in the World Heritage Site from any preceding period.

These are:

- the steady growth in Cornish and Devon tin production which was represented mostly by exploitation in depth and was based on underground lode mining (as opposed to tin streams or placer mining). Small-scale tin-blowing was gradually replaced by larger-scale coal-fired reverberatory smelting.

- landmark technical advances in steam pumping which marked the formative period of the Industrial Revolution in Cornish mining. By the end of the eighteenth century deep mining was made possible by the development of this new technology.

- the mining of copper which experienced steady growth from the beginning of the eighteenth century. From 1750 to 1850 it was the most important mineral in the region. Cornish and west Devon output dominated the world's copper markets.

- the laying down of the industrial transport infrastructure during the late eighteenth and early nineteenth centuries. This was essential to the production of copper. The major mining ancillary industries (such as engineering) were also established. The mining of a wide range of other metals (such as silver, lead, zinc, iron, manganese, tungsten, antimony and cobalt) between the late-eighteenth and the mid nineteenth century. These were as diverse as any mining field in the world. During the early nineteenth century Cornwall was the first centre of world arsenic production and during the later nineteenth century west Devon was its leader.

- the availability of large-scale employment in the industry which caused major population growth, spawned new settlements and a range of institutions for self-improvement and scientific study. There was a corresponding growth in agriculture and a large-scale emergence of mineworkers' smallholdings. Great houses were built or remodelled and estates and gardens were created or expanded on profits from the industry.

- the export of Cornish mining technology and labour during the nineteenth and early twentieth centuries – the later known as the Cornish Diaspora or '…great migration'.

- 1914 is a significant date in the mature phase of the British Industrial Revolution. It marks the commencement of the First World War and a significant reduction in economic growth. One effect of the war was to dramatically increase the demand for tungsten (for armaments), which stimulated some mines and led to others mines being started. However by 1919 the globalisation of metalliferous mineral production and the post-war slump had taken their toll, and combined to reduce metal mining in Cornwall and west Devon to a small scale activity.

Tin

A substantial amount of tin output in the region came from tin-streaming. Until the eighteenth century most tin came from these deposits. From the eighteenth century lode mining became dominant. There was a virtual absence of world competition in tin mining until the 1820s and the market remained dominated by Cornish tin until the 1870s. Periods of increased demand, such as the rapid rise of the tin-plate industry after 1800, strongly influenced the metal market price and hence production levels. The ability to increase production however depended upon the available mining technology of the time. The introduction of gunpowder for blasting and of reverberatory furnaces for smelting began a rising trend in production towards the end of the seventeenth century. From 1700 there began a steady improvement in the understanding of the nature of tin mineralisation and hence the ability to predict where tin deposits might lie. The development towards an industrial economy, with the ability to raise risk capital from investors, was a crucial factor that enabled expansion of the industry.

The improvement of steam pumping technology during the second half of the eighteenth century, and dramatic improvements to the Cornish engine from the 1820s enabled deeper mining and greater output. Cornish tin mines survived the threat of competition during the 1820s and 1840s from producers in the Far East. Following the 1866 copper crash, and the closure of a large percentage of Cornish copper mines, tin mines became the principal mines within the areas now defined as the World Heritage Site. The 1870s marks the peak production period at a time when Malayan production was temporarily halted by internal political anarchy. From 1874 production declined as Australia and Malaya produced a large output from extensive shallow deposits of cheaply exploited ore that continued to be mined through the 1880s and 90s. The consequent drop in the tin price, coupled with a decline in investment and the irony of a shortage of miners due to emigration, caused production to continue to fall sharply. It was not until the second half of the twentieth century that there was a substantial recovery in output. This followed a programme of financial support targeted at the mining industry by the United Kingdom.

Copper

In 1785 the exploitation of the large and shallow deposit of copper-rich sulphide ores at Parys Mountain on Anglesey (north Wales) precipitated a sharp economic downturn in the fortunes of many Cornish mines. During this period, British copper production exceeded demand by a large margin, whilst a struggle for the control of the copper market between the smelters and the Cornish producers resulted in a glut of copper on the world market; inevitably this was followed by numerous mine closures.

In the event, the readily-exploitable ores at Parys Mountain were worked out within two decades. Meanwhile the Cornish had responded to this threat to their mining economy through marked improvements in pumping technology and better working

methods. During the early years of the nineteenth century Cornwall had once again become the pre-eminent copper ore producer in Britain, indeed, in the world; and was to remain so for several decades.

The Consolidated Mines in Gwennap produced 442,493 tons of copper ore from 1819-1858 and the adjacent United Mines 347,640 tons from 1815-1861; the area was so rich that it was dubbed ‘the Copper Kingdom’. In the 1830s Cornwall completely dominated world copper production. However, two decades later Chile's production far exceeded Cornwall's output and the Lake Superior mines (N. America) and those in South Australia were developing fast. Cornwall and Devon's peak year for production was 1855-6, when 209,305 tons of ore were mined. By the end of that decade tin was replacing copper as the region’s most important mineral, particularly in its western mines, and in 1866 a disastrous crash in the copper market occurred which Cornish copper mining could not survive. Chile, Australia, Lake Superior, Montana, and Arizona spelt the end for Cornish copper mines and for the Welsh smelters.

Some Cornish mining districts were fortunate in that they also possessed tin reserves, and through increasing mechanisation and the adoption of efficient ore-dressing technology, their mines were able to work on towards the end of the century, despite falling tin prices. Some former copper mines found a new lease of life in working the arsenical pyrite which they had formerly discarded as waste. Devon Great Consols in the Tamar Valley produced nearly two-thirds of the world's arsenic during the closing years of the nineteenth century. Nevertheless, the great days of Cornish mining were over and, one by one, mines whose reputation had spread far beyond Cornwall were abandoned.

Arsenic

During the early nineteenth century Cornwall pioneered world arsenic production as a by-product of tin and copper mining in the western part of the nominated Site (Gwennap Mining District). The first commercial British arsenic was produced at Perran-ar-Worthal in 1812, followed by a works at Bissoe (1834) in the Carnon Valley that became a stronghold of arsenic production. Its principal market was the expanding Lancashire cotton industry which used it in pigments and dyes.

It was also used by other industries such as glass manufacture (as a decolouriser), in the production of lead-shot, in leather tanning, in wallpaper manufacture (to create green and yellow print), in pharmaceuticals, in agriculture for sheep dips and, from the 1870s, as a pesticide to control the Colorado beetle which devastated potato, tobacco and other crops in America during the late nineteenth century.

The principal arsenical insecticides were Paris green (from 1869) superseded by London purple (from 1878). During the latter half of the nineteenth century the leading world output came from the eastern part of the nominated Site (Tamar Valley). Production of this semi-metal prolonged prosperity long after other metalliferous productions had declined.

Calciners or ‘burning houses’ (furnaces) were an essential part of most eighteenth century Cornish tin mines whose ores contained arsenic and sulphur. These essential elements had to be ‘cleansed out’ by roasting as they proved deleterious to smelted tin. It was not until the nineteenth century however that demand arose, induced by technological advances, for the white arsenious oxide.

For some flagging copper mines, the working of arsenic provided several more years of profitable work and in some cases these ores became their principal output. Substantial works were established at the English Arsenic Company factory at

Roseworthy, Gwithian and at Greenhill near Gunnislake, but the largest in the region was at Devon Great Consols, which at its peak produced 3,000 tons of refined arsenic a year. It was in the 1870s that a handful of mines in the Tamar Valley mining district were producing over half of the world's arsenic; the works at Wheal Anna Maria (part of Devon Great Consols) covered 3.2 hectares and had over 6,850 cubic metres of arsenic flues.

Cornish mining from AD 1900 - 1914

One of the Old World's greatest copper mines Devon Great Consols, in the Tamar Valley, was finally abandoned in 1901. In west Cornwall a few large tin producers - mostly concentrated in the Camborne and Redruth District - dominated the Cornish mines that entered the twentieth century. Tin had doubled in price within five years and the mines that survived were reorganised and consolidated; although as a percentage of world output, Cornish tin accounted for less than 5 per cent.

The alluvial tin deposits north of the St Austell china clay district at Goss Moor, Tregoss Moor, Molinnis Moor, Redmoor and Breney Common are the sites of the largest and most important alluvial tin workings in Cornwall. Though worked from prehistoric times, large scale mining in the early twentieth century, using suction and bucket ladder dredges, was successful for a time.

The London and West Country Chamber of Mines was formed in 1900 to protect and promote Cornish Mining interests; this later became the Cornish Chamber of Mines. High prices prompted the reworking of old waste tips and some ventures met with swift success employing state of the art plant, such as that installed at Gunnislake Clitters Mine in the Tamar Valley.

Secondary tin streaming, or recovery, plants along the Red River near Camborne, prospered during these times when the mills of large mines could still lose well over a third of their tin in slimes that were discharged. In the years leading up to 1914 Dolcoath Mine (which closed in 1920) was returning some of its highest ever levels of output; around a quarter of United Kingdom production. By this time South Crofty Mine (finally closed for production in 1998) had established itself and was a name that was to become synonymous with Cornish tin for generations; indeed its name persists in Cornish mining culture in the twenty-first century.

Cornish mining (AD 1914 to the present)

A number of mines were recapitalised or reworked during the period up to the 1920s. Carn Brea & Tincroft, Basset and Grenville United (all Camborne & Redruth Mining District), Botallack, Boscaswell United (both St Just Mining District), Phoenix United (Caradon), Wheal Vor (Tregonning), West Kitty, Wheal Kitty & Penhalls United (all St Agnes Mining District) amongst others. They were mostly unsuccessful.

The Redruth & Chasewater Railway closed in 1915 and G. F. Basset (the most prominent private mineral lord in Cornwall at the time) sold his entire mineral rights to a London syndicate. Lord Clifden (Agar-Robartes family of Lanhydrock) followed with the disposal of 25,000 acres (c.10,000 hectares) in 1919, the same year in which 31 miners perished in the terrible man-engine disaster at Levant Mine. These were on the whole sad times for Cornwall.

Arsenic supplemented tin output and East Pool & Agar Ltd (having discovered a fabulously rich tin lode at the same time) became a leading producer; its chimney bearing the arsenic brand name 'EPAL' picked out in white brick. The largest tin smelter that Cornwall possessed – the Cornish Tin Smelting Company's Seleggan Works near Carn Brea – was the last to close in 1931.

In 1935 South Crofty Mine acquired the Dolcoath and Roskear setts. Shortly afterwards the Second World War created a renewed demand for tin and tungsten. East Pool & Agar Mine (Camborne and Redruth Mining District, closed 1945), Castle-an-Dinas Wolfram Mine (1915-1956) and South Crofty Mine recorded significant outputs of tungsten. New Consols mine at Luckett (Tamar Valley) reopened for tin and tungsten in the 1950s and nuclear detonation detection tests were conducted in the nearby Excelsior Tunnel at Kit Hill.

South Crofty and Geevor Mine (St Just) were now the largest tin producers in Cornwall. In the 1960s tin prices began to soar and Wheal Jane (Gwennap Mining District) was reopened (1970-1991). New operations also began at Mount Wellington Mine (Gwennap Mining District) and at Pendarves Mine (Camborne, 1970-1988). High prices persisted (albeit with artificial price intervention by the International Tin Council) until October 1985 when the Council collapsed financially in spectacular style and the price of tin halved overnight. By the end of the year the tin price had dropped from over £10,000 per tonne to under £3,000 per tonne. Wheal Concorde (St Agnes) and Pendarves closed in 1988, Geevor closed in 1990, Wheal Jane closed in 1991, and South Crofty closed in 1998.

Large steel headframes dominate the mines at Geevor and South Crofty which have become cultural icons that join the engine houses of a former era to mark the landscape with a reminder of a proud mining tradition.