THE INVISIBLE REVEALED

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Large print guide

Invisible Revealed
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THE INVISIBLE REVEALED

The Powerhouse collection of more than half a million objects tells us much about our material culture but it also inspires many questions. What are our objects made of? How old are they? Is anything hidden inside? Over time, new research and technologies can help us solve these mysteries — and reveal new ones. The Museum is working with the Australian Nuclear Science and Technology Organisation (ANSTO) to examine pieces in our collection at a sub-atomic level. With this partnership we learn more about our collection while ANSTO develops new applications for their analytical technologies. Using their state-of-the-art neutron beam and synchrotron X-ray facilities combined with digital visualisation techniques, we've learned how to identify different makers of our samurai swords and how a 200-year-old pocket watch can play a waltz.

The following techniques were used by ANSTO to investigate the objects in this exhibition: neutron imaging — radiography and tomography; neutron activation analysis; radiocarbon dating; synchrotron X-ray tomography; neutron diffraction; residual stress analysis; PIXE — proton induced X-ray emission and X-ray fluorescence microscopy. Scan the code below to learn more about each technique.

DEVELOPED IN PARTNERSHIP WITH

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Tomb guardians

Tomb guardians, or *lokapala*, were warrior sentinels often placed near the entrance of Chinese Tang dynasty tombs to protect the dead from evil spirits. This pair was acquired by the Museum almost a century ago. They are made of glazed earthenware and thought to date from 700–750 CE. Scanning them using a combination of X-ray and neutron imaging showed how they were made and repaired, and captured the composition of the *sancai* glaze. The glaze will be compared to similar glazes of this period that are linked to specific Chinese kilns or provinces — this could inform us where the guardians come from.

Scan this code to interact with the 3D model.

SWORDS

A katana is the longer of a pair of swords worn by samurai. We were able to date three of these Japanese blades because they were signed by their makers, but the one displayed third from the top has no signature. Based on its style, we believed it could be up to four centuries old. Neutron tomography, diffraction and residual stress analysis have revealed that its manufacturing technique matches that of older swords made in the Koto age (about 987–1596), similar to the blade at the top. The modern hilt and scabbard were added during World War II when historic swords were re-deployed by descendants of the samurai.

Scan this code for more information and to interact with the 3D models.

– Katana blade made by Sadatsugu in Bitchu, Japan, about 1346–70.

– Katana blade made by Tsuguhiro about 1661–1673.

– Katana blade manufactured by an unknown maker about 987–1596, with hilt and scabbard from the mid-20th century.

– Katana blade made by Yokohama Sukenaga in Bizen, Japan, about 1830.

BUDDHIST OBJECTS

In the Buddhist faith devotional statues are prepared for a shrine or altar with a consecration ritual in which these hollow figures have sacred materials, such as scriptures, herbs and seeds, carefully sealed inside. With ANSTO's neutron tomography and neutron diffraction techniques we can see within the Buddhist objects in our collection without disturbing their consecration seals and spiritual significance, as shown on the screen on the right.

Scan this code for more information and to interact with the 3D models.

Figure of Bodhisattva Manjusri

Bodhisattvas are enlightened beings who can relieve the suffering of others. Manjusri, the Bodhisattva of Wisdom, holds his hands in the *dharmachakra mudra*, the gesture of preaching. This Tibetan figure was made of gilt-bronze in about 1400–1500 CE. Neutron imaging uncovered a ceramic core, which confirmed the lost-wax method of construction in which wax and clay are used to create a mould for liquid metal. The scans also show that the Bodhisattva's seven-point crown has been repaired. There are traces of an organic material in the base which is part of the consecrated relic.

Donated through the Australian Government's Cultural Gifts Program by Alastair Morrison, 2005

Figure of Mahasiddha Catrapa

The *mahasiddhas* were eighty-four men and women from all walks of life who attained enlightenment through Tantric Buddhist practice. This Tibetan bronze figure, made around 1400–1600 CE, represents Mahasiddha Catrapa. Known as the lucky beggar, he is identified by the volume of scripture in his left hand. Catrapa's right hand is shown in the *vitarka mudra*, or gesture of teaching. Neutron tomography revealed a fibrous object inside that might be wrapped tissue or a piece of textile. The metal is also full of small air bubbles which come from the manufacturing process.

Donated through the Australian Government's Cultural Gifts Program by Alastair Morrison, 2005

Sculpture of Kadampa chorten

The chorten (Tibet) or stupa (India) is a powerful symbol of the Buddha. Originally built over the mortal remains of Buddha and other religious leaders, chortens can also contain sacred objects. A small-scale chorten, like this bronze one from Tibet made about 1200 CE, would have served as an element of a devotee's altar, a temple donation, or have been taken on pilgrimage. Neutron imaging showed the expected sacred organic materials as well as a mystery item embedded in the top of the chorten. Neutron diffraction confirmed the item is made of iron but its purpose remains unknown.

Donated through the Australian Government's Cultural Gifts Program by Alastair Morrison, 2005

Eucalyptus cross-section

In the late 1940s, the Museum planted stands of eucalyptus trees at Castle Hill to conduct research to support Australia's essential oil industry. This slice of timber, cut from the plantation in 2021, has still more to tell us: its rings preserve the signature of hundreds of above-ground nuclear bomb tests conducted worldwide between 1945 and 1963 which temporarily doubled the amount of radioactive carbon in the atmosphere. Since all living things store carbon in their cells, ANSTO's radiocarbon dating of the tree rings captured a record of the nuclear tests and associated spikes in carbon levels.

Image: Powerhouse Eucalyptus plantation, Castle Hill, Amanda Williams, negative scan, 2021.

COMPLEX MECHANISMS

The Powerhouse is undertaking a digitisation project that will give online access to our collection. As we photograph our objects, we also use computer technology to create 3D models from those digital images. ANSTO's techniques take us deeper into the collection — with a combination of neutron and synchrotron X-ray imaging we can see inside complex mechanical objects in extraordinary detail.

Pocket watch

The elegant simplicity of this rose gold pocket watch conceals a rare musical component which could be set to play a waltz on the hour. Made in France around 1815–1820, the watch still worked perfectly upon acquisition in 1983. Neutron imaging was used to see through its layers of metal components and give an insight into its mechanism. The scanned images of the music box cylinder are so clear they could be used to recreate the tune. The imaging also revealed bubbles in the glass, possibly indicating the watch face is a replacement.

Mikroma II camera

Czech manufacturer Meopta entered the subminiature camera market immediately after World War II with the rugged Mikroma. Subminiatures were designed to use 16 mm film, then cheap and readily available, and to meet consumer demand for pocket-sized 'spy' cameras. This Mikroma II camera was made in Prague in 1957. New methods were used at ANSTO to create a combined image in which the neutron imaging is coloured red and synchrotron X-ray imaging in blue and green. This reveals internal components more clearly — two lens elements and lubricant still left on the focusing ring can be seen in pink. A third lens, made of a different type of glass, is visible in blue.

Curta calculator

The Curta was the world's first handheld calculator when manufactured by Contina AG in Liechtenstein in 1947. Inventor Curt Herzstark designed it while imprisoned in Buchenwald concentration camp where the commander thought the idea had potential as a gift for Adolf Hitler. Neutron imaging revealed a layer of dirt inside the object so our Curta, made about 1954, was probably used outdoors by a surveyor or engineer just as Herzstark intended.

Donated through the Australian Government's Cultural Gifts Program in memory of Associate Professor Allan Bromley, 2010

Figurine of Artemis

Artemis, the ancient Greek goddess of the hunt, wears a quiver for arrows on her back as she strides forward. Small figurines like this one, made in Greece in about 200 BCE, were items of personal devotion usually found in sanctuaries and burial sites. Reddish-pink residue on her garment suggests that the marble was once brightly painted. Neutron imaging also identified traces of wax — highlighted in colour on the screen. Future studies will help us determine whether the wax is ancient or modern and whether the coloured material is pigment.

TEXTILES

As textiles are made from organic materials, we can determine their age range through carbon dating and compare it to the age we have estimated from their style and design. Through a combination of synchrotron imaging techniques such as infrared and X-ray fluorescence microscopy, and X-ray tomography, we can magnify the textiles to reveal how they were made, what they were made of and how they have been conserved.

Egyptian textile fragment

Ancient Egyptians used an elaborate mummification process to preserve the bodies of their dead. After embalming, the body was wrapped in many lengths of linen strips. Donated more than a hundred years ago, this linen fragment was thought to have come from a mummy. Radiocarbon dating revealed that the fabric is almost a thousand years younger than we believed. Dated at 550–650 CE, it is unlikely that this is a fragment of mummy wrappings. Linen was also commonly used for clothing and bedding so this is more likely to be a remnant of a garment preserved within an Egyptian grave.

Gift of E Dredge, 1908

Floral textile fragment

During the Coptic period (about 201–700 CE), Egypt was a major manufacturer of garments for Mediterranean trade routes. Floral patterns, like this one worked in wool on a linen base, were common decorations on clothing. Most ancient textiles from the region have been found in burials, where the arid environment preserved them for centuries. This textile fragment was radiocarbon dated to 350–440 CE, meaning it was likely to have been made about a century later than we originally thought. Analysis from the synchrotron imaging revealed the warp and weft, damage from tearing, and specks of embedded foreign matter.

Gift of Professor Said El Sadr, 1972

Clavus band textile fragment

This strip of Coptic linen fabric would have once adorned a tunic worn by an Egyptian in about 540–610 CE. In ancient Rome *clavus* bands were plain purple stripes running down a man's tunic from each shoulder that symbolised his political status. By this later period, the two cultures had mixed and old symbols took on new meanings. Egyptian people wore more elaborate clavus bands to demonstrate their wealth. Sometimes the bands were reapplied to newer garments to extend the lifespan of such intricate work. Images from the synchrotron on the left-hand screen allow us to see a highly detailed view of every strand across the whole band.

Gift of Professor Said El Sadr, 1972

Uşak carpet

The town of Uşak in western Turkey had a vibrant carpet making industry from the early 1500s CE. Organised workshops produced very large carpets with a typical medallion or star pattern. Radiocarbon dating has shown that this hand-knotted wool medallion carpet was made about 1600 CE, as we expected from its design. Such an old fragment may have come from the deepest layer of carpets in a mosque. It has been common practice in mosques for many centuries to cover the floor with rugs. New carpets were customarily placed on top of more worn ones so fragments of very fine early Turkish carpets survive to this day. The screen on the right shows an AI reconstruction of the missing portions of the carpet.

Gift of the Oriental Rug Society of New South Wales, 2008

Coin

On acquisition we recorded that this coin was made of electrum, a naturally occurring alloy of gold and silver. This metal, and the characteristic lion and bull design, suggested it was made in Lydia in western Turkey about 561–546 BCE, during the earliest days of coinage. Its authenticity was cast into doubt by an initial scientific analysis by the Museum that identified tungsten, a metal unknown in ancient times. Neutron imaging by ANSTO revealed bubbles, as seen on the left, that could not have formed in tungsten. Neutron activation analysis showed it is mostly made of gold, with too little silver to be electrum. This tells us the coin is likely to come from a slightly later period in Lydia when the same design was made in gold.

Wine vessel or *jue*

The unusual shape of this ancient bronze wine vessel, or *jue*, gives us a clue to its purpose: its long, pointed legs could be pushed into hot coals and the overhanging flaps at the rim could be gripped with tongs. *Jue* were typically used in China's Shang Dynasty period for heating and pouring wine during ancestor worship rituals. Manufactured around 1000 BCE, the vessel is heavily corroded but ANSTO's analysis has provided information that will help us conserve this object for the future. Neutron imaging and proton induced X-ray emission (PIXE) showed that the vessel was cast as one piece and identified areas of corrosion and repair.

Scan this code to interact with the 3D model.

Horse

This horse comes from a Chinese Tang dynasty (618–907 CE) tomb. Figures of animals and people were often placed in tombs during this period, as gifts to accompany the dead to the next world. Neutron tomography has given us a picture of the many repairs this fragile ceramic object has undergone over the centuries. The legs have had to be glued back together, and parts of the tail and a whole ear were replaced with new materials.

FIRST NATIONS OBJECTS

The Powerhouse collection contains several Indigenous Australian artefacts, many of which came from non-Indigenous collectors or donors who were unable to provide any insight into their use or meaning. ANSTO's non-destructive techniques may be able to provide some clues to their design, construction and use. This information can be combined with cultural knowledges to arrive at a more complete understanding of the material culture in our collection and allow a more accurate history of the First Nations people of Australia.

Hat or water carrier

This wooden object inspires many questions. Australian writer Dame Mary Gilmore donated the 'hat' to the Royal Australian Historical society in 1943. Her accompanying note claimed the hat had been made by a convict from the burl of a box tree more than a hundred years earlier. Yet it seems strikingly similar to wooden water carriers made by First Nations people. We believe its surface may hold the answers: the presence of resin would tell us it was made to hold liquid, while traces of hair oil would suggest it was worn as a hat at some point. Further cultural research is underway.

Knife

Adorned with seeds of the *Abrus precatorius* plant, the striking resin handle of this knife suggests that it had cultural significance. The plant is abundant in Queensland, where the knife was acquired in 1941, but is also found in other parts of Australia. It was uncertain whether the blade was made from horn or bone. Synchrotron X-ray tomography showed that it is likely to be made of bone from a southern cassowary. Radiocarbon dating of the seeds suggests they were collected between 1877–1930 so it is likely the knife was made in this period.

Boomerang

In the early 1930s this boomerang was unearthed in Hillsdale, in Sydney's Eastern Suburbs. It was found more than ten metres underground in swampy terrain that helped preserve it. ANSTO used radiocarbon dating to find out how old the boomerang is, giving us a range of 1520–1795 CE. If five hundred years old, it would be one of the oldest surviving boomerangs found in New South Wales. Further study will show us which part of the tree the boomerang came from and identify the timber species. This will give us insights into its design and origin.

Alarm clock

This 70-year-old alarm clock, manufactured in Adelaide by Colton, Palmer and Preston Ltd, reminds us of the many intricate but everyday mechanisms that have been replaced by phone apps today. By using gears, winding mechanisms and springs, the clock can keep time and emit an alarm without needing battery power. ANSTO combined neutron imaging and X-ray imaging in colour to reveal the many small parts that make the clock function. While the X-rays (blue) could not penetrate the clock's dense metal components, neutron imaging (pink) has been able to show that the central mechanism (green) is composed of two different kinds of metal.

Gift of J H Wolfe, 1966

Geiger counter

Perhaps the best-known instrument associated with nuclear science and technology, Geiger counters are used to tell us if a substance is radioactive. While they have sophisticated electronics to provide numerical data outputs, they are famous for their clicking; the rate of clicks represents the level of radiation. This counter was scanned using neutron and synchrotron X-ray tomography with spectacular results. The study showed how an object's internal components can disrupt imaging and proved the benefit of using different techniques: neutrons absorbed by the lithium in the batteries that power the counter blurred the imaging. In contrast, X-rays revealed a very detailed picture of the object, with the batteries and other components clearly visible.

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