

## STONE GATES

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



Fig. 1: Gate A before conservation, 2010

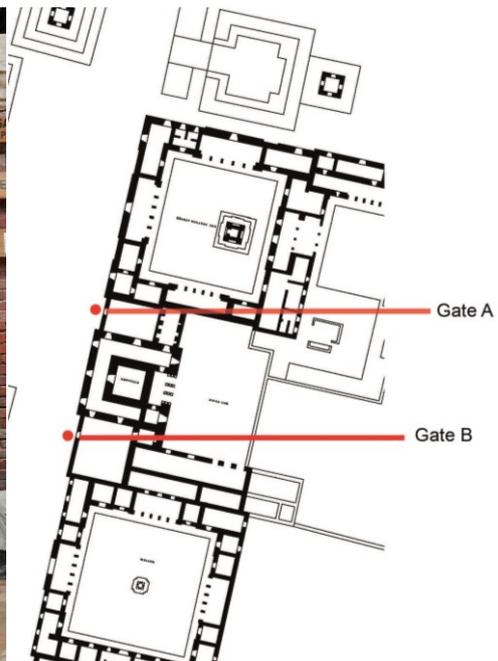


Fig. 2: Location within the Patan Royal Palace

## Data Sheet

### Description

The two Relief Gates are part of the Royal Palace located on either side of the Degutale Temple. They consist of finely carved stone blocks that feature rare Malla-period bas-reliefs dating back to the 17th century. Only very few stone gates survived from this period in the Kathmandu Valley: two other examples can be found in the Darbar Squares of Kathmandu and Bhaktapur.

Both gates collapsed in the 1934 earthquake and were then reassembled, unfortunately disarranged. Later, they suffered from inadequate restoration efforts and were covered with a bituminous coating, which caused damage to the stone matrix. The courtyards behind were closed to the public and either filled with debris or used as garbage dump and latrine.

<b>Names</b>	Relief Gates, Stone Relief Gates	
<b>Dated</b>	Between 1640-1734	
<b>Measurements (H x W x D)</b>	Gate A consists of 14 fine carved stone blocks	
	Gate B consists of 18 fine carved stone blocks	
	Seize of stone blocks Ø (HxWxD, 30-40 x 29-40 x 14-20 cm)	
<b>Materials/Technology</b>	Stone, bitumen coating	
<b>Interventions (IoC)</b>	Survey	2011-12
	Mapping	2012-2013
	Sampling	2012
	Analyses	2012-2013
	Conservation	2012-2014
	Maintenance	2013-2014
<b>Team (IoC)</b>	Gabriela Krist, Katharina Fuchs, Martina Griesser-Stermscheg, Manfred Trummer, Marija Milchin, Lisa Gräber, Kathrin Schmidt	
<b>Academic Research (IoC)</b>	Pre-Thesis Katharina Fuchs	2013
	Diploma Thesis Katharina Fuchs	2014

### Survey: Materials and Technology

- Gate constructions are integrated in brick masonry
- Inner profile cell of the gate is made out of calcitic schist [2]
- Fine carved stone blocks are made out of sandstone [1] showing deities and guarding animals
- Visible work marks (e.g., flat chisel) on the sandstone
- Stone blocks with guarding animals in the low area have immersions at the bottom and flat dowels at the top
- Joints filled with cement mortar (later addition)



Fig. 3: Stone dowel at the top, 2012



Fig. 4: Fine carved ornaments with pigments (worshipping), 2012



Fig. 5: Work marks at the front side, 2012



Fig. 6: Work marks at the side face, 2012

## Previous (Conservation) Interventions

Unknown	Application of bitumen coating (bituminous material, probably tar or asphalt) on all surfaces
Unknown	Application of cement mortar for joints and infills
Unknown	Partial re-carving of surfaces
After 1934	Re-assembling of both gates after their collapse in the earthquake in a different manner/order and introduction of different stones not belonging to the gates

## Survey: Condition and Causes of Decay (2012)

- Missing parts
- Bursted parts at exposed areas
- Salt deterioration appearing as surface loss through sanding, flaking and scaling of the first stone grain layers; salt crystallization beneath the water repellent layer (bituminous coating)
- Cement joints and infills and partial cement layer over surfaces
- Biological colonisation
- Soiling
- Most of damage (e.g., sanding, scaling, flaking, biological colonisation) accelerated by impaired drying behaviour and retention of water mainly caused by too dense joint mortar and bituminous coating



Fig. 7: Bituminous coating, scaling due to salinisation, 2012



Fig. 8: Surface loss due to salinization, 2012



Fig. 9: Bursted edges due to inappropriate handling, 2012



Fig. 10: Losses on exposed parts, 2012



Fig. 11: Biological growth in protected areas, 2012

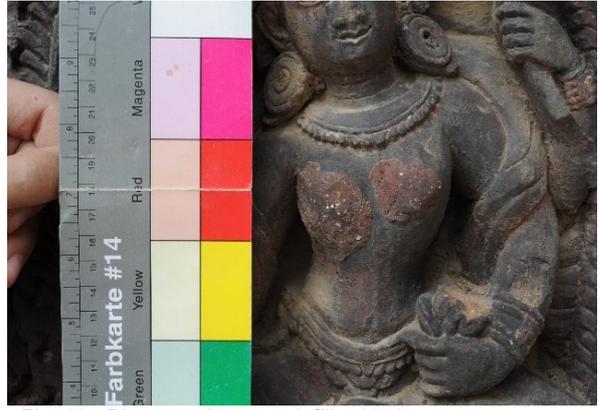


Fig. 12: Pigmented cement infills, 2012



Fig. 13: Scaling of grain layers, 2012



Fig. 14: Peeling of first grain layers, 2012

## Conservation (IoC)

- 2012
- Dismantling both gates (done by the KVPT) to enable treatment of all sandstone blocks
  - Cleaning with water and brushes
  - Mechanical removal of cement layers with hammer and chisel
  - Mechanical removal of thick layers of bitumen with spatulas and scalpels
  - Cleaning with acetone and acetone-poultices (cotton soaked with acetone and covered with aluminium foil)
  - Biocide treatment with QUATS (solved in water 1:10), applied twice with an application time of 12-24 hours, cleaning with water afterwards
  - Desalination bath with collected rain water
  - Re-construction of missing parts (done by the stonemason of the KVPT); one element (pinnacle) was made completely new, at other blocks missing parts were replaced in stone and glued with a local two-component adhesive glue
  - Gluing of loose parts with a local two-component adhesive glue
  - Re-assembling with inox cramps within the masonry structure while leaving an air gap for faster drying of the stone blocks
  - Re-assembling the single carved blocks with inox needles to each other; re-assembling was done according to the original position (before 1934)
  - Pointing joints with mortar made out of lime and brick dust powder
  - Final cleaning with water

**Conservation Materials\* and Recipes used:**

- QUATS (quaternary-ammonia-salts 1:10 in water)
- Acetone
- Inox clamps and needles
- local two-component adhesive glue

**Joint Mortar: lime (local), brick dust (local), sand (local), ratio unknown**

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

- 2013
- South Gate:**
- Cleaning with Acetone and brushes
  - Laser cleaning with modified Laser Eos 1000 LQS (in cooperation with Dr. Alessandro Zanini, El.En group) to reduce bituminous coating
  - Biocide treatment of joints with QUATS (solved 3% in water)
  - Re-pointing of joints with cracked or porous mortar
  - Retouching of stone blocks in low area (which could not be cleaned to a satisfactory level) with pigmented silicate paint
  - Retouching of joints with pigmented silicate paint
  - Retouching of newly made stone blocks (2012) with pigments dispersed in ethanol and fixed with Ethylsilicate (Funcosil)

**Conservation Materials\* and Recipes used:**

- QUATS (quaternary-ammonia-salts 3% in water)
- Acetone
- Ethanol
- Funcosil 500 E (Remmers), diluted 1:1 with ethanol
- Silicate paint Granital (Keim)
- Pigments Yellow Ochre, Umbra burnt greenish, Charcoal Black, Sienna burnt (Clavé Feinste Künstlerpigmente)

**Joint Mortar: 1 vol. lime : 3 vol. parts brick dust**

- lime (local)
- brick dust (local)

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

- 2014
- North Gate:**
- Cleaning with Acetone and brushes
  - Laser cleaning with Thunder art high power Q-switched Nd-Yag Laser from Quanta Systems (in cooperation with Dr. Alessandro Zanini, El.En group) to reduce bituminous coating
  - Mechanical removal of all joint mortar with hammer and chisel
  - Re-pointing of all joints to the level of the surrounding stone

- Retouching of stone blocks (which could not be cleaned to satisfactory level) with pigmented silicate paint
- Retouching of newly made stone blocks (2012) with pigment dispersed in Acetone and fixed with Ethylsilicate (TEOS, Funcosil)

**Conservation Materials\* and Recipes used:**

- Acetone
- TEOS Funcosil 500 E (Remmers)
- Silicate paint Adler Silikatfarbe GW, mixed with Adler Triokat Color W 19 and water (1:1)
- Pigment Terre Naturali (Clavé Feinste Künstler Pigmente)

**Joint Mortar: 2/3 vol. lime : 1/3 vol. part cement : 2 ½ vol. parts sand : ½ vol. part brick dust**

- slaked lime (local)
- grey cement
- brick dust (local)
- sand (local)

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



Fig. 15: Dismantling of the gate, 2012



Fig. 16: Removal of cement with hammer and chisel, 2012



Fig. 17: Wet cleaning with collected rain water, 2012



Fig. 18: Removal of thick bitumen layers with scalpel, 2012



Fig. 19: Removal of bitumen by using acetone /-poultices, 2012



Fig. 20: Missing half replaced in stone (bright area), 2012



Fig. 21: Missing part replaced in stone (bright area), 2013



Fig. 22: Missing part replaced in stone (bright area), 2013



Fig. 23: Air gap and cramps during re-assembling, 2012



Fig. 24: Pointing joints with lime-brick dust mortar, 2012



Fig. 25: Intermediate status, 2012



Fig. 26: Laser cleaning, 2013



Fig. 27: Detail laser cleaning before (r.) and after (l.), 2013

Before and after Conservation



Fig. 28: Gate A before conservation, 2010

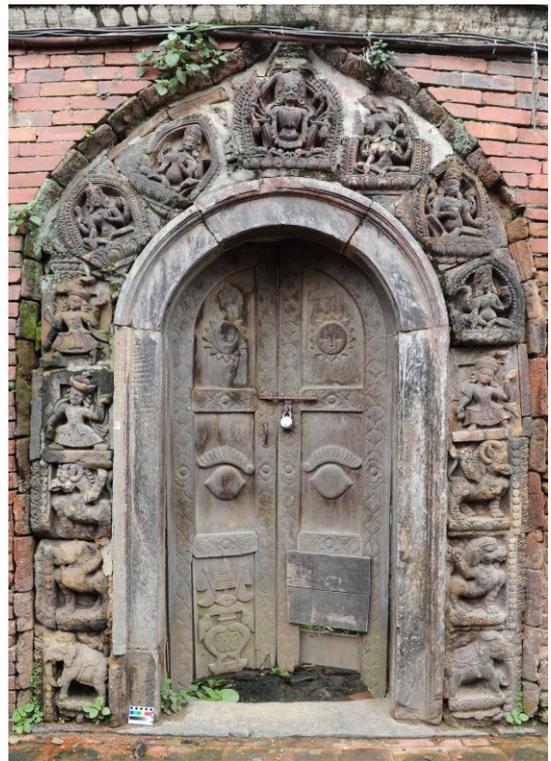


Fig. 29: Gate B before conservation, 2010



Fig. 30: Gate A after conservation, 2014



Fig. 31: Gate B after conservation, 2014

## List of Publications / Reports (IoC)

Fuchs, Katharina. 2013. "Bitumen Coating on Stone, a Nepalese Problem? The Conservation of Two Stone Relief Gates at the Nasal Chowk, Patan Royal Palace." Unpublished Pre-Thesis, University of Applied Arts Vienna.

Fuchs, Katharina, Krist, Gabriela, and Marija Milchin. 2015. "Bündellicht und Feuer - Laserreinigung zweier Steinreliefportale eines Palastes in Nepal." *Restauro* 4: 38-45.

Fuchs, Katharina, and Alessandro Zanini. 2014. "The Stone Gates of the Royal Palace in Patan (Nepal): A Peculiar Cleaning Problem Solved by the use of Laser." In *Proceedings of the International Conference on Conservation of Stone and Earthen Architectural Heritage 2014*, edited by the Chan Hee Lee, Jiyoung Kim and Ran Hee Kim, 185-192. The Graduate School of Cultural Heritage, Kongju National University, Republic of Korea: Kongju.

## Supplements

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

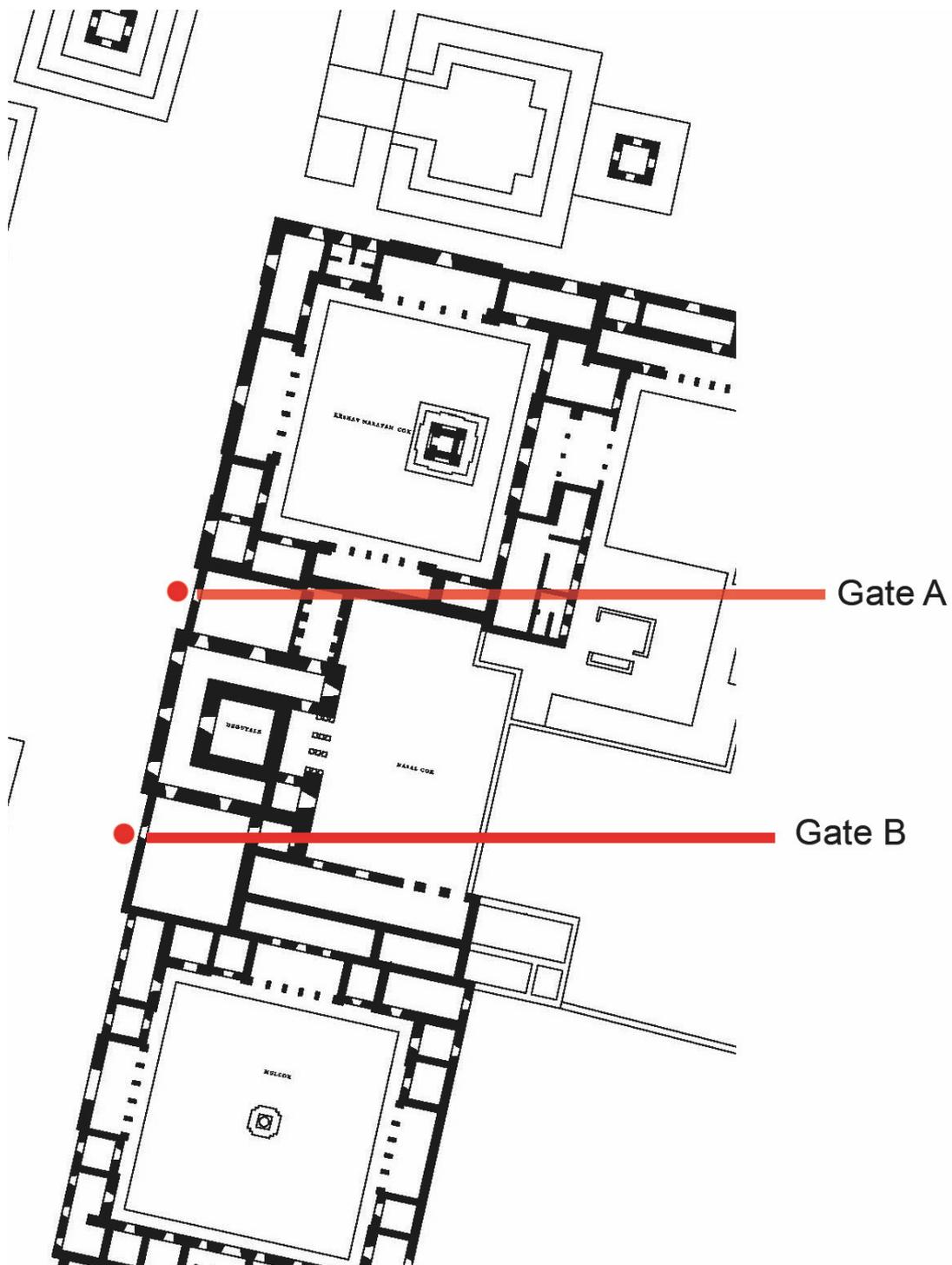
[1] Detailed material characterisation - sandstone

[2] Detailed material characterisation - calcitic schist

## Photo Credits

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

GENERAL INFORMATION		
<b>Monument</b> Stone Gates (Gate A)	<b>Orientation</b> -	<b>Size (H x L x W)</b> -
<b>Date of Production</b> 1640-1734	<b>Location</b> Flanking Degutale Temple	
<b>Date of the last Treatment</b> Conservation 2012-2014	<b>Institutions of the last Treatment</b> IoC	



**Condition Assessment**

**Date of Evaluation**

May 2024

**Evaluation done by**

Martina Haselberger  
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

Split off areas / missing parts – old?

From left to right:

Second element piece at the left upper corner

broken that was already glued? Glue still intact (Fig. 1, 2).

6<sup>th</sup> element, lotus seat at blossom (Fig. 3).

8<sup>th</sup> element, breast area (Fig. 4)

10<sup>th</sup> element head (Fig. 5)

11<sup>th</sup> element, head and right leg (Fig. 6)

Comment:

Joints

Not detected

Open

Cracked

Many

Some

Few

Many

Thin joints (Fig. 7)

		<input checked="" type="checkbox"/> Some <input type="checkbox"/> Few	At the borders to the stone (Fig. 8)
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Comment:

<input type="checkbox"/> Scaling, Sanding or Powdering <input checked="" type="checkbox"/> Not detected	<input type="checkbox"/> Major <input type="checkbox"/> Medium <input type="checkbox"/> Minor		
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Comment:

<input checked="" type="checkbox"/> Biological Colonization <input type="checkbox"/> Not detected	<input type="checkbox"/> Microbiological Growth  <input checked="" type="checkbox"/> Mosses  <input type="checkbox"/> Higher Plants	<input type="checkbox"/> Major <input type="checkbox"/> Medium <input type="checkbox"/> Minor  <input type="checkbox"/> Major <input type="checkbox"/> Medium <input checked="" type="checkbox"/> Minor  <input type="checkbox"/> Major <input type="checkbox"/> Medium <input type="checkbox"/> Minor	    At the bottom of the element on top of the arch.
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Comment:

<input checked="" type="checkbox"/> Mechanical Damage <input type="checkbox"/> Not detected	<input type="checkbox"/> Abrasion  <input checked="" type="checkbox"/> Other	<input type="checkbox"/> Major <input type="checkbox"/> Medium <input type="checkbox"/> Minor  <input type="checkbox"/> Major <input checked="" type="checkbox"/> Medium <input type="checkbox"/> Minor	    13 <sup>th</sup> element, straight cuts in vertical direction (stone cutting tool?), surface abrasion present (Fig. 9).
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Comment:

<input type="checkbox"/> Salt Deterioration <input checked="" type="checkbox"/> Not detected	<input type="checkbox"/> Efflorescence	<input type="checkbox"/> Major <input type="checkbox"/> Medium <input type="checkbox"/> Minor	
-------------------------------------------------------------------------------------------------	----------------------------------------	-----------------------------------------------------------------------------------------------------	--

	<input type="checkbox"/> Subflorescence	<input type="checkbox"/> Major	_____
		<input type="checkbox"/> Medium	_____
		<input type="checkbox"/> Minor	_____

Comment:

<input checked="" type="checkbox"/> Soiling	<input type="checkbox"/> Heavy	In lower parts blocks are covered with mud, currently the gates are within the construction site Bird Droppings Sticky substances on surface (gums, etc.)
<input type="checkbox"/> Not detected	<input type="checkbox"/> Medium	
	<input checked="" type="checkbox"/> Light	

Comment:

<input checked="" type="checkbox"/> Other	Comment: 10 <sup>th</sup> element joint to indent not properly pointed (Fig. 5, red arrows).
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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, apart from cracks at the border to the stone, in good condition: stable, no sanding and the colour is not pinkish.

**PHOTO DOCUMENTATION**

**Condition at Evaluation Date**

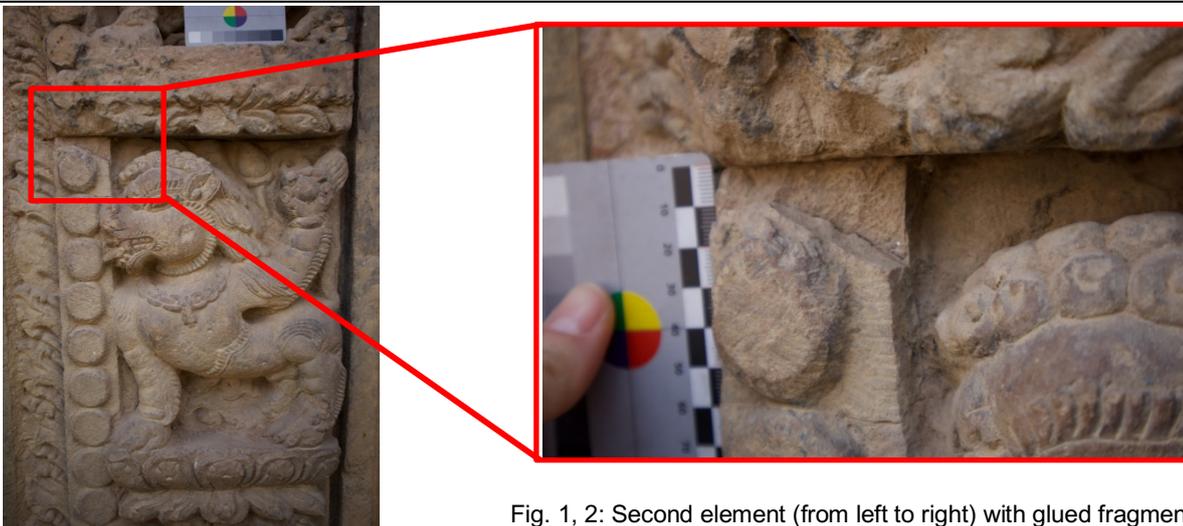


Fig. 1, 2: Second element (from left to right) with glued fragment.



Fig. 3: Missing part at lotus seat.

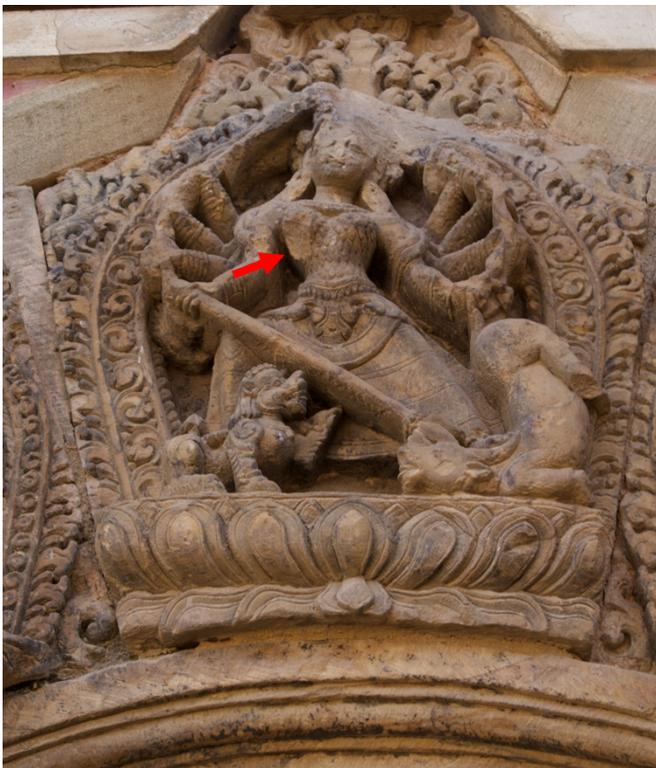


Fig. 4: Missing part on breast of the figure.



Fig. 5: Missing part on the head of the figure.  
Red arrows: inadequate pointing.

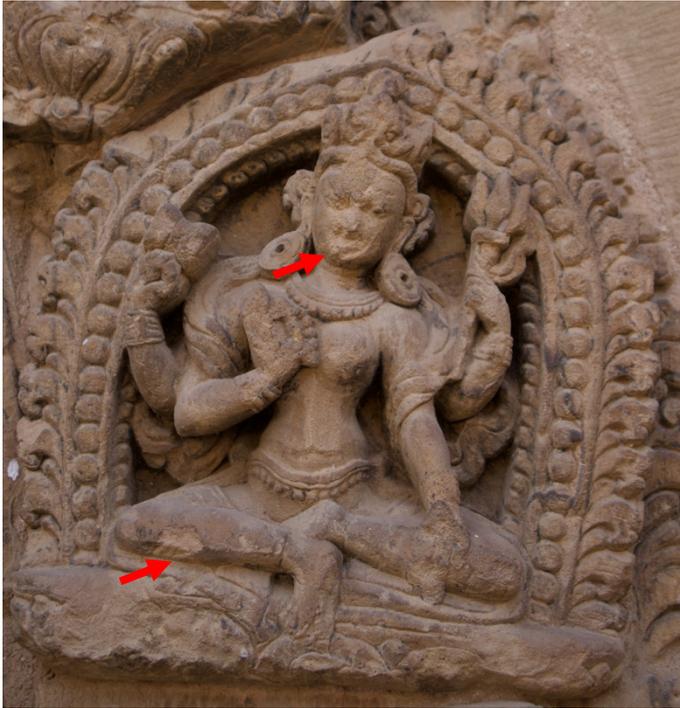


Fig. 6: Missing part on right leg and head of the figure.



Fig. 7: Opened thin joints.

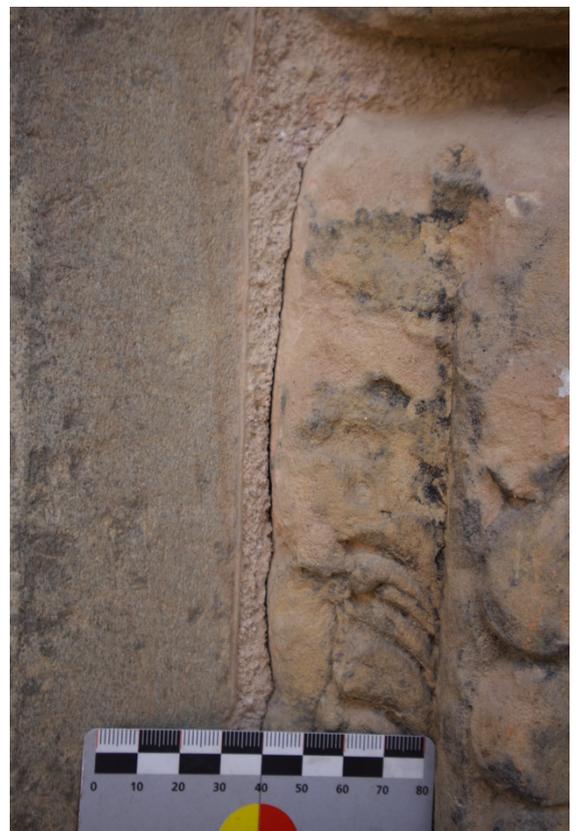
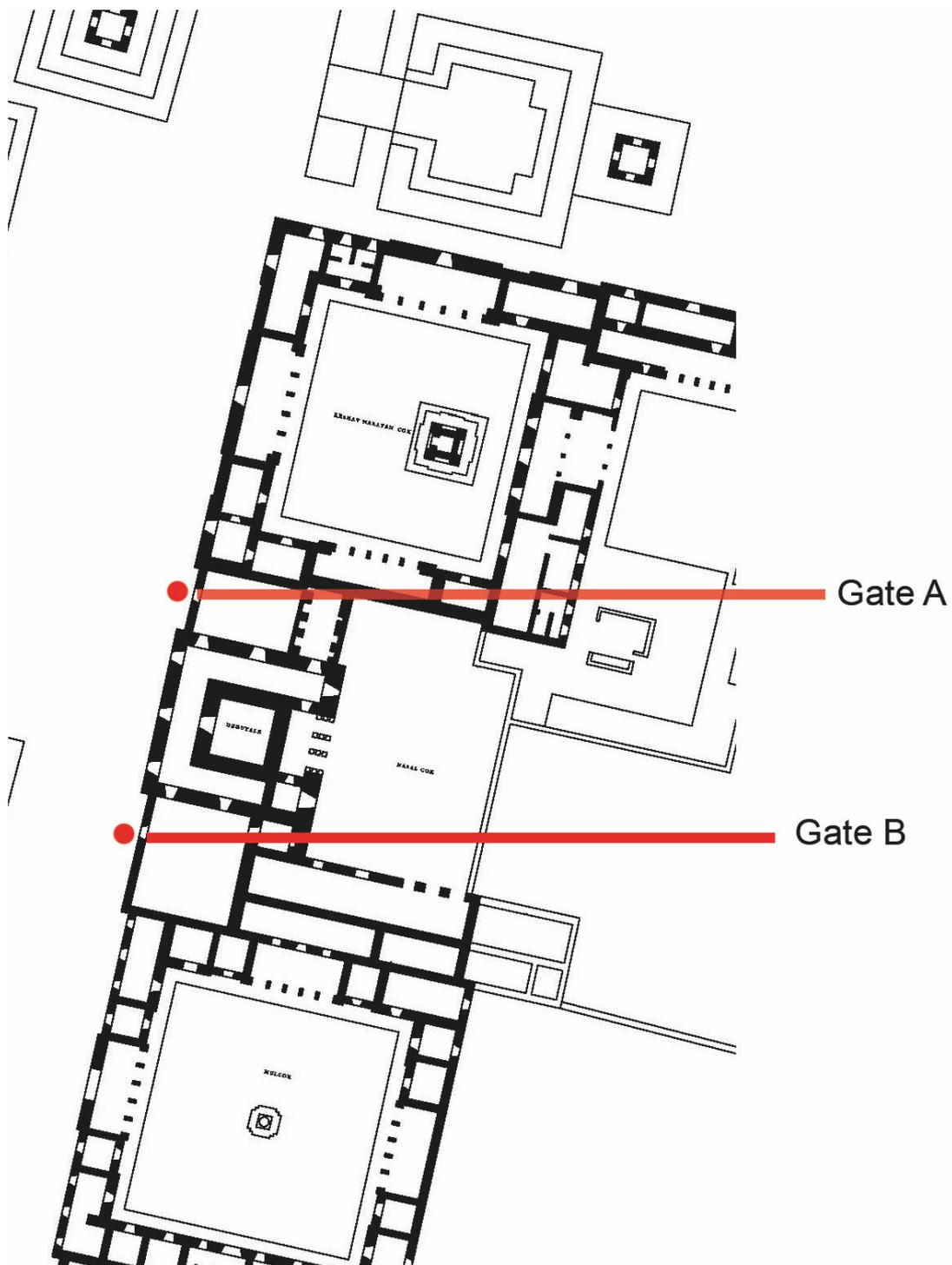


Fig. 8: Joint cracked along the edge.



Fig. 9: Vertical cuts from stone cutting tool (?).

GENERAL INFORMATION		
<b>Monument</b> Stone Gates (Gate B)	<b>Orientation</b> -	<b>Size (H x L x W)</b> -
<b>Date of Production</b> 1640-1734	<b>Location</b> Flanking Degutale Temple	
<b>Date of the last Treatment</b> Conservation 2012-2014	<b>Institutions of the last Treatment</b> IoC	



**Condition Assessment**

**Date of Evaluation**

May 2024

**Evaluation done by**

Martina Haselberger  
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

Split off areas – recent?

From left to right:

5<sup>th</sup> element, frame on the right (Fig. 1).

6<sup>th</sup> element lotus, right chisel? (Fig. 2)

Abrasion on the arch

Comment:

Joints

Not detected

Open

Many

Some

Few

Thin joints (Fig. 2, blue arrow)

Cracked

Many

Some

Few

Comment:

Scaling, Sanding or Powdering

Major

<input checked="" type="checkbox"/> Not detected	<input type="checkbox"/> Medium	
	<input type="checkbox"/> Minor	

Comment:

<input checked="" type="checkbox"/> Biological Colonization	<input checked="" type="checkbox"/> Microbiological Growth	<input type="checkbox"/> Major	
<input type="checkbox"/> Not detected		<input checked="" type="checkbox"/> Medium	Particularly on the left side of the gate, on original and indent stones
		<input type="checkbox"/> Minor	
	<input checked="" type="checkbox"/> Mosses	<input type="checkbox"/> Major	
		<input checked="" type="checkbox"/> Medium	Same as above
		<input type="checkbox"/> Minor	
	<input type="checkbox"/> Higher Plants	<input type="checkbox"/> Major	
		<input type="checkbox"/> Medium	
		<input type="checkbox"/> Minor	

Comment:

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

Comment:

<input type="checkbox"/> Salt Deterioration	<input type="checkbox"/> Efflorescence	<input type="checkbox"/> Major	
<input checked="" type="checkbox"/> Not detected		<input type="checkbox"/> Medium	
		<input type="checkbox"/> Minor	
	<input type="checkbox"/> Subflorescence	<input type="checkbox"/> Major	
		<input type="checkbox"/> Medium	
		<input type="checkbox"/> Minor	

Comment:

<input checked="" type="checkbox"/> Soiling	<input type="checkbox"/> Heavy	
<input type="checkbox"/> Not detected		

	<input checked="" type="checkbox"/> Medium	Mud and brick dust on lower parts due to the construction site around
	<input type="checkbox"/> Light	Lime mortar splashes on the stone
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

**Joint mortar is generally in good condition: stable, no sanding, colour adequate, more biological growth than on gate A)**

## PHOTO DOCUMENTATION

### Condition at Evaluation Date



Fig. 1: Missing pieces on the ornamental frame.



Fig. 2: Missing pieces on the figures' arm and the frame. Blue arrow: open thin joints.



Fig. 3: Condition of Gate B in 2024.

## [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.sigmaldrich.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.

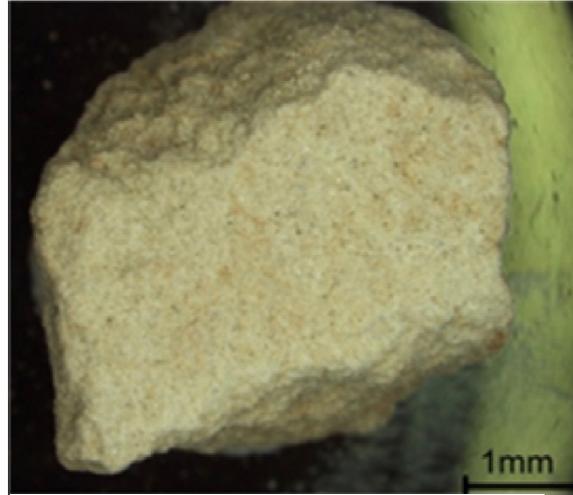


Fig. 2: Visual inspection of the sandstone from Bhandarkhal Tank Pavilion Base, © IoC 2010.

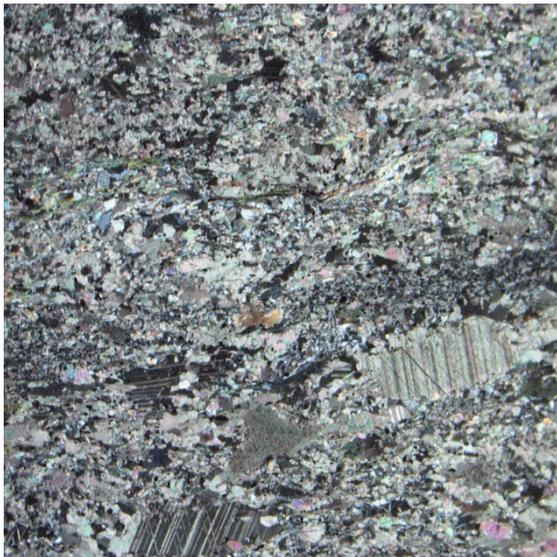


Fig. 3: Sample KAT2, thin section, optical microscopy, polarized light, x24.



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

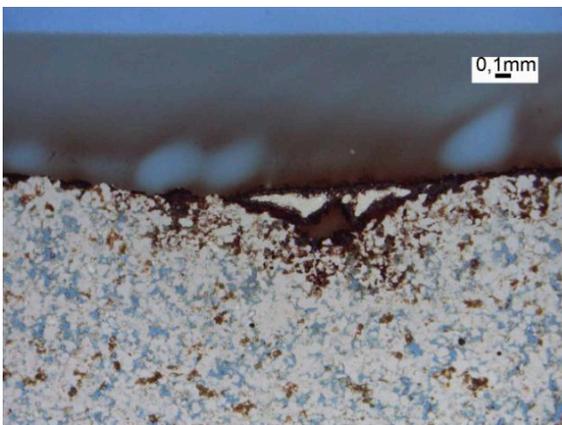


Fig. 5: Sample KRP Original, polished thin section, stereo microscope (Nikon SMZ 1500), reflected light, polarized light. The sample shows stone with bitumen coating.

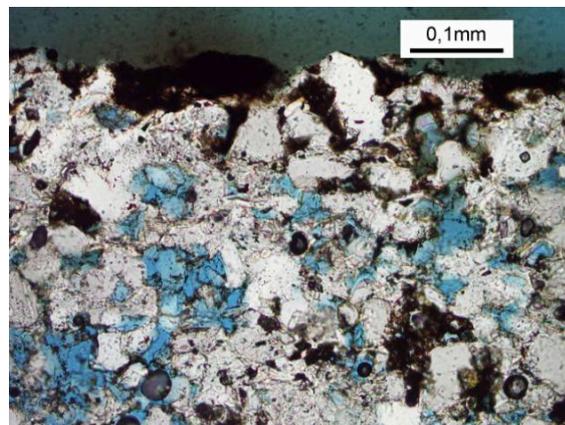


Fig. 6: Sample KRP Original, polished thin section, stereo microscope (Nikon SMZ 1500), reflected light, polarized light. The sample shows stone with bitumen coating.

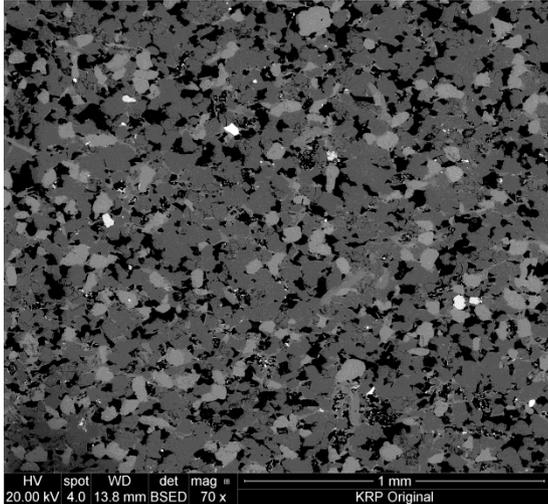


Fig. 7: Sample KRP Original, SEM; description: black = pores, dark grey = quartz, light grey = feldspar, white spots= Fe-(hydr)oxides.

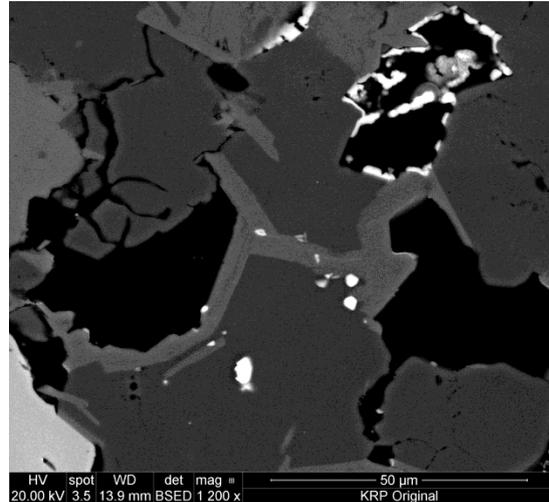


Fig. 8: Sample KRP Original, SEM; description: black = pores, dark grey = quartz, light grey = feldspar, white spots= Fe-(hydr)oxides.

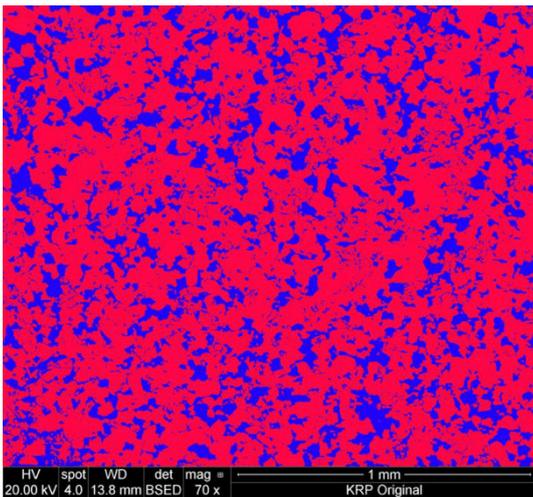


Fig. 9: Sample KRP Original, SEM photo of thin section in false colours (red = grains, blue = pores).

## [2]“Calcitic schist”

<b>Description of visual characteristics</b>	<ul style="list-style-type: none"> <li>- light grey to almost black colour</li> <li>- occasional white inclusions with reddish center</li> <li>- characteristic schist surface with homogeneous foliation and inclusions</li> </ul>
<b>Samples taken (sample name and origin)</b>	<ul style="list-style-type: none"> <li>- <b>KAT1</b> (Leiner 2010), Bhandarkhal Tank Pavilion Base (upper covering) (Fig. 3, 4)</li> <li>- <b>P06, P07</b> (Kaipf 2017), Yoganarendra Pillar (Fig. 5–16)</li> <li>- <b>NEP_ST_1</b> (Haselberger/Fuchs 2023), loose material around Royal Garden workshop (Fig. 17–22)</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.            Kaipf, Luis. 2017. “The Pillar of Yoganarendra Malla. Condition Survey, Conservation Treatment and Re-erection.” Pre-thesis, University of Applied Arts Vienna.            Johannes Weber, Katharina Fuchs, Martina Haselberger. 2023. Scientific investigation of the stone sample NEP_ST_1 from Patan Royal Garden Workshop. Unpublished report, Institute of Conservation, University of Applied Arts Vienna.</p>
<b>Petrographic/geological characterization</b>	<ul style="list-style-type: none"> <li>- weakly metamorphic schist, predominantly calcareous</li> <li>- high concentration of silicates arranged in foliations, surrounded by a very fine-grained siliceous marble</li> <li>- homogenous matrix and slight banding</li> <li>- average grain size of major calcite crystals between 0.03–0.05 mm; 0.05–0.25mm for silicate crystals</li> <li>- minor components of Phlogopite mica (grain size 0.1–0.2mm)</li> <li>- grain borders linear or curved</li> <li>- analyzed sample displays shear zone of ore minerals or graphite</li> </ul>
<b>Pyhsical properties</b>	<ul style="list-style-type: none"> <li>- relatively dense and heavy material</li> <li>- almost no water absorption</li> </ul>
<b>Damage patterns</b>	<ul style="list-style-type: none"> <li>- (hair) cracks and loss of material due to mechanical stress – probably stone intrinsic due to metamorphosis</li> <li>- almost no water related damage</li> </ul>
	Scientifically confirmed: <ul style="list-style-type: none"> <li>- Pillar Yoganarendra Malla</li> <li>- Bhandarkhal Tank Pavilion Base (upper covering)</li> </ul>

<p><b>Use at Patan Darbar Square:</b></p>	<p>By visual inspection only:</p> <ul style="list-style-type: none"> <li>- Lion Pillar</li> <li>- Garuda Pillar</li> <li>- Harishankara Temple Base (cornerstones with lion protomes, inner threshold)</li> <li>- Kings Throne</li> <li>- Stone Gates (inner profile)</li> <li>- Tusha Hiti</li> <li>- Visveshvara Temple Base (cornerstones with lion protomes, inner threshold)</li> </ul>
<p><b>Probable origin of material:</b></p>	<ul style="list-style-type: none"> <li>- Probably mined in the Kathmandu Valley – the alluvium filled Kathmandu Valley is bordered by a sequence of unmetamorphosed to slightly metamorphosed sedimentary rock in the east, south and west</li> <li>- Most probably from the southern part of the Kathmandu Valley, according to the geological map (Himalayan Maphouse [Ed.] Comprehensive Geological Map, GL701), possibly associated with the Chandragiri Formation.</li> <li>- According to the map, the stone from the Chandragiri Formation is defined as following: <i>“light fine grained crystalline limestones partly siliceous thick to massively bedded white quartzites in upper parts. Wavy limestones contain late ordovician schinoderms.”</i></li> </ul>



Fig. 1: Upper stone covering of Bhandarkhal Tank Pavilion Base, © loC, 2010.

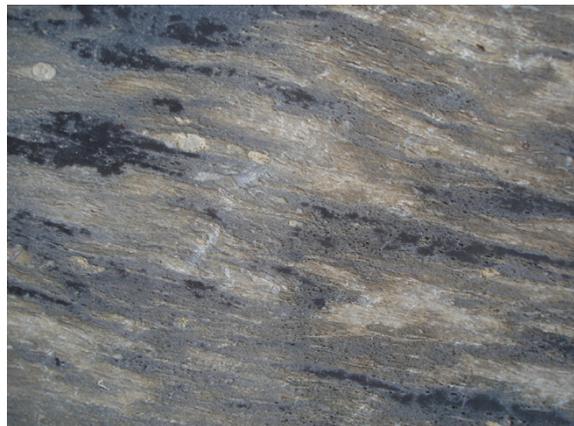


Fig. 2: Visual inspection of stone from Yoganarendra Malla Pillar, © loC, Kaipf, 2017.

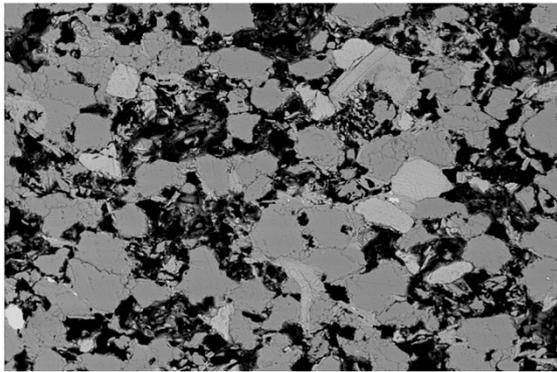


Fig. 3: Sample KAT1BS1, thin Section, SEM BSE.

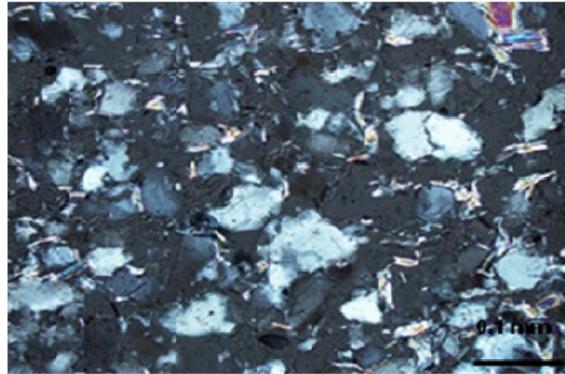


Fig. 4: Sample KAT1, thin section, optical microscopy, x200.

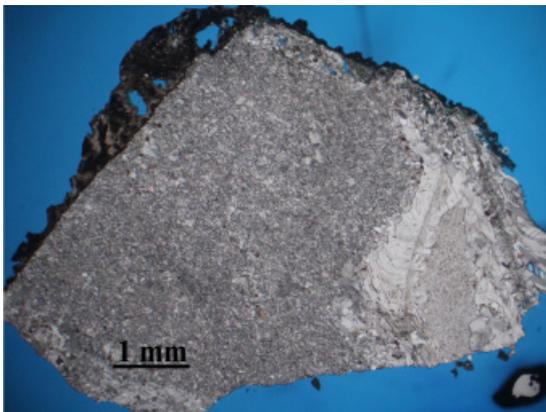


Fig. 5: Sample P06, thin section, optical microscopy, x24.

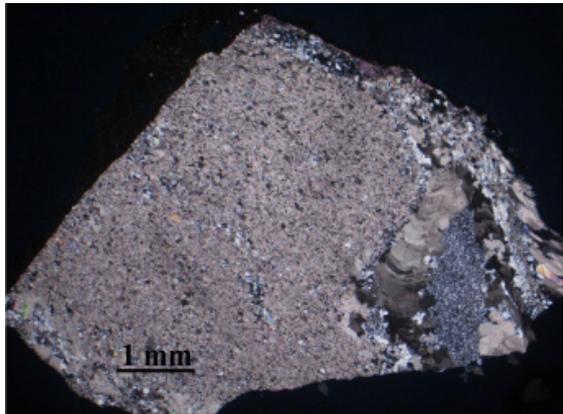


Fig. 6: Sample P06, thin section, optical microscopy, x24.

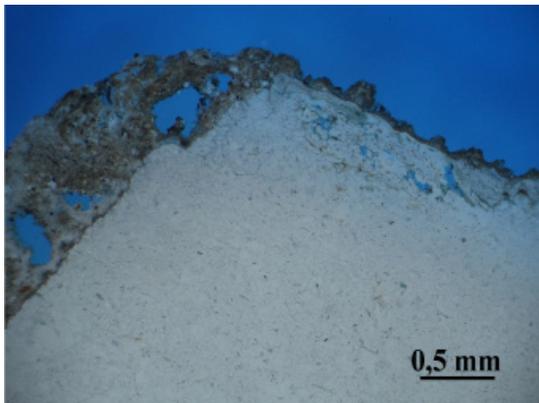


Fig. 7: Sample P06, thin section, optical microscopy, x48.

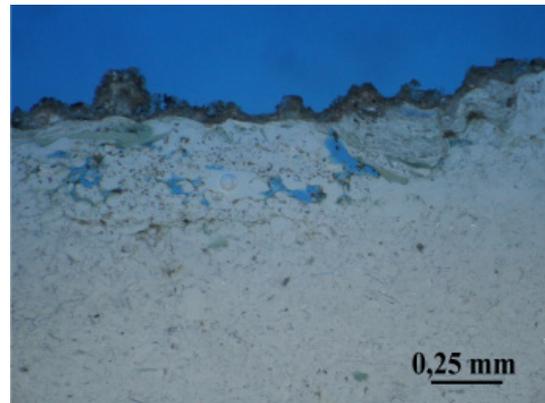


Fig. 8: Sample P06, thin section, optical microscopy, x48.



Fig. 9: Sample P07 taken in 2016, Lotus ring, Pillar of Yoganarendra Malla, Kaipf 2017.



Fig. 10: Sample P07, thin section, x72. Fabric with relatively homogenous matrix and slightly developed banding.

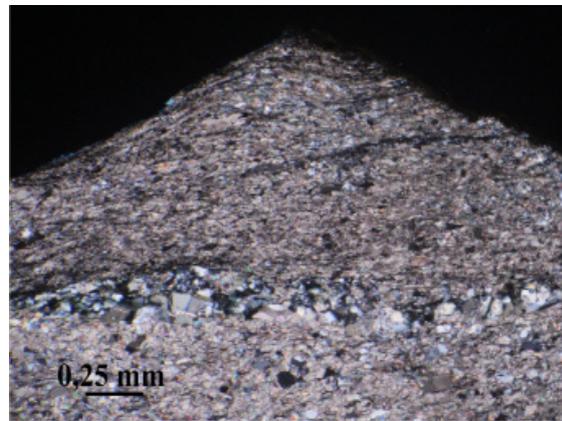


Fig. 11: Sample P07, thin section, x72.

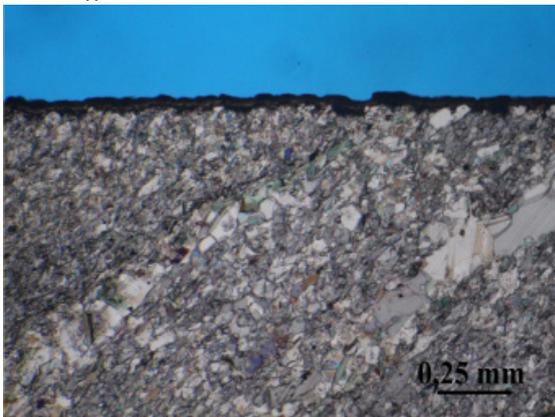


Fig. 12: Sample P07, thin section, x90.

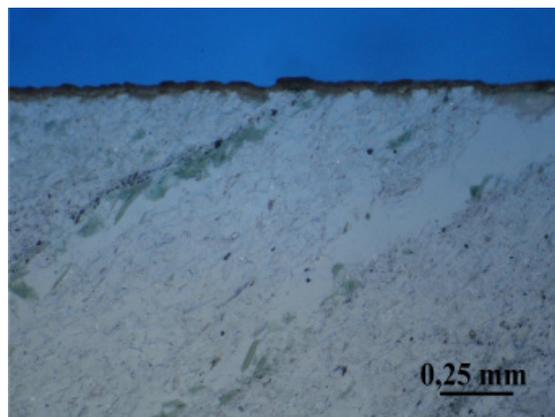


Fig. 13: Sample P07. thin section, x90.



Fig. 14: Sample P07, thin section, x100; Phlogopite.

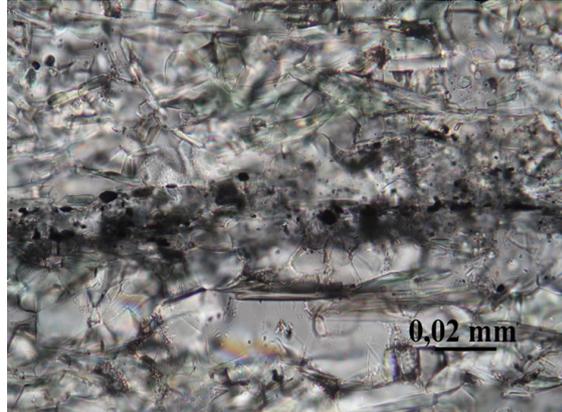


Fig. 15: Sample P07, thin section, x1000; Shear zone.



Fig. 16: Sample P07, thin section, x500. Equigranular grain aggregate with mainly polygonal grain forms.



Fig. 17: Sample NEP\_ST\_1.



Fig. 18: Sample NEP\_ST\_1.



Fig. 19: Sample NEP\_ST\_1, Nikon SMZ 500, transmitted light, crossed polarizers. Overview of the rock matrix with coarser and finer layers.



Fig. 20: Sample NEP\_ST\_1, Nikon SMZ 500, transmitted light, parallel polarizers. Detailed view of the matrix.



Fig. 21: Sample NEP\_ST\_1, Olympus BX40, incident light, bright field. Overview of mica inclusions (whitish spots).

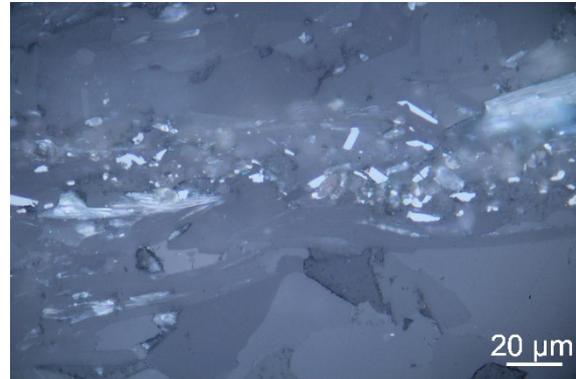


Fig. 22: Sample NEP\_ST\_1, Olympus BX40, incident light, bright field. Detail of a fine layer with mica flakes.