The **conservation project** of the **Temple of Quetzalcoatl**

The Temple of Quetzalcoatl is one of the most representative buildings of the archaeological site of Teotihuacan, due to its monumentality and its delicate decoration, consisting on the undulating body of the Feathered Serpent on the panels and the large heads of Quetzalcoatl and Cipactli. Furthermore, the façade decoration is completed with representations of aquatic beings, such as seashells, and elements that refer to the jaguar.

The recent history of this monumental building began with its excavation in 1917. At this moment the displaced pieces were placed in its original position and the complete structure was consolidated with cement mortar, according to the criteria of the age. Since it became exposed to weathering again, it started to suffer decay. Therefore restoration interventions were conducted during the 1960s.

What we know nowadays but was unknown at the moment, is that cement mortar, as well as the treatments applied during the mid-twentieth century, caused serious decay to archaeological buildings. These damages were more visible at the beginning of this millennium. Therefore, in 2003 Rogelio Rivero Chong, restorer and Chief of the Department of Catalogue and Restoration of the Archaeological Site of Teotihuacan, considered the urgency to conduct an integral conservation project of the temple to stop its problems. The intention was to create a field laboratory for the analysis and monitoring of the building.

In 2004 Rogelio Rivero made an application to the World Monuments Fund (WMF) to request financial support for the project, which was drafted in collaboration with the National Coordination for Conservation of Cultural Heritage (CNCPC) of the National Institute of Anthropology and History (INAH). Three stages were included in this project:
- Emergency interventions
- Evaluation, research, diagnosis and intervention of the sculptural elements
- Monitoring, evaluation and maintenance plan

The first contribution from the World Monuments Fund arrived in 2006. This financial support, in addition to INAH resources, allowed to expand the research and the documentation process. Conservation treatments were discussed and agreed interdisciplinarily with professionals from various fields. These interventions, led by Rogelio Rivero Chong, were aimed at addressing the detected causes of decay, using compatible and reversible materials.

The project of the Temple of the Quetzalcoatl allowed us to learn more about the constructive system of Teotihuacan, its materials and technology. Furthermore, the support from WMF brought the opportunity to carry out an intervention along three lines of action: urgent conservation, preventive conservation and direct conservation.
In this small exhibition we hope to have shared some of this knowledge: how it was constructed, how it deteriorates and how a pyramid like the one of Quetzalcoatl was restored.

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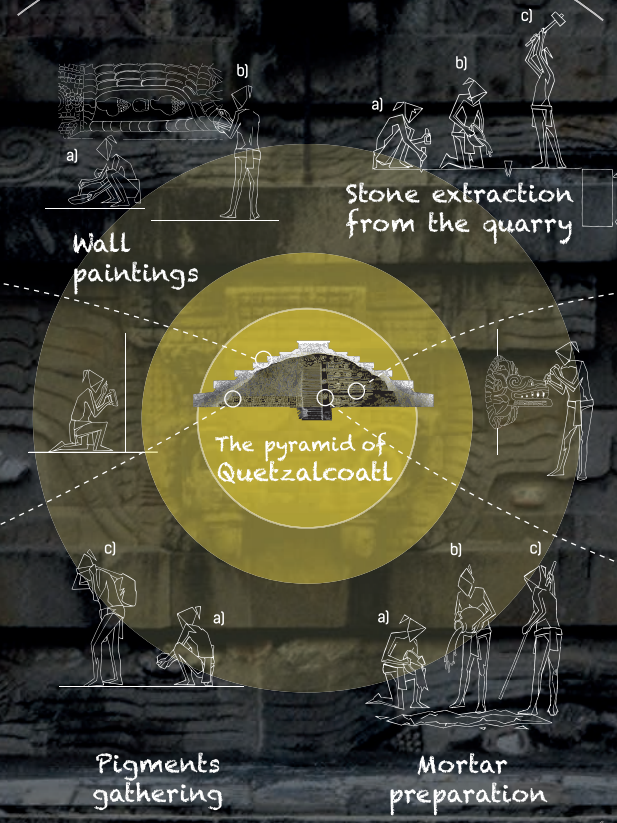
How was a pyramid such as Quetzalcoatl built?



1

The pyramid is covered with stone blocks called **ashlars** which were extracted from the quarry.

a) The first step was to **open a groove on the stone**. Afterwards, wooden wedges were hammered into the groove.

b) The **wooden wedges** were then wet with water to make the wood expand, thus exerting pressure on the stone.

c) Finally, the **wedges were** hit to break the stone and split the block.

d) Once split off, the **block was honed** to remove uneven areas.

2

Sculpting stone decoration

The stone figures **were sculpted with tools made from harder stones**.
At the end, the surface was smoothened with sand.
The heads had obsidian pieces to simulate the eyes. They were burnished until a mirror-like brightness was obtained, which made them sparkle with the sunlight.

Colors were directly applied on the stone.
The most common pigments used in Teotihuacan were:

Red: iron oxide

White: calcium carbonate

Green: malachite (copper carbonate hydroxide)

3

Mortar is a mixture of lime, water and sand that was **used for the construction** of floors and horizontal surfaces of the temple:

a) Sand or other aggregates are collected. Later, lime is added to the mix.

b) Lime chemically reacts with water.

c) After blending and once dried, lime reacts again with carbon dioxide from the air to cure (harden) the mix.

The structure is **protected** by a **mortar layer**

Plaster: layer or fine mortar to protect the building

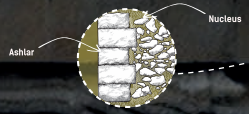
Ashlar: outer stone blocks (facing) of the pyramid

4

Different earth pigments were extracted from mineral deposits **to paint the building**.

a) First, the proper earths or minerals were selected. Later, they were ground down to obtain smaller particle sizes.

b) They were finally transported to the site and mixed with organic binders in order to be applied as paints.



Based on the archaeological research, the pyramid was built with a **rough nucleus** covered with sculpted stones

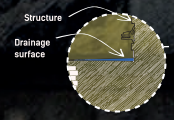
Ashlar: external stone blocks (facing) with sculpted faces

Nucleus: irregular stones and mud inside

5

Plaster

Buildings in the past were **plastered**, that is, they were covered with a layer or fine mortar to protect them.
The plaster is a mortar made with sand or other aggregates, which was applied with a **trowel** to produce a **flat surface**.



Architectural surfaces were prepared to **drain** rainwater away from the structure

Structure: external surface of the pyramid

Drainage surface: sloping pavement that was built to expel water

6

Once plastered, the surface was decorated with natural pigments:

a) Pigments were prepared by **grinding** minerals in a **harder stone bowl**, in order to obtain a fine powder.

b) Colors were applied with different types of **brushes**, mixing pigments with organic binders.

What happened to the pyramid?

The pyramid of Quetzalcoatl has been **exposed to weathering factors** from the environment since the moment of the excavation, due to the **loss of its original protection** (coating) throughout time.

Wind

It transports **particles that hit the surface** and abrade building materials.

Rain

It falls over the building and **penetrates the building.**

Sun

Its heat produces **thermal tensions.**

Dew

It forms every morning and **wets surfaces.**

Humans

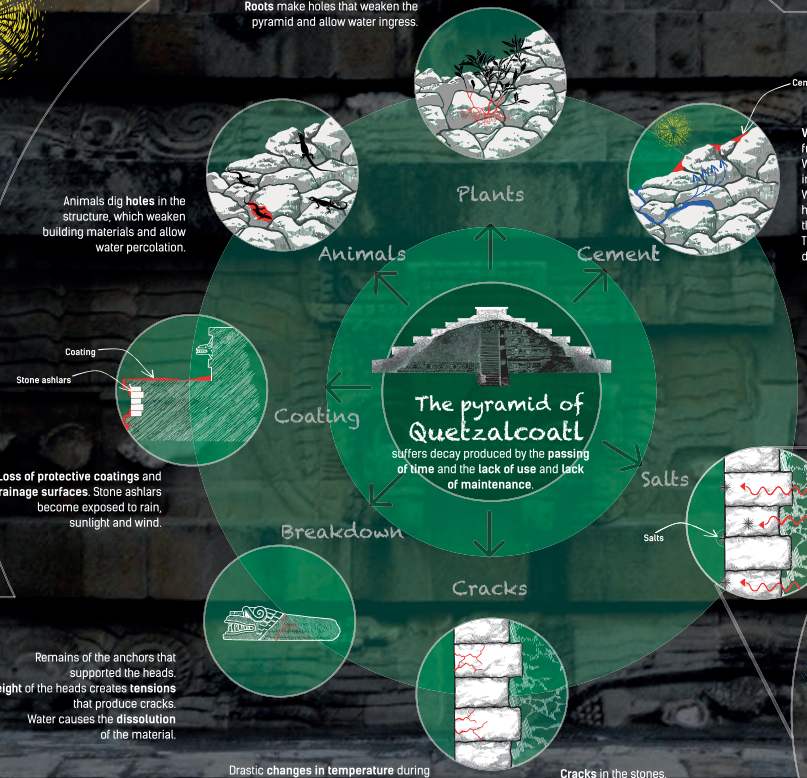
They may **alter** the structure, on occasion producing damage.

Animals and plants

Animals: they **nest** inside the structure.
Plants: they **grow** on the building.

Capillarity

Groundwater **rises from the soil** and foundations up to the inner structure.



Plant growth.
Roots make holes that weaken the pyramid and allow water ingress.

Animals dig **holes** in the structure, which weaken building materials and allow water percolation.

Water-proof layer of cement mortar from previous interventions.
When the layer breaks it allows water inside the pyramid.
Water tries to evaporate when the sun heats the surface, getting trapped inside the impervious cement layer.
The cement mortar is also a source of damaging salts.

Coating
Stone ashlars

Loss of protective coatings and **drainage surfaces**. Stone ashlars become exposed to rain, sunlight and wind.

Remains of the anchors that supported the heads.
The **weight** of the heads creates **tensions** that produce cracks.
Water causes the **dissolution** of the material.

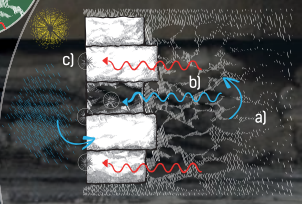
Drastic **changes in temperature** during day and night affect the stones, producing subtle changes of volume that **micro-crack** the material.
As time passes, micro-cracks become larger until **fractures** are produced

Cracks in the stones.
Salt crystallization affects the surface of the stone by disintegrating the material.
The water inside the building freeze when the temperature drops below 0°C.
While **freezing**, ice increases its volume, creating small cracks in the stones.

DOCUMENTATION, RESEARCH AND DIAGNOSIS

- **Graphic and photographic survey** (drawings and photography)
- **Drawings and 3D model** (architectural survey)
  Decay mapping (identification and location of damage)
- **Ground-penetrating radar and magnetometry** (identification of different materials inside the pyramid by means of electromagnetic radiation)
- **Archival research** (previous works study)
- **Petrography, X-ray diffraction, optical microscopy and scanning electron microscopy** (micro-chemical analysis, salts, pigments and stone materials identification)

MICROSCOPIC PROCESSES



Stone deterioration depends on the stone composition and texture. In the pyramid we can find two main different types of decay: granular and laminar.

Salts

Water is the **most damaging agent** that affects the pyramid. It produces dissolution of materials and salt crystallization:

a)
Water inside the pyramid **dissolves salts** from both original and conservation materials, such as cement.

b)
Once dissolved in water, salts **migrate** to the surface.

c)
Sun heat promotes the **evaporation** of water, causing salts **crystallization** on the surface.

d)
Salt **crystals** produce three effects:
1. **Stains** on the stones.
2. **Whitish saline veils** that cover the stone surface.
3. Salts **increase their volume**, exerting pressure inside the stone pores and creating micro-cracks. This process slowly produces the disaggregation of stones.

How was the pyramid restored?

Every problem of the pyramid was treated with a different strategy to stop the decay.

Plants removal

Plants growing on the surface were removed and holes **refilled** with lime mortar to avoid water penetration.

Holes

Holes that allow **ingress of water** were **filled** with lime mortar.

Cement removal

Cement mortar was removed and holes were refilled to recover the water-shedding surface in order to avoid water accumulation and seepage into the pyramid.

Consolidation

The surface was limewashed where it was **disintegrated** in order to consolidate the loose particles.

Salts removal

Salts on the surface forming stains or whitish saline veils were removed using "**paper pulp poultices**". This is an absorbent material impregnated with distilled water that **attracts salts** removing them from the surface.

Borders protection

Plasters borders were protected with **lime mortar edgings** in order to avoid water seepage.

Sacrificial layers

"**Sacrificial layers**" were applied where salts had started to disintegrate the stone surface. These layers are lime mortar replacements that cover the original surface, accepting the crystallization and thus protecting the original material.
The sacrificial layer is periodically replaced, thus preventing stone deterioration.

Injections

Plaster detachments were treated with **lime injections.**

Restored volumes

Volumes are restored with new lime mortar where figures were lost. These restitutions allow to understand the original shape and they also work as "**sacrificial layers**".

Water drainage

Missing parts of the sloping pavement were replaced in order to allow water drainage.

Drainage

Drains were made to avoid water accumulation under the pyramid and, consequently, water rising by capillarity. Drains are underground **channels** that drive water outside the building area, avoiding water accumulation under the structure.

Handrail

A new **handrail for public protection** was installed and the deteriorated old one was removed.

Substitution

Cracked stones compromising the stability of the structure were **replaced** with new ones made of a similar material.

Rods

Some of the heads were cracked and they were reinforced by the insertion of metal **rods** to avoid breakdown and collapse.