TECHNICIAN TRAINING FOR THE CONSERVATION OF MOSAICS

PART 1
THE CONSERVATION OF IN SITU MOSAICS

Conservation mortars for in situ mosaics: their components

Livia Alberti, Ermanno Carbonara, Thomas Roby
Mortars

A mortar is the combination of a binder (lime, etc.), aggregates (sand, gravel, etc.) and the appropriate quantity of water.

This mixture is used while still soft and malleable, and fulfills its structural function when it sets and becomes hard.
Binders

A binder is a material that keeps aggregates together when the mortar is set and has become hard. Binders can be divided in two categories:

- **NON-HYDRAULIC** binders
- **HYDRAULIC** binders

A non-hydraulic binder needs to be in contact with air to set, whereas a hydraulic binder sets predominantly when in contact with water.
## Binders

<table>
<thead>
<tr>
<th>NON-HYDRAULIC</th>
<th>HYDRAULIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Lime putty (paste)</td>
<td>• Natural hydraulic lime (powder)</td>
</tr>
<tr>
<td>• Hydrated lime (powder)</td>
<td>• Cements and artificial hydraulic limes (powder)</td>
</tr>
</tbody>
</table>
### Binders

<table>
<thead>
<tr>
<th>NON-HYDRAULIC</th>
<th>HYDRAULIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lime putty (paste)</td>
<td>Natural hydraulic lime (powder)</td>
</tr>
<tr>
<td>Hydrated lime (powder)</td>
<td>Cements and artificial hydraulic limes (powder)</td>
</tr>
</tbody>
</table>
### Binders

#### NON-HYDRAULIC
- Lime putty (paste)
- Hydrated lime (powder)

#### HYDRAULIC
- Natural hydraulic lime (powder)
- Cements and artificial hydraulic limes (powder)
### Binders

<table>
<thead>
<tr>
<th>NON-HYDRAULIC</th>
<th>HYDRAULIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Lime putty (paste)</td>
<td>- Natural hydraulic lime (powder)</td>
</tr>
<tr>
<td>- Hydrated lime (powder)</td>
<td>- Cements and artificial hydraulic limes (powder)</td>
</tr>
</tbody>
</table>

Artificial hydraulic lime
<table>
<thead>
<tr>
<th>Binders</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NON-HYDRAULIC</strong></td>
</tr>
<tr>
<td>• Lime putty (paste)</td>
</tr>
<tr>
<td>• Hydrated lime (powder)</td>
</tr>
</tbody>
</table>
NON-HYDRAULIC binders

Lime putty (paste)
Lime cycle
Basin for slaking and aging the lime putty
HYDRAULIC binders

Natural hydraulic lime (NHL) (powder)
Limestone containing siliceous components

Burning in industrial kilns

Natural hydraulic lime (NHL)
Storage of natural hydraulic lime
Aggregates

Aggregates make up the skeleton of the mortar; their hardness contributes to its strength, and they help decrease mortar shrinkage during setting. Aggregates can be divided into two main categories:

- **INERT aggregates**
- **aggregates giving HYDRAULIC properties to the mortar**

Inert aggregates do not react chemically with the binder. Aggregates giving hydraulic properties to the mortar have the capacity to react chemically with the binder and can significantly improve the hydraulic setting of the mortar.
## Aggregates

<table>
<thead>
<tr>
<th>INERT aggregates</th>
<th>Aggregates giving HYDRAULIC properties to a mortar</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Sand</td>
<td>• Fired clay</td>
</tr>
<tr>
<td>• Gravel</td>
<td>• Volcanic earths and rocks</td>
</tr>
</tbody>
</table>

### Quarries

- Ermanno Carbonara 2019 © J. Paul Getty Trust
- Ermanno Carbonara 2017 © J. Paul Getty Trust
## Aggregates

<table>
<thead>
<tr>
<th>INERT aggregates</th>
<th>Aggregates giving HYDRAULIC properties to a mortar</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Sand</td>
<td>• Fired clay</td>
</tr>
<tr>
<td>• Gravel</td>
<td>• Volcanic earths and rocks</td>
</tr>
</tbody>
</table>

### Quarries

![Quarry Image]

- **Ermanno Carbonara 2013 © J. Paul Getty Trust**
- **Livia Alberti 2007 © J. Paul Getty Trust**
- **Ermanno Carbonara 2012 © J. Paul Getty Trust**
<table>
<thead>
<tr>
<th>INERT aggregates</th>
<th>Aggregates giving HYDRAULIC properties to a mortar</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Sand</td>
<td>• Fired clay</td>
</tr>
<tr>
<td>• Gravel</td>
<td>• Volcanic earths and rocks</td>
</tr>
</tbody>
</table>

Preparation and firing of bricks
### Aggregates

<table>
<thead>
<tr>
<th>INERT aggregates</th>
<th>Aggregates giving <strong>HYDRAULIC</strong> properties to a mortar</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Sand</td>
<td>• Fired clay</td>
</tr>
<tr>
<td>• Gravel</td>
<td>• Volcanic earths and rocks</td>
</tr>
</tbody>
</table>

---

**Formation**

![Volcano erupting](https://via.placeholder.com/150)

**Quarry**

![Quarry scene](https://via.placeholder.com/150)

**Aggregates**

![Aggregates](https://via.placeholder.com/150)
Preparation and storage of aggregates
Storage

Aggregate depot
Crushing

Mechanical crushing
Crushing

Manual crushing
Sieving

Mechanical sieving
Sieving

Manual sieving
Sieving

Sieving of aggregates in several fractions
Cleaning
Protective gear

- Rubber gloves
- Single-use gloves
- Paper dust masks
- Safety glasses
- Small mats
MOSAIKON is a partnership of four institutions: the Getty Conservation Institute, the Getty Foundation, ICCROM, and ICCM. The aims of the project are to strengthen the network of professionals concerned with the conservation, restoration, maintenance, and management of mosaic heritage in the southern and eastern Mediterranean region; provide training to a variety of individuals involved in mosaics conservation and, more generally, with the management of archaeological sites and museums with mosaics; work with national and international bodies to provide a more favorable legislative, regulatory, and economic environment for the conservation of mosaics in the Mediterranean; and promote the dissemination and exchange of information.