COPPER BASED PIGMENT ALTERATION FROM DIAGUITA CULTURE

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STUDY

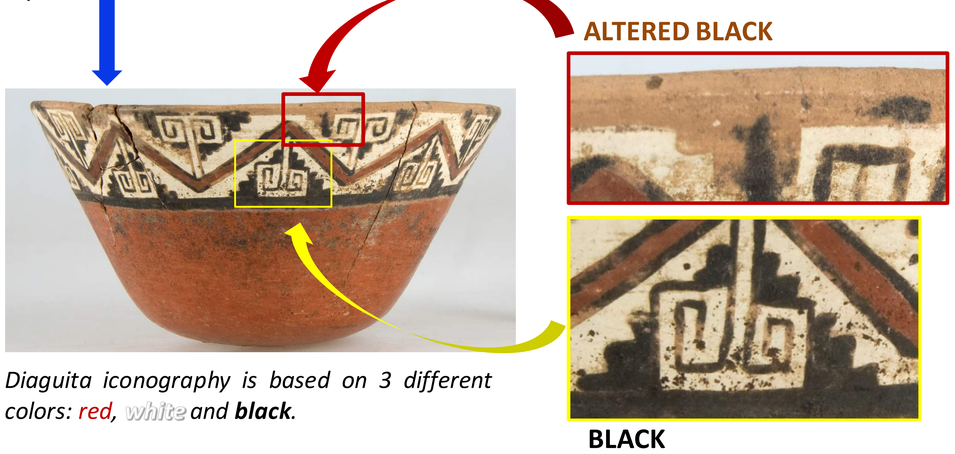
Pottery vessels from the Chilean Diaguita Culture show alteration of the **black** paint that was used for its decoration. Loss of cohesion, change in color from an intense **black**, to a **reddish brown**/**greenish brown** layer, and modification in composition account for this alteration.

WHERE

The Diaguita Culture occupied N-central Chile and NW Argentina (900-1536A.D.) In Chile they inhabited 5 valleys: Copiapó, Huasco, Choapa, Elquí and Limarí

WHAT WE WORKED WITH

- Raw pigment from archaeological sites of El Olivar (white and **red**) and Ovalle (**green**)
- Potteries with iconography that present the **black** and **altered black** paint



*Diaguita iconography is based on 3 different colors: red, white and **black**.*

ANALYSIS

Espectrocolorimetry
X-ray fluorescence and EDS: C, O, Na, Mg, Al, Si, P, S, Cl, K, Ca, Ti, Mn, Fe, Ni, Cu, Ba
X-ray diffraction: paint and raw pigment
Cross section: paint differenciation and firing process

Bowl, Diaguita Phase I. La Serena Archaeological Museum

atacamite, $Cu_2Cl(OH)_3$
antlerite, $Cu_3(SO_4)(OH)_4$
quartz, SiO_2
alunite, $K(Al_3(SO_4)_2(OH)_6)$

THE GREEN ISSUE

Cu minerals are the major components for this **green** pigment. **BUT** green is **NOT** part of the Diaguita iconography. **HOWEVER** one pottery showed a rare partial **green** paint in combination with **black** on its surface. Surprisingly, mineral associations of the **green** paint and the raw pigment are basically the same.

THE BLACK ISSUE

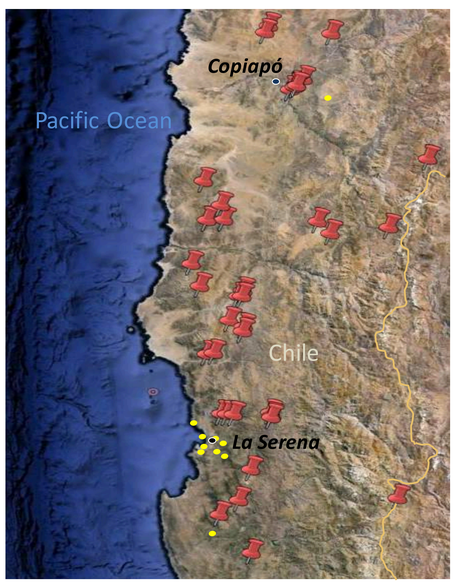
Cu is the major component of the **black** paint mainly as **tenorite** (**CuO**) and with lesser Fe, as hematite (Fe_2O_3). **Tenorite** may be the primary source of **black** for the Diaguita iconography. **BUT tenorite** has not yet been found as pigment in archaeological sites. In Andean prehistoric cultures C, Mn and Fe minerals are the primary sources of **black**, **NOT tenorite**. 2 origins are proposed for its presence: **NATURAL** or **MANUFACTURED**

NATURAL

It occurs in oxidized zone of primary copper sulfide deposits. Chili is the world leader in Copper production. It has a long pre-hispanic mining tradition. Copper deposits containing **tenorite** are present In the Diaguita territory.

CONSIDERATIONS

- Making pigments is linked to metallurgy (1). The Diaguita metalwork is well represented with a preference for **Cu** and **Cu** alloy ornamental objects and tools. It is assumed to be of local origin (2)
- Exchange of goods could also provide primary material
- **Tenorite** can form in certain alkaline conditions over other **Cu** compounds (3)



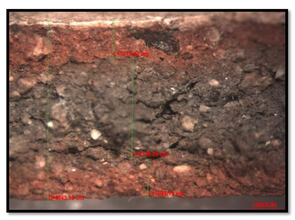
Modern Cu deposits in Diaguita territory. Archaeological sites are in yellow dots.

MANUFACTURED

Most **Cu** minerals can transform to **tenorite** when heated in air, like **malachite**, **azurite** (4) **atacamite**, **antlerite**, **cuprite**, chalcosite. Temperature varies. These minerals occur within the study area.

CONSIDERATIONS

- **Tenorite** pigment could be prepared first, then used as a **black** paint **OR** transformed during heating
- **Atacamite** could provide material for the formation of the **black tenorite** via firing process. What would be the necesary quantity of pigment for coloring?
- Firing process is important. Some Andean cultures did not heat the **black** and **red** paint on their potteries. Numerous Diaguita potteries show an incomplete oxidation process during firing



Incomplete oxidation during firing. Zoomorphological bowl. Diaguita Phase II. Limarí Museum

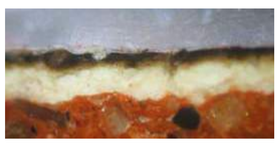
SOME THINGS TO THINK ABOUT

- The use of **tenorite** as **black** pigment could differenciate Diaguita from their neighbors.
- Could the Diaguita have ingeniously heated **atacamite** or **cuprite**, and endup with black **tenorite**?
- Study of paste and coloring layers in microscope (SEM) will give more information on firing and alteration processes

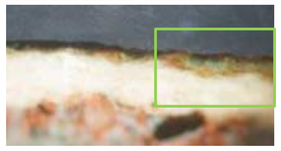
THE ALTERED BLACK ISSUE

Physical and chemical mechanisms are responsible for the alteration of the **black** paint. "Transformation" from **black** to **brown** corresponds to an impoverishment in **Cu** compared to Fe. **Hematite** (**Fe_2O_3**), quartz (SiO_2) and **cuprite** (**Cu_2O**) are present.

Cross sections from sherds from Limarí Museum show multiple scenarios of alteration



***Black** layer with **brown** interface*
Bowl, Diaguita, phase II



***Rare green** lens between **black** and **brown** layers. **Black** sample from this sherd showed **ajoite**, $(K,Na)_3Cu_{20}Al_3Si_{29}O_{76}(OH)_{16}\bullet{\sim}8(H_2O)$*
Zoomorphic bowl, Diaguita, phase II

Brown** layer with small lens of **black
Bowl, Diaguita, phase II

***Brown** layer over white*
Bowl, Diaguita, phase II

CONSIDERATIONS

Key parametres for understanding the alteration processes are:

- Manufacture
- Firing processes and techniques
- Soil dynamics and composition
- Alteration during burial and/or post excavation?

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