

# New analytical data on the Mediterranean core formed glass vessels: the example of Hellenistic Epirus, Greece

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## Introduction

### Epirus:

- Located on the North West part of Greece (Fig. 1).
- Six archaeological sites (Dodona sanctuary, Cassope, Ambracia, Elea, Gitana and Dymokastro) which flourished during the Hellenistic period (mid 4<sup>th</sup> to 1<sup>st</sup> c. BC).
- Developed into an important node of communication and transport of goods.

### Research objectives:

- To suggest the raw materials used to make the glasses.
- To suggest a provenance for the glass.
- To provide new insights about the core formed industry in Greek region.

## Materials and Methods

**Samples:** 40 fragments of core formed glass vessels: alabastra, amphoriskoi, unguentarium and non-diagnostic (see Table 1 and Fig. 2)

**SEM-EDX:** SEM-JEOL(JSM-6510LV), EDXS-Oxford Instruments (Fig. 3)

Operating Conditions:

- Voltage at 20kV, spot size 50µm.
- Working distance at 15mm.
- Calibration with established geological standards tested by SRMs (NIST SRM620, SRM1831 and SRM612).

**LA-ICP-MS:** NewWave UP193FX laser, Agilent 7500 ICP-MS (Fig. 4)

Operating conditions:

- Laser ablation craters at 70µm,
- Laser firing for 45s at 10Hz
- Typical fluence of 2.8 Jcm<sup>-2</sup>.
- Calibration with NIST SRM610 and NIST SRM612 was used for quality control purposes.

## Figures

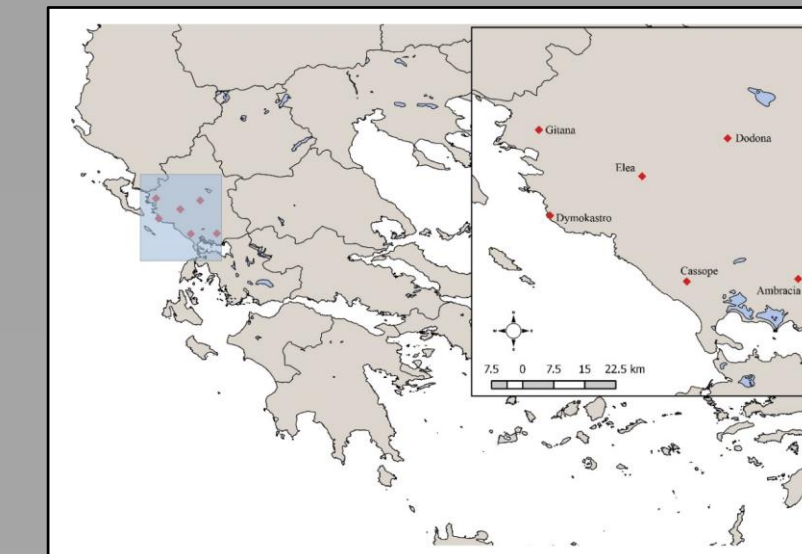


Fig. 1. Map of Epirus and the archaeological sites.



Fig. 2. Characteristic fragments of the core formed vessels found in the archaeological sites of Epirus.

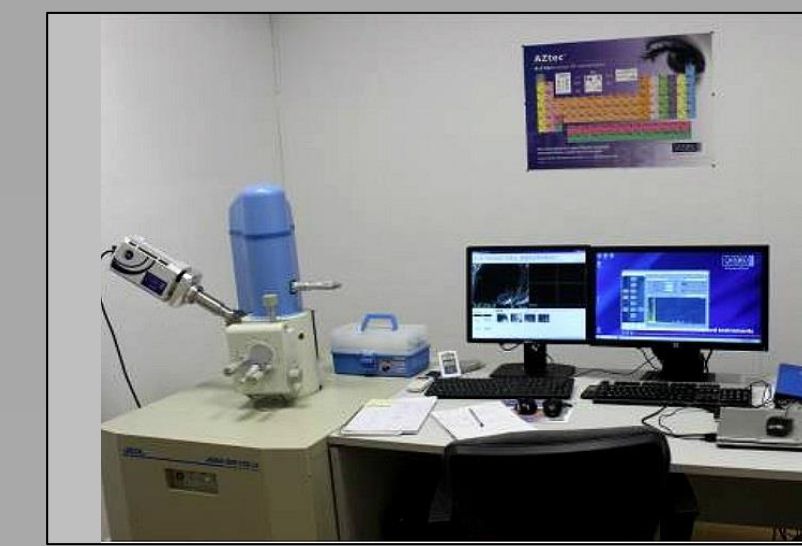


Fig. 4. General view of the SEM/EDX facility used in this study.



Fig. 3. General view of the LA-ICPMS facility used in this study.

## Results

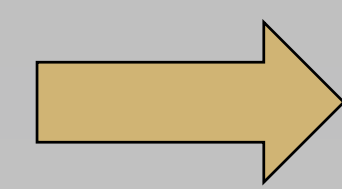
### Typology of samples

Region	Sample	Typology	Group
Dodona (Dakaris 1965, 1983)	Do3	Amphoriskos	I
	Do5	Amphoriskos	I
	Do6	Alabastron	II
	Do7	Alabastron	II
	Do8	Unguentarium	II-III
	Ar13a	Alabastron	I
	Ar13b	Alabastron	I
Ambracia (Aggeli 2000)	Ar36a	Alabastron	II
	Ar36b	Alabastron	II
	Cas1	n.diag.	II-III*
Cassope (Hoepfner and Schwandner 1994)	Cas2	n.diag.	II-III*
	Cas3	Alabastron	II-III
	Cas4	n.diag.	II-III*
	Cas5	Alabastron	II-III
	Cas6	Amphoriskos	I
	Cas20	n.diag.	II-III*
Elea (Riginos and Lazari 2008)	EI2	n.diag.	II-III*
	EI3	n.diag.	II-III*

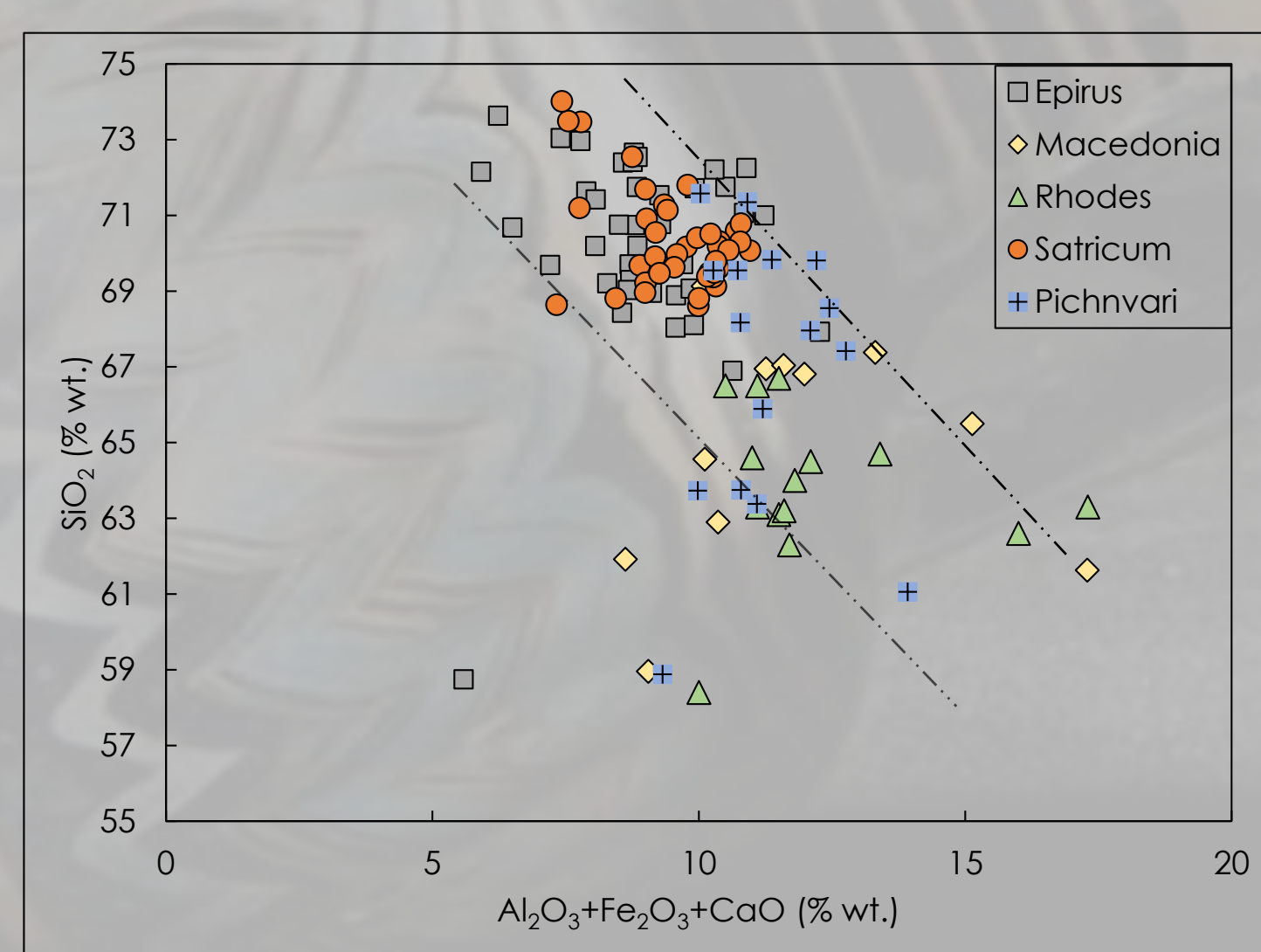
**Table 1.** Typological characteristics of the glass fragments under study. \*The assignment of the non-diagnostic (n.diag) fragments to Group II-III category is based on the dating of the archaeological context.

Typology	Dating
Mediterranean Group I	Late 6 <sup>th</sup> – mid 4 <sup>th</sup> c. BC
Mediterranean Group II	Mid 4 <sup>th</sup> – late 3 <sup>rd</sup> c. BC
Mediterranean Group III	Mid 2 <sup>nd</sup> – early 1 <sup>st</sup> c. AD

- **Earlier dates (Group I)** → more impurities less silica content of the sand
- **Later dates (Group II & III)** → less impurities more silica content



### Major and minor elements



- The majority of the Epirotic samples:

SiO<sub>2</sub> (↑) and Al<sub>2</sub>O<sub>3</sub>+Fe<sub>2</sub>O<sub>3</sub>+CaO (↓)

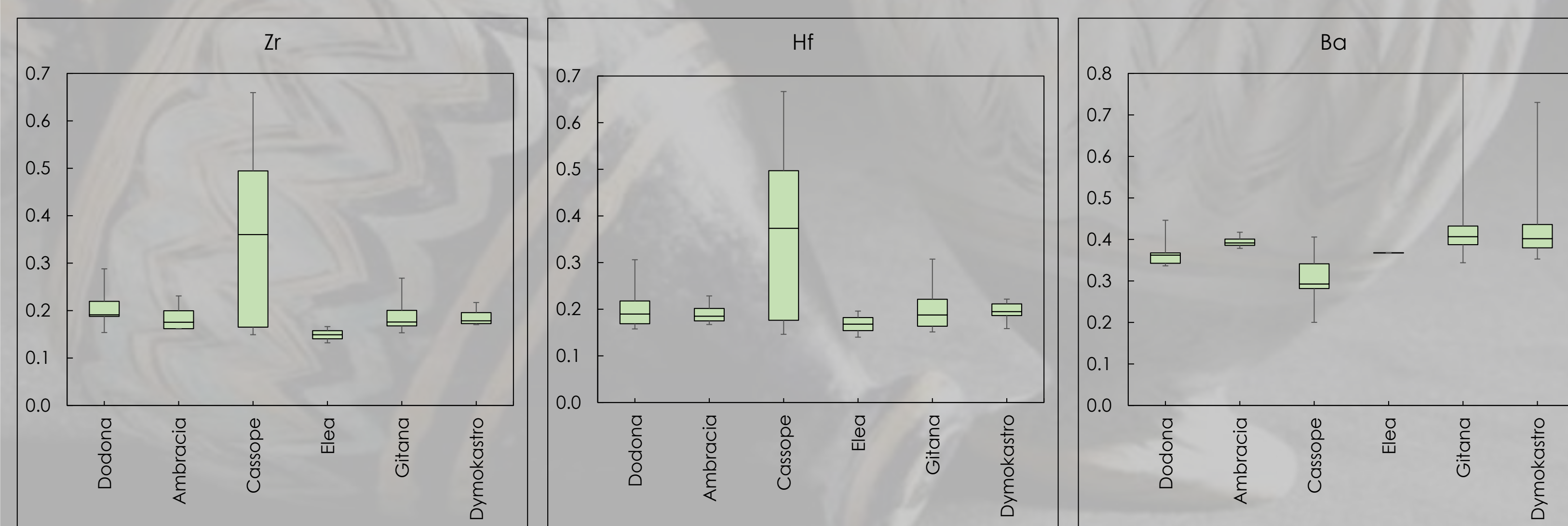
- The majority of the other samples:

SiO<sub>2</sub> (↓) and Al<sub>2</sub>O<sub>3</sub>+Fe<sub>2</sub>O<sub>3</sub>+CaO (↓).

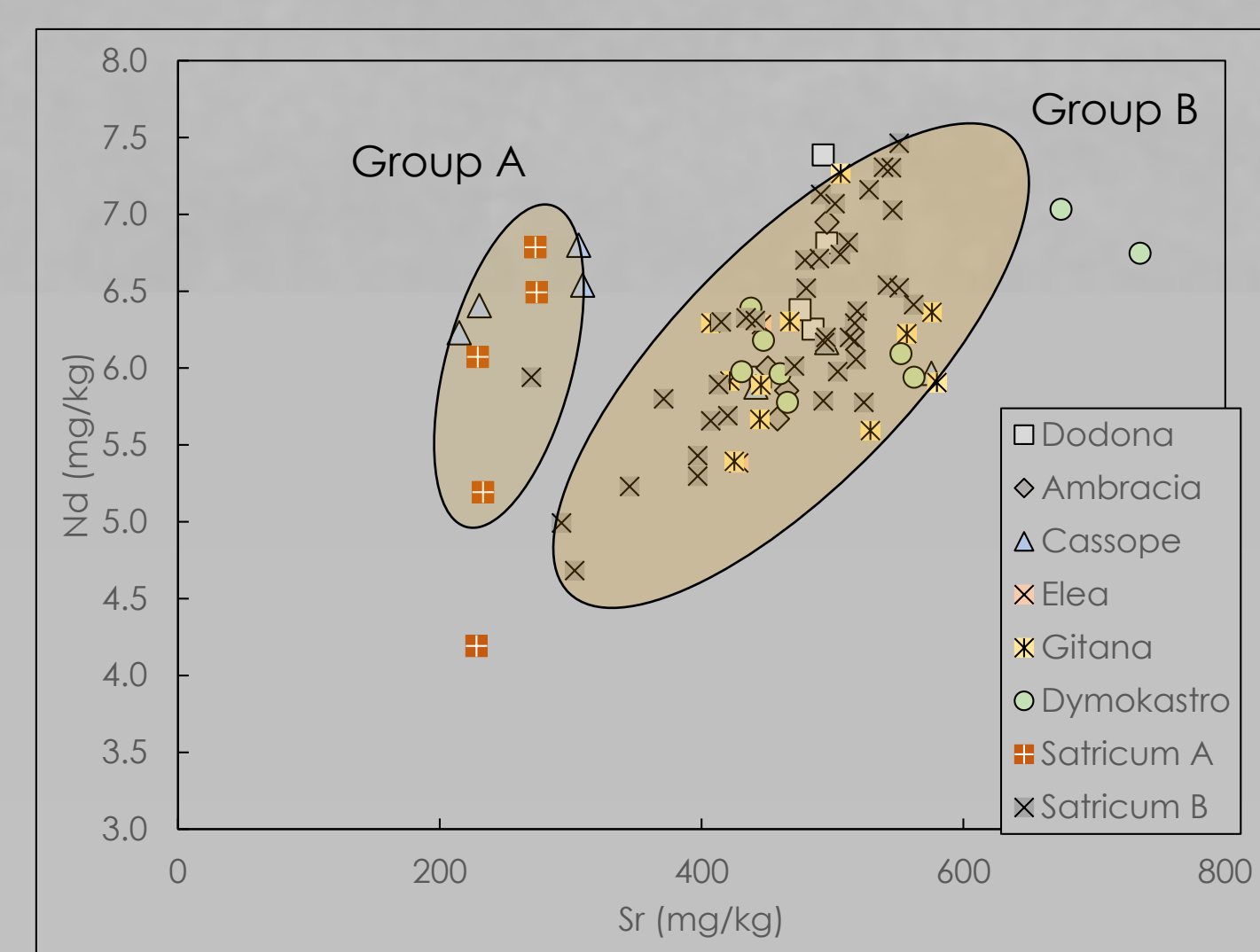
- All samples (this study and the published data) have a tendency to correlate in a negative slope (dashed lines).

- Earlier samples (Pichnvari, Rhodes, Macedonia: mainly Med. Group I samples) are plotted in the lower end of the dashed lines, while the later ones (Epirus, Satricum: Med. Group II&III samples) on the top of the dashed lines. This correlation might serve as a compositional and dating marker (Oikonomou 2018).

### Trace elements



- The majority of the trace elements of all regions have similar average values, there are three elements Zr, Hf and Ba, which have the biggest variation among the regions.
- The samples coming from Cassope can be easily distinguished from the rest, having higher Zr and Hf and lower Ba values.



- Nd vs Sr show the distinction of two groups, Group A and B.
- Few samples from Cassope (Group A) are correlated with Satricum A samples which according to Oikonomou et al (2016) have an Egyptian origin.
- The majority of Epirotic samples (Group B) are very well correlated with Satricum B which according to Oikonomou et al (2016) have an Italian origin.

## Conclusions

- According to the major and minor elements there is a choice for purer sands during the Hellenistic period, while earlier samples exhibit totally different patterns.
- The majority of the Epirotic samples, due to their technological similarities with Italian samples in terms of both major-minor elements and more importantly trace elements we may assume they have an Italian origin.
- A part of the Epirotic samples (samples from Cassope) have similar chemical fingerprint with samples having an Egyptian origin indicating the same provenance.

## References

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