Technical study of polychrome clay sculptures from the Buddhist temple complex at Nako, Himachal Pradesh, North India

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Abstract
This paper presents the first results of a technical study of two sets of 12th century polychromed clay sculptures from the Buddhist temple complex at Nako, North India. Since the sculptures today have been largely overworked, the investigations focused on the appearance and material composition of the oldest polychromy and of the structural earthen material.

The oldest polychromy of one set of sculptures, numbering nine in total, is based on full-area gilding, while that of the other group is different. In this group of five sculptures one statue was gilded, two were painted in characteristic colours and no conclusions could be made about the remaining two. The painting technique and materials used correspond to those employed in the surrounded original wall paintings. Over the earthen support made up from local soils, paint layers are applied onto the gypsum ground using mineral pigments – azurite, vermilion and orpiment bound in a proteinaceous binding media. Several remodelling and repainting phases were documented.

Keywords
Buddhist temple complex, Nako, clay sculptures, polychromy, a technical study, painting materials, clay analyses

Introduction and status of research
Since 2004 the Conservation Department of the University of Applied Arts Vienna has dedicated itself to preserve the cultural heritage of the Buddhist temple complex at Nako, North India in the form of the conservation and restoration of the temples’ interior decoration. Parallel to conservation activities a three year research project, entitled “Scientific study of the artwork at Nako, India”, is currently ongoing which addresses the study of supports and painting materials used at Nako. Two initial technical studies at Nako were focused on original wall paintings [Bogin, 2005] and on polychromed wooden ceiling panels [Kohler, 2006]. Material characteristics of the polychrome sculptures have never been...
examined to date, and thus it became an integral part of the current research which may further assist interpretations of previous art historical studies at Nako [Luczanits, 2004; Klimburg-Salter, 2007]. Two term papers addressing the basic study of sculptures from the material and conservation point of view were undertaken at the Conservation Department recently [Perwög, 2009; Pöllnitz, 2009]. Today the sculptures are overworked and heavily overpainted, and therefore the primary goal of the study was to reveal the appearance and material composition of the oldest preserved polychromy and to characterise the clay from which the statuary is made. To meet the research objectives, a systematic approach was undertaken comprising field work, analytical work and interpretation of results. Examination of minute samples taken from clay and paint layers included light microscopy, scanning electron microscopy with energy dispersive X-ray analysis, micro-chemical tests, X-ray diffraction, gas chromatography-mass spectrometry, and micro-Raman-spectrometry.

Significance of the Nako temple complex

Nestled in a magnificent landscape of the Western Himalaya at 3,600 m above sea level, the small village Nako is located in the northern Indian province of Himachal Pradesh close to the Tibetan border. The Buddhist temple complex consists of four earthen temples originating probably from the same period – from the 11th to 12th centuries. Due to the largely-preserved, splendid interior decoration, comprising of polychrome clay sculptures, decorated wooden elements and wall paintings expressing the earliest Tibetan Buddhist artistic iconography, the complex has become one of the most important art works of its kind.

Clay sculptures at Nako

This paper highlights the polychrome clay sculptures from the two largest temples at Nako with preserved original artwork: clay sculptures representing five Jinas from the apse of the Translators’ Temple (see Figure 1) and eight Buddhas flanking the statue of Prajnaparamita on the east wall of the Upper Temple (see Figure 2). Sculptures in both temples are contemporaneous with the 12th century murals [Luczanits, 2004], but since they are now largely remodelled and overpainted, their original coloured appearance remains unknown. The five Jinas – Amoghasiddhi, Ratnasambhava, Vairocana, Amitabha and Aksobhya – represent male deities in the sitting position on a double lotus. The statues are in nearly life-size, painted in the characteristic colours highlighted with polychrome elements in form of jewellery and crowns and wear simple loincloths. The sculptures in the Upper Temple are distinctly smaller, also in the sitting position, but appear cruder than those from the Translators’ Temple.

The statues’ construction contains a variety of materials, comprising wood, ropes, paper and textiles, glue, clay and earthen materials, ground and painting materials. According to Buddhist sources the making of clay sculptures was not just a complex process from the aspect of material technology but also bore symbolic meanings. Materials and techniques were attributed to elements of the human body and explained within the Buddhist tenets [Luczanits, 2004].
Figure 1: Five Jinas from the apse of the Translators’ Temple. Down left – Amoghasiddhi, upper row from the left to the right – Ratnasambhava, Vairocana, Amitabha, down right – Aksobhya. Photo © Conservation Department, University of Applied Arts Vienna

Figure 2: Eight Buddhas with the statue of Prajnaparamita in the middle, east wall of the Upper Temple. Photo © Conservation Department, University of Applied Arts Vienna
**Experimental**

**Samples preparation**

Cross-sections for studying decorative layer build-up were prepared by mounting of samples in acrylic resin (Spofacryl, Dental a.s.) followed by dry grinding and polishing.

**Stratigraphy of layers and analysis of inorganic components**

Light microscopy of cross-sections was carried out in normal reflected light and UV-fluorescence-microscopy using Nikon Eclipse ME 600 fitted with digital camera Nikon Coolpix 990, 100W halogen lamp, 100W high pressure mercury lamp, UV filter 330-380 nm.

Two instruments were employed for scanning electron microscopy of cross-sections with energy-dispersive X-ray analysis (SEM-EDS): Philips XL-30 ESEM [1] and JEOL JSM 5500 LV [2], both under high vacuum at an acceleration voltage 20kV, fitted with the X-ray device. Micro-Raman-spectrometry (MRS) for pigment identification employed Renishaw InVia, 785nm laser source, 1000x magnification, Peltier cooled (203 K) NIR enhanced deep depletion CCD detector [3].

**Identification of organic binding media**

Microchemical tests to indicate the types of binding media (oils or proteins) were performed directly on selected scrapings and on the dried samples’ water extracts. Testing for drying oils (test of presence of glycerol) and for proteins (detection of pyrrole-derivatives) was undertaken.

Gas chromatography-mass spectrometry (GC-MS) employing 6890N gas chromatograph connected to a quadrupole mass spectrometer, model 5973N, both Agilent Technologies, USA, was used to identify proteins after an acidic hydrolysis (100 µl HCl, heated to 105°C for 24 hour) [4].

**Identification of mineralogical and clay mineralogical compounds of the substrate and local soils characterization**

Mineralogical and clay mineralogical composition of three local soils and of clay samples were analysed through a multi-purpose X-ray diffractometer (Philips X’PERT MPD) fitted with Philips software for qualitative und semiquantitative mineral phases analyses [5]. Soil mechanical parameters such as particle size distributions were determined by a standard sieving method (Retsch, Vibro Type, 220V, 50Hz, 430W) and plasticity indices on the Casagrande apparatus [6].

**Results**

**Local soils**

Local soils traditionally used as raw earthen materials for a range of applications are called Thawa, Tua and Sassa and differ in texture, material composition, and qualities. The abundant Thawa, meaning “earth”, is a commonly-used rather coarse aggregate, and at 6% is poor in clay. Around 30% of the minerals are quartz and 50% feldspars, 11% are layer silicates. Clay minerals are mainly formed by mica and illite, a little chlorite and even less kaolinite. The plasticity index is low, 7%. Found on one particular site at Nako, Tua is utilized as a binder, is fine grained and contains 26% clay. 25% of the minerals are of quartz, around 30% layer silicates, and nearly 40% calcite. The clay mineralogical composition is almost identical with the Thawa. The plasticity index is 12.1%. Sassa is an inhomogeneous material: fine grained components containing 21% clay are selected and used for waterproofing applications. Sassa comprises around 50% of quartz and feldspars, 35% layer silicates, and almost 20% calcite and dolomite. Clay minerals are different to Thawa and Tua – containing mostly swelling clay minerals and little mica/illite and kaolinite. Thus the plasticity index is 32.92%.
Technical study of polychrome clay sculptures from the Buddhist temple complex at Nako

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<tr>
<th>Thawa (brown colour)</th>
<th>Quartz</th>
<th>Feldspars</th>
<th>Layer Silicates</th>
<th>Calcite</th>
<th>Dolomite</th>
<th>Mixed-Layers</th>
<th>Mica/Illite</th>
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<th>Layer Silicates</th>
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Table 1: Mineralogical and clay mineralogical composition of local soils. Mineral content is given in mass percentage (%), clay mineral content with symbols for high (***), average (**) and low (*) content.

Modelling materials of the sculptures

A closer examination of the so called "clay" from which the sculptures are made reveals the use of locally available soils. Besides mineral compounds of the soils, also fibres deriving from plants, animal hair and skin, ash, as well as proteinaceous binding materials were found within the substrates correlating with the Buddhist sources mentioned.

On the sculptures from the Translators’ Temple pure Thawa without any Tua addition was found as a construction material on one statue. The lack of Tua in the rather large corpus might be explained by an awareness of the shrinkage risk that could be minimized by keeping the clay amount as low as possible. The corpus construction revealed a coarse layer of Thawa wound with straw to the wooden armature before another coarse and finer layer was applied (see Figure 3). Later remodellings, applied to replace missing sections and remodel existing elements, were also made of local soils but they differ to the construction materials in texture – mostly finer, and in composition regarding inorganic and organic components (see Figure 4). The application of Sassa could be verified at one remodelling place.

Figure 3: Sculpture of Akshobhya illustrating construction from a coarse layer of Thawa-clay wound with straw to the wooden armature. Photo © Conservation Department, University of Applied Arts Vienna

Figure 4: SEM-BSE micrograph of a cross-section from the shank of Prajnaparamita showing the primary coarse earthen support (A) followed by gilding (C) and the thick layer of finer secondary earth (D). The gilding (C) is applied over thin red and yellow underlaying layers and a gypsum ground (B). Photo © Institute for Art and Technology, University of Applied Arts Vienna
The Upper Temple sculptures ensemble in the first decoration phase features a mixture of local soils Tua:Thawa in the ratio 1:4 (by volume) applied in a lower coarser and finer upper layer as evident on two Buddha sculptures. Later decoration phases again show the use of modelling materials that are different in texture and composition to the original supports. Furthermore, a construction material very rich in Tua could be identified in one case for fixing the wooden armature onto the clay body. The 1:4 mixture of Tua and Thawa could not only be traced in the substrates under the oldest polychromy in the Upper Temple clay sculptures, but also in the original building structures of the temples. Thus building materials and the sculptures’ construction materials in the Upper Temple feature a very similar mixture of two locally available soils. Sassa was not used for the original temple building structure at all and only in one case was verified for the remodelling of one sculpture. In this context it is worth mentioning that local craftsmen still use Tua and Thawa 1:4 for recent building activities as it is considered most efficient for plastering work. This knowledge seems to have been passed down by generations of masons stemming back to the Nako temple craftsmen.

Painting techniques and materials
Five Jinas from the Translators´ Temple indicate two to four remodelling phases of different extent and thickness; the crowns of all sculptures are new, most of the jewellery has been replaced and no original polychromy is visible today.

Amoghasiddhi’s present colour is green with older layers under the present one. The oldest body colour that might have been considered original is the blue layer based on azurite applied over a gypsum ground, followed by yellow and green overpaintings. The oldest colour found on the loincloth is red, but a red executed in red ochre. This pigment does not fit in the original colour scheme of the surrounding original wall paintings, which comprise of expensive pigments where the use of red ochre was limited only to underdrawings [Bogin, 2005], and therefore the red layer is very probably not original. Altogether, the presence of two to three remodelling phases on the sculpture was confirmed.

Today the figure of Ratnasambhava is yellow, but several previous yellow layers as well as other colours still exist beneath as evidence of the changing decorative tastes. Three different repair phases and six phases of overpaintings were documented, but unfortunately, based on the composition of bottom layers, none of the oldest layers can be considered original. The original polychromy of the Ratnasambhava sculpture remains unknown.

Vairocana, surrounded with a decorative polychromed frame, is currently painted white. The oldest polychromy found on the nose, waist and forearm as well as in one sample from the decorative frame is the gold foil applied over thin red and yellow layers underlaid with a white gypsum ground. These findings clearly indicate that the body of Vairocana was gilded overall and it is possible that the water gilding might have been the original decorative layer. The oldest preserved colours found on the loincloth are in blue and red-orange colour, but since the sampling places seem to have been overworked, it is improbable that these colours are original. Altogether, three remodelling phases on the sculpture were confirmed.

Amitabha’s present colour is red. The oldest layers found in cross-sections are also red (containing vermilion only) and four red overpaintings (containing a mixture of vermilion and ochre) are present, indicating that in the past Amitabha was always painted red. It is possible that the oldest found red body colour containing vermilion, applied over a white gypsum ground could be considered original. In summation, the presence of up to four reworking phases on the sculpture was confirmed.

Aksobhya is currently blue with older layers underneath. The only sample from the not reworked, probably original surface (neck) reveals the oldest layer is blue followed by six overpaintings in red, blue and green. Based on this one finding it is not possible to generalize what the original colour of Aksobhya was. Overall two remodelling phases were confirmed.
Generally, nothing can be said about the oldest polychromy of the lotus pedestals below the sculptures since no samples were taken from them.

Possibly original pigments found in lowest layers of the sculpture are azurite, vermilion and the water gilding applied over thin layers of orpiment and vermilion. These findings correspond with the palette of the original murals [Bogin, 2005]. Binding media of the oldest layers are currently under investigation. The number of remodelling phases, overpaintings and their build-up varies from one statue to the next as well as from one sampling place to another within the same sculpture. Azurite, indigo, vermilion, red ochre, red lead, orpiment, malachite and gypsum were found in overpaintings applied over or without the gypsum ground. None of these pigments help to address the issue of dating and chronology of the secondary interventions.

The statue of Prajnaparamita from the Upper Temple is now yellow decorated with coloured ribbons, a crown and jewels and surrounded with a decorative polychromed frame. Today the eight Buddhas wear red and blue monks’ robes and have bodies in yellow, red and blue. The oldest polychromy revealed on almost all sculptures except the Buddha 2, decorative frame and lotus pedestals, is based on gilding (see Figure 5). Gold foil is applied over thin red and yellow layers underlaid with a white gypsum ground. It is highly probable that eight Buddhas and Prajnaparamita were completely gilded. Over this first decoration phase there are one or two remodelling clay layers finished in different colours. Structural remodelling in the areas of navel is relatively fine and thin, but on the arms and legs it is relatively crude, attaining a thickness of several centimetres (see Figure 4). Water gilding, that might have been considered original, is applied over thin size-layers of orpiment and vermilion. This build-up (see Figure 6) and material composition tallies with findings from the Vairocana sculpture and original murals from the Translator’s Temple [Bogin, 2005].

Figure 5: White points indicating presence of the gilding on the sculptures from the Upper Temple.
Photo © Conservation Department, University of Applied Arts Vienna
The binding medium of the scraping from the Buddha 3, representing the whole sandwich of layers from the oldest gilding with the underlaying size-layers to an overpainting layer (separation of layers was not possible), was unambiguously identified as animal glue without traces of any other kind of binder. The presence of no other binding media can indicate that the animal glue was used as a binder for both the gold-size layers as well as for the secondary paint layer. This result conforms to findings from the surrounding original murals where animal glue was also positively identified as a binding medium [Bayerová, 2009].

Figure 6: Incident light micrograph of a cross-section from the navel area of Buddha 8. The build-up of layers from bottom to top: primary earthen layer (0), white gypsum ground (1), thin yellow layer containing orpiment (2), thin red layer containing vermilion (3) and gold foil (4). Followed by secondary thin earthen layer (5), green layer containing orpiment and indigo (6), thin blue indigo layer (7), another thin earthen layer (8) and uppermost blue layer containing indigo and silicates (9). Mud deposits are visible on the top. Photo © Conservation Department, University of Applied Arts Vienna

Stratigraphy and number of secondary layers differ from one sample to another. Pigments found in overpaintings are azurite, indigo, Prussian blue, vermilion, red lead, red and yellow ochre, orpiment, carbon black and gypsum. No statement about the dating, chronology and mutual comparison of the secondary interventions can be made, except the uppermost blue layer from the body of Buddha 7. Prussian blue was identified by MRS in this layer – a synthetic pigment first time prepared in 1704, indicating the earliest possible execution date for that layer. This finding does not provide any further relevant information since the occurrence of Prussian blue is limited only to this one place.

Binding media of eleven samples from the uppermost layers of different statues were positively identified by microchemical tests as a protein, probably animal glue. A GC-MS of the final layer from Buddha 6 confirmed this anticipation by detection of the animal glue. GC-MS analyses of earlier overpaintings are not completed yet.

Conclusions
The preliminary results of the technical study of both sculpture ensembles have confirmed, and from material point of view completed, the art-historical study [Luczanits 2004]. Sculpture construction techniques and the diverse materials used provide evidence of the “classical Indian technique” adopted
for Western Himalayan Buddhist statues around the 12th century. Locally available earthen materials were prepared and applied in layers as substrates for polychrome decorations according to the classical canon, in which the making of Buddhist sculptures is not only idealized, but which seems to provide practical directions for the sculptors and craftsmen.

The examination of cross-sections helped in interpreting the structure of paint and clay layers and confirmed hypotheses deduced after on-site inspection: the number and extent of remodelling phases and overpaintings varies from one statue to the next as well as within the same sculpture. No statement about the dating, chronology and mutual comparison of the secondary interventions could be made since they differ conspicuously and do not contain any pigment applicable as a characteristic marker for dating. The painting techniques and materials used in the oldest polychromy that might have been considered original appear to be similar to those used in the original wall paintings. Continuation of the research should offer a better insight into the evolution of painting techniques of the Nako artwork including the colour palette and the binding media.

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**Endnotes**

[1] Measurements undertaken by Dr. Johannes Weber, Institute for Art and Technology, University of Applied Arts Vienna
[2] Measurements undertaken in cooperation with Dr. Milan Vlček, Joint Laboratory of Solid State Chemistry, University of Pardubice
[3] Measurements undertaken in cooperation with Dr. Jana Sanyova, Scientific Department, Royal Institute for Cultural Heritage, Brussels
[5] Measurements undertaken by Dr. Ingeborg Wimmer-Frey, Department of Rohstoffgeologie, Geological Survey of Austria
[6] Measurements undertaken by Dr. Renata Adamcová, Faculty of Natural Sciences, Comenius University in Bratislava

**References**


Biographies

Mag. Maria Gruber (Researcher) gained an MA in Conservation from the Conservation Department at the University of Applied Arts Vienna in 2007. She is currently working on a three-year research programme 'The Scientific Study of the Artwork at Nako, India’, funded by the Austrian Science Fund as a Scientific Associate at the Conservation Department of the University of Applied Arts. In her concurrent PhD she is studying earthen supports at the Nako Temples and earthen building materials in the Himalayan village of Nako. (University of Applied Arts Vienna, Conservation Department, Salzgries 14, 1010 Vienna, Austria, www.dieangewandte.at/konservierung, maria.gruber@uni-ak.ac.at)

Prof. Mag. Gabriela Krist (Head of the Conservation Department) has been a professor at the University of Applied Arts in Vienna since 1999. Following her studies in conservation at the Academy of Fine Arts in Vienna as well as taking a PhD in Art History and Archaeology at the Universities of Vienna and Salzburg she worked for many years at ICCROM in Rome and at the Austrian Federal Office for the Protection of Monuments. She is the author of many publications on current conservation issues and on the training in conservation and restoration, is the Council member of IIC and ICCROM, Austrian delegate to the ICCROM General Assembly, member of the Board of Directors of IIC-Austria, as well as of the Working Group Training in Conservation and Restoration of ICOM-CC. Since 2004, Gabriela Krist heads up the Conservation Department’s programme for the preservation of Tibetan cultural heritage in Nako, India. (University of Applied Arts Vienna, Conservation Department, Salzgries 14, 1010 Vienna, Austria, www.dieangewandte.at/konservierung, gabriela.krist@uni-ak.ac.at)

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