ARCHAEOLOGY AND MATERIALS SCIENCE: The Red Etched Stones from Ancient Caesarea: Copies or Trade?

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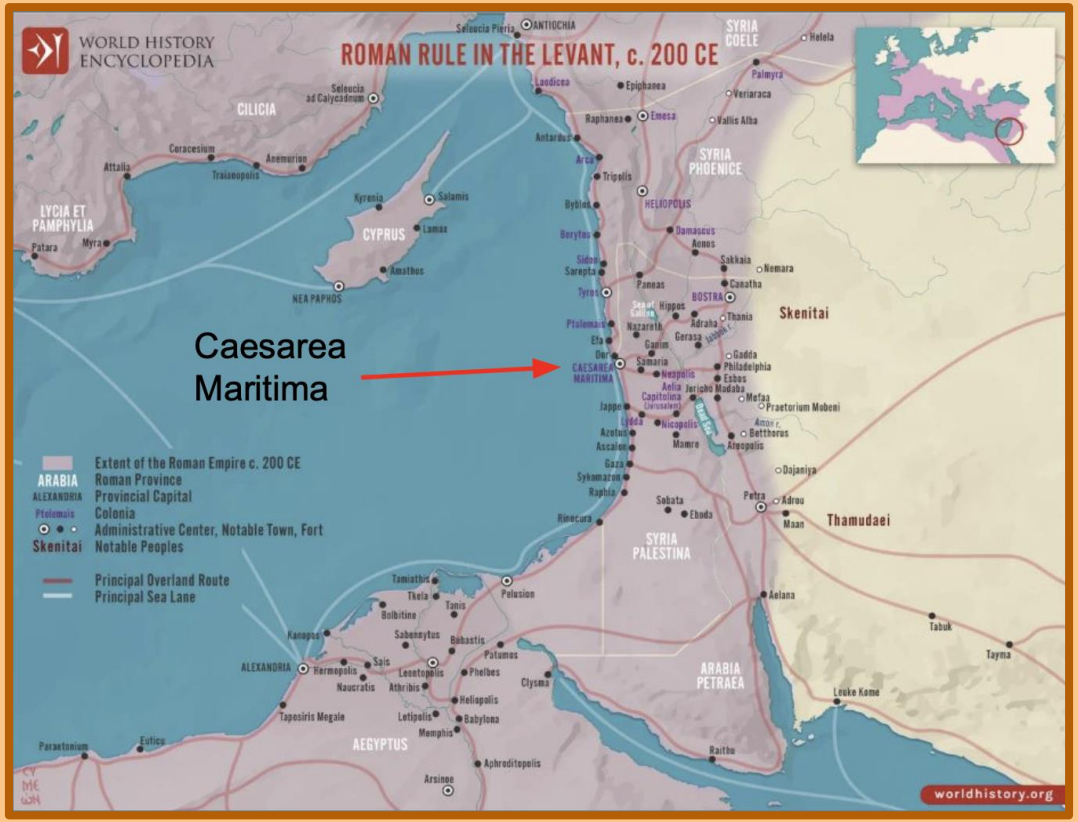
Assistants: Daylin Evans and David Hwang

Advisor: Dr. Maria Masucci



Geographic Context

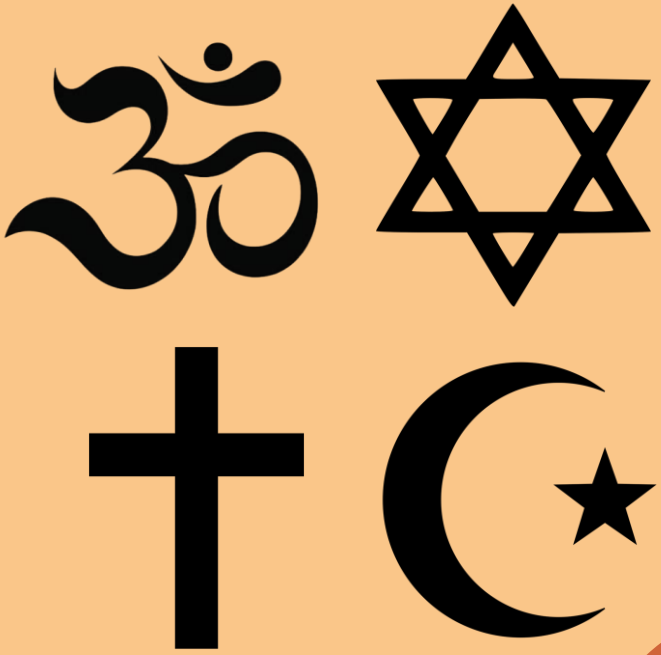
3rd to 11th Century CE



Cultural Significance and Time Periods

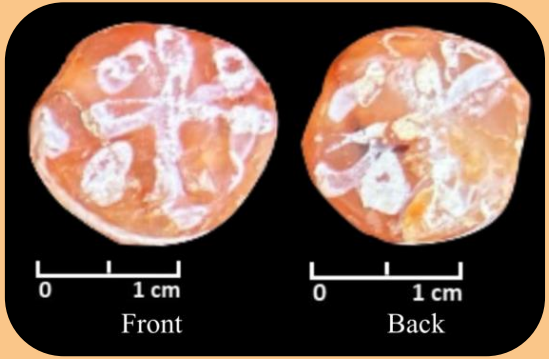


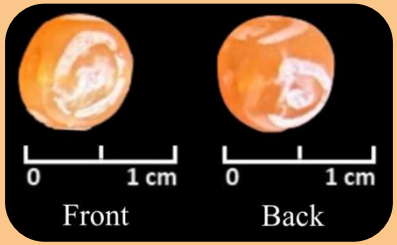
Color



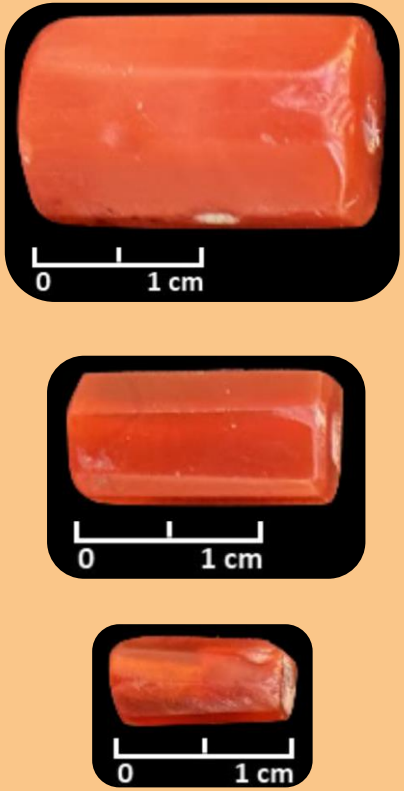
Religion

Carnelian Bead Background

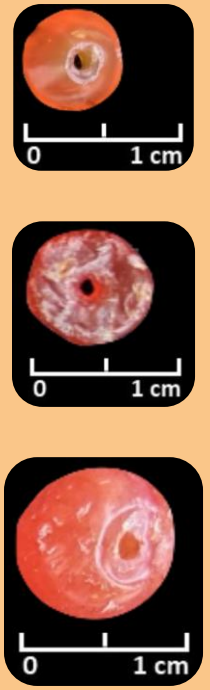




Etched



Rectangular



Circular

Methodology



Chemical



Stylistic



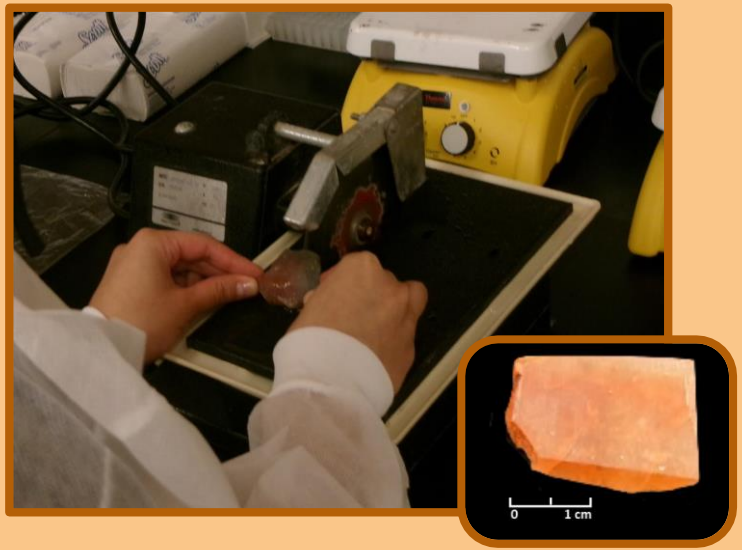
Experimental

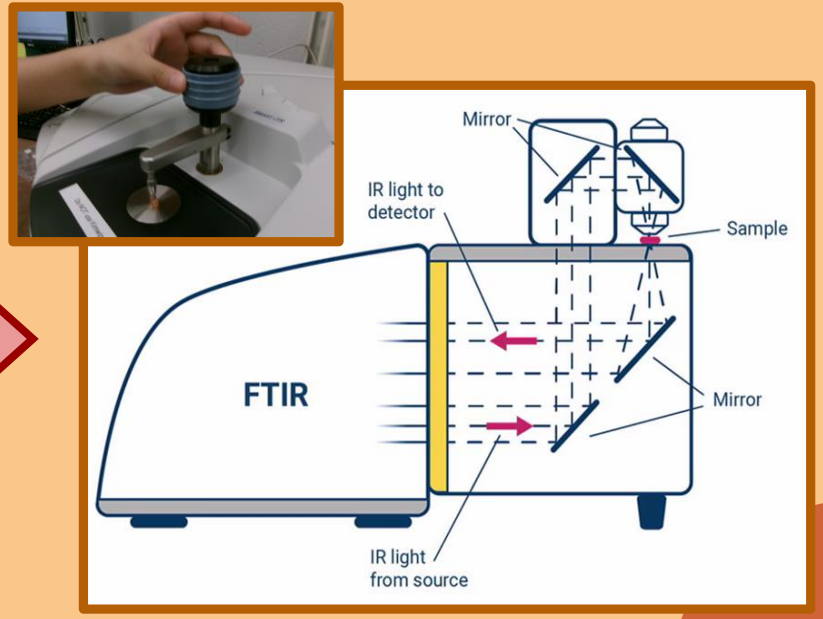


Morphological

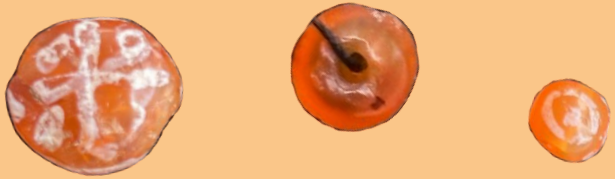
Who made them? Where were they made?
How did they get to Caesarea?

ATR-FT-IR

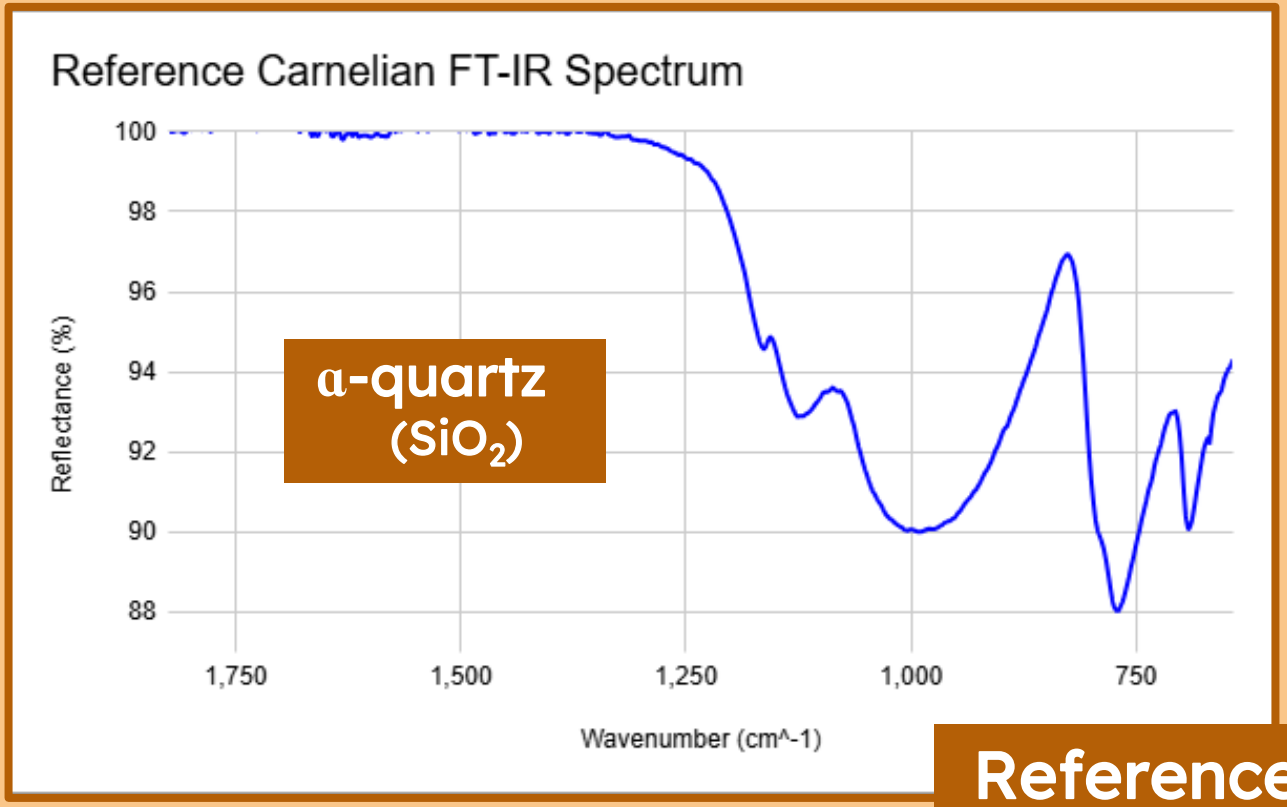




(Agilent, 2026)



Graph Interpretation



Reference

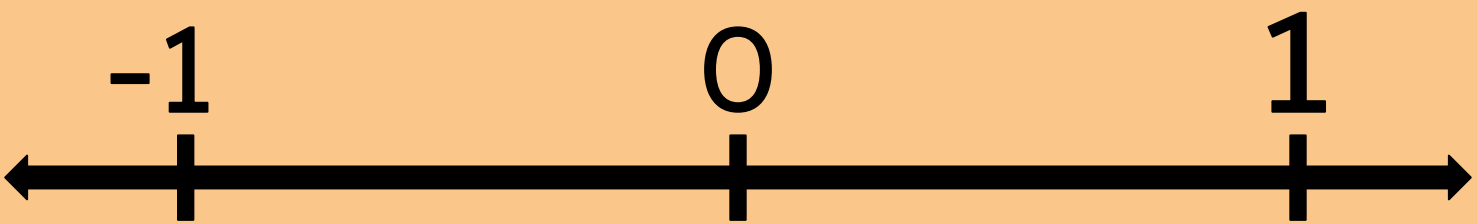
Statistical Analysis

Pearson's correlation coefficient

$$r = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}} \quad (1)$$

Spearman's rank correlation coefficient

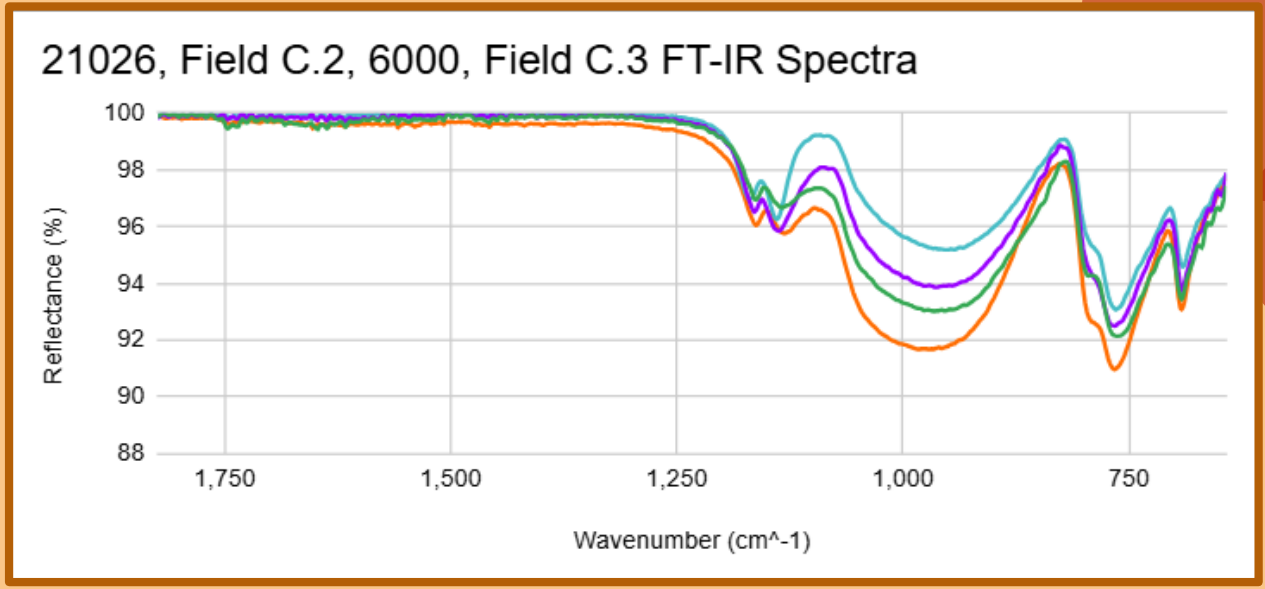
$$\rho = 1 - \frac{6\sum d^2}{n(n^2 - 1)} \quad (2)$$

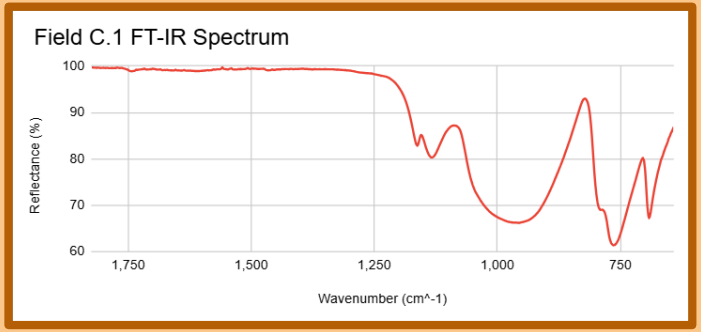


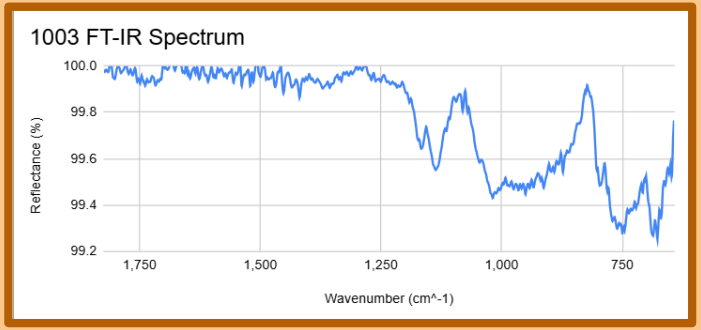
Results

r	ρ
0.983	0.940
0.943	0.851
0.947	0.829
0.978	0.911
0.978	0.865
0.977	0.927

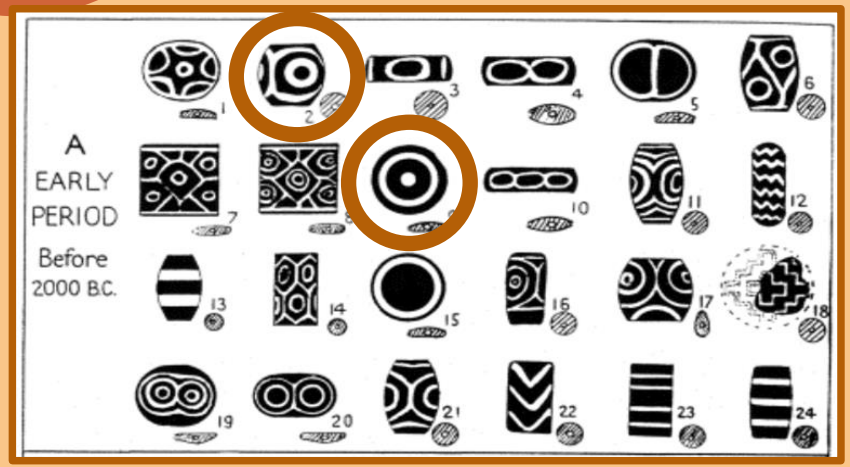
> 0.8 ≡ Strong Correlation







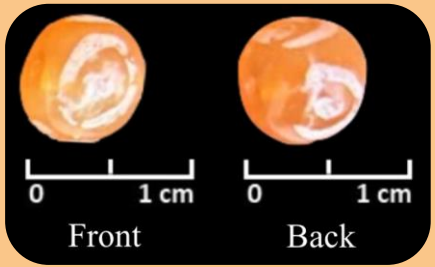
Beck's Chronology

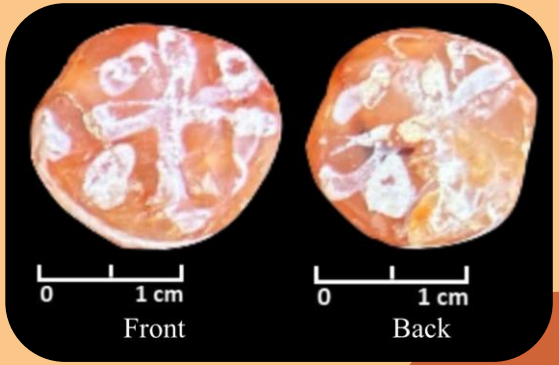






Our Beads





(Beck, 1933)

Style Comparison



Our Beads





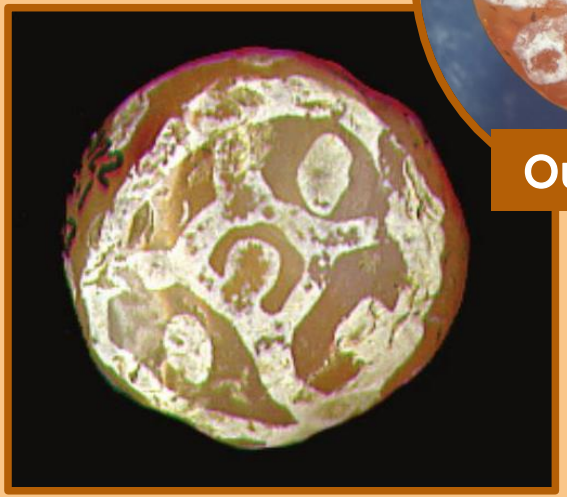
India

(Prabhakar, 2018)

Designs



Our Bead



Excavated in West Russia

(British Museum, 2022)



(Britannica, 2026)

Designs



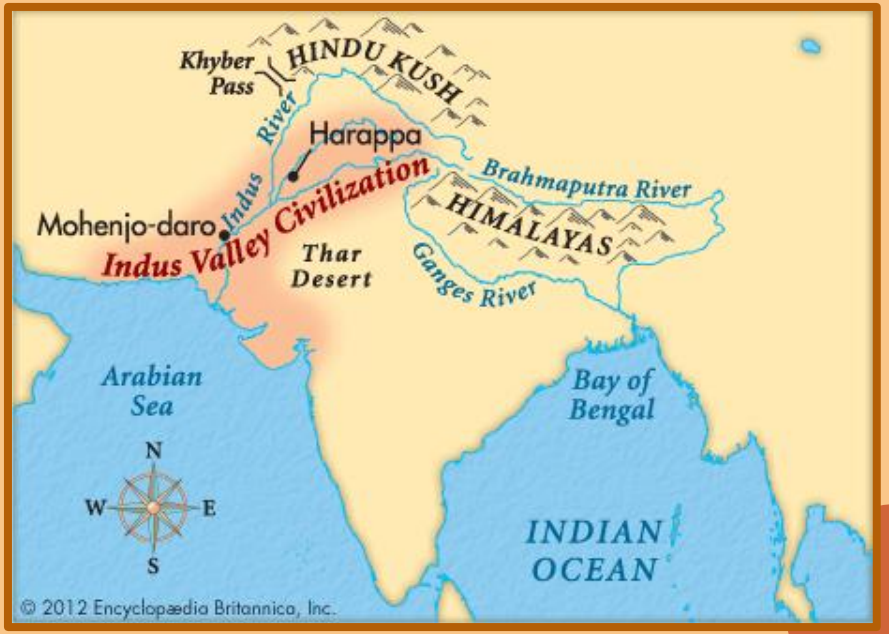
Our Bead



Figure 8.10. Spherical etched carnelian bead from Ban Don Ta Phet, 1981. (Photograph © I. Glover)

Excavated in Thailand

(Glover & Bellina, 2003)



(Britannica Kids, 2026)

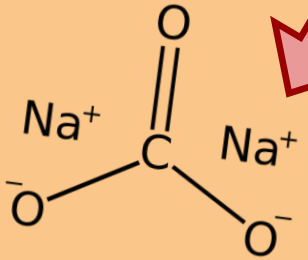
Etching History



Plant Resin

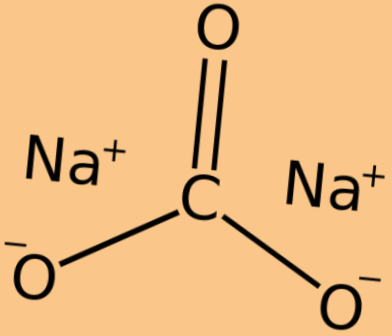
Plant Ash





Na_2CO_3

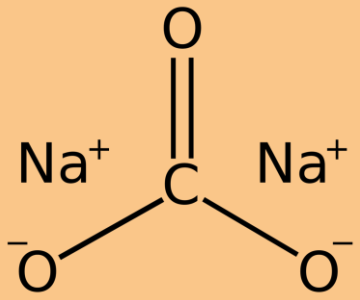
Washing Soda (Na_2CO_3)





Kirar Plant Juice *(Capparis aphylla)*

Experimental Procedure





Sodium Alginate

or





Temperature

Drying Time

Ratios

1:?

Results









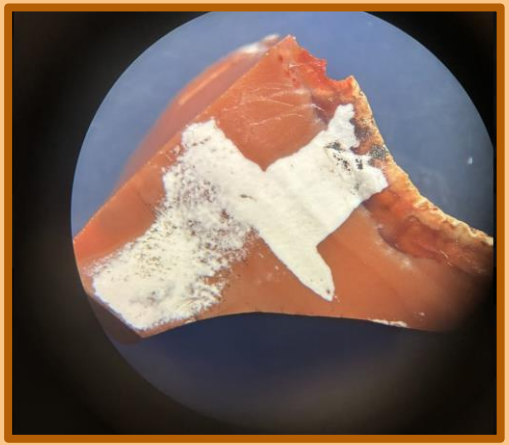
Firing

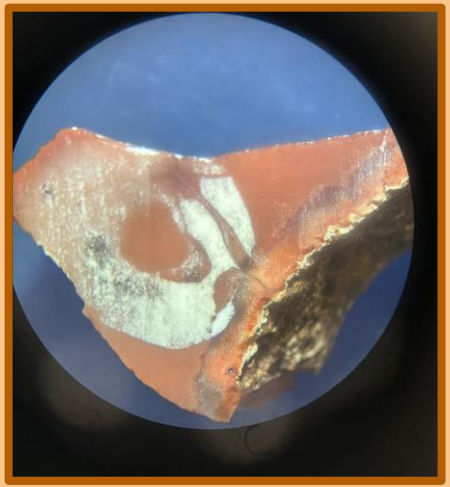




Wiping

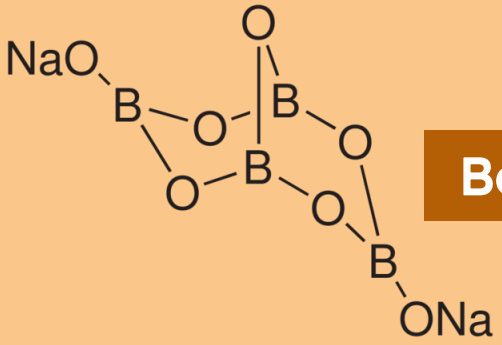
Results







Caper

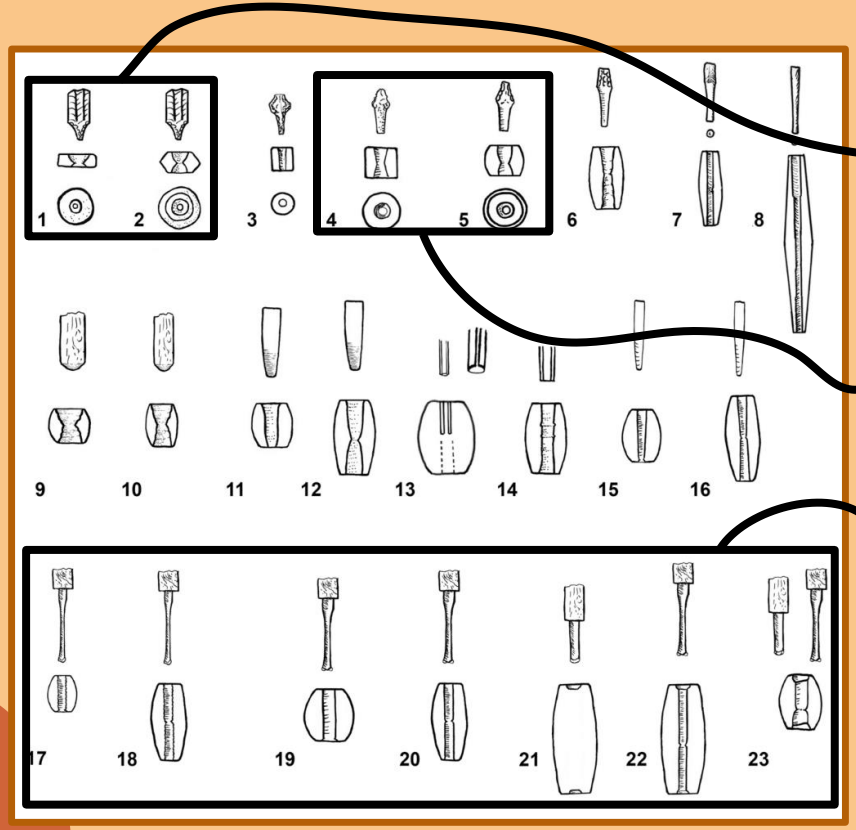


Borax



Gum Arabic

Drilling Methods



(Ludvik et al., 2022)

- **Pecking** (7000-1000 BCE)
- **Stone Drilling** (~3000-1000 BCE)
  - **Ernestite**
- **Diamond Drilling** (~1000 BCE-today)

Procedures

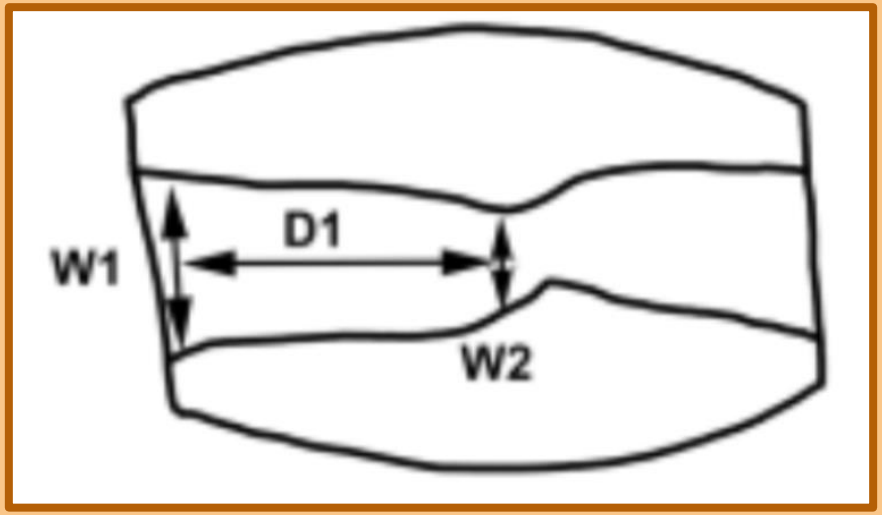


Back-Light Test

Drill Impression Analysis



Drill Hole Taper Value



(Ludvik et al., 2022)

$$DHTV = \frac{Width\ 1\ (W1) - Width\ 2\ (W2)}{Depth\ 1\ (D1)}$$

Results



1	2	3	4	5



1	2	3	4	5



1	2	3	4	5



1	2	3	4	5



1	2	3	4	5



1	2	3	4	5



1	2	3	4	5



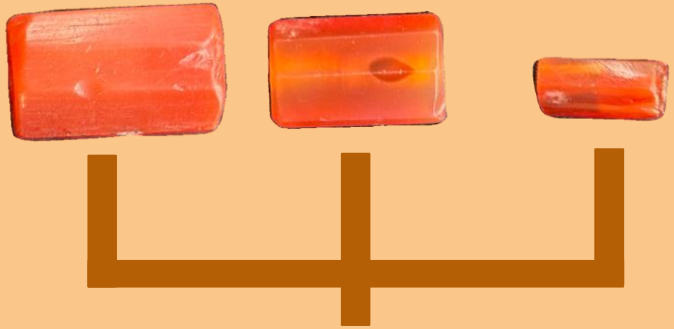
1	2	3	4	5

1. Straight hole
2. Polished internally
3. Circular drill hole
4. Tapered
5. Drilled from both sides

Yes

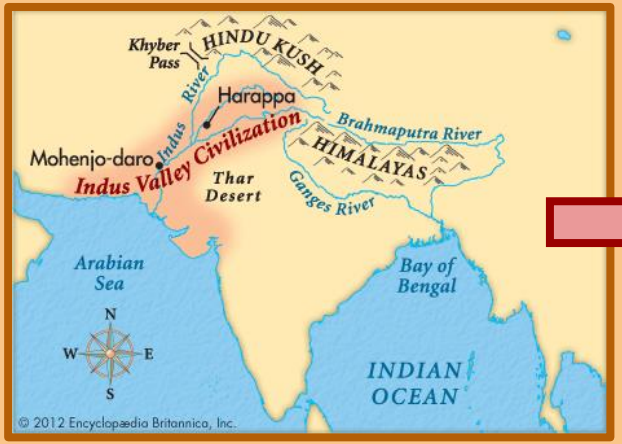
No

Conclusions













(Britannica, 2026; Britannica Kids, 2026)

Acknowledgements

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Thank you!

Dr. Maria Masucci
Daylin Evans and David Hwang
GSS Staff, Families, & Alumni

Questions?









