**STONE QUARRYING LANDSCAPES AS WORLD HERITAGE SITES**

*This document is offered as a draft towards establishing TICCIH/ICOMOS guidelines on identifying stone quarry landscapes with the potential to be nominated for inscription as World Heritage cultural landscapes, following discussion with European Quarry Landscapes Network delegates at Teruel (Spain) in October 2014.*

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**Stone quarrying landscapes – a definition**

A landscape as defined by the European Landscape Convention (article 1 a) is 'an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors.'

Stone quarrying landscapes are those formed by human intervention in the natural environment in order to extract stones, clays and useful earths.

In practice there is considerable overlap between quarrying landscapes and mining landscapes. Both are shaped by extractive industry, and may in fact work the same minerals. For the purposes of this study, quarrying landscapes are defined as those which at the least:

- Extract stone (granite, limestone, marble, sandstone, slate and others) and clay from its geological formation for whatever purpose, in a *quarry*

These landscapes may, furthermore, provide evidence for:

- *processing sites* where quarried stone is turned into a commercial product, whether by hand-tools, or mechanical or chemical means or by heating or cooling
- *transport* of stone, whether in its quarried or processed state, and of unprofitable rock
- the human society brought into being as a result of *social provision* for the workforce

These landscapes may additionally include evidence for:

- The *end-use* of stone, in buildings, monuments and other structures, sculpture and other decorative arts, as tools or as aggregates or as related industrial goods

This definition does not include the working of coal and other naturally-occurring hydrocarbons, or of mineral-ores.

Not relevant to a definition of quarrying landscapes as distinct from mining landscapes is whether the workings are open to the sky or underground. In the English language, the word 'quarry' is generally applied to open-air workings, but also includes some which are, or were, worked underground, such as Bath stone and Merionethshire slate. In Italy, the mining law of 1859 distinguished simply between *minieri* (mines) and *cave* (quarries). The French law of 1810 divides workings into *mines*, *minières* and *carrières*. Workings for gold, silver, lead, copper, sulphur, coal and iron ore constitute *mines*. *Minières*, for which there is no exact translation in English, include bogiron ore, pyritous earths fit for working, sulphate of iron, aluminous earths, and peat, whilst *carrières* work stone, clay or sand, whether above or below ground.

**Stone quarrying landscapes – an historical introduction**

The extraction of stone from its geological formation for human purposes is an ancient activity, predating the use of metals, and is central to the evolution of human society. Quarried stone, once processed (whether by trimming, splitting, sawing, drilling, shaping, crushing, chemical process or heating/cooling), has been variously used:

- for the construction and decoration of buildings and roofing elements, field walls and paving as well as other structures, such as defensive and harbour walls
- for the creation of artistic sculptures, monuments and memorials, and for decorative uses
- for the fabrication of tools such as mauls and hammers
- for the production of abrasives such as grindstones, millstones, quernstones and whetstones
- as a fertiliser
- as a flux and as refractory material
- as aggregate, whether used alone or mixed with other materials as in coated roadstone or concrete
- as a component in cements, concrete and plasters

It is at least as important to the history of civilisation as the use of ceramics, as the use of organic building materials such as timber, turf and clay, and as the use of metals. Because of the durability of stone, it is often the main heritage of past civilisations.

In this context, however, it is also important to bear in mind that by no means all world cultures have made extensive use of stone. In Japan, it is only with the Meiji restoration of 1868 that stone begins to replace traditional timber architecture on a significant scale. It is under the Tang dynasty (616-907CE) that stone (and brick) buildings begin to predominate in China, though where stone was easily available, it was used in defensive structures, most notably in the Great Wall (Needham 1971, 38-91). In West African traditional architecture, mud/adobe buildings are common; Central Africa makes use of thatch and wood and other perishable materials. In East Africa the pattern is more varied, but stone is common only in the northern and southern parts of the continent. Great Zimbabwe ('the house in stone') is built of granite (http://whc.unesco.org/en/list/364).

However, it is European expansion into other continents from the 15th century onwards that (very gradually) brings the use of quarried stone into parts of the world where it had previously been uncommon or unknown, such as North America, Siberia, West Africa and Oceania. The global reach of quarried stone over the last 500 years has expanded dramatically, and by the 19th century was promoted by the practice of government-sponsored scientific testing of different types of rock for durability and water-resistance. Broadly speaking, however, and with exceptions discussed below, until recently the only stones exported over long distances were those intended for specialist purposes or as decorative elements such as obelisks, columns and facades.

Technological developments have led more recently to the new generation of 'super quarries', with examples in the UK, South America, India and China, exporting significant amounts of stone over great distances. Conversely, there is pressure from building conservationists to re-open older and much smaller quarries to provide specialist stone to rebuild historically significant structures.

The use of quarried stone in buildings and other structures is as much a matter of prestige as of the availability of material. Pericles rebuilt Athens in marble; Augustus found Rome brick, and left it marble, and the ninth Inca, Pachakuti, ordered Cuzco to be rebuilt in stone *c.* 1438 CE (Protzen 1985). The use of a particular stone far away from its place of origin can in places be identified as the particular architectural 'signature' of a power-group. One example is the use of Egyptian porphyry in Rome and Byzantium. Another is the Caen stone associated with the Norman expansion of the $11^{th}$ century, used on Canterbury, Chichester, Rochester, Norwich and Durham cathedrals as well as at the White Tower in London. Mussolini encouraged the use of Italian marble, and made a gift of columns from the Carrara quarries to the Dome of the Rock/Masjid Qubbat As-Sakhrah in Jerusalem as part of his policy of extending Italian influence over the Middle East. Hitler, echoing Ruskin, insisted that high-quality stone be used for buildings and infrastructure of the Third Reich so that they would have 'ruin-value' (*ruinenwert*) – even in decay they would look magnificent (Speer 1970).

The use of stone as a building material in locations such as these reflects the emergence of a centralised authority that is conscious of the need to express power and identity through the use of a costly and durable material, and that might also need to guard its resources by building defensive walls. This authority need not necessarily be imperial, monarchical or presidential – it can be a merchant elite in a free town, or a sacerdotal caste in a religious community. Both secular and religious authorities might also be the patrons of sculptors in stone, skilled artisans who were supported by a social network of studios and workshops.

This authority will have access to landscape resources. The first of these is a suitable geological formation to open a *quarry*, and sometimes also the space to tip unworkable or unproductive rock.

A second landscape resource may well also be a suitable location for a *processing site* where rough stone can be turned into a commercial product. Sometimes a processing site might be located where water power is available to operate machinery. This may be in the quarry itself or immediately adjacent to it. Alternatively, it may be near the *point of use*, or at any point in between along whatever transport route connects them.

An overland *transport route* forms the third landscape resource. Topography needs to be favourable to the movement of large loads towards the point of use or to a shipping point, and a dedicated transport system needs to be engineered and maintained. From ancient to modern times, cities have often had their own quarries near at hand, reflecting the difficulties of moving stone long distances – examples are Pentelikon for Athens, Combe Down for Bath (UK), and Beacon Hill for Boston (Massachusetts). Because stone is heavy, it needs carters and carriers and their technologies to move it overland, and in some cases specialised vessels are required if it is to be transported by water.

A quarrying industry also requires human resources – stone can be difficult to extract and to process, and therefore requires a capable and experienced workforce, though unskilled labourers can also be required. Workers, supervisors and their families require *social provision* - accommodation and related infrastructure.

In some cases, quarries lie near their major *point of use*, which might be a town or city which makes distinctive use of locally-quarried rock as a building material. Conversely, stone might be exported further afield.

*The quarry*

The layout and arrangement of a stone quarry depends on geology and topography. A quarry may be opened on a hillside or as an open pit. In either case, the rock may be worked as one face or may be made up of stepped working benches in a hill-slope. This practice is known from the Egyptian and Roman periods (Pearson 2006) but at the turn of the 18th and 19th centuries it was developed on a major scale at the Penrhyn slate quarry in North Wales (Lindsay 1974). It became common where geology permits, and favoured the use of railway systems for removing useful rock and for dumping waste.

Waste-tips and debris form an important part of quarry landscapes, as they illustrate the human interaction with geology, and often form impressive landscape features in their own right.

A quarry may also be worked underground. Limestone has been worked underground near several English towns, such as Bristol, south-east London, Manchester, Bath and near Dudley (UK); slate has been worked underground in the French and Belgian Ardennes, in Maine-et-Loire (France) and in Gwynedd (UK) (Voisin 1987; Soulez Larivière 1979; Lindsay 1974). From the 17th century, Paris limestone, quarried underground on the outskirts of the city, was raised to the surface in vertical shafts by winch or tread-wheel (de Rochefort 1672, Cerf and Babinet 1994). Volcanic rocks have been worked underground at Naples from the Graeco-Roman period into modern times.

Long-established methods of extracting stone from the quarry rock face include frost-splitting and fire-shattering. Inca quarrymen at Rumiqolqa and Kachihqata shaped the quarried rock by pounding it with balls of dolerite, as Egyptian stone-masons did (Protzen 1985). Imported stone tools have been identified in Egyptian basalt and gypsum quarries from the Old Kingdom (early-mid-third millennium BCE – Bloxham and Heldal 2007). Other early tools include wooden bars; wooden hammers have remained in use until modern times. Iron tools include picks, hammers and wedges; percussive rods were used to create holes to enable the rock to be split by plug-and-feathers or (from the 17th century) by blasting. This was initially carried out by gunpowder; high explosives for mass extraction were introduced in the 19th century. The use of electrical charges to detonate explosives is recorded at Holyhead to supply stone for a breakwater, a project which went on from 1845 to 1873 (Hayter 1875-6).

The use of cranes to move stone is of great antiquity. The builders of Eflatun Pinar, the Hittite Spring Sanctuary in the modern-day Turkish province of Konya, made innovative use ancones or bosses to lift and place the thousands of tons of andesite transported there from a nearby quarry in the 13th century BCE (WHTL 5912). Vitruvius (*c.* 15BC) discusses their use on building sites but it is likely that they were also used at extraction points (Vitruvius 10 2). Jib cranes have been identified archaeologically in Medieval quarries (Moorhouse 1990). Redvers-Higgins, Willies and Wain 2011 describe the innovative use of cranes in the Bath stone quarries in the 18th century. The adoption of steam power and of railways in the 19th century meant that they could lift larger loads and could themselves be moved. Ropeway haulage systems are recorded from the Medieval period in French slate quarries (Soulez Larivière 1979). The blondin ropeway, named after Charles Blondin who walked across Niagara Falls on a tightrope in 1852, was developed in the Scottish stone industry from the first installation at Kemnay Quarry in Aberdeenshire in 1872. Their use spread to other types of quarry and to civil engineering works (Donelly 1979).

Mechanical drilling and channelling were introduced in the mid-19th century, making use of steam, compressed air and electricity. Mechanical excavators (from 1839) and draglines (from 1904), both initially devised to cut canals, found an application in stone quarries. Wire-sawing was introduced at the Carrara marble quarries in Italy in 1895 (*Enciclopedia Italiana* 1934) and is now extensively used in slate, granite, limestone and marble quarries.

Hillside quarries are generally self-draining. Pits and underground quarries may require pumping, and adopted the technologies used in mining. A Newcomen-type steam engine was installed to pump an Ardennes slate quarry before 1771 (Voisin 1987). The Easdale (Èisdeal) slate quarries in Scotland were also early users of Newcomen technology (Tucker 1976). As quarries grew larger in the 19th century, pumping systems evolved in mining were increasingly adopted, such as the use of flat-rods and other forms of prime-mover.

When quarries become disused, their owners and operators are often obliged by law to return them to a natural environment, or to sanction use as landfill or recreational sites (Uhlir, Schaller and Unterwurzacher 2013; Thomas 2014).

*Processing sites*

Processing sites in which quarried stone is turned into a commercial product may be located at any point between the quarry-face and the point of use. This category therefore includes masons' yards in towns and cities. They take many different forms, and may preserve debris, traces of semi-finished goods and abandoned objects, and of structures and machinery.

Stone was, and is, processed by hand-tools such as crowbars, picks, chisels, hammers and plug-and-feathers, which often leave evidence in the form of smithies. Hand-processing can include initial reduction of the quarried blocks, which calls for both skill and physical strength, but might equally include the delicate work of carving the capital of a Corinthian column, which requires great dexterity. Work such as this might take place in the open, sometimes in rudimentary shelters such as the wind-breaks erected by French slate *fendeurs* (splitters) or the 'quarr houses' of Purbeck (Phillips 1996).

Bronze saws with diamond cutting points were used to process building stones for the pyramids and associated structures in the Old Kingdom (third millennium BCE) (Flinders Petrie 1883; Bloxam and Heldal 2007). A tool with a long history in the stone industry is a wrought-iron saw for harder rocks in which a paste of sand and water acts as the cutting agent. Pliny states that sand from Ethiopia was used in such saws (Pliny 36 9).[1] Hand-held and -operated saws of this sort were to be found into the 20th century even in such massive undertakings as the Carrara marble quarries (*Scientific American* 1902) but archaeological evidence also indicates water-wheel powered versions from the second part of the 3rd century AD in Phrygia and Anatolia (Turkey) (Grewe 2009; Mangartz 2010). They are attested by written sources in the 4th century AD in Gallia Belgica, on the banks of the Moselle, preparing stone for the imperial city of Trier (Ausonius). Ramelli shows sand-saws operated by horse and by water-wheel cutting marble in his machine book of 1588 (Ramelli 1994, plates 134-5). Very similar machines could be seen at work in Welsh slate quarries in the 1920s, and diamond-bladed reciprocating frame-saws have only been superseded by wire frame saws very recently.

Though the Egyptians seem to have used bronze hole saws (Petrie 1883), circular saws for cutting stone seem first to have been introduced in the North Wales slate industry, in the first decade of the 19th century, possibly inspired by the block-making machinery installed by the Royal Navy at

[1] In chapter 6 of the *Historia Naturalis*, Pliny suggests that the palace of Mausolus at Halicarnassus was the first to be covered with cut marble, 403 *ab urbe condita* = 350 BC.

Portsmouth (Lewis and Williams 1987). The Hunter saw, an early application of renewable tip tooling, was used in Irish and Welsh slate quarries and in Scottish freestone quarries from the 1850s. Though wire sawing was and is most commonly employed at the quarry face it can also be used in processing (Wood 2006c). The Bessemer process, patented in 1855, made it possible to use progressively less expensive forms of steel as a component in cutting and crushing technology. The use of manganese and tungsten as components improved their efficiency. Gantry cranes derived from engineering workshop practice also come into common use in the 19th century, particularly where stone-processing sites were served by railway. These could be used to lift raw blocks off wagons and sort them by size, or distribute them to the machines by which they would be sawn or shaped (Fitzgerald 1990, Stanier 1995, Wood 2006c).

Water-power had become the most important energy source for powering stone-cutting machinery by the 19th century, and processing sites are for this reason often located where there is a good fall of water, rather than immediately adjacent to where the rock was quarried or to the point of sale. By the mid-19th century, cheap and reliable steam plant could also be put to operating machinery. A stone-processing plant often came to resemble a classic factory of the period, dominated by a chimney for a stationary steam engine and with all the paraphernalia of a time-office, siding access, coal bunkers and a weigh-bridge. A variant is the 'horseshoe shed' of the USA granite industry, arranged around a derrick crane (Wood 2006c).

Quarried stone may also be processed by chemical reaction, when limestone and gypsum are heated and slaked to create an agricultural fertiliser or (in conjunction with an aggregate) to make mortar. Lime-burning is attested in Europe since at least the 2nd century BC (Cato 38, Newby 2001). Early 'clamp kilns' involve layers of fuel and limestone stacked together in a mound, covered with clay or turf and burnt slowly; permanent structures, either 'flare kilns' (also known as 'intermittent' or 'periodic' kilns) and 'perpetual', 'running' or 'draw' kilns, came later. An annular kiln was patented in Britain by John Gibbs in 1841, followed by the Brockham patent kiln and the Belgian De Witt kiln later in the century. Experimental continuous kilns reflecting contemporary developments in brick-making were being built in the 1780s; as developed by Friedrich Hoffmann their use spread world-wide in the 1870s (Johnson 2002). The development of these sophisticated multi-cellular lime-kilns had two main outcomes. They helped sustain the great population boom and the urban development of the classic Industrial period by providing agricultural fertiliser on a much greater scale than hitherto, thereby ensuring that the new industrial working-classes could be adequately fed. They also enabled the large-scale development of metal and chemical industries.

*Transport*

Transport systems associated with stone quarrying landscapes include internal systems within an extraction point to move quarried stone to a yard and to dump unsalable rock, as well as longer systems which give access to a processing site, to a harbour on navigable water or to a point of use, and also the evidence of river- or -sea-going vessels which transported stone. They are considered together here.

Primitive systems using sledges, carts, cradles and rollers, drawn by horses and oxen, lasted into the 20th century (Wood 2006b). Wheelbarrows were in use in a European context by the 12th century, and were doubtless to be found in quarries early on (Lewis 1994). Inclined ramps or (from the late 18th-early 19th centuries) railed inclined planes are often found in quarries.

Transport of stone between the quarry, the processing site and the point of use is attested from the third millennium BCE in the form of the 11km-long paved road from Widan el-Faras and Lake Moeris in Egypt (Bloxam and Heldal 2007). Parts of the *lithagogia*, the road which carried stone from the

Pentelikon quarries to Athens, have recently been identified. The total length was 17.4km long, and it was engineered so that it ran downhill in favour of the load. The initial descent from the quarry was accomplished by loading the stone onto carts which were lowered down an inclined plane, using a rope as a brake; thereafter the blocks were moved by animal-drawn carts (Malacrino 2010). Pentelic stones for Eleusis were drawn by 37 yoke of oxen, and it has been suggested that the *hyponomoi* recorded in the inscriptions were prepared stone rut-ways (Lewis 2001). Vitruvius (*c.* 15 BC) discusses techniques for using sleds to move long columns (Vitruvius 10 2, 2-14). The *lizzatura* (sledging) of the Carrara marble quarries is attested in the zig-zag roads that descend the mountain sides. Among the most remarkable monuments of quarry transport from earlier times are the rut-ways in limestone quarries on Malta and Gozo, which seem to reflect the use of single-axle carts, but there is no scholarly consensus as to whether they date from the late Bronze age, the Punic period and the Roman empire, or even as early the Neolithic or as late as the Arabic period (*c.* 870). Those at Misrah Ghar il'Kbir are widely known as 'Clapham Junction' because in their complexity they resemble a modern railway (Mottershead, Pearson and Schaefer 2008).

Otherwise, railways, both internal networks and overland systems connecting a quarry to navigable water or to a point of use, are evident from the 18$^{th}$ century, having already been used for many centuries in metalliferous mines and (since at least the early 17$^{th}$ century) in collieries. The first significant system was in England, Ralph Allen's wooden railway of 1731 near Bath which connected his Combe Down quarries to the river Avon, and which was integrated with the use of river-boats and cranes to formed an integrated industrial handling system (Redvers-Higgins, Willies and Wain 2011; Lewis 1970). In Ireland, a short wooden railway was installed in 1740-1741 to connect a quarry at Ballycastle, Co. Antrim, with harbour improvement works (Rynne 2006). From the 1790s South Wales' limestone outcrops were directly connected to the furnaces by iron railways, to supply flux to the furnaces, and those of Derbyshire by rail and canal to agricultural districts (van Laun 2001, Boyes 2012). Other quarry railways are the Haytor in Devon (1820) and the Quincy railroad in Massachusetts (1826), both of which made their rails out of the same stone they transported (Ewens 1977, Gamst 1997).

A more important early quarry system is the Penrhyn iron railroad in Wales (1800-1801), which both served for internal movement within the quarry and also transported finished slates and slabs to the sea. Its gauge of approximately 0.6m soon became common in Welsh quarries, as it was well suited to carrying a compact mineral. By the late 19$^{th}$ century, following the example of the nearby Festiniog Railway, also built to serve the slate industry, this technology was being widely copied for industrial, public and military railways across the globe. However, depending on the nature of the rock to be moved and the distance, quarry railway systems were also built to other gauges, up to and including 2.140m (7' 0¼"), which was used in the UK, the Isle of Man, the Açores and South Africa to connect quarries with breakwaters. Other significant rail systems serving stone quarries include la Ferrovia Marmifera di Carrara (the Carrara Marble Railway), operational from 1876 (extended 1890) to 1964 (Scheibner 1891). Some USA quarry railroads operating on severe gradients used articulated locomotives initially developed for the logging industry (Wood 2006b). Inclined planes were also used to overcome differences in height, either within the quarry or on an overland transport system, seen to spectacular effect at Portland (Jackson 1999), and in the slate and granite quarries of North Wales (UK) (Mountford 2013; Hindley 1986).

Navigable water was used wherever possible for moving stones. The Nile was the means by which stone was transported from Upper to Lower Egypt, and boats are frequently depicted in the rock-art near the quarries (Heldal, Bloxam, Storemyr and Kelany 2005). Stone traffic on the rivers of central Europe is attested in the late Medieval and early Modern period (Kryza, Uhlir, Kryza, Striškiene and Höck 2011). Specialist ocean-going vessels for moving large stones were known in late Hellenistic and Roman times, and wrecks have been identified in the Mediterranean (Pliny 36 1 2; Littlefield 2012).

In the Modern period, canals have been used to transport stone. Some supplied building sites in growing cities, like the Middlesex, which moved granite from the Chelmsford quarry in Massachusetts to the Charles river and thence to Boston (Wood 2006a). Others provided agriculture and industry with the stones they needed, such as the Llangollen canal which carried limestone from the Welsh hills for use as a fertiliser and as an ironworks flux in the English midlands. Lime-kilns are frequently located by the side of canals (*Canal Monuments* 1996).

*Social provision*

Social provision for quarry- and stone-workers and their families may take the form of towns and villages, or suburbs within them; scattered settlements, sometimes as part of a dual economy of industry and agriculture; barracks for free workers; and prison and camp accommodation for coerced workers.

Archaeological evidence from the Roman granodiorite quarry at Mons Claudianus in Egypt revealed a settlement of 1,000 people, mainly soldiers and free civilian quarrymen, who were well-paid and well fed, who brewed their own beer and grew their own vegetables (van der Veen 1997). It has been suggested that building remains at Kachihqata, a pre-Hispanic quarry site in Peru, are houses for supervisors and quarters for quarrymen, suggesting a hierarchically-organised workforce (Protzen 1985). Some quarrying settlements are of long standing; though the Roman marble-quarrying town of Luni declined and was abandoned, nearby Carrara evolved into a city-state in post-Roman times. Generally however, the revival of quarrying in Europe in the Medieval period does not seem to have led to the creation of 'free towns' such as were brought into being by gold, silver, lead and copper mining, and significant urban development for quarry workers seems to be a function of the 19th century. When they become evident, they take many forms – developments on the fringes of existing or evolving settlements, planned company towns, and uncontrolled developments where often newly-arrived workers would begin their working life.

A quarrying industry could lead to the establishment of institutions of higher education. Carrara has a specialist academy of stone carving and the fine arts, the Accademia di Belle Arti Carrara, founded by Maria Teresa Cybo-Malaspina in 1769, and in some towns, such as Bangor in North Wales (UK) and Middletown (Connecticut, USA), universities owe their existence to money generated by locally-based quarrying industries.[2]

Because quarrying was often seasonal, or might not provide sufficient income by itself, quarry workers and their families often created dual economy settlements on upland small-holdings. Other distinctive types of upland accommodation might be barracks for free workers, often located near, or within, the quarry and away from other settlement. They are particularly a feature of the Welsh slate industry (Foster and Cox 1910).

Accommodation for coerced labour is also evident in some places. The use of prisoners has been a feature of quarrying since Antiquity; it is recorded by Josephus (Yosef ben Matityahu) in Ancient Egypt (Josephus 1 26). The use of convicts and of the enslaved for unskilled work in quarries was revived in the Modern period. Examples are Dartmoor prison (UK) where conscientious objectors were put to work from 1917 to 1918, the Nazi-era Mauthausen concentration camp (Austria), one of several where 'incorrigible political enemies of the Reich' worked in quarries owned by Deutsche Erd- und Steinwerke GmbH (Kopalek 2013), and the World Heritage site of Robben Island (South

[2] These are the University College of North Wales (now Bangor University) and Wesleyan University.

Africa), where Nelson Mandela was put to work in a quarry. Political prisoners were made to work in granite quarries in Lower Silesia (Poland) until the collapse of the Soviet system.

Quarry- and stone-workers have frequently identified with progressive and radical religious and political movements. Some quarries were worked as co-operatives; by the late $19^{th}$ century unionisation was common in an industry where competition was strong, the margins tight, and large capital investment in machinery drove down wages (Wood 2007). Within a non-revolutionary tradition, Welsh slate quarrymen's dedication to the values of Liberal protestant nonconformity is evident in their *cabanau* (lunchtime discussion places) and impressive workers' chapels as well as in the fabric of Bangor University, to which they contributed regularly. The revolutionary approach is evident in Carrara (Italy) where the Anarchist Federation of Italy has been located at Piazza Matteoti since 1944; the town is also home to an anarchist bookshop and has a memorial to the regicide Bresci. Carrara's marble quarrymen lived at a high altitude on a diet of bread, cheese, fruit and rainwater, which made them fiercely independent - which in turn made them ill-disposed to the introduction of new machinery. They frightened respectable Yankee opinion when they emigrated to join the already multi-ethnic workforce in the quarries of the USA. Italian stonemasons built the Socialist Labor party block at 46 Granite Street, Barre (VT) in 1900, now a National (USA) Historic Landmark and the headquarters of the local Historical Society (Tomlinson 1854 'Marble'; Benjamin 1891; *New York Times* 19 January 1894; *Scientific American* 1902; Wood 2007). In many cases where a local or regional culture has been shaped by quarrying in modern times, progressive traditions remain strong, and the landscape itself forms 'the memorial to the unknown labourer' (Fowler 2004).

*End-use*

Stones are sometimes transported over long distances. A quarry at Carn Menyn in Pembrokeshire (Wales [UK]) produced spotted dolerite pillars within the geological source-area for the Stonehenge bluestones, though debate continues to whether human or glacial agency was involved in their removal to Wiltshire. Large andesite blocks from the Inca quarries at Rumiqolqa have been identified 1,600km away in Ecuador as well as at nearby Cuzco (Ogburn 2004). The distribution of querns and millstones from Hyllestad reflects the maritime reach of Viking-age Scandinavia; burrs from La Ferté-sous-Jouarre (France) are found in America, Africa and Oceania as well as in Europe (Baug 2013; Baug and Jansen 2014; Baug 21014; Ward 1993).

Even so, and even in widely spread and highly organised states, widespread distribution is the exception. Under the Roman empire, quarries were worked from Northumberland to Aswan, and from North Africa to Germany, yet in most of the 719 sites which have been identified, production was distributed locally. In 151 cases, distribution was, or is believed to have been, regional, and only in 31 cases, was distribution inter-regional. These are mainly stones from Greece and the eastern provinces, though it is suggested that Caen stone was exported to Britain in this period (Russell, online gazetteer). Cross-channel distribution of British freestone in the Roman period may reflect the role of the *classis Britannica*, the provincial naval fleet of the empire (Hayward 2009). Professor Miles Lewis' discussion of stones used in early colonial Australia suggests that imports from Britain were common in the early days until suitable sources were identified nearby, and that thereafter only specialist stones were brought in over long distances. Even after the building of the transcontinental railways, timber (and brick) architecture continued to predominate in Siberia and the American West.

Examples of quarry landscapes where a particular stone was exported widely but has also shaped the immediate environment are Aberdeen, Bath and Carrara. The landscapes of North Wales demonstrate extensive use of locally-quarried slate not only for roofing but as a walling material, and in fences. Slate is also unusual in that its cost-to-weight-to-durability ratio means that it is worth exporting globally as a common element in building, and there is abundant evidence that slate from Wales and from France is to be found all over the world (Lindsay 1974; Soulez Larivière 1979)

**Stone quarrying landscapes as World Heritage sites – some considerations**

There are currently 1007 World Heritage sites, of which more than 40 are related to Industrial Heritage in one way or another. Eighteen involve mining, with a heavy preponderance in favour of copper, silver, lead, tin gold and coal.

What Outstanding Universal Value or Values do quarrying sites exhibit, and on what intellectual basis might inscription be possible? Increasingly, sources of quarry-stone are identified within nomination documents for high-status architectural and sculptural ensembles and élite buildings (already well represented on the World Heritage list), where the source, composition and appearance of the rock could form an Attribute which contributes to the Outstanding Universal Value. Quarries also form components of inscribed industrial landscapes. However, no site has yet been inscribed by UNESCO specifically as a cultural landscape of quarrying – a significant thematic gap in view of the fundamental importance of this type of social and economic activity.

Nevertheless, researchers are studying stone quarrying landscapes in terms of global heritage value. Uhlir, Schaller and Unterwurzacher 2013 use Austrian examples to consider them as valorised heritage on this basis. Bloxham and Heldal 2007 analyse Egyptian basalt and gypsum quarries from the Old Kingdom (early-mid-third millennium BCE) in terms of Outstanding Universal Value following key concepts from the inscription of the 18th-19th century industrial landscape of Blaenavon in Wales as a World Heritage site. As they point out, the concepts of Outstanding Universal Value and authenticity have provoked controversy on how these can be attributed to cultural landscapes situated across diverse locations and within different cultural traditions and concepts of monumentality.
*Authenticity*

The Nara document on Authenticity emphasises that the respect due to all cultures requires that heritage properties must be considered within the cultural contexts to which they belong, and that judgements on what constitutes authenticity may derive from a great variety of sources. This makes Outstanding Universal Value a more challenging concept in that it needs to be reconciled with different traditions and concepts of heritage, but it is important in the context of any landscape shaped by the participation of non-elite populations, where many individual features will therefore be mundane rather than monumental or heroic. Quarries themselves may be spectacular undertakings but may equally be shallow and apparently unremarkable. Processing sites might contain no more than debris or rough-outs, and transport systems might use established and entirely commonplace technology. Social provision accommodated working people, and their housing and infrastructure reflects this. The end-use of stone may be directed to monumental structures but might have far more utilitarian ends. Recognising their Outstanding Universal Value may therefore be problematic, but it is these features, 'the memorial to the unknown labourer', which authenticate the 'human experience of industrialisation' (Bloxam and Heldal 2007). They may co-exist with features that are pioneering or monumental, but it is important also to note that industries often adapt and imitate technologies rather than innovate, and that a mundane feature – for instance, a tip of unusable rock created over generations by workers pushing a wagon to its furthest point – may itself be monumental. Elites create a demand for stone, and invest capital in an undertaking which then requires the specialisms of geologists, engineers and technicians, but workers invest in the quarry their craft skills, perfected over many years, as well as physical strength and often their lives.

A World Heritage stone quarry landscape bid should therefore not only make a strong case for qualities that can be acknowledged globally but should also be strongly rooted in the cultural context of its own social groupings, however defined. This should encourage applications from areas where quarrying is a strong cultural memory, or is still active.

*Integrity*

As with any property nominated as a cultural landscape, a quarry site should contain key interrelated, interdependent and visually integral elements – the physical attributes necessary to express its Outstanding Universal Value, and their relationship with each other.

Conditions of integrity also include social and cultural practices and values, economic processes and the intangible dimensions of heritage; for this reason, when craft-skill maybe identified as an attribute, present-day transformation of the landscape by modern quarrying need not necessarily detract from integrity.

**Attributes**

Attributes are aspects of a property which are associated with or express the Outstanding Universal Value. ICOMOS recognises that some attributes are tangible, expressed in *form and design*; *materials and substance*; *use and function*. In a potential quarry World Heritage site these attributes should be clearly inter-related with each other in a landscape context, and should be drawn from the *quarry* itself, any associated *processing sites*, the *transport route* and from *social provision*. In addition, a *point of use* may also be evident and constitute an attribute.

In this context, it is worth quoting the ICOMOS study *Railways as World Heritage Sites* – 'Railways have always been built as a means to some other end, and it would be fitting if this fact were reflected by the inclusion of railways as integral parts of locations designated as parts of World Heritage sites partly or chiefly for other reasons' (Coulls 1999).

Other attributes are intangible, expressed in *traditions, techniques and management systems*; *location and setting*; *language, and other forms of intangible heritage*; and spirit and feeling. As with authenticity, these need to be grounded in the cultural context of the proposed site. Workers' physical strength and craft skill can be distinguished as visible Attributes within stone quarrying landscapes by the sheer scale of a quarry and the physicality of the site. However, skill as an Attribute may also be exemplified in the evident intellectual, political or religious liveliness of quarry workers' communities and in the infrastructure that sustained it. A further Attribute of skill is the readiness of quarry workers to move from one part of the world to another, taking with them not only their way of life but also their prized knowledge of a particular type of rock and how to work it. This can be identified in the archaeological evidence for the journeys they undertook, such as Roman shipwrecks where masons' tools have been identified, or in the way they sustained their language or religious identity in the communities that received them.

Skill as an Attribute may be found in the end-use of a stone product. In this sense it merges with the skill of the builder and of the architect, but what should be more clearly understood is that urban development relies not only on those who design and erect buildings but also on a much wider network of less well-acknowledged trades and crafts, including those associated with stone.

**Proposed criteria for internationally significant quarrying landscapes**

Quarrying landscapes are cultural landscapes, and as such may potentially fulfil one or more of the following criteria:

*Criterion 1: a masterpiece of human creative genius*

Although quarries are in a sense 'engineered' landscapes, they differ from (for instance) a major transport route in that they are gradually evolved over long periods of time. For this reason, evolving craft-skill and an affinity for the materials being quarried and worked are more important than individual creative genius. In addition, many of the technologies associated with quarrying have either evolved over very long periods of time or have been imported from other industries, such as the mining of metal ores.

*Criterion 2: to exhibit an important interchange of human values, over a span of time or within a cultural area of the world, on developments in architecture or technology, monumental arts, town-planning or landscape design*

This criterion may potentially apply to many significant quarrying landscapes, given that they are often the result of a lengthy process, sometimes extending over millennia, which reflects social context as well as geological opportunity. They also nurture a skilled workforce that can sell their labour and their knowledge in other parts of the world. The choice of a particular stone, and the resources available to quarry, process and transport it, has exerted a profound influence on sculpture, architecture, town planning and bridge-building. Where a particular stone is exported world-wide and has had a distinctive impact on architecture and town- and city-scapes, this criterion might apply.

*Criterion 3: to bear a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared*

The quarrying and processing of stone is in many cases skilled work, and as such can promote strong cultural traditions amongst its workforce, based around shared values and skills. This is most apparent amongst skilled sculptors and monumental masons but is also true of the ordinary quarry worker. Conversely, some forms of stone quarrying call for physically demanding but unskilled labour, which has meant that in many cases, and from earliest times to the present day, coerced labour has been a feature of the industry.

*Criterion 4: to be an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates (a) significant stage(s) in human history*

This criterion may apply to certain quarries as technological ensembles, though it is noted above that on the whole quarrying technologies are imported from other industries.

*Criterion 5: to be an outstanding example of a traditional human settlement, land-use, or sea-use which is representative of a culture (or cultures), or human interaction with the environment especially when it has become vulnerable under the impact of irreversible change*

This criterion may apply when quarrying is on a significant scale and has generated a workforce with its own strong cultural traditions, and has exerted a profound influence on the surrounding environment, through working and processing the rock, and though the building of transport systems and workers' settlements.

*Criterion 6: to be directly or tangibly associated with events or living traditions, with ideas, or with beliefs, with artistic and literary works of outstanding universal significance. (The Committee considers that this criterion should preferably be used in conjunction with other criteria)*

This criterion might potentially apply to stone quarrying landscapes associated with sculptural masterpieces or distinctive materials.

**Conclusions**

There is a strong case for globally-significant stone quarrying landscapes to be considered as potential World Heritage Sites. Such landscapes need to be identified through expert knowledge and peer-discussion, acknowledging the cultural context to which a potential site might belong. The authors of this draft report trust that the approach outlined here will facilitate that process.

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**Online resources**

European Landscape Convention
http://conventions.coe.int/Treaty/en/Treaties/Html/176.htm

Lewis, M, Australian Building
http://www.mileslewis.net/australian-building/

Russell, B J, Gazetteer of Stone Quarries in the Roman World. Version 1.0.
www.romaneconomy.ox.ac.uk/databases/stone_quarries_database/

*Enciclopedia Italiana* 1934 http://www.treccani.it/enciclopedia

Saxa-loquuntur database

www.saxa-loquuntur.org

Historic quarry information system
www.historic-quarries.org

**APPENDIX 1**

The following sites are currently on the UNESCO list as cultural landscapes in which quarrying is an element:

- Upper Middle Rhine Valley (Germany)
- Takht-e Soleyman (Iran)
- Archaeological Monuments Zone of Xochicalco (Mexico)

- Gochang, Hwasun and Ganghwa Dolmen Sites (Republic of Korea)
- City of Bath (UK)
- Blaenavon Industrial Landscape (Wales, UK)

The following sites are currently on the UNESCO tentative list as cultural landscapes of quarrying:

- The Slate Industry of North Wales (Wales, UK)
- The Yapese Disk Money Regional Sites (Republic of Palau and Federated States of Micronesia).

The following sites are currently on the UNESCO tentative list as cultural landscapes in which quarrying is an element:

- Viking-period quernstone quarries (Norway), forming part of the transnational 'Viking Monuments and Sites' bid, along with ship burials
- Hoge Kempen (Belgium), a Rural - Industrial Transition Landscape, where sand and gravel quarries form part of a changing industrial landscape
- Mining Historical Heritage (Spain) – the Mares de S'Hostal calcarenite and eolianite quarries in Menorca
- The Hittite-era Yesemek Quarry and Sculpture Workshop (Turkey)
- The Chamangá Rock Paintings Area in Uruguay

In addition, quarries are mentioned as a source of supply for building complexes or structures in the following sites on the tentative list: Diocletian's Palace and the Historical Nucleus of Split (extension); La Moneda Palace (Chile); Catacomb Complexes (Malta); Archaeological Site of Aphrodisias (Turkey); Crusader Fortresses (Israel); Al Qastal (Settlement) (Jordan); the Archaeological Site of Göbeklitepe (Turkey); Sacred Ensembles of the Hoysala (India); Orvieto (Italy); Stećaks - Mediaeval Tombstones (Bosnia and Hercegovina); The Victorian & Art Deco Ensemble of Mumbai (India); Eflatun Pinar: The Hittite Spring Sanctuary (Turkey); Ekamra Kshetra – The Temple City, Bhubaneswar (India); Stećci - Medieval Tombstones (Montenegro); the historic town of Korčula (Croatia); and the Silk Road (Kazakhstan).

The following site is currently on the UNESCO tentative list as a mixed landscape:

- The Marble basin of Carrara

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