



Micro-XRF for non destructive analysis of museum and archaeological objects

The XGT-5000 is ideally suited for analysis of archaeology specimens and museum objects. Key features of the instrument for this research include:

- **non-destructive sampling** - delicate and fragile artifacts can be analysed at atmospheric pressure without risk of damage. Single point, automated multi-point and XY mapping analysis ensures versatility in sampling.
- **ultra-narrow x-ray beam** - even small and intricate features, down to 10 µm in size can be interrogated. For flexibility, both micro and macro beams can be accommodated on the same instrument. Switching between beams is fast and easy, and requires no operator alignment.
- **large area analysis** - areas up to 20 cm x 20 cm can be routinely mapped out, so that even large objects can be analysed with ease.
- **high information content** - fast analysis of elemental composition, from sodium to uranium.
- **transmission x-ray imaging** - provides added structural information, even on sealed/encased items.

Nepalese Manuscript

Analysis of a coloured illustration in a Nepalese manuscript was carried out to understand more fully the types of pigments used to obtain particular hues. Due to the penetrating nature of x-rays it was possible to probe not only the topmost layer of pigments, but also those which had been used for undercoating.



Figure 1: Extract from the manuscript page – the red box highlights the analysis region

A mapping experiment over the 70 mm x 70 mm area with a 100 µm beam diameter quickly identified the main elements used in the pigments. Figure 2 illustrates the resulting XRF mapped images.

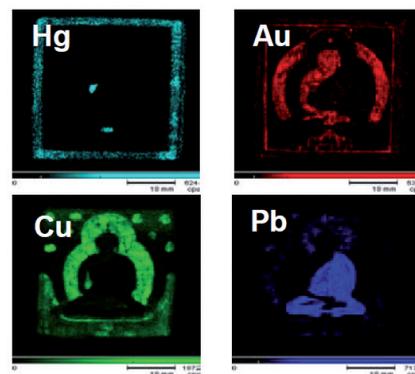


Figure 2: XRF mapped images showing the intensities of mercury (Hg), lead (Pb), gold (Au) and copper (Cu)

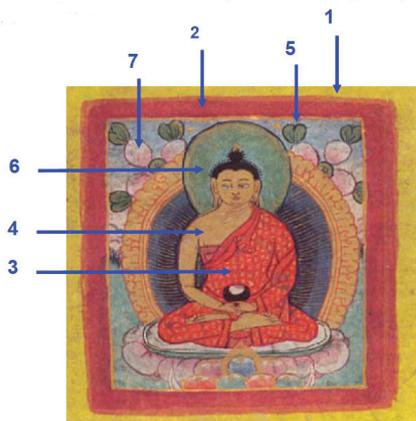


Figure 3: Detail of the painted illustration – numbered regions relate to those given in Table 1.

Analysis Points	Colour	Elements	Assignment
1	Undercoat	Yellow	Pb, Cr Chrome Yellow (PbCrO ₄)
2	Frame	Red	Hg Vermilion (HgS)
3	Surplice	Orange	Pb Diachylon (Pb ₃ O ₄)
4	Skin	Gold	Au Gold leaf
5	Leaf	Green	Cu Carbonate (CuCO ₃ /Cu(OH) ₂)
6	Halo	Blue	Cu Basic copper (2CuCO ₃ /Cu(OH) ₂)
7	Petal	White/Pink	Ca, Mg, Si, Pb, Cr, Cu Mixture of rubine toner (CaO, CaCO ₃), talc (Mg ₃ (Si ₄ O ₁₀)(OH) ₂) and chrome yellow (PbCrO ₄) painted on top of copper containing blue pigments

Analysis of seven individual points allowed tentative assignments to be made of the pigments used. These range from pure gold leaf for the skin, and traditional lead, mercury and copper containing inorganic species for other areas. The white/pink petals contain a complicated mix calcium and magnesium compounds, mixed with chrome yellow, all of which have been painted onto an underlying coating of blue copper pigments.

Gangi-dama

A *gangi-dama* is a special ring/bead left within old Japanese burial mounds as a personal ornaments – they are typically made up of two or more coloured glasses. A particular *gangi-dama* from the Funaki-yama excavations was analysed with the XGT-5000 to shed light on the specific elements used for the colouring of the glass. Figure 4 shows the results of mapping experiments across the whole ring, approximately 12 mm in diameter.

The yellow glass of the groundwork is identified as lead glass, whilst the other coloured regions are due to iron (red areas), copper (green areas), and manganese (red areas) additives.

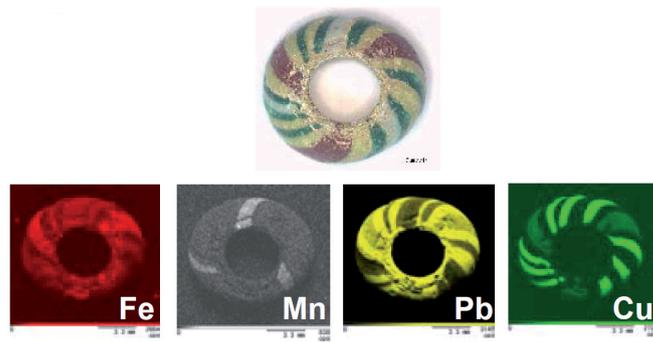


Figure 4: Optical image and XRF mapped images of gangi-dama showing intensities of iron (Fe), manganese (Mn), lead (Pb) and copper (Cu)

Summary

The non-destructive nature of micro-XRF analysis with the XGT-5000 system has allowed fast and easy elemental characterisation of museum objects as diverse as manuscripts and ornaments. Samples were analysed intact without any time consuming or damaging preparation. In addition, the unique mono-capillary x-ray guide tube ensures that high sensitivity measurements can be made without the need for a full vacuum, a further potentially damaging process for fragile historical objects.

References

Data recorded for the Nepalese manuscript is provided courtesy of Mr Kato and Mr Konan, Classical Manuscripts Digital Archive Study Center, owned by Ryukoku University Library

This precious *gangi-dama* sample is one of the few that can be found in Japan, and the cooperation of the Paleo Laboratory Company, Ltd, is gratefully acknowledged.



XGT-5000

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