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Tech Note

Inappropriate Use and Expectations of Iron-Containing Stone

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Introduction

In recent years, the use of natural stone in new construction and landscape design has become increasingly popular. While natural stone can be a beautiful and durable part of a construction project, the mineral composition of certain stone types can create problems once the stone is exposed to weathering.

Iron-bearing minerals that impart colorful contrasts in some popular stone varieties can transform into a rusty eye-sore when featured in stone paving or some exterior facades. Iron-containing stones such as slate and flagstone are commonly used around pools and water features, and problems are occurring shortly after the stone is installed. What was once a beautiful stone patio with red and orange hues can quickly become a rusty mess that property owners refuse to live with.

Many designers and installers mistakenly believe that the tendency for such stones to degrade quickly around pools, water features or in vertical facades can be overcome by application of a water or stain repellent. **These types of conditions cannot be overcome by topically applied treatments.** The purpose of this article is to stress the need for designers, contractors, and property owners to carefully select stone for certain exposures. No topically applied water repellent is going to prevent this type of staining from occurring.

Oxidation Process

Weathering of stone is a complex interaction of physical, chemical and biological processes that alters the stone in some way. The minerals within a stone can be broken down, dissolved or converted to new minerals by a variety of processes that are either mechanical or chemical. This article discusses the chemical weathering process called oxidation, or sometimes referred to as “rusting”.

Oxidation occurs when oxygen and moisture combine with iron-bearing minerals. Oxidation is accelerated by moisture and high temperatures. It is an important process in the alteration of iron and magnesium rich minerals. From a mineralogical standpoint, iron occurs in three states: metallic, ferrous (Iron II), and ferric (Iron III). During oxidation, Iron II is converted to Iron III, which results in a color change and a weakening of the mineral structure. Ferrousmagnesian silicate minerals that go through the oxidation process are responsible for rust spots on some stones. During oxidation, an increase in volume of the mineral structure occurs, which weakens the stone and often stimulates surface scaling, increasing the stone’s vulnerability to progressive chemical and mechanical decay.

Once this decay process begins, the rate at which it accelerates in some individual stones can be alarming. To make matters worse, neighboring mortar and stones which do not exhibit high concentrations of these iron bearing minerals are often discolored by staining which washes from oxidizing stones to adjacent surfaces.

Iron often concentrates along bedding planes. Stones often are laid with the bedding plane parallel to the weather-exposed surface to maximize color variation. When you treat a face-bedded stone it’s like treating the book cover in hopes that water won’t get in around the edges to damage the underlying pages.

The stones in the below photographs look good but cannot be rendered stable when exposed to weathering extremes.

PHOTOGRAPHS

Figure 1: The above slate is high in iron content and is beginning to "bleed" a rusty stain. Some of the most dramatic colors are already ferric – they don't react well to surface treatments.

Figure 2: A closer look at the rusting of the same slate around the pool.

PHOTOGRAPHS (cont.)

Figure 3: Iron-containing slate after oxidation.

PHOTOMICROGRAPH

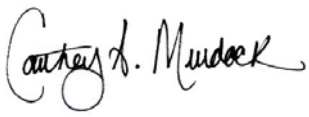
Figure 4: Oxidized pyrite (iron sulfide) grains generating a film of iron oxide on quartz grains. Note the rusty pigmentation near the weathered surface (top), but not deeper (bottom).

Why Topical Water Repellents Won't Help

Though topically applied water repellents will reduce the rate of oxidation caused by rain or splashed water that penetrates the surface of un-protected stones, water repellents cannot prevent penetration of standing water. More significantly, topically applied water repellents cannot prevent water from collecting beneath the stone, or the movement of water vapor through the stone as evaporation occurs through the exposed surface.

Anyone that has walked barefoot across a sunlit paved surface knows that it is not unusual for stone pavers to achieve surface temperatures in excess of 150°F. Temperatures on the back side of those same pavers, however, are substantially lower and often accompanied by direct contact with moist soil, gravel, concrete or setting mortars. Temperature and humidity gradients through the thickness of the stone causes liquid water and water vapor to migrate to the exposed stone surface. Unfortunately, as water passes through the stone and encounters reactive iron-bearing minerals, oxidation occurs. The result is unsightly rust stains and progressive surface scaling – in spite of whatever protective treatments may have been applied to the exposed surface.

Iron-containing natural stone will "rust" at some point no matter what treatment is topically applied. It is important for industry professionals to make designers and property owners aware of this issue prior to stone selection in order to prevent unhappy customers.



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