

## BHANDARKHAL TANK LIONS

Report of the Institute of Conservation (IoC), University of Applied Arts Vienna

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Fig. 1: Overview of north lion after conservation in 2011

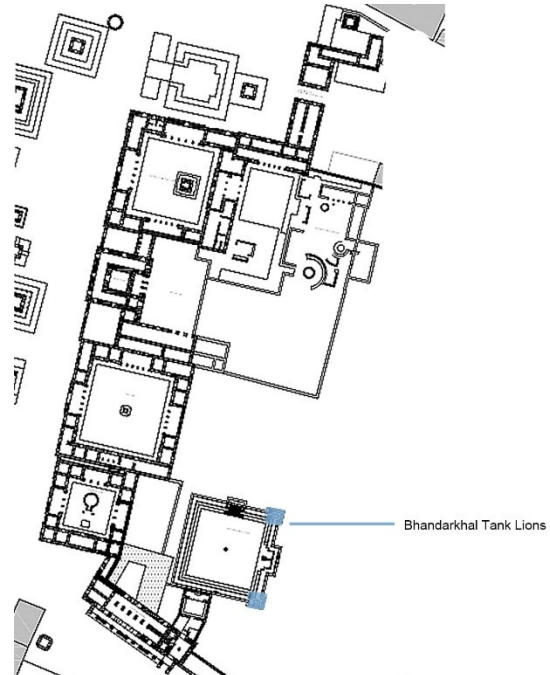


Fig. 2: Location within the Palace Complex

## Data Sheet

### Description

Bhandarkhal Tank is the focal element of the palace garden and measures about 16 by 16 metres. Dating back to 1674 (Malla era), the water basin is part of Patan's historic water infrastructure and was once the main water supply for the adjacent Royal Palace.

The tank is guarded by two stone lions, male and female, positioned at ground level at the corners of the east tank wall. Each of them is composed of more than fifty small sandstone blocks.

<b>Names</b>	Guardian-Lions (male lion located at the north, female lioness located at the south)	
<b>Dated</b>	1674 (?)	
<b>Measurements (H x W x D)</b>	Incl. plinth: 170 x 90 x 170 cm Without plinth: 130 x 60 x 165 cm	
<b>Materials/Technology</b>	Stone (blocks minimum size 20 x 20 x (?) cm), brick	
<b>Interventions (IoC)</b>	Survey	2011
	Mapping	-
	Sampling	2013 (mortar)
	Analyses	2013 (mortar)
	Conservation	2011
	Maintenance	2014
<b>Team (IoC)</b>	Gabriela Krist, Manfred Trummer, Marija Milchin, Lisa Gräber, Martina Haselberger, Katharina Fuchs	
<b>Academic Research (IoC)</b>	Pre-Thesis by Susanne Leiner	2010
	Diploma Thesis by Katharina Fuchs	2014

## Survey: Materials and Technology

- Constructed with more than 50 relatively small sized sandstone [1] blocks incl. base

## Previous (Conservation) Interventions

2010/11 Complete dismantling of the structures; renewal of platforms; introducing inox needles for reassembling; repointing with lime-brick dust mortar (done by KVPT)

## Survey: Condition and Causes of Decay (2011)

- Pressure of higher plants deranged stone blocks
- Open and cracked joints

## Conservation (IoC)

2011

- Removing damaged and unsatisfactory joint mortar until a depth of 3-4 cm
- Wet cleaning with brushes and water
- Biocide treatment (quaternary-ammonia-salts 2% in water), repeated 2-3 times
- Repointing of joints with mortar; locally available green pigment was added to adjust the colour (pigment was tempered in water and alcohol, fluid colour was then added to slaked lime before it was mixed with the brick dust); scratching-off of the joints to the surface level of the stone

### Conservation Materials\* and Recipes used:

- QUATS (quaternary-ammonia-salts 2% in water)

Joint mortar: 1 vol. part lime : 3 vol. parts brick dust

- Slaked lime (local)

- Brick dust 0-3 mm, finer parts with 0-1 mm and coarser ones with 0-3 mm grain size distribution (local)

- Pigment "Iron-oxide pigment – green" NCS S 2050-B80G (local)

\* Product / technical data sheets can be found in the supplement [A]



Fig. 3: Removal of former joints, 2011



Fig. 5: Pointed joints while wet, 2011

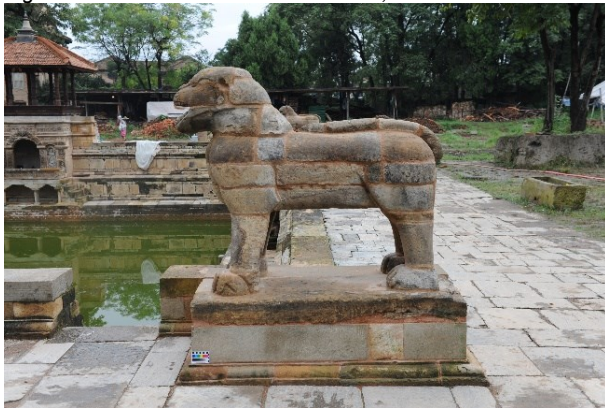


Fig. 4: Biocide treatment, 2011

## Before and after Conservation



*Fig. 6: Lioness before the conservation, 2011*



*Fig. 8: Lioness after the conservation, 2011*



*Fig. 7: Lion before the conservation, 2011*



*Fig. 9: Lion after the conservation, 2011*

## **List of Publications / Reports (IoC)**

Leiner, Susanne. 2010. "Der Pavillon am Bhandarkhal-Tank. Palastkomplex Patan, Nepal." Unpublished Pre-Thesis, University of Applied Arts Vienna.

Fuchs, Katharina. 2014. "The Royal Palace in Patan, Nepal. Evaluation of the Conservation Treatments and Recommendation for a Maintenance Program." Unpublished Diploma-Thesis, University of Applied Arts Vienna.

## **Supplements**

[A] All product / technical data sheets can be found in this additional document.

[1] Detailed material characterisation - sandstone

## **Photo Credits**

Unless otherwise stated, all photographs © Institute of Conservation, University of Applied Arts Vienna

**GENERAL INFORMATION**

**Monument**

Bhandarkhal Tank Lion

**Orientation**

North-east corner of Bhandarkhal  
Tank

**Size (H x L x W)**

With Plinth: 170 x 90 x 170 cm

**Date of Production**

1674 (?)

**Location**

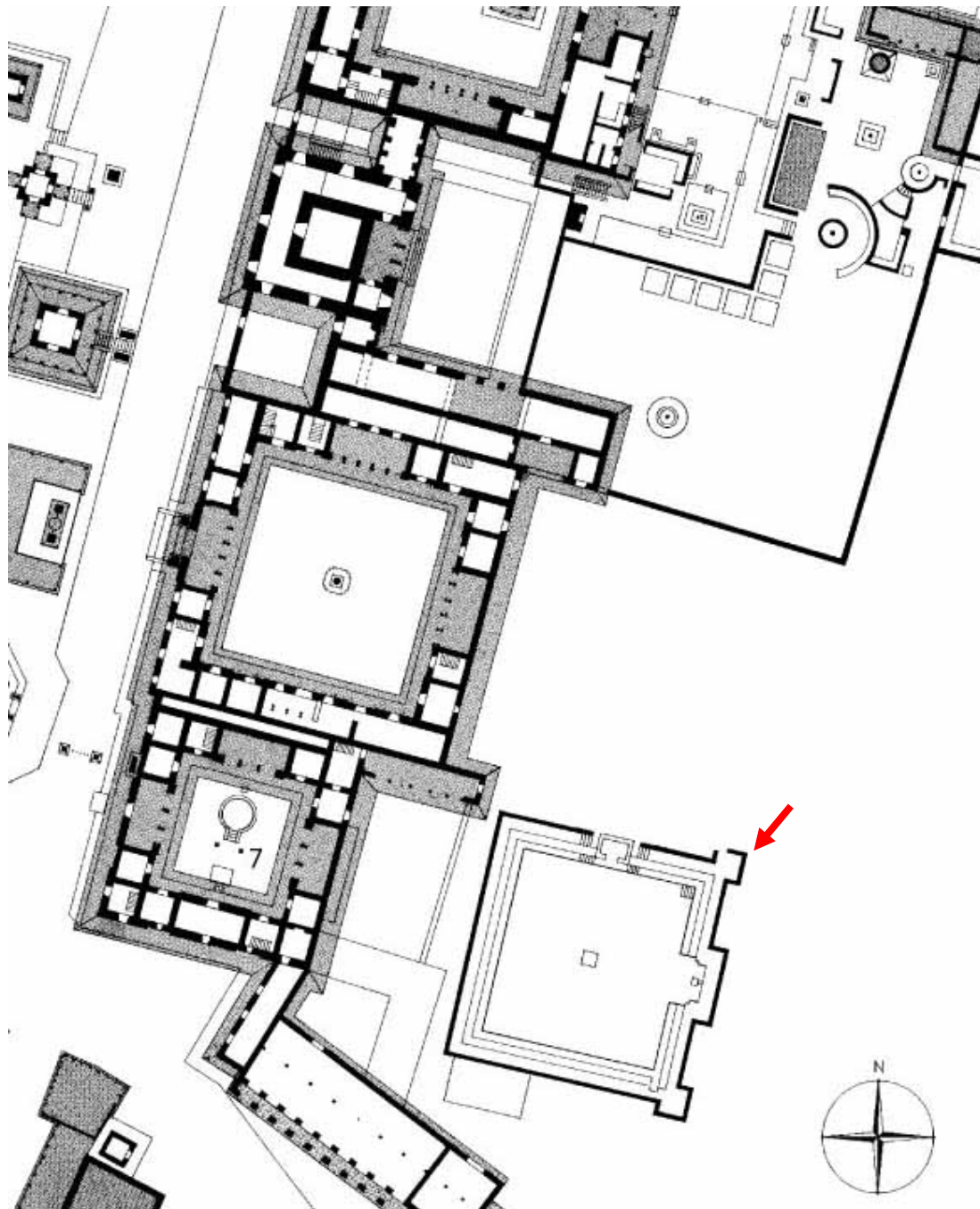
Royal Palace Gardens

**Date of the last Treatment**

Conservation 2011: see short report

**Institutions of the last Treatment**

IoC



**Condition Assessment**

**Date of Evaluation**

May 2024

**Evaluation done by**

Martina Haselberger

Fabian Sever

Sarah Moyschewitz

**Recent Damages:**

Stability Problems

Not detected

Major

Medium

Minor

Comment:

Broken / - into several Pieces

Not detected

Many

Some

Few

Comment:

Lose / Missing Parts

Not detected

Many

Some

Few

Comment:

Joints

Not detected

Open

Many

Some

Few

Only very thin joints are missing (Fig. 1).

Cracked

Many

Some

Few

Few joints are cracked at the stone border, also joints that simultaneously serve as a filling are occasionally cracked

Comment:

Scaling, Sanding or Powdering

Not detected

Major

Medium

	<input checked="" type="checkbox"/> Minor	Scaling at left front foot. Surface hardening on the underside of the lion which contributed to or was the reason for scaling; scaling may have also been caused by salt deterioration (Fig. 2).
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Comment:

<input checked="" type="checkbox"/> Biological Colonization  <input type="checkbox"/> Not detected	<input checked="" type="checkbox"/> Microbiological Growth	<input type="checkbox"/> Major	
	<input type="checkbox"/> Not detected	<input checked="" type="checkbox"/> Medium	Present mostly on joints, but also occasionally on the stone surface (Fig. 3).
		<input type="checkbox"/> Minor	
	<input checked="" type="checkbox"/> Mosses/ Lichens	<input type="checkbox"/> Major	
	<input type="checkbox"/> Not detected	<input type="checkbox"/> Medium	
		<input checked="" type="checkbox"/> Minor	Lichens are found mostly on the upper side, mosses all over (Fig. 4).
	<input type="checkbox"/> Higher Plants	<input type="checkbox"/> Major	
	<input checked="" type="checkbox"/> Not detected	<input type="checkbox"/> Medium	
		<input type="checkbox"/> Minor	

Comment:

<input checked="" type="checkbox"/> Mechanical Damage  <input type="checkbox"/> Not detected	<input type="checkbox"/> Abrasion	<input type="checkbox"/> Major	
	<input checked="" type="checkbox"/> Not detected	<input type="checkbox"/> Medium	
		<input checked="" type="checkbox"/> Minor	
	<input checked="" type="checkbox"/> Other	<input type="checkbox"/> Major	
		<input type="checkbox"/> Medium	
		<input type="checkbox"/> Minor	

Comment:

<input checked="" type="checkbox"/> Salt Deterioration  <input type="checkbox"/> Not detected	<input checked="" type="checkbox"/> Efflorescence	<input type="checkbox"/> Major	
	<input type="checkbox"/> Not detected	<input type="checkbox"/> Medium	
		<input checked="" type="checkbox"/> Minor	Subflorescence on the underside of the lion caused minor scaling and powdering.

	<input checked="" type="checkbox"/> Subflorescence <input type="checkbox"/> Not detected	<input type="checkbox"/> Major <input type="checkbox"/> Medium <input checked="" type="checkbox"/> Minor	<hr/> <hr/> <hr/>
Comment:			
<input checked="" type="checkbox"/> Soiling <input type="checkbox"/> Not detected	<input type="checkbox"/> Heavy <input type="checkbox"/> Medium <input checked="" type="checkbox"/> Light		<hr/> <hr/> <p>Light soiling present, mostly bird droppings</p>
Comment:			
<input type="checkbox"/> Other	Comment:		

**Evaluation of the Condition**

- good (no need for treatment)
- satisfactory (some minor treatments necessary)
- unsatisfactory (major conservation measures necessary)

**Conclusion**

The joint mortar is in good condition, although some cracks along the edges are present.

General surface condition is good, but there is more biological growth and soiling than on the pavilion base.

Inox pins are in good condition

The south east lion is in similar condition, although some more biological growth, open joints and sanding and flaking of one stone block at the lion's chest are present.

**PHOTO DOCUMENTATION**

**Condition at Evaluation Date**



Fig. 1: Thin joint section open.

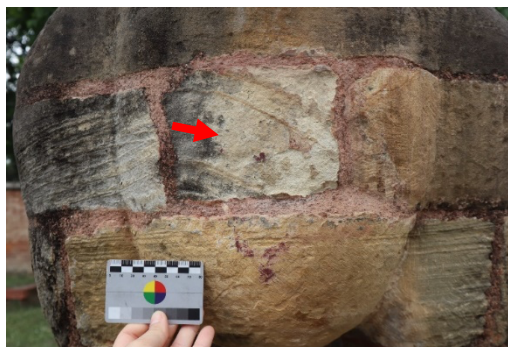


Fig. 2: Scaling/Sanding.

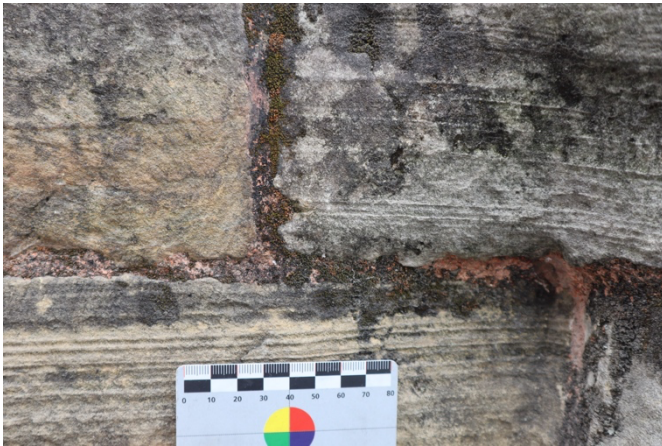


Fig. 3: Microbiological growth on the joints.



Fig. 4: Microbiological growth and lichen on the top part.



Fig. 4: South side of north-east lion.



Fig. 5: North side of north-east lion.

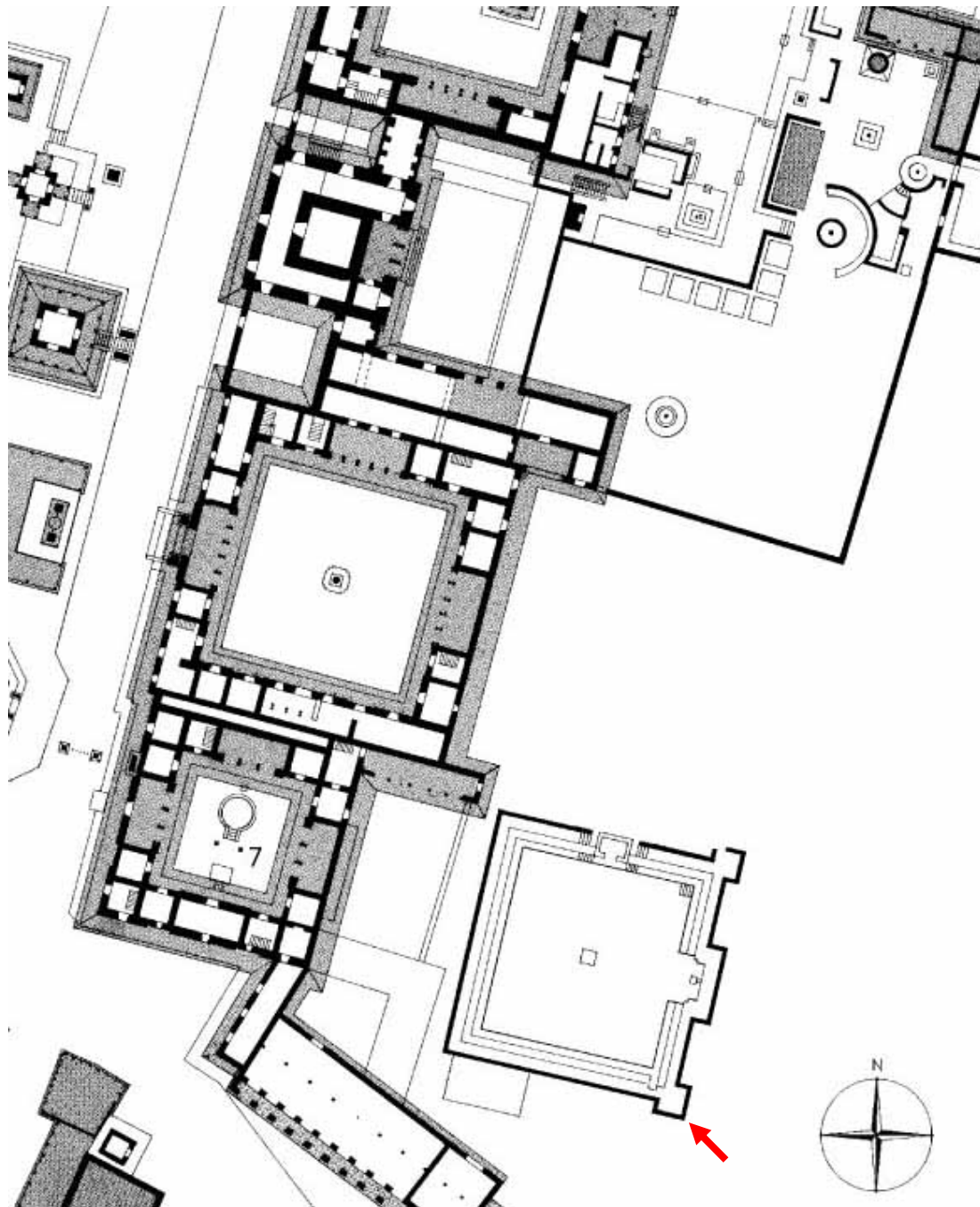


Fig. 6: East side of north-east lion.



Fig. 7: West side of north-east lion.

GENERAL INFORMATION		
<b>Monument</b> Bhandarkhal Tank Lions	<b>Orientation</b> South east corner of Bhandarkhal Tank	<b>Size (H x L x W)</b> With Plinth: 170 x 90 x 170 cm
<b>Date of Production</b> 1674 (?)	<b>Location</b> Royal Palace Gardens	
<b>Date of the last Treatment</b> Conservation 2011: see short report	<b>Institutions of the last Treatment</b> IoC	



**Condition Assessment**

**Date of Evaluation**

May 2024

**Evaluation done by**

Martina Haselberger

Fabian Sever

Sarah Moyschewitz

**Recent Damages:**

Stability Problems

Not detected

Major

Medium

Minor

Comment:

Broken / - into several Pieces

Not detected

Many

Some

Few

Comment:

Lose / Missing Parts

Not detected

Many

Some

Few

Comment:

Joints

Not detected

Open

Cracked

Many

Some

Few

Many

Some

Few

Very thin joints are missing

Few cracked joints, along the border to the stone; joints that also serve as a filling are occasionally cracked

Comment:

Scaling, Sanding or Powdering

Not detected

Major

Medium

Minor

Minor scaling of the stone surface at left front foot of the lion. Hardened surface is present on the under-

side which contributed to or was the reason for the scaling; this may also have been caused by salt deterioration

Comment:

Biological Colonization

Not detected

Microbiological Growth

Mosses/ Lichens

Higher Plants

Major

Medium

Minor

Major

Medium

Minor

Major

Medium

Minor

Joints and stone surface are minorly affected by biological growth

Lichens were found at the upper side of the lion, mosses all over

Comment:

Mechanical Damage

Not detected

Abrasion

Other

Major

Medium

Minor

Major

Medium

Minor

Fine scratches, maybe due to the usage of not suitable tools for surface cleaning

Comment:

Salt Deterioration

Not detected

Efflorescence

Subflorescence

Major

Medium

Minor

Major

Medium

		<input checked="" type="checkbox"/> Minor	Subflorescence led to light scaling and powdering on the underside of the lion
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Comment:

<input checked="" type="checkbox"/> Soiling <input type="checkbox"/> Not detected	<input type="checkbox"/> Heavy <input type="checkbox"/> Medium <input checked="" type="checkbox"/> Light	Light soiling due to bird droppings
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Comment:

<input type="checkbox"/> Other	Comment:
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**Evaluation of the Condition**

- good (no need for treatment)
- satisfactory (some minor treatments necessary)
- unsatisfactory (major conservation measures necessary)

**Conclusion**

**The joint mortar is in good condition, although some cracks along the edges are present.  
The overall surface condition is good, but more biological growth and soiling than on the pavilion base is present.  
Inox pins are in good condition**

**PHOTO DOCUMENTATION**

**Condition at Evaluation Date**



Fig. 1: North side of the south east lion.



Fig. 2: South side of the south east lion.



Fig. 3: West side of the south east lion.



Fig. 4: East side of the south east lion.

## [A] Product Data Sheets – Links<sup>1</sup> to Suppliers/Manufacturers

AEROSIL® 200

[https://products.evonik.com/assets/or/ld/AEROSIL\\_200\\_TDS\\_DE\\_DE\\_TDS\\_PV\\_52043839\\_de\\_DE\\_WORLD.pdf](https://products.evonik.com/assets/or/ld/AEROSIL_200_TDS_DE_DE_TDS_PV_52043839_de_DE_WORLD.pdf)

Aviva Silikat Grundierung

[https://www.adler-lacke.com/Canto/tmb/aviva-silikat-grundierung\\_tmb\\_4079\\_de.pdf](https://www.adler-lacke.com/Canto/tmb/aviva-silikat-grundierung_tmb_4079_de.pdf)

Alkylbenzyltrimethylammonium chloride

<https://www.sigmaaldrich.com/AT/en/sds/mm/8.14858?userType=anonymous>

KluceI™ EF

<https://www.kremer-pigmente.com/elements/resources/products/files/63701-63713.pdf>

Aviva Tirokat-Color, Adler

[https://www.adler-lacke.com/Canto/tmb/aviva-tirokat-color\\_tmb\\_4087\\_de.pdf](https://www.adler-lacke.com/Canto/tmb/aviva-tirokat-color_tmb_4087_de.pdf)

Mixtion Le Franc, Kremer

<https://shop.kremerpigments.com/elements/resources/products/files/98000e.pdf>

Waxes, Deffner und Johann

[https://deffner-johann.de/media/datasheets/4186000/EN/Zusatzinformation\\_Wachse\\_DE\\_DJ.PDF](https://deffner-johann.de/media/datasheets/4186000/EN/Zusatzinformation_Wachse_DE_DJ.PDF)

Injection mortar HFX

[https://productdata.hilti.com/APQ\\_HC\\_RAW/ASSET\\_DOC\\_7567931.pdf](https://productdata.hilti.com/APQ_HC_RAW/ASSET_DOC_7567931.pdf)

Köln Classic Ölmixtion 3h; 12h; 24h

<https://www.kolner-vergolderprodukte.de/produkte/koelner-oelmixtion/>

KSE 500 E

[https://media.remmers.com/celum/export/documents/Remmers\\_0715\\_KSE-500-E-\\_Technisches-Merkblatt\\_de\\_DE\\_26355.pdf](https://media.remmers.com/celum/export/documents/Remmers_0715_KSE-500-E-_Technisches-Merkblatt_de_DE_26355.pdf)

Lascaux 498 20 X acrylic adhesive

[https://deffner-](https://deffner-johann.de/media/datasheets/2051100/DE/2051100_Technisches%20Datenblatt_Lascaux%20Acrylkleber%20498%2020%20X_DE_DJ.pdf)

[johann.de/media/datasheets/2051100/DE/2051100\\_Technisches%20Datenblatt\\_Lascaux%20Acrylkleber%20498%2020%20X\\_DE\\_DJ.pdf](https://deffner-johann.de/media/datasheets/2051100/DE/2051100_Technisches%20Datenblatt_Lascaux%20Acrylkleber%20498%2020%20X_DE_DJ.pdf)

Marble dust

[https://www.kremer-pigmente.com/elements/resources/products/files/58500-58580\\_59001-59690.pdf](https://www.kremer-pigmente.com/elements/resources/products/files/58500-58580_59001-59690.pdf)

Natural hydraulic lime

<https://www.preservationworks.us/wp-content/uploads/2019/10/NHL-Datasheet-Lafarge-23.5.pdf>

Plextol B-500 (acrylic dispersion)

[https://deffner-](https://deffner-johann.de/media/datasheets/2556500/DE/2556500_Technical%20Data%20Sheet_Acrylic%20Dispersion%20B%20500_EN_DJ.pdf)

[johann.de/media/datasheets/2556500/DE/2556500\\_Technical%20Data%20Sheet\\_Acrylic%20Dispersion%20B%20500\\_EN\\_DJ.pdf](https://deffner-johann.de/media/datasheets/2556500/DE/2556500_Technical%20Data%20Sheet_Acrylic%20Dispersion%20B%20500_EN_DJ.pdf)

Primal® SF 016

[https://deffner-](https://deffner-johann.de/media/datasheets/2543001/DE/2543001_Technical_Data_Sheet_Primal_SF_016_DJ_EN.pdf)

[johann.de/media/datasheets/2543001/DE/2543001\\_Technical\\_Data\\_Sheet\\_Primal\\_SF\\_016\\_DJ\\_EN.pdf](https://deffner-johann.de/media/datasheets/2543001/DE/2543001_Technical_Data_Sheet_Primal_SF_016_DJ_EN.pdf)

AKEPOX® 2010

[https://data.akemi.de/fileadmin/user\\_upload/products/productdocuments/TMB/Akepox\\_2010\\_TMB\\_D.pdf](https://data.akemi.de/fileadmin/user_upload/products/productdocuments/TMB/Akepox_2010_TMB_D.pdf)

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<sup>1</sup> All links were last accessed on 13 May 2025.

EPO-TEK® 301-1

<https://www.epotek.com/docs/en/Datasheet/301-1.pdf>

Titebond Wood Glue

<http://sds.franklini.com/msds/1411.042k0nmo0020.pdf>

Paraloid™ B-72, Kremer

<https://www.kremer-pigmente.com/elements/resources/products/files/67400-67409.pdf>

Keim Granital®

[https://www.keim.com/documents/de-AT/723/TM\\_Granital\\_DE-AT.pdf](https://www.keim.com/documents/de-AT/723/TM_Granital_DE-AT.pdf)

<b>[1]“Sandstone”</b>	
<b>Visual characteristics</b>	<ul style="list-style-type: none"> <li>- Fine and homogenous grain structure</li> <li>- Whitish to ochre colour</li> </ul>
<b>Samples taken (sample names and origin)</b>	<ul style="list-style-type: none"> <li>- <b>KAT2</b>, (Leiner 2010) Bhandarkhal Tank Pavilion Base (Fig. 3, 4)</li> <li>- <b>KRP Original</b> (Fuchs 2013), Stone Gate, Patan Darbar Square (Fig. 5–9)</li> </ul> <p>Cross and thin sections of the samples were prepared and examined with light microscopy and SEM.</p> <p><b>Sources:</b>  Leiner, Susanne. 2010. "Der Pavillon am Bhandarkhal-Tank. Palastkomplex Patan, Nepal." Pre-thesis, University of Applied Arts Vienna.  Fuchs, Katharina. 2013. "Bitumen Coating on Stone, a Nepalese Problem? The Conservation of Two Stone Relief Gates at the Nasal Chowk, Patan Royal Palace." Pre-thesis, University of Applied Arts Vienna.</p>
<b>Petrographic/geological characterization</b>	<ul style="list-style-type: none"> <li>- quartz sandstone ("arkose" sandstone)</li> <li>- rich in feldspar</li> <li>- silica grains angular, interlocked and covered by layers of iron oxides/hydroxides and clay</li> <li>- clayey binder (contains mostly sheet silicates)</li> <li>- different amounts of iron-compounds with sheet structure</li> <li>- fine grained with average grain size of 50 µm, coarse grain fraction with 250 µm</li> </ul>
<b>Physical properties</b>	<ul style="list-style-type: none"> <li>- varying porosity but in general highly porous, 20–25% porosity (Leiner 2010, S. 62), intergranular porosity</li> <li>- capillary active</li> <li>- varying colours and weathering behaviour due to different clay and iron content</li> <li>- homogenous structure with some bedding</li> <li>- relatively soft</li> </ul>
<b>Use at Patan Darbar Square</b>	<p>Scientifically confirmed:</p> <ul style="list-style-type: none"> <li>- Stone Gates</li> <li>- Bhandarkhal Tank</li> </ul> <p>By visual inspection only:</p> <ul style="list-style-type: none"> <li>- Harishankara temple base</li> <li>- Vishveshvara temple base and elephants</li> <li>- Krishna Mandir</li> <li>- Tusha Hiti</li> <li>- Mul Chowk Lions</li> </ul>
<b>Origin of material</b>	<ul style="list-style-type: none"> <li>- unknown</li> </ul>



Fig. 1: Visual inspection of the sandstone from Bhandarkhal Tank Pavilion Base, © IoC 2010.

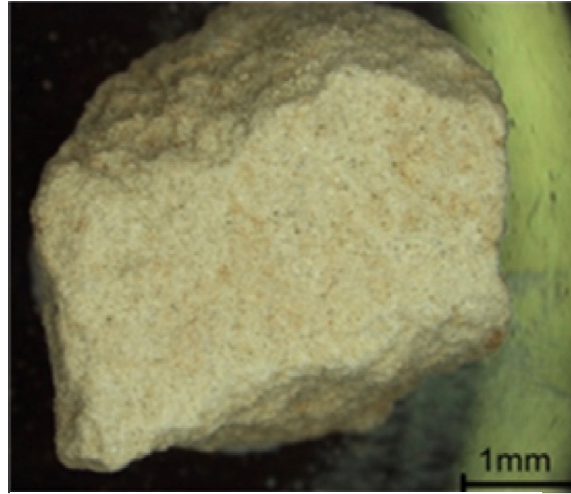


Fig. 2: Visual inspection of the sandstone from Bhandarkhal Tank Pavilion Base, © IoC 2010.

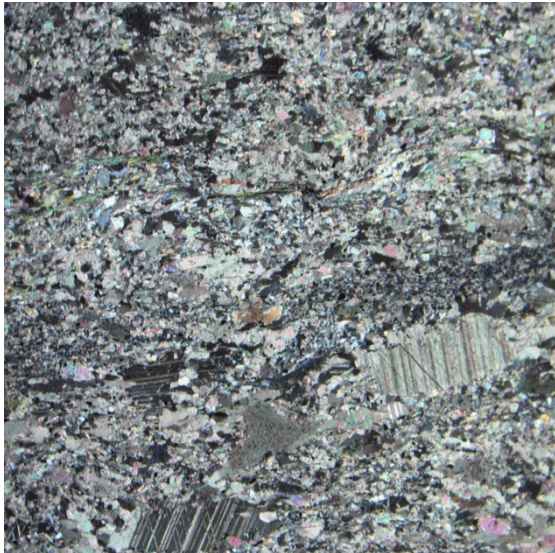


Fig. 3: Sample KAT2, thin section, optical microscopy, polarized light, x24.



Fig. 4: Sample KAT2, thin section, optical microscopy, transmitted light, x24.

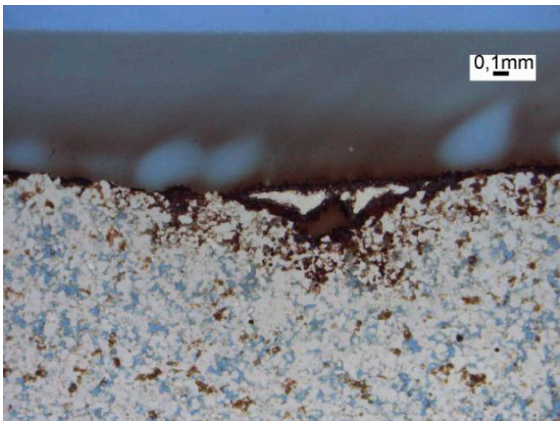


Fig. 5: Sample KRP Original, polished thin section, stereo microscope (Nikon SMZ 1500), reflected light, polarized light. The sample shows stone with bitumen coating.

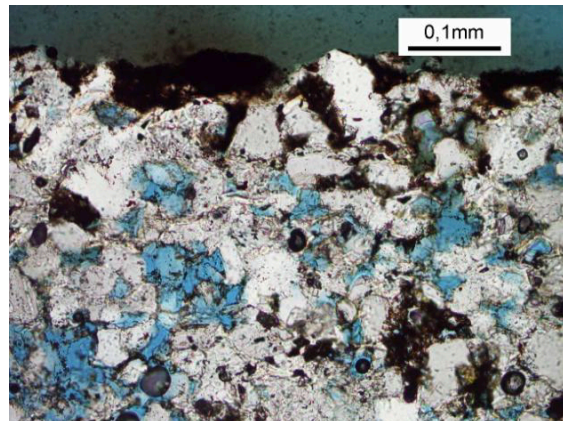


Fig. 6: Sample KRP Original, polished thin section, stereo microscope (Nikon SMZ 1500), reflected light, polarized light. The sample shows stone with bitumen coating.

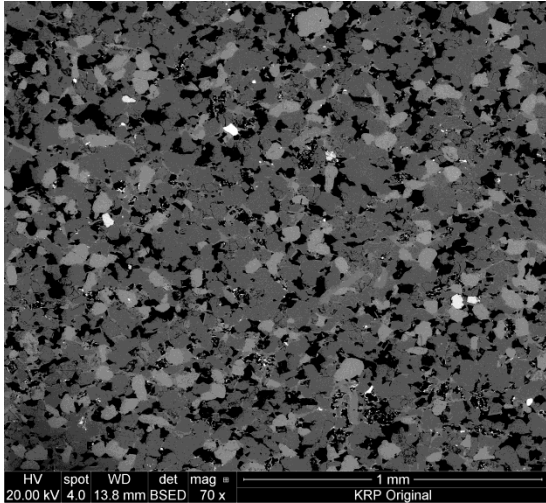


Fig. 7: Sample KRP Original, SEM; description: black = pores, dark grey = quartz, light grey = feldspar, white spots= Fe-(hydr)oxides.

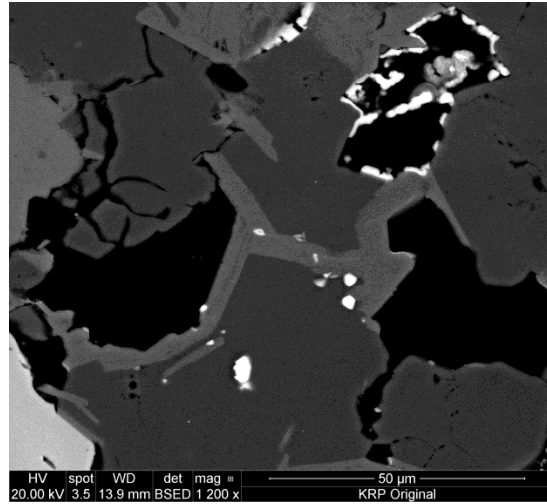


Fig. 8: Sample KRP Original, SEM; description: black = pores, dark grey = quartz, light grey = feldspar, white spots= Fe-(hydr)oxides.

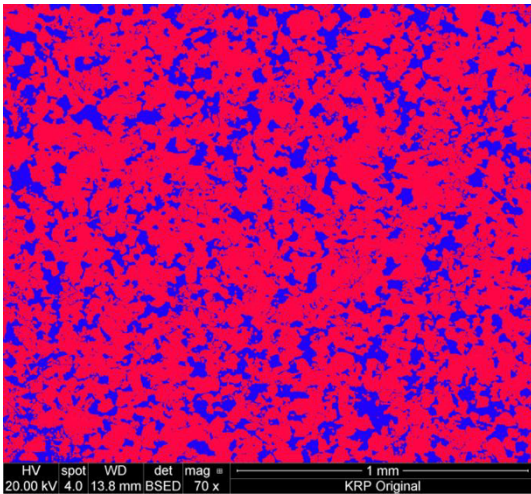


Fig. 9: Sample KRP Original, SEM photo of thin section in false colours (red = grains, blue = pores).