



Conserve O Gram

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Soluble Salts And Deterioration Of Archeological Materials

Porous archeological artifacts such as ceramics, stone, bone, and ivory often contain soluble salts. Ground water and seawater can carry these salts into the pores of the artifact during burial leaving them behind when the water evaporates. After excavation, these salts can crystallize at or just below the surface of the artifact causing damage. A variety of descriptive terms are used for this damage including spalling, flaking, powdering, and sugaring. Identification may be difficult if this damage is done to the painted, polished or slipped surface of an object. The force of growing crystals can break apart the surface of bone, stone, ceramics and other porous materials so that detail is lost. In bad cases it can remove the entire surface of an artifact. In the worst cases, it can destroy an artifact. This *Conserve O Gram* will help you identify salts and discuss treatments and storage alternatives.

Soluble Salts and Insoluble Salts

Conservators divide the salts that are deposited in and on an artifact during burial into two groups: insoluble salts and soluble salts. Soluble salts will dissolve in moisture in the air. This property is known as deliquescence. The salts can move through the porous structure of an artifact as moisture is drawn out through evaporation. As the salts reach the surface of the artifact they may crystallize as white, often furry growths on the surface. If the surface is less porous than the underlying structure they can crystallize just below the surface. These crystals exert immense pressure and may cause the surface layer to spall off.

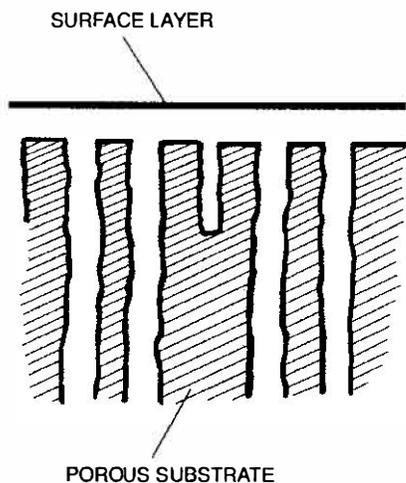


Figure 1. Sketch of a porous object with undamaged surface layer.

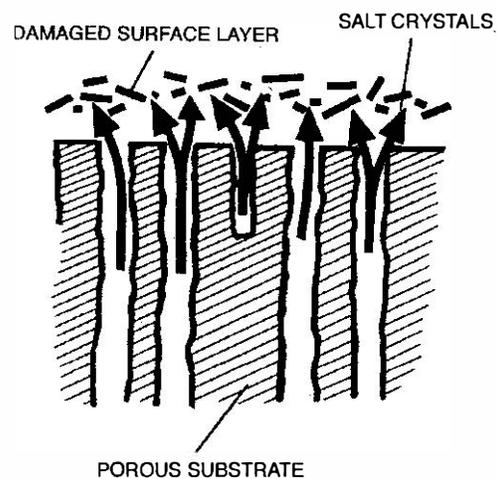


Figure 2. Damage caused when salt drawn out of pores crystallizes and pushes off the surface layer.

“Insoluble” salts are not truly insoluble but will take days or weeks to dissolve in water. They are not deliquescent and so will not cause further damage after excavation. Insoluble salts can, however, be quite disfiguring, and may require removal for identification or reconstruction of an artifact. Common salts are listed in Table 1.

<i>Soluble Salts</i>	<i>Insoluble Salts</i>
Chlorides	Carbonates
Nitrates	Sulphides
Sulfates	Phosphates

Table 1. Common salts affecting porous materials from archeological sites

Soluble salts can also be deposited into artifacts through past conservation treatments, including “acid cleaning.” In this process, objects are dipped in a dilute acid solution to remove insoluble salt deposits from the surface of ceramics. The acid changes them into a form that is water-soluble. The soluble salts can then penetrate into the porous body of the artifact and later recrystallize on or under the surface as described above. Acid residues may also react with the artifact causing crystal growth.

Identifying Salts

Soluble salts are visible as a white growth on the surface of an artifact. In newly excavated material, they often form first along cracks or abraded areas of a surface. Often they can look like a white bloom or haze on the surface. As the crystals continue to grow and form they will extend further from the surface and appear as a white powder or even look somewhat like table salt. They may have a soft, fuzzy feel if touched.

If the soluble salts have grown in storage, they are often first noticed when powder and small fragments are seen on the shelf around the artifact. They may show up more clearly if viewed with raking light (light shining at a low angle from the side). If the crystal growth has taken place undisturbed for a long time, they can

be visible as tall fibers extending up from the surface.

In contrast, insoluble salts usually have a lumpy, uneven appearance that contains contaminants from the surrounding soil. They may be laid down in long lines following root growth. They may obscure the whole surface of the artifact. They are usually hard. Since they usually have been deposited underground they often incorporate sand grains or small pebbles and may have a “muddy” appearance. These salts will not dissolve in atmospheric moisture, and will not cause any further deterioration over time. Insoluble salts are also known informally as “caliche” and “marl.”

Salts can also form on artifacts due to reaction with storage materials. Acids released from woods and paints, among other things, can react with components of the artifacts causing crystal growth.

In order to identify the salts conservators use analytical methods such as spot tests or x-ray diffraction. Identification of salts can help pinpoint whether a problem comes from previous treatment or improper storage.

Traditional Treatment for Soluble Salts

There are problems with the traditional technique for removing soluble salts. However, no good alternatives have been developed so conservators and archeologists still commonly use this technique. Many artifacts that come into collections or that are housed in collections now may have gone through the soaking treatment described below.

The method is described here to identify the problems with this technique. Any treatment will cause changes to archeological objects that may limit their usefulness for analysis in the future. Conservators typically weigh the drawbacks of any treatment against the likelihood of physical deterioration of the object if no treatment is done.

The best course of action may be to not desalinate at all.

To remove soluble salts from artifacts the traditional technique has been to soak the artifact in water. This technique is not appropriate for artifacts with fragile surfaces. A typical treatment is carried out as follows:

1. The artifact is immersed in a known volume of deionized or distilled water and left to soak.
2. After a set amount of time, typically 24 hours, the salt level is measured using the silver nitrate test (see *Conserve O Gram 6/3*) or a conductivity meter to identify the levels of salt that have been removed from the ceramic.
3. The old water is discarded and clean water is replaced to the same level as before.
4. These steps are continued until the amount of measured salt has leveled off or reached a low level.

There are several problems with this technique.

- Desalination can take many days or even weeks. Soaking for days can remove components of the original ceramic or stone, use residues, or organic and inorganic constituents of bone. This can affect the usefulness of these materials for analyses in the future and can structurally weaken the artifact.
- There is no generally agreed upon standard for what level of salt removal is enough. No one knows how much salt in an artifact is necessary to cause damage and the level may vary from object to object. Recent studies suggest that what have typically been considered to be “safe” levels may be drastically lower than necessary. This level is

- probably dependent on many factors, including the exact types of salts present, the porosity of the object and the environmental conditions in which the object is to be kept.
- It may take gallons of deionized or distilled water to desalinate an artifact if this treatment is carried out in the field. Clean water can be hard to acquire in a field lab.

Museum Storage for Objects Containing Soluble Salts

In a museum context, inorganic materials like ceramics, bone, or stone are often considered hardier than wooden or textile objects. However, because of the contaminants introduced during burial, porous, inorganic, archeological objects also require environmentally controlled storage.

Soluble salts from burial or previous treatment can be controlled through storage in a stable relative humidity. Fluctuations in RH can move the deliquescent salts in and out of solution, which draws the salts up through the pores of the artifact. At a high RH they will be dissolved. When the RH drops they will crystallize. To limit salt movement, keep the RH stable.

If active deterioration is found on objects in storage a conservator should be contacted. Actively deteriorating objects will have fragile surfaces. Salts may be seen as a white “bloom” or as crystals. Small fragments of material may litter the surface around the object.

To stop salt deterioration, once it has begun, consult with a conservator who will help you develop a preservation strategy that takes into account the material and the storage environment. There are a variety of preventive or interventive techniques that may be appropriate. These include improving the storage environment, creating stable RH microenvironments, or treatment, depending on the particular situation.

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