Calcium Scale

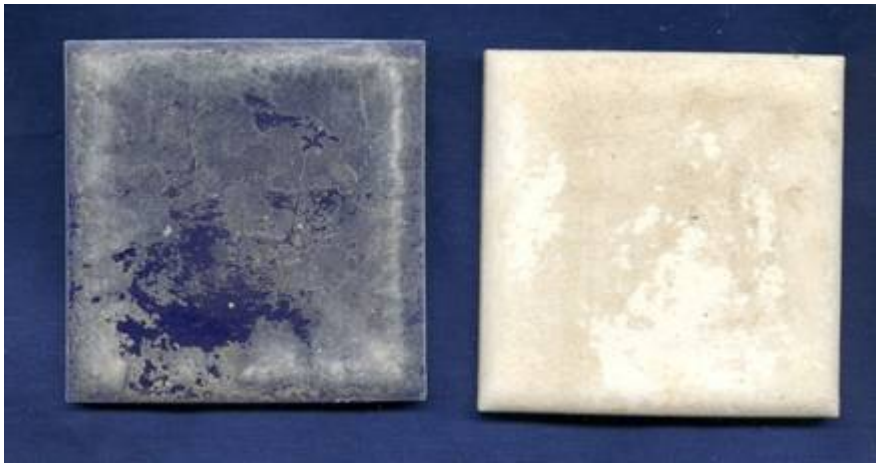
A series of e-mail articles from the research group onBalance, June 2006

Calcium Scale Update #1

When calcium ions in pool water precipitate onto tile and interior pool surfaces as a solid white crust or crystal, the most common form of precipitate is calcium carbonate ($CaCO_3$), commonly referred to in the trade as “scale”.

Calcium Carbonate scale has some specific, known characteristics, such as being soluble in acid, having a value of 3 on the Mohs hardness scale (with 0 being the softest – such as talc, and 10 being the hardest, such as diamonds).

Calcium Carbonate scale is generally relatively uniform is its deposit pattern, although a certain amount of it will concentrate at the waterline as an evaporate.



Calcium scale that deposited over a long period of time (in what we would refer to as a “natural” process) tends to be smooth and low in profile, influenced in patterning by flow and/or porosity of the surface it precipitates onto, and colored by incorporated dirt or other suspended water impurities (see tile samples above). Calcium scale that deposits in a short period of time (usually through an environment trigger such as high temperature, high pH, high alkalinity and calcium, etc.) tends to be totally uniform in deposition, pure white, with sharp defined crystals:

Calcium Scale Update #2
An interesting (although fortunately not too common) variation to calcium carbonate precipitation is the precipitation of ***calcium sulfate***. Calcium sulfate is chemically designated $CaSO_4$, and is commonly called gypsum.

If an appreciable amount of ***sulfate*** is found in pool water, it can combine with calcium (if also high in content) in the water and form a crystalline deposit. Sulfate can be introduced as a component of treatment chemicals. These treatment chemicals can include one type of liquid pool acid (sulfamic acid), dry granule acid (sodium bisulfate), dechlorinators (sodium sulfite and sodium thiosulfate), and even non-chlorine shocks (such as persulfates).

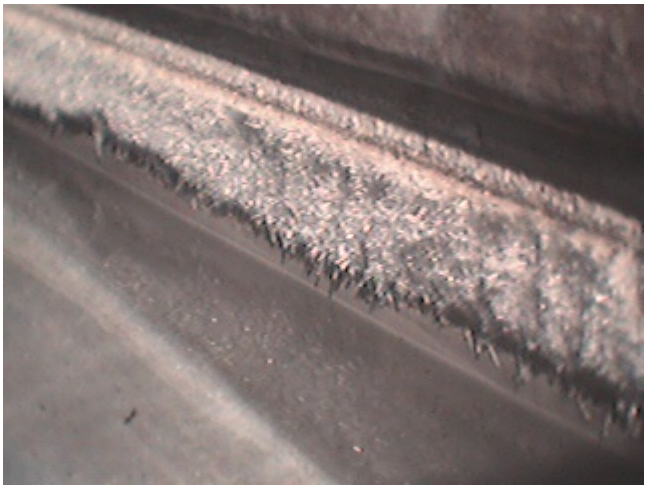
Occasionally in some isolated parts of the country, high amounts of sulfate may be present in tap water, generally from well or ground water.

Calcium sulfate crystals which form as evaporates in pools are distinctive and different from calcium carbonate precipitates in several key ways. They are softer (only 2 on the Mohs scale), soluble in acid only if that acid is at boiling temperatures, and are in what is called a swallowtail crystal formation.

Here is a pool with tile covered in calcium sulfate crystals:

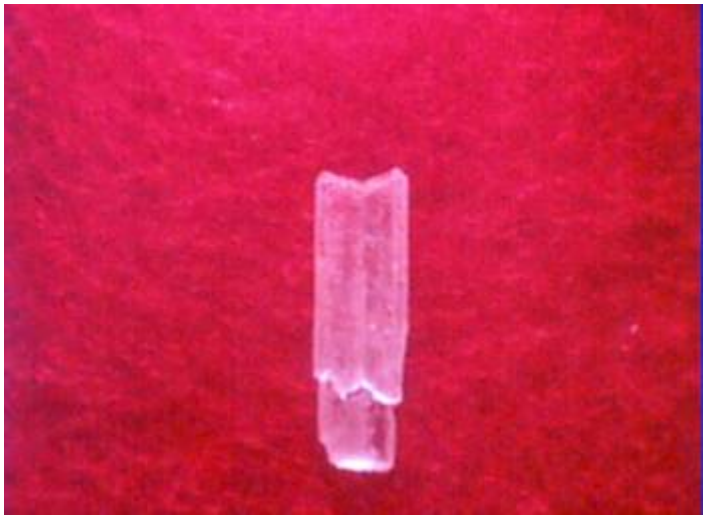
You can see that the tile is almost totally obscured by the deposited crystals, but the grey plaster underwater is not.

Here is a close-up of that tile:



Calcium Scale Update #3

In a previous update we mentioned that calcium sulfate is in the form of swallowtail crystals, and that these crystals are softer than carbonate. Here is a close-up of the crystals from the pool, showing the distinctive swallowtail shape:



Fingernails have a Mohs hardness of 2.5, while calcium sulfate is 2 and calcium carbonate is 3. Here is a calcium sulfate crystal that has been scratched on the side with a fingernail to show that the crystal is softer than the nail:

Calcium Scale Update #4

We also previously mentioned that “room temperature” acid will dissolve calcium carbonate, but not calcium sulfate… but that heated (boiling) acid will dissolve the sulfate crystals. Here is a picture sequence showing us sanding some of the sulfate deposition layer off the top step:

We then poured (non-heated) acid on the sulfate deposit near the sanded area, getting no reaction:

But when the acid hit the bare plaster, which contains calcium carbonate, it reacted, in the form of white effervescence:

We don’t have pictures of using the boiling acid, because we were too busy trying not to breathe the fumes… but it worked!

Calcium Scale Update #5

This pool was located near a mountain mine, where the well-pumped source water had sulfate in it. Since that water was also high in both calcium and alkalinity, the regular use of dry acid also contributed to the problem.

The homeowner chose to resurface his pool with an exposed aggregate finish, so we didn’t do a boiling acid wash on the entire pool. This condition is also relatively rare, so you may never see one with calcium sulfate deposits. But now, if you do, you’ll know what you are looking at!