ISSUE No. 8

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CMT TESTING BULLETIN

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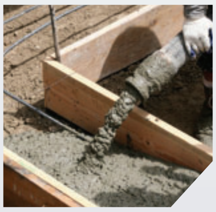

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EFFLORESCENCE, SALT CRYSTALLISATION & LIME STAINING – CAUSE & EFFECT

Efflorescence on brickwork

White deposits forming on brickwork, masonry, concrete or plaster are often described collectively as ‘efflorescence’. This can be misleading as efflorescence is in fact only one of two main types of such white deposits. Efflorescence is the result of soluble salt crystallisation under particular conditions and is not usually problematical. In other circumstances however, salt crystallisation can result in significant damage to the affected materials. This article takes a brief look at the origins and consequences of the ‘white deposits’ in question together with the potential effects of harmful soluble salt crystallisation.

SALT CRYSTALLISATION

Basically the crystallisation of water soluble salts within the pore structure of the construction materials mentioned above. The salts may originate from external sources (surrounding ground, groundwater for example) or from materials used in the fabric of the construction (brick, masonry, mortar etc.). If sufficient moisture is present, such salts are dissolved and transported towards the outer surface via the pore structure. The point at which the salts re-crystallise will depend on the balance between the rate of evaporation of moisture from the surface and the rate of transport of the salt solution to the point of re-crystallisation. If the rate of solution movement is faster than the rate of evaporation, re-crystallisation will occur at the outer surface. This white surface crystal growth is known as efflorescence and usually consists of mixtures of calcium, magnesium, sodium and potassium compounds (particularly sulphates and carbonates). Although not aesthetically pleasing, efflorescence is not damaging and will usually diminish over time as it will dissolve away in rain water (the timescale for this will vary depending on the source and concentration of soluble salts, location of the structure, environmental conditions etc.).

Damage to stonework due to Cryptoflorescence

Efflorescence requires the following conditions:

- presence of water soluble salts within (or in proximity to) the construction
- availability of sufficient moisture to dissolve the salts
- a capillary pathway to the surface of the structure and conditions where surface evaporation can occur leaving deposits of re-crystallised salts

In circumstances where the rate of solution movement is slow and/or the salts are only sparingly soluble, crystallisation will occur within the pores of the construction material in question, this is known as sub or cryptoflorescence and the corresponding crystal growth can give rise to delamination, spalling and flaking of the near surface as a result of volume increase and expansive forces associated with such growth. The vulnerability of construction materials to cryptoflorescence is governed by:

- the porosity/microporosity and pore size distribution of the materials
- the strength of the affected materials

Characteristic lime staining ‘runs’ from mortar joints

LIME BLOOM & LIME STAINING/WEEPING

Lime bloom occurs when calcium hydroxide solution (formed when lime, usually from mortar or other construction materials, dissolves in available moisture) migrates to a surface and, following evaporation, reacts with atmospheric carbon dioxide to produce a white deposit of relatively insoluble calcium carbonate crystals. If the crystals are ‘fine’, subsequent exposure to rainfall might physically remove them, otherwise the bloom will need to be cleaned off by dry brushing or with a suitable cleaner.

Lime staining/weeping usually forms at mortar joints and mostly involves a similar mechanism to lime bloom, with lime leaching out as calcium hydroxide in instances where water is free to pass through areas of a structure. Calcium carbonate crystals form on the joint and often leach further over brick or masonry to appear as white ‘runs’ extending from the joint. This staining will not weather away naturally and requires application of a hydrochloric acid based cleaner to remove it.

It is important to understand the mechanisms nature and cause of each of the above to prevent damage, re-occurrence and, where necessary, allow selection of appropriate cleaning/ remedial measures.

CMT (Testing) Ltd. offer various testing techniques for identification of the type of deposit . Such techniques also include thin section examination and associated methods to identify cryptoflorescence. For further information please contact our Chemistry Department.

CHANGES UNDERFOOT

A LOOK AT SOME OF THE DIFFERENT FLOORING MATERIALS AND CONSTRUCTIONS USED OVER THE YEARS

HISTORY

Before the mid 1300's, most houses in Europe had earthen floors made from compacted soil covered with straw for warmth. In some countries earthen floors are still favoured today, modern versions comprising either layers of earth compacted over a substrate of sand, gravel or pumice or a mixture of clay, sand and fibre placed on compacted gravel. Floors constructed during the Roman occupation of Britain used flint cobbles, tiles, bricks, mortar (with added pieces of pumice or brick) and stone, usually placed onto compacted earth. After the Roman departure, wooden floors began to be used for some of the more elaborate homes, the construction consisting of bearing timbers mounted on low 'sleeper' walls overlain by wooden boards.

Placing an in-situ reinforced concrete floor

Over time parts of Britain used stone flags, slate and lime based materials for ground and basement floors. One version of the latter was Lime Ash Flooring. Used for ground and upper floors during the 17th, 18th and 19th centuries, lime ash was highly variable consisting essentially of the material dug out from the bottom of lime kilns, usually a mixture of lime, wood ash and, if the kiln was coal fired, clinker residue. In certain parts of the country gypsum was added, sometimes to the extent that the result was really a 'gypsum floor'.

Lime ash material had the ability to form compounds with cement-like qualities due to siliceous and aluminous components present together with calcium hydroxide $Ca(OH)_2$. It was placed as a slurry on reeds, wood laths or thin boards spanning timber joists. The floor was fairly strong but remained flexible enough to allow movement without cracking, this characteristic was enhanced by the absence of fixed connection between the reed base and the supporting joists (where laths or board bases were used straw was often spread on top of the base to maintain this lack of connection). Occurring more frequently in the Midlands, original lime ash floors tended to be used more for attics, outbuildings, granaries, maltings and storerooms.

Many houses built in the 19th century had carpeted timber or tiled floors although brick floors were used in some instances. Timber floors continued to be used but the late 19th and early 20th centuries saw the emergence of reinforced concrete for solid ground bearing and suspended floor construction in commercial/industrial buildings and domestic housing.

CONCRETE FLOOR COVERINGS AND FINISHES

Numerous materials have been, or continue to be used to finish concrete floors. Examples are:

- tiles
- magnesite (magnesium oxychloride)
- mastic asphalt
- vinyl (sheet or tile)
- epoxy resin
- terrazzo
- granolithic courses
- cement/sand screeds
- 'anhydrite'

Tile, mastic, vinyl and epoxy are all in regular use. The remaining types may be summarised as follows:

Magnesite flooring material showing typical red pink colouration

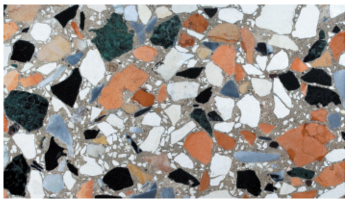
MAGNESITE

Limited in industrial application, magnesite was used mainly in domestic properties between 1920 and 1940 and particularly for Local Authority housing in the period 1945 to 1960, before falling out of common use. Made by mixing calcined (kiln heated) magnesite ($Mg CO_3$) with magnesium chloride solution plus various fillers including sawdust, wood flour, asbestos (rarely) and pigments (sand was occasionally added), it was often reddish-pink in colour. Frequently laid as a 10 to 25mm coating over concrete ground floor slabs or sometimes as two layers to achieve a nominal 50mm thickness. Magnesite has two drawbacks:

- It is very susceptible to moisture and disintegrates if persistently wet;
- Chlorides may leach out in moist conditions increasing the risk of chloride induced corrosion of steel reinforcing or services pipes.

TERRAZZO

A polished composite of marble chips within a cement matrix with pigment additives. A hardwearing aesthetically pleasing finish used extensively in commercial buildings in tile or unit form. Advantages including ease of cleaning and maintenance and increased slip resistance over other polished surfaces



Terrazzo flooring

CEMENT/SAND SCREED AND GRANOLITHIC FINISHES

Reinforced concrete floors may receive a power float finish, alternatively a cement/sand screed layer may be applied. This may be laid in a number of ways:

- Monolithic - placing the finishing screed coat directly onto 'green' concrete sub-floors so that the concrete and screed cure with a complete bond;
- Unbonded - used if the existing sub-floor is old, contaminated or suspended/ prone to movement. The new screed finish is placed on a waterproof membrane to separate it from the concrete. The screed coat tends to be thicker than other applications to ensure good performance in service;
- Separate - here the screed is placed on an existing hardened concrete base the surface of which has been prepared (manually or mechanically) to provide a suitable 'key';
- Floating - this involves laying the finish screed on suitable insulating material such as extruded polystyrene or quilt blanket. Often used in domestic houses with under-floor heating systems, the finish also enhances sound insulation qualities;

There are many cement based materials and screeds in addition to traditional cement/sand mixes, these include:

- Granolithic course -basically cement/sand and granite aggregate mixes, these provide a resistant wearing layer in areas of heavy trafficking such as commercial garages, service corridors, plant rooms and power stations;
- Fast-set screeds-these incorporate aluminium based cements (calcium aluminate/sulpho-aluminate (CSA) for example) to provide the rapid set qualities;

Float finishing a cement sand screed

- Polymer modified screeds - essentially cement/sand mixes with PVA or SBR additions. They have good water and chemical resistance;
- Gypsum & Anhydrite screeds -referred to as Anhydrite, Alpha Hemihydrate, Gypsum and Calcium sulphate, these screeds all contain calcium sulphate as a binder. Mostly delivered to site in liquid form, they can be placed by pumping which allows rapid coverage of large areas. Additional advantages include self levelling and smoothing characteristics and quick setting with minimal cracking or curling. They are vulnerable to moisture and cannot be laid in areas where they may become wet unless they are given adequate protection.

The above provides a basic summary. CMT (Testing) Ltd. offer testing and analysis to identify screed and flooring materials, provide details of their condition or identify the cause of problems and failures in service. Please contact us for further information .

DERBY ROCKS.

Derbyshire. What a place for a geologist to be. From the Peaks to the Trent there are a wealth of places to enjoy a day out with the family. The family – wife, kids, pets and of course – the rocks. Great in their natural state, but even better when they are a little more accessible. And what if you can't get out for the weekend? Well in Derby City Centre one can admire the variety of local, national and international rocks on show too. From the macroscopic to the microscopic the rocks are there all ready for inspection having been quarried and polished. Handy.

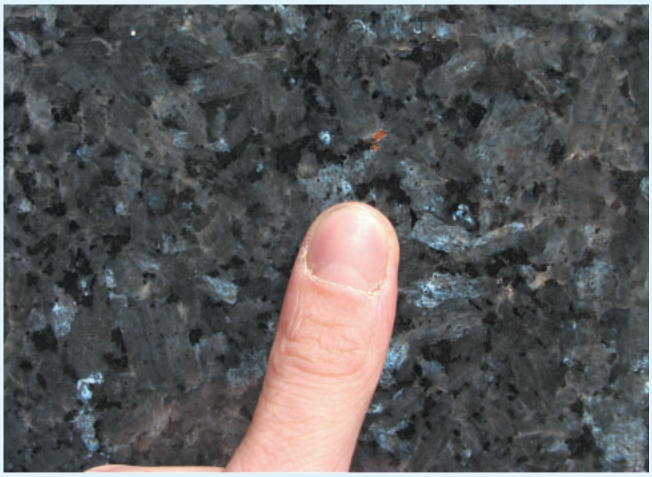
Sedimentary structures on show at Derby Cathedral

Being located near to many quarries (in all directions) the churches, courts, walls and many buildings of Derby help to highlight the close proximity of Carboniferous sandstones. Chatsworth Grit, Ashover Grit (usually pinkish in colour, pebbly), Kinderscout Grit (can be very coarse grained and contain shale pellets too) and Rough Rock (very feldspathic) are varieties that are employed throughout Derby, Derbyshire and Yorkshire as common building stone. The Cathedral of Derby shows many large and small scale sedimentary structures as is the nature of the Ashover Grit (in this instance apparently quarried from Darley Dale) – the cross bedding is fantastic which one might enjoy after an appropriate amount of time in a nearby hostelry.

Another structure rich lithology, the Rough Rock sandstone at Coxbench was quarried extensively in order to provide Derby with numerous buildings during times of expansion. Coxbench quarry had since become a hazardous landfill up until closure. A rather interesting tale of a lady that is said to have lived, amongst other places, in the quarry can be viewed at http://www.ashbourne-derbyshire.co.uk/localhistory.html the tale of Alice in the Bacon Box.

Larvikite is a very popular decorative stone, there is certainly plenty of it on display, and is probably the most recognisable of fascia rocks predominantly due to its pleasing and shiny aesthetic nature – however, there are several variations. The large feldspar crystals (porphyry) make it obvious to even the youngest of (enforced) geologists as to what they are. The crystals can be highly variable too, as crystallisation of all ternary end-member feldspars (albite, anorthite and orthoclase) all occur at the same time in the magmatic melt. Indeed some of the crystals are so large other minerals can be seen between the laths of the feldspar crystals (see picture).

The crystals in the rock have certain lustre, not bad for just less than 300 Million years old. The lustre is due to the Schiller effect - where the nature of the crystals allow light to reflect differently in certain planes - due to the alternation of the laths within the crystals between orthoclase and alkali feldspar provided by exsolution and prompting this perthitic texture. The rock also contains quartz or nepheline ± olivine ± Ti-poor augite ± hornblende ± ilmenite ± magnetite ± apatite ± zircon ± biotite.



Larvikite

This monzonitic rock originates from Scandinavia (the Larvik Pluton Complex) that was emplaced into upper crustal Palaeozoic bedrock during the Permian period. The extrusion allowed the pluton to remain in not only dry but also within reducing conditions thus helping to limit any interaction with the country rocks. A whole tale of magmatic evolution is there to be unfolded by the geologist. (Petersen, 1978).

The Larvik complex is some 1000km2 in plan and contains at least 10 singular plutons (Peterson, 1978) and as I stand here in Derby with my hand lens against my eye I know I am looking (ridiculous?) at rock that originated deep into the earth as magma from some time way back when the Earth was a very different place. With a range of rock types depicting a variety of geological histories from around the globe it is evident that we are temporally placed to enjoy them.

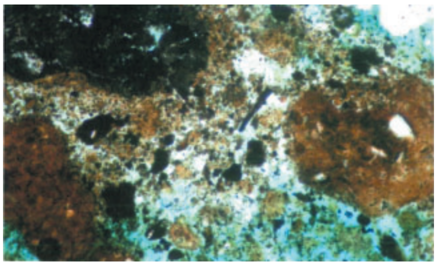
Many of those rock types are evident in Derby buildings – limestones, marbles, slates, granites, mudstones, sandstones, etc. and we would do well to remember that we are living in special times on this planet that is a usual victim of violent, harsh and extreme environments.

Rocks on display – town shopping is always exciting

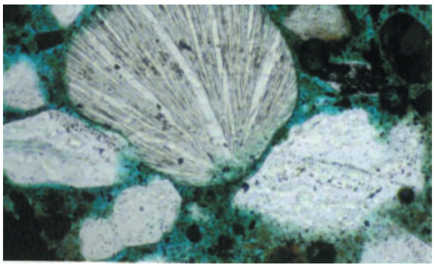
As a service CMT (Testing) Limited can offer mineralogy, petrology and petrography for natural and natural effect stones as well as concretes and other construction materials.

Petersen, J.S. (1978) Structure of the Larvikite-Lardalite complex, Oslo-Region, Norway, and its evolution. Geologischen Rundschau, 67, 330-342.

Russell Corbyn



Photomicrograph showing a typical Roman Cement clinker particle



Photomicrograph showing a gypsum filled void within a Roman Cement matrix

'ROMAN' CEMENT – SOMETHING THE ROMANS DIDN'T DO FOR US!

In essence a generic name for certain natural hydraulic binders, 'Roman' cement was used for rendering building exteriors and engineering applications in the UK and Europe in the 19th and early 20th centuries until 'replaced' by modern 'Portland type' cements after the mid 1800's. 'Roman' cements had the characteristics of short set times (usually noted in minutes, with some very short times recorded), good overall performance and durability to atmospheric effects and conditions and minimal shrinkage on hydration.

DIVINE INTERVENTION?

In the UK, the 'discovery' of 'Roman' cement is mostly attributed to the Reverend James Parker who, in the late 1700's, experimented by literally putting a rock, collected from the Isle of Sheppey locality, onto a fire. After the crude 'firing' he crushed the rock to a suitably fine powder; on adding water, he found that the 'paste' set hard in minutes. The Reverend Parker went on to patent the material using the prefix 'Roman' because it was synonymous with the sound, resilient mortars in many surviving Roman structures and had a similar yellow to red/brown colouring. Reverend Parker sold the patent which continued to run for 14 years until 1810, after which several manufactures produced such 'natural cements' in the UK (using either the term 'Roman' or their own trade name) notably on the mainland in the Whitby and Isle of Sheppey/Harwich vicinities and on the Isle of Wight where the Medina Cement Company (located on the bank of the island's main river) supplied a 'Roman' cement displaying the quick setting durable qualities described. Such cements were also produced in Europe, particularly France, Austria and Germany. The cements were not supplied as an hydrated powder as with modern materials, and were mixed on site with water and aggregates. There was significant variation in characteristics and properties including colour and setting times.
What the Reverend Parker had originally achieved was the calcination of natural concretions or nodules of limestone and clay (the latter containing silicates and aluminates) which may be found in the clay beds of particular rivers, and the production of hydraulic cement. The term calcining or calcination came into usage to describe the process by which heat is applied to solid materials in furnaces or kilns to cause thermal decomposition, reaction or removal of volatiles and is derived from the common practice of producing quicklime from limestone in this manner.

HERE AND NOW

In present times, there is an increasing need to identify the original use of 'Roman' cement and, where present, replicate the materials for the purpose of repair and refurbishment of buildings and structures. At the moment, this involves use of hydraulic lime hydrate mixed with selected aggregates with brick 'dust' included for colour. A movement is underway to begin production of 'Roman' cement and make it once more commercially available in Europe.

WHERE DOES CMT (TESTING) LTD. COME IN?

In terms of testing and analysis, the presence of original 'Roman' cement may be identified in materials via petrography and similar methods. As such cements and materials varied widely, establishing particular mix constituents and proportions will often require relevant analyses using appropriate methodologies. Here CMT (Testing) Ltd. can help by furnishing petrographic and other necessary analytical techniques to assist in resolving questions relating to original mixes and reproduction thereof.

DID YOU KNOW...

The characteristic 'heat' of chilli peppers is due to the presence of capsaicin (N-Vanillyl-8-methyl-6-(E)-noneamide !!!).

In 1912, a chemist called Wilbur Scoville devised a means of measuring the 'heat' of chillies; this involved the grinding and mixing of pure chillies with a sugar/water solution and having each blend tasted by a testing panel at increasingly diluted strengths, until the point at which corresponding solutions no longer burned the mouth. Each chilli was given a number according to the particular dilution required to reach this point. The units became known as 'Scoville units' with the 'fieriness of chillies being noted in multiples of 100 (Scoville) units. The range of 'heat' ? - basic 'bell' peppers often rate less than 1 unit, Jalapenos 2,500 to 5000, Cayenne 30,000 to 50,000 and Scotch Bonnets 100,000 to 350,000 units. The (Mexican) Habanero scores around 300,000 units with the Red Savina Habanero hitting a searing 577,000. The latter was thought to be the hottest until India came up with the Naga Jolakia at an incendiary 855,000 Scoville units!!. The Scoville test provides only a guide to 'hotness' and has been criticised. Other procedures have been used but the Scoville is still the most common and other tests often relate back to it.

By the way, if your mouth is 'on fire' due to chillies, lager, beer or water won't really do the trick. The best relief is achieved via fatty foods and dairy products – happy eating!

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