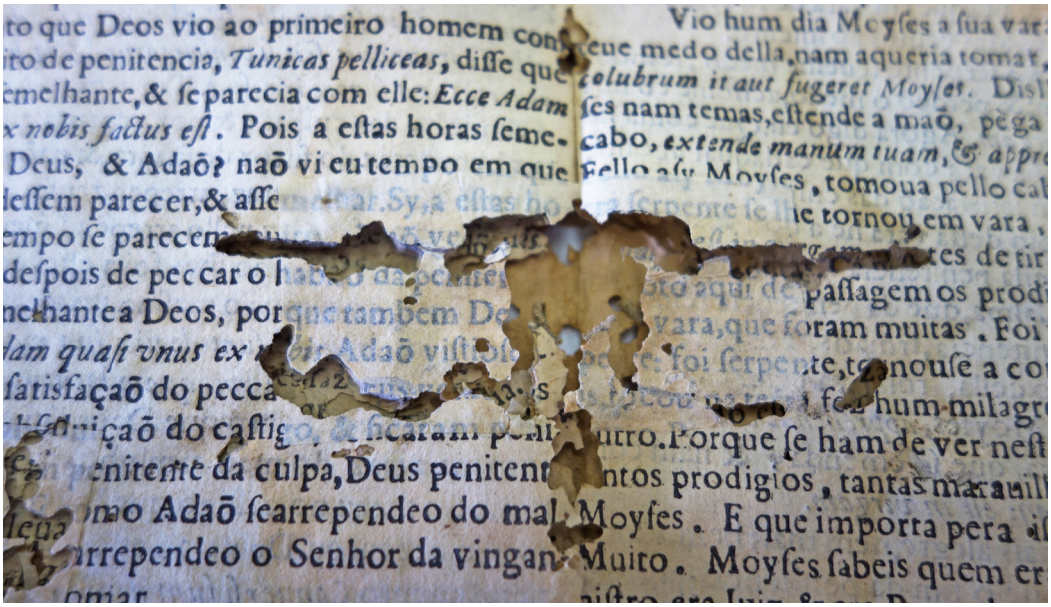
Culture meets nuclear in Brazil

By Laura Gil



Scientists use radiation techniques to treat cultural artefacts like this damaged book and help improve their durability.
(Photo: Institute of Brazilian Studies — IEB/USP)

Art conservationists and nuclear scientists may make an unlikely team, but in Brazil these specialists have joined forces to harness nuclear technology to preserve more than 20 000 cultural artefacts.

"By merging these two worlds together, we are preserving our heritage and uncovering details about our past in a way we had never done before," said Pablo Vasquez, researcher and manager of the multipurpose gamma irradiation facility at the Nuclear and Energy Research Institute (IPEN) in São Paulo. "Radiation technology has become an essential part of our conservation process."

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The multi-disciplinary group at IPEN has worked with the IAEA for more than 15 years to use radiation techniques to treat, analyze and preserve cultural artefacts ranging from art pieces to old military paraphernalia to public document archives (see The Science box). Among these are well-known pieces from artists such as Anatol Wladyslaw and Wassily Kandinsky, as well as modern Brazilian painters such as Tarsila do Amaral, Anita Malfatti, Di Cavalcanti, Clóvis Graciano, Candido Portinari and Alfredo Volpi.

From medical devices to cultural heritage

The team repurposed the IPEN irradiation facility that was originally used for sterilization of medical devices, so that it could also use gamma irradiation on historical objects to disinfect them, fight mould and insect infestations, and help improve the durability of these artefacts.

This technique helps to protect artefacts from the effects of the country's climate, Vasquez explained. "The problem in Brazil is the weather, the humidity and natural disasters. We have a larger amount of fungi and termites than other countries do, and these can be destructive to books, paintings, wooden pieces, furniture, sculptures and modern art."

Using gamma radiation is a much less invasive way to disinfect pieces than using conventional methods, explained Sunil Sabharwal, a radiation processing specialist at the IAEA. "Using gamma rays is a better alternative because it is done at room temperature using no additional substances, unlike conventional decontamination methods that often involve heat or chemicals that can alter material," he said.

Uncovering clues buried in artefacts

Before treating a piece, the team analyzes it using various nuclear and conventional techniques including radiography, X-ray fluorescence and X-ray diffraction (see The Science box). This process uncovers details buried in the pieces, such as the kind of pigment or metals the artist used. This helps the team identify the most appropriate preservation method.

Scientists used these analytical techniques to study a pre-Hispanic canvas from the collections of the Palace of the State Government of São Paulo. They took measurements that helped them determine the kind of paint the artist used and uncover details of how the piece of art had previously been restored. They also found hidden drawings under the original painting.

A hub of knowledge

Today the IPEN team's decades of experience is a main source of knowledge for many experts in the region and around the world. In 2016, IPEN staff were involved in the first ever training course on this topic for Latin American experts. Organized by the IAEA, the course brought together conservators, restorers, museologists, librarians, curators and radiologists from ten countries in the region to learn about the different applications of radiation technologies in cultural heritage.

IPEN now has a long list of requests for support. Its staff work on objects from different countries and regularly train foreign scientists and cultural experts.

Many objects from the Afro Brazil Museum in São Paulo, Brazil, have been treated with gamma irradiation at the Nuclear and Energy Research Institute (IPEN).
(Photo: L. Potterton/IAEA)

An interesting project in the pipeline, said Vasquez, is the possibility of bringing three mummies that have been attacked by insects and fungi to the institute for treatment from Ecuador. The IAEA is supporting this project with expertise and training.

"I am glad that experts and international organizations are placing more and more importance on preserving cultural heritage because our heritage is what represents the identity of our people," Vasquez said. "We must continue to work to protect it."

THE SCIENCE

Gamma irradiation and X-ray diffraction (XRD)

Gamma radiation, also known as gamma rays, refers to electromagnetic radiation of an extremely high frequency. It is emitted as high energy photons, an elementary particle with wave-like properties.
A chemical element called cobalt-60 is a commonly used source of gamma radiation.

Gamma rays are a type of ionizing radiation. At the dose levels used to protect cultural artefacts, this type of ionizing radiation inhibits reproduction of microbes at room temperature without any physical contact. The high frequency, high energy electromagnetic waves interact with the critical components of cells. And at these dose levels, they can alter the DNA so as to inhibit the reproduction of cells.

This process of inhibiting cell reproduction helps to kill off unwanted insect and mould infestations.
At the right dose levels, it can also be used to reinforce and consolidate the resins that specialists use to cover the porous materials of artefacts to protect them and give them a second life.

X-ray diffraction is a non-destructive, highly sensitive technique that relies on X-rays to uncover information about crystalline materials. Crystalline materials are solid materials, such as glass and silicon, whose constituents are arranged in a highly ordered microscopic structure. The technique is beneficial in that it can be used in very small samples of many different types of crystalline materials.

Scientists expose a crystalline material to X-rays, and as the X-rays interact with the atoms of the crystals in the material, they scatter and produce an interference effect called a diffraction pattern. This pattern can provide information on the structure of the crystal or the identity of a crystalline substance, which helps scientists characterize and exactly identify the crystalline structure of an object.