



Mineralogy of Sasanian Bullae

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Abstract

The Sasanian Empire is one of the most magnificent dynasties in ancient Iran. Numerous archaeological and artistic works as well as written manuscripts have been remained from the Sasanian period. In the meantime, oral traditions of the period and its inspiration on Islamic era cannot be denied. The Sasanian inscribed bullae are among the most important heritages of this glorious era. This article deals with a technical analysis based on “electron probe microanalysis” to understand compounding materials of the Sasanian bullae. It also stresses on the mineralogy of the bullae’s compounds and raise a question if their manipulation follow any standard(s) or not? Evaluating such a hypothesis, the authors have selected small sample pieces of the bullae from three well-known historical sites: Takht-e Soleyman (West Azarbaijan Province), Qasr-e Abu-Nasr (Fars Province) and Teppe Kabudan (Golestan Province). To answer to main question of the paper, EMPA technique has been selected, which is one of the most accurate tests. Initially, fixed compound elements of each bullae were discovered and then an attempt was undergone to evaluate and compare the bullae compounds of the three Sasanian sites.

Keywords: Sasanian, Bullae, EPMA, Mineralogy, Compound Materials.

Introduction

The Sasanian Empire is one of the most magnificent dynasties in ancient Iran, which was founded by Ardashir I (224 AD), and constituted the last great Iranian empire before the advent of Islam (651 AD). The collapse of this dynasty was so bitter for Iranian identity and nationality, that it can be equal to Zoroastrian final resurrection in some texts.

Varied cultural heritage of this magnificent era, including royal inscriptions, coins, gold and silver vessels, glass containers, seals and bullae belonging to nobles and officials, including priests, governors and army commanders, can be a proof of the claim. Such archeological evidences have been discovered in most of the historical sites of Iran, especially in Sasanian homeland: Fars province (cf. Gyselen 2006: 25).

Nevertheless these Zoroastrian Pahlavi manuscripts, written heritage, or the Sasanian heritages in the other countries, is out of this paper.

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Although so many scholarly works have been published about the history, art and culture of the Sasanian in the past 100 years up to now (Malandra 2005: online), but less effort has been made on technical tests such as fingerprinting of the bullae, analyzing glass works with non-destructive testing, etc. in Iran. These technical tests are obviously a part of Iranian Studies, Archaeology and Museum studies. So, we decided to conduct a highly accurate EPMA (electron probe micro-analyzer) test on some Sasanian bullae in three different geographic regions. This paper describes the results for the first time. We avoided ICP (Inductively Coupled Plasma) test or other destructive technical tests. EPMA is one of the safe ways to examine and preserve objects without any damages. In professional ICP technical test a solution, i.e. part of an object with a liquid should be made, but such a test runs counter to the rules.

Sasanian Bullae

The Sasanian inscribed bullae are one of the most important remnants from this great cultural period. These works are most important references in archeological studies and Iranology, etc. such as research on artistic aspects and inscriptions (including individual names, their designation and religious legends). The bullae were also used in administrative matters, both in political affairs and in commerce (Gyselen 2002: 24). Several collections of Sasanian bullae has been discovered in Iran's provinces most of which have been printed by Western scholars (cf. Gignoux and Gyselen 1987). These works have been made out of raw mud which has been kneaded with hands and are mostly in rounded form. In an overview, most of them are looks like the same in shape and color. The largest collection of Sasanian bullae is discovered from Takht-e Soleyman.

However, this article doesn't focus on historical, artistic and administrative aspects of the works (cf. Azarpay 2003: online; Gubaev et al 1996: 56); but the authors of the paper are looking to find out how well the makers of these bullae were familiar with the knowledge of mineralogy? Whether they used any standard(s) to extract mines or select initial mud for the creation of these works? Whether technical tests, based on analyzing of the compound materials of the samples, can improve us about ability and knowledge of the makers? How much similar or dissimilar are those compound materials from a site to another one?

Background

In the past years, some scholarly works were published based on the technical tests (or chemical) on metals, ceramics, bronze and porcelains. Most of them used "XRF" or "PXRF" (cf. Ashkanani 2013: 245; Tanasi et al 2017: 222-234). Meanwhile no chemical or other tests have been reported on bullae

Furthermore, the results of the tests such as XRF and the like cannot be comparable with the technical test of EPMA. While the other tests are destructive, EPMA is completely safe. Moreover, it is much easier for scholars to access to the ancient archeological works such as ceramics and bronze rather than bullae.

Selecting Samples of the Bullae from Three Historical Sites

To answer the above mentioned questions, we selected samples from three known Sasanian sites (Iran) including: Takht-e Soleyman in West Azarbaijan Province^I, Qasr-e Abu Nasar in Fars Province^{II} and Tappeh Kabudan in Golestan Province^{III}. The samples were selected from the Department of Seals and Coins of the National Museum of Iran, where the bullae of these three sites are kept. The samples were sent to Research Institute of Processing Minerals of the Ministry of Industry, the only holder of EPMA instrument in the country; Mr. Qolizadeh and his colleagues were responsible to do the technical test. Two small pieces of bullae were selected from each above mentioned site

(Bullae) and sent for the EPMA test. Meanwhile, the team was unable to use the “polish section” test on the basis of BSE because of ICHTO rules; also the EPMA photos are of a higher resolution. Obviously the resolution of %10 - %15 is enough for such a test and there is no need for resolution of %1 - %2. In this work, the expert team used the BSE shooting method, which means “backscattered electrons (for photography)”. The following, charts indicate the compound materials of the samples:

According to the charts, close similarities have been seen in the compounds of the Takht-e Soleyman samples except iron. Qasr-e Abu Nasr’s samples could be considered of having the same similarities next to Takht-e Soleyman. In fact, remarkable dissimilarities between the examples of these two sites can be seen in those of Teppeh Kabudan.

Meanwhile the question arises as: “why there are such similarities and dissimilarities between the compounds?”

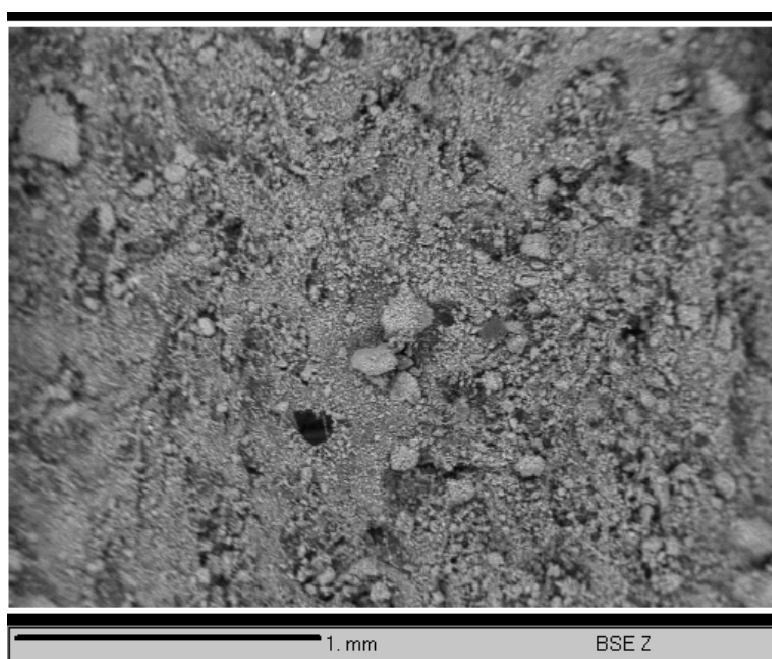
Takht-e Soleyman is one of the most sacred, important and well-known Sasanian sites. Enough has been said and written about the religious aspect of the site for the Zoroastrianism (Boyce 1987: online) and Iran under Sasanian; the very important works of the Sasanians have been discovered in this site (Gobl 1976). This site is geographically surrounded by the nearby mountains so that the craftsmen accessed probably to the mines of clay. It is not reasonable to suppose that they transferred mud from far away!

Although Qasr-e Abu Nasr is one of the most important Sasanian sites, but it cannot be compared with Takht-e Soleyman. Meanwhile archeological excavations attest its rank in Sasanian studies. The Achaemenid evidences from Qasr-e Abu Nasr can be considered as a part of archaic background of the site (Frye 1973: 8).

Tappeh Kabudan, unlike the two above mentioned sites, is almost unknown, in which the least excavations have been conducted. Sasanian bullae from Tappeh Kabudan in the

The result of the testing of bullae pieces of Takht-e Solayman (and BSE photo):

Nom.	Na	Mg	Al	Si	K	P	Ca	Ti	Cr	Mn	Fe	Total
3 / 1 .	0.04	1.08	3.39	6.99	0.66	0.03	21.8	0.04	0	0.01	0.6	34.63
4 / 1 .	0.06	1.14	2.62	6.17	0.64	0.02	15.99	0.06	0	0.02	0.97	27.69



National Museum of Iran have been discovered in the site accidentally. The lack of the archeological excavations to get more information about the site from one side, and its special geographical location in Golestan Province which has been surrounded by the mines, fertile hills and rivers from another side, differentiate Tappeh Kabudan from the previous sites. Most probably the craftsmen who worked in Takht-e Soleyman and Qasr-e Abu Nasr cannot be compared with those in Teppeh Kabudan. Post-Sasanian texts have frequently referred to Sasanian kings who visited Takht-e Soleyman for the ritual rite. Also a royal gateway of Qasr-e Abu Nasr’s site can be assumed as a connection between the site and the Power, while there is no trace in this regard on Tappeh Kabudan. It seems that Takht-e Soleyman and Qasr-e Abu Nasr were two significant political and religious sites in Sasanian era.

In spite of this, we need many other samples from the north, south, east and west sides of the country to determine similarities and dissimilarities of the bullae. However such destructive tests on objects are illegal, we were unable to find more samples.

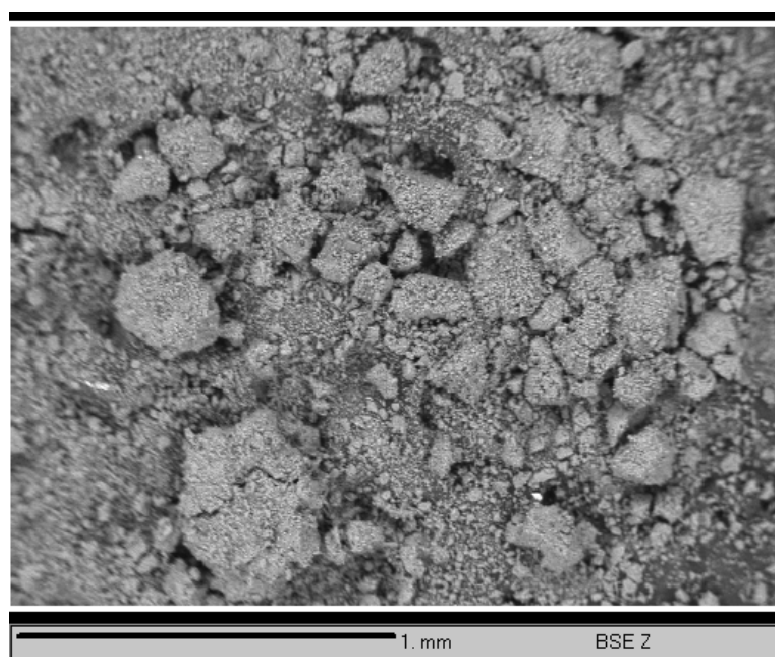
Conclusion

The Sasanian bullae are one of the most outstanding heritages for understanding the administrative geography of Iranshahr in the era^{IV} These bullae have been widely used in administrative matters, especially in the trade.

They belonged to the nobles and ranked class such as the priests, army commanders, provincial governors, tradesmen and etc. Despite the scholarly works, the technical tests to analyze the compounds of the bullae have not been done yet. As any destructive test is prohibited according to the rules, we need broken fragments and pieces for doing such a test on the bullae. In fact we hardly received a few number of the samples for EPMA test from the National Museum of Iran.

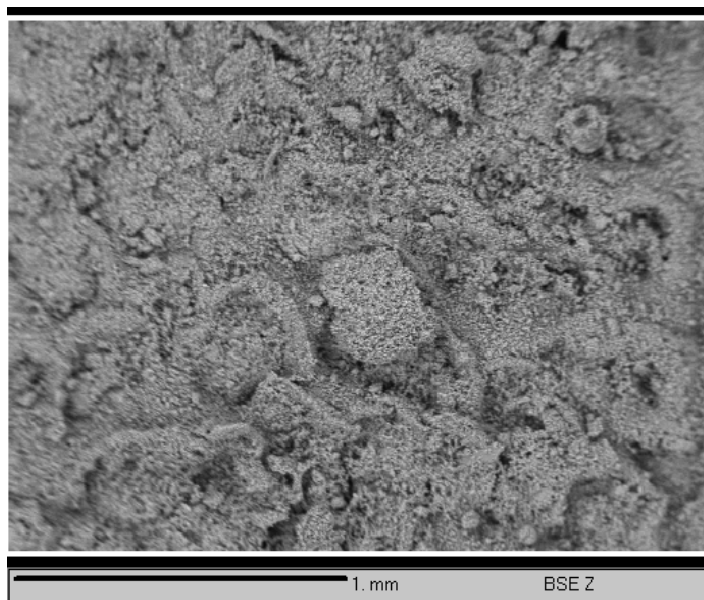
The result of the testing of bullae pieces of Qasr-e Abu Nasr (and BSE photo):

Nom.	Na	Mg	Al	Si	K	P	Ca	Ti	Cr	Mn	Fe	Total
5 / 1 .	0.04	0.97	3.36	12.1	1.05	0.04	9.34	0.22	0	0.05	1.97	29.12
6 / 1 .	0.09	1.21	5.73	39.52	2.02	0.06	2.93	0.16	0	0.04	1.47	53.24



The result of the testing of bullae pieces of Tappeh Kabudan (and BSE photo):

Nom.	Na	Mg	Al	Si	K	P	Ca	Ti	Cr	Mn	Fe	Total
1 / 1 .	0.17	1.79	2.33	7.49	1	0.06	24.91	0.14	0	0	1.13	39.02
2 / 1 .	0.08	0.93	1.98	8.03	1.43	0.06	7.98	0.15	0.03	0.05	1.91	22.61



The EPMA is one of the most accurate technical tests for analyzing the compound elements of the archeological clay objects; thus it can serve as a gateway to other tests on the other clay works such as jars, bowls and etc. The result of our technical test testifies that the bullae compounded from fixed elements, the issue that has not been studied during the last century.

The results of the tests show that the makers prepared raw mud very accurately; so that they did not use the raw mud of anywhere. The similarities of the compound's elements of the two most important sites of the Takht-e Soleyman and Qasr-e Abu Nasr show that the makers have had good information for selecting the mud. These similarities have been certified as a standard selection of raw mud for Sasanian bullae. However, a question arises as to whether those who provided the mud were same as who kneaded it?

It cannot be also ignored that most of these bullae date back to the late Sasanian (sixth century A.D.). Obviously during the sixth century art, music, coinage technique, and probably the knowledge of how to prepare mud for such a work had reached its peak. At least The percentage of silver in Sasanian coins is a good attest for standardization in this century. However the tests, which have been done on the bullae, testify the skill of the makers of these works.

Furthermore this achievement is a significant event in archeology, Iranian studies, and etc. Takht-e Soleyman, as a sacred religious site, was probably a place where craftsmen and masters worked in. The specific geographical location of this Zoroastrian site would have possibly provided the artists with a unique opportunity to look for their required mud within the site and nearby. Perhaps the similar compounds of the bullae can be considered as a proof to testify that makers extracted mud from specific mine(s) of that region.

Many masterpieces have been discovered from Qasr-e Abu Nasr site in Fars province. Similarity in compounds of the bullae of this site, same as Takht-e Soleyman, can be

a claim that craftsmen followed a kind of standards for their works. Historical sites of Fars province, homeland of Sasanian kings, have played a significant role on Sasanian studies since the last century.

Tappeh Kabudan, unlike the two above mentioned sites, is a less known site in archeological studies, especially on Sasanian era. A considerable difference is being noticed in the percentage of the compounds of the samples of this site in comparison with the two discussed sites. The geographical location of Tappeh Kabudan can be a notable factor that causes dissimilarities between this site and Takht-e Soleyman and Qasr-e Abu Nasr. Against to the archeological knowledge about Takht-e Soleyman and Qasr-e Abu Nasr in the past fifty years, our information about Tappeh Kabudan is not enough. In fact, the results of the tested samples of this less known site, in northern part of the country, cannot be compared with the two mentioned well known Sasanian sites.

Endnote

ⁱ. The site was excavated by German archaeologists in 1960s. They discovered a most important collection of the bullae and seals (Osten and Naumann 1961). Meanwhile Mr. Y. Moradi (RICHTO) excavated the site some years ago and discovered more than 300 new bullae: cf. RICHTO, Archive).

ⁱⁱ. Qasr or Takht-e Abu Nasre is located in Fars Province, near Shiraz city. The collection of the bullae (and other objects) was published by R. Frye (Frye 1973).

ⁱⁱⁱ. Cf. Akbarzadeh and T. Daryae 2012: online.

^{iv}. The term used by Sasanian inscriptions and Zoroastrian Pahlavi texts (Daryae 2009: 5).

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