# CONSERVATION TALK

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## Slate Monument Problems

Slate was the choice of the wealthy during the 17th and 18th centuries for their tombstones. As a result, cemeteries are filled with slate tablets, especially those in the New England area. Scholars have written tomes on stylistic variations and the meaning of various carving nuances—one need go no further than the Association's own *Markers* for evidence of this interest.

What isn't so obvious is how little published research is available on the deterioration and treatment of these exceptional stones. In fact, there is far more literature available on the conservation of the lowly slate shingle than the slate gravestone (of course the former covers your head while alive and may be viewed as more immediately important). Even the relatively recent (2006) *Stone Conservation: Principles and Practice* by Alison Henry contains no discussion of slate treatments. It is a shame that more research hasn't been devoted to the slates in cemeteries.

In the simplest terms, slate is a microgranular or very fine grained metamorphic rock, formed by the recrystallization of clay sediments, often shale. The higher the temperature and/or the greater the pressure, the greater the degree of metamorphism. Slate tends to break along flat planes, called rock cleavage, and this tendency makes slate a great material for gravestones, as well as blackboards, roofing and even pool table tops. Curiously, the plate-like mineral grains in the original rocks were deposited parallel to the bedding; during metamorphism they are realigned to a new orientation at right angles to the deforming forces. This results in cleavage that is often different from traces of the original bedding.

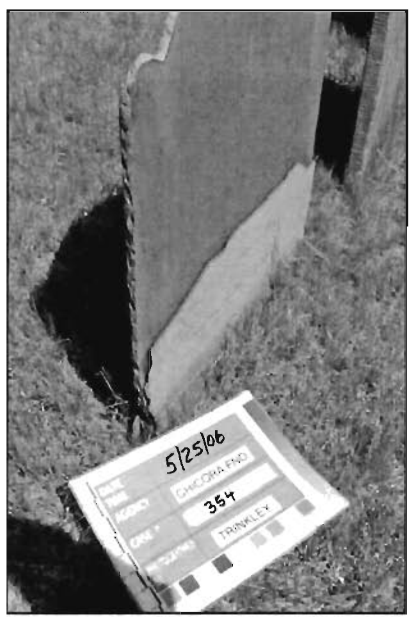
Still actively quarried in Cumbria, England, is Cumbrian slate, a product known to have been used in medieval times, although Wales was the largest historic producer of slates. Here in the United States most comes from the Slate Valley of Vermont and New York, Pennsylvania, Maryland and even Georgia.

While gray and black are the most common colors (the gray resulting from sericite and illite inclusions; the black coloring the result of carbonaceous matter such as graphite), slate may also be found in greens (chlorite and muscovite), browns (limonite) and reds (hematite), with the color dependent on the types of elements and chemicals present in the shales and clays. Color will also change as a result of weathering.

A petrographic study of the slates from Friends' Cemetery in Jamestown, Rhode Island, reveals the stones to be low-grade metamorphic rocks containing quartz, chlorite, muscovite, epidote and albite. Some slates contain pyrite, which can oxidize to produce iron sulfide. Some forms of the latter, such as pyrrhotite and marcasite, are more prone to weathering than others. The corrosion of these inclusions will cause delamination of the stone. Other slates include quantities of carbonate minerals that are found in veins or as discrete inclusions. These are subject to deterioration by atmospheric attacks. Research also shows that calcium sulfate can be formed from the presence of calcite and pyrite inclusions through repeated wetting and drying.

So what causes slate deterioration? One documented factor may be seasonal saturation and desiccation in climates with distinct wet and dry seasons. Rainwater infiltrates the stone; where clay minerals are present along cleavage traces, the rock can be hydrated, causing expansion. As the stone dries or dehydrates, there is shrinkage. Cracks develop along the cleavage planes, thus exposing the stone to additional damage.

**Example of spalling with extensive damage. Notice the leaves and vegetation in the cracks.**




**Cracking and spalling with the entire face of the slate headstone lost.**

Another factor thought to affect slate stones set vertically is frost wedging. When water freezes to ice there is an expansion of about 9%. Cycles of freezing and thawing in pre-existing cracks can cause repeated wedging, opening the crack wider and allowing even more water to penetrate.

Just as low temperatures can affect slate, so too can high temperatures through thermal expansion and contraction. Since slates tend to be dark, they absorb solar radiant heat. Studies in Arizona show that asphalt readily reaches temperatures of nearly 160°F in summer. The heated surface of the monument will expand, but slate has a relatively low coefficient of thermal conductivity, so the rock immediately beneath the surface stays cooler. This can result in cracks about 3 mm (about ⅛ inch) from the front and back of the stone.

Slate, like sandstone, may be subject to taking up salt in solution that then crystallizes, causing spalling, although this seems to be a relatively rare situation. Slate may also be affected by the growth of roots that wedge the rock apart. Moss, fungi and lichen all have potential to damage slate physically through their rhizoids, hyphae and rhizines.

Finally, slate is as susceptible to landscape maintenance as any other stone, being readily damaged by mowers, trimmers and trees.

**Tree growing into a slate headstone. Excavation and resetting a foot away is sufficient to prevent damage to both the monument and the tree.**

Treatment for various cracking problems typically requires preventing water from reaching the cracks in the stone. In the past this was accomplished by installing lead shields over their tops. Lead could be readily worked around caps, the tympanum and other features and wasn't too noticeable. It was, however, attractive to vandals and rarely stayed in place very long. There also have been efforts to fill the cracks with some sort of cementitious mortar, such as Jahn or one of the Edison Coating products, such as Custom System 45 specifically for slate. These products have good adherence, as they protect the cracks from rainfall or melting snow. Thus, they reduce penetration and any resulting damage.

**Extensive mower damage (losses along the edges) and nylon trimmer (parallel striations) damage on this otherwise beautiful stone.**

**In this case the mower ran over the slate stone hidden by tall grass. Here the remnant pieces are piled up.**

Slate, unlike marble, sandstone or even granite, is not easily drilled and can shatter unexpectedly. As a result, most repairs are performed with "simple" epoxy repairs. These seem to be more successful than marble primarily because slate doesn't sugar like marble and joints are therefore less likely to fail. But, there is anecdotal evidence that many repairs are not ground breaks and issues of support may be less significant.

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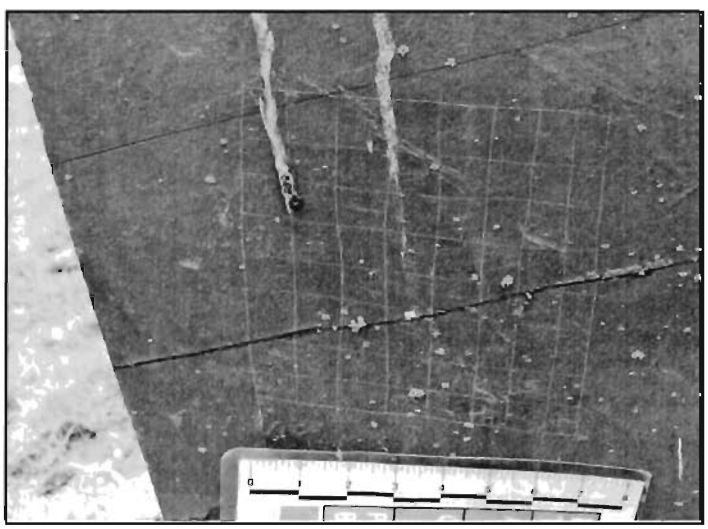
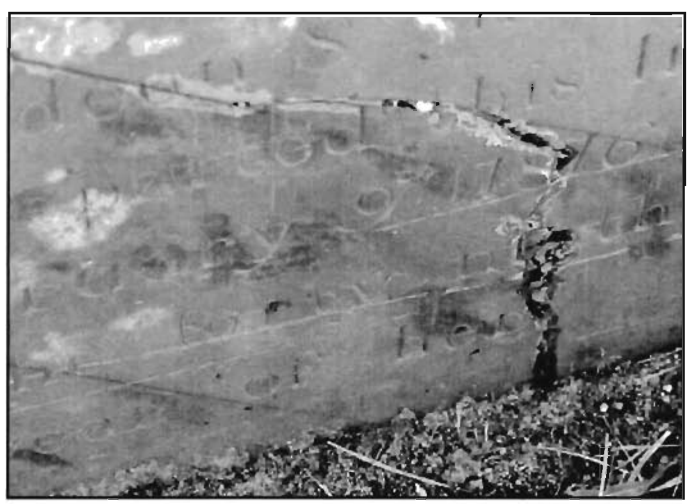
**The inscription on this stone has been completely obscured by heavy lichen growth that requires treatment with a biocide in order to allow the stone to be legible.**



**Although slate is hard, it is not immune from graffiti. Here a vandal has inscribed a checkerboard on the back of a stone.**


**Example of an old repair using ferrous straps and bolts. As these corrode, the iron jacking will begin cracking the stone causing additional damage.**

**Cracks repaired in the past using a mortar to shed water. Although not color matched, the infill has served its purpose, but is beginning to crack and requires replacement.**



**Slate repaired with an epoxy. This is a minimally acceptable repair since the epoxy was not removed from the face of the stone and no infill was added to prevent water intrusion.**