Microorganisms influence the mechanisms of the rock erosion at Tang-e Chogan

Azadeh Ghobadi [1], Mohammadamin Emami [1,2] , and Hesam Aslani [1]

1. Department of Conservation & Archaeology, Art University of Isfahan, Isfahan 1744, Iran
2. Department of Building Material Chemistry, University Siegen, Siegen 57068, Germany

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Introduction

The rock reliefs of "Sasanian king Shapur II at Tang-e Chogan" gorge, close to "Bishapur" one of the most important ancient works in Iran, and known as "Bishapur" reliefs is unique when considering both its style and its imaging.(Fig.1)
Six oversized rock reliefs belonging to the Sassani monarchy is placed on the two sides of Tang-e Chogan in Bishapur area which is the first and greatest ancient area in Fars province. Bishapur was founded by Shapur II, second Sassanid king, to celebrate his victory over the Romans in 260 AD. Outside the city, Shapur II decorated the sides of the Bishapur River gorge with huge historical reliefs commemorating his triple triumph over Rome.(Fig.2,4)

On the general view of Tang-e Chogan in Bishapoor ancient city is located on the geographical coordinates of (29°46′40″N 51°34′15″E), one hundred and fifty four kilometers far in the west of Shiraz. The natural historical environment of Bishapoor and Tang-e Chogan is located by the side of the road that was used to be the royal pass in ancient times (Sassani age) that connected Bishapur and Goor town to Tisfoon the capital of the Sassani government.(Fig.3)
Erosion evaluation of the "Chogan" reliefs due to many causes, such as biological and atmospheric damaging and others which are not well known, the facade has been seriously damaged during the last 50 years.(Fig.5)

Figure1: Tang-e chogan, relief III: Victory of Shapur over the Roman Army (241-272 AD)
Width:11 m Height:4.20 m

Figure2: sides of the Bishapur River gorge with huge historical reliefs

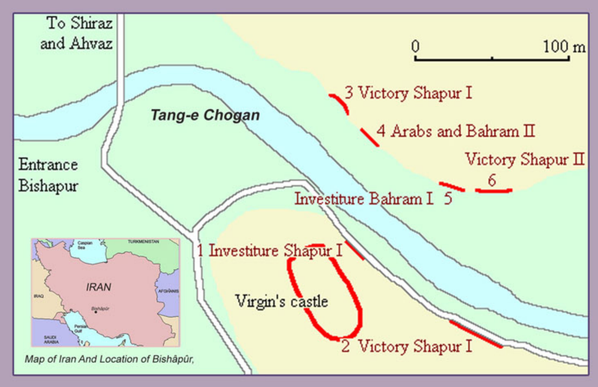


Figure3: Map of Bishapur's reliefs (Bishapur, Kazerun, Fars Province, Iran)
Coordinates: 29°46'40"N 51°34'15"E

Figure4: Relief depicting the triumph of Shapur over three Roman Emperors at a gorge made by the River Chogan just outside Bishapur

Figure5:The fifth Sasanian rock relief atBishapur is a classical representation of an investiture, this time of king Bahram I (273-296 AD).

Methodology

Due to Unspecified reasons, the fresh rock is dominated by black layers. In this study several experiments were carried out on the stone surface. (Fig.6)
Elemental analysis from X-ray fluorescence microscopy on samples shows carbon dioxide and organic matters, whereas the matrix is composed of Cao, Sio2, Fe2o3, and Mgo. Transmission electron microscopic observation showed that various types of lichens.(Table.1)

X-ray fluorescence spectrometry

LAB. NO.	276
Formula	Conc.%
L.O.I.	43.42
Na2o	<0.10
Mgo	0.61
Al2o3	0.26
Sio2	0.82
So3	0.07
K2O	0.03
Cao	54.46
Fe2o3	0.11
Wo3	0.11

Table 1 :mineral reconnaissance report

Data analysis:
L.O.I.: The materials discharging out of the exam are water and carbon dioxide and organic matters.
Cao: limestone or carbonate which involves in a large part of the sample.

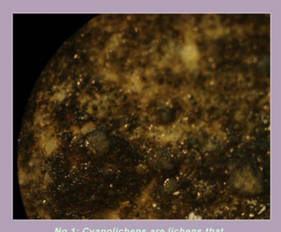
Figure.6: Rock Sampling

Result

Experimental results indicate that the formation of both minerals must be attributed essentially to the action of kinds of lichens and Cyanobacteria (Species :Lempholemmaisidioides + Thallinocarponnigritellum) which live and proliferate on the stone.(Table.2)
The rocky carving seems strong but is actually extremely sensitive to erosion caused by lichens, fungi, and bacteria. Water-adsorbing and microorganisms influence the mechanisms of the rock erosion.

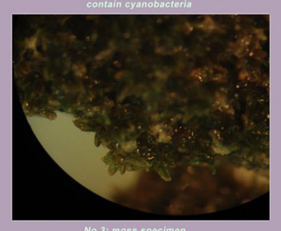
Table 2: Experimental Results

NO.	Species
No.1 is a cyan lichen	Lempholemmaisidioides
No.2 is a fused rock (clinker) + Cyanobacteria	Tuffa
No.3 is a bryophyte species	A moss specimen
No.4 is a bryophyte species	Grimmia
No.5 is two species from Cyanobacteria and free living fungi (Ascomycetes)	uncompleted for identification
No.6 is a cyanolichen	Lempholemmaisidioides
No.7 is a cyanolichen	Lempholemmaisidioides
No.8 is a cyanolichen	Lempholemmaisidioides + Thallinocarponnigritellum

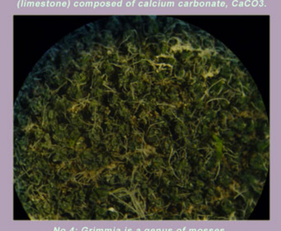


No.1: Cyanolichens are lichens that contain cyanobacteria

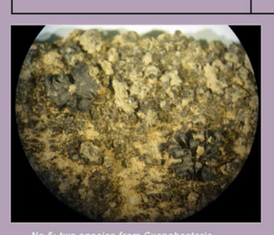
No.2: Tufa is a highly porous, sedimentary rock (limestone) composed of calcium carbonate, CaCO3.



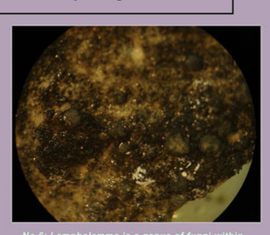
No.3: moss specimen



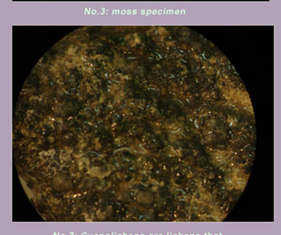
No.4: Grimmia is a genus of mosses



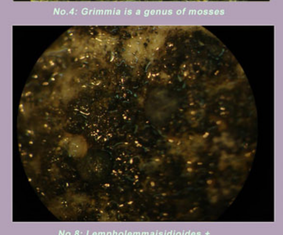
No.5: two species from Cyanobacteria and free living fungi



No.6: Lempholemma is a genus of fungi within the Lichinaceae family



No.7: Cyanolichens are lichens that contain cyanobacteria



No.8: Lempholemmaisidioides + Thallinocarponnigritellum

Conclusion

Since many lichens are frequently exposed to dry condition in nature, the change between dry and wet conditions may be an important process for the growth of lichens, recommended Cleaning method. There have been a number of newer products developed which will effectively remove all biological activity from stone without any risk of harming the stone itself. These types of cleaning products are known as biological cleaners.
An alternative media for non-abrasive blasting is water-ice, known as ice blasting.
Dry ice-blasting is a form of carbon dioxide cleaning, where dry ice, the solid form of carbon dioxide, is accelerated in a pressurized air stream and directed at a surface in order to clean it. This method is similar to other forms of abrasive blasting such as sand blasting. Proposed treatment for prevention of lichens erosion is removal by low-pressure Blast Cleaning technique by using Dry Ice.

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Corresponding author: Azadeh Ghobadi,
Ph.D. candidate,
Research fields: GIS and Cultural Heritage deterioration diagnosis.
Email: azadeh.ghobadi@yahoo.com.