Volume 16 • February 2000

REACTIONS

FROM THE AMERICAN NUCLEAR SOCIETY TO TEACHERS INTERESTED IN THE NUCLEAR SCIENCES

Knowing Age of Wax May Help Confirm Tale of Murder

Accelerator Scientists Contribute to Historical Research

Your students may have heard of Francisco Pizzaro in a history course. But, they might be surprised to learn that modern scientific methods are of interest to historians who want to know more about Pizzaro's conquest of Peru in the early 1530s.

Researchers at the Australian Nuclear Science and Technology Organisation (ANSTO) have used the ANTARES tandem accelerator* and radiocarbon dating to establish the age of wax samples that may help clarify history.

The tale is one of murder and intrigue that may be bloodier than historians suspected. There are interesting characters – the mysterious Incas, the conquistadors, and a Jesuit priest who may have faked his death to protect himself.

Ancient Letter ANSTO recently studied a tiny sample of sealing wax from a letter dated August 5, 1533 and addressed to Carlo V, King of Spain. In the letter, Francisco de Chaves, a conquistador and chronicler of Pizzaro's expedition, wrote that the Inca King Atahuallpa had agreed to go to Spain to honor Carlo. But, according to the letter, Pizzaro feared that the defeated Atahuallpa would reveal to Carlo the atrocities committed during the conquest.

Startling Claim The letter says that Pizzaro had Atahuallpa assassinated by strangulation and his generals poisoned with arsenic-laced wine. This account is quite different from the long-held view that Atahuallpa was put to death for ordering the execution of his brother and a rival for the title of Inca.

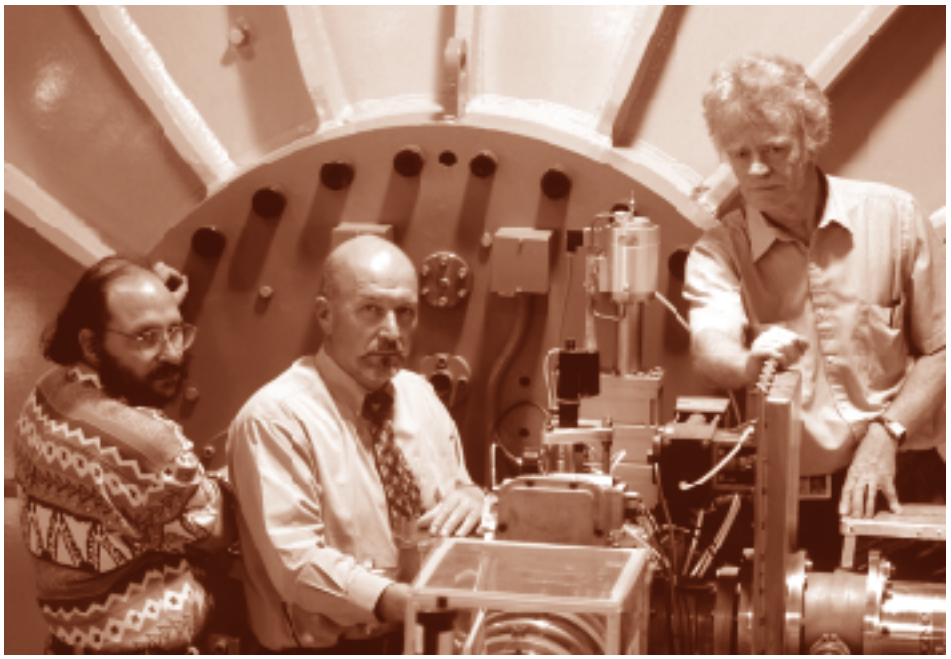
Priest's Writings The letter never reached Carlo V. It eventually passed into the hands of the Jesuit priest, Blas Valera, who sought to document the crimes of the conquerors. Some historians believe that Blas faked his death in 1599 and began writing under false names. If they are right, Blas is the author of a complex history of the conquest, Nueva Coronica y Buen Gobierno, written sometime before 1618. To support his claims, he attached the Francisco de Chaves letter written to Carlo V. He also wrote an account of his actions, titled Exsul Immeritus, dated May 10, 1618. This account was found with a wax box containing other documents. A second wax sample, taken from this box, was also studied by ANSTO.

Somehow, the documents found their way into a Spanish library, but their importance was not recognized until they were rediscovered last century. Historians Clara Miccinelli and Laura Laurencich-Minelli have recently undertaken an effort to study them.

Modern Technology In an effort to authenticate the documents, the two wax samples were sent to ANSTO's Physics Division for radiocarbon dating on the Antares tandem accelerator, a giant mass spectrometer so powerful it can detect one specific atom in a thousand million million. It is just one of a few such instruments in the world, according to ANSTO.

Using the tandem accelerator, the sealing wax from Francisco de Chaves' 1533 letter to Carlo V

ANSTO's Dr. Ugo Zoppi, Dr. Claudio Tuniz and Dr. Ewan Lawson with the Antares tandem accelerator, the giant mass spectrometer used to date the wax samples.



***Information about the Antares tandem accelerator, radiocarbon dating, and a diagram of the accelerator are available at <www.ansto.gov.au/natfac/antares.html>**

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Teacher Workshops on Radiation, Nuclear Science and Technology presented by American Nuclear Society, ANS Members or Related Groups

(Scheduled as of Feb. 10, 2000)

State	City	Date	Length	Event or Contact	Cost	Registration Deadline
AZ	Phoenix	TBA	90 min	NSTA Area Convention Dec. 7-9	free	n/a *
CA	San Diego	06/04	6 hour	ANS - Outreach Dept. 708-352-6611 outreach@ans.org	$25	TBA
DC	Washington	11/11	6 hour	ANS - Outreach Dept. 708-352-6611 outreach@ans.org	$25	TBA
ID	Boise	TBA	90 min	NSTA Area Convention Oct. 5-7	free	n/a *
MI	Lansing	03/03	90 min	Mich. Sci. Teacher Assn. March 3 & 4	free	n/a *
MD	Baltimore	TBA	90 min	NSTA Area Convention Nov. 16 -18	free	n/a *
MO	Columbia	June (TBA)	1 week	Dr. William Miller 573-882-9692 MillerW@missouri.edu or Gayla Neumeyer 573-882-8366 NeumeyerG@missouri.edu	no cost to attendees	May (TBA)
TX	College Station	03/04	6 hour	Dr. Robert K. James Director, Texas Alliance Texas A & M University ph. 409-845-3910 fax 409-845-9663	$11 after 1/31	check with contact for space availability and final deadline
WI	Milwaukee	TBA	90 min	NSTA Area Convention Oct. 19-21	free	n/a *

***We only post workshop registration deadlines established by ANS or a related group. Generally, our convention presentations do not require advance registration for the workshop itself. We are NOT able to provide registration information or deadlines for conventions; check with the organizing group for details. FOR THE LATEST WORKSHOP LISTINGS, VISIT OUR WEB SITE at <www.ans.org>**

Scientists Strive to Improve Medical Imaging Methods

Scientists at Brookhaven National Laboratory are working with Schering AG, a German pharmaceutical company, to develop a safer, higher-quality medical imaging method.

X-ray images of bones are easily created, but images of internal organs usually require a contrast agent. An x-ray radiography contrast agent is a dye that absorbs x-rays; an organ containing such an agent is visible on a radiograph in contrast to the surrounding tissue. Traditional, injectable radiography contrast agents are based on iodine and can cause adverse reactions in patients with allergies, asthma, kidney diseases, diabetes or poor general health. Also, iodine-based agents aren't efficient at absorbing the high-energy portion of the x-ray spectrum used for imaging today. As a result, the contrast characteristics of the radiograph aren't ideal.

Brookhaven and the pharmaceutical company plan to create a contrast agent based on lanthanides, which are heavier than iodine and better able to absorb higher-energy x-rays. The element gadolinium is under consideration because it has been used with relatively little risk in magnetic resonance imaging (MRI). However, standard MRI agents are not concentrated enough for x-ray use, so the research team will be developing and testing more concentrated versions.

Brookhaven scientists will develop a device to select a narrow spectrum of x-rays and methods for K-edge beam filtration, to be used with conventional x-ray sources. Both will be tailor-made to select x-rays that are best absorbed by gadolinium.

When the new system is in clinical use, patients will be exposed only to those x-rays that are most useful with the new contrast agent. As a result, they will get less x-ray exposure. And, at the same time medical personnel will get better images — images that are more useful for diagnostic purposes.

Earthbound Research into Effects of Deep Space Radiation

The prospect of sending humans on long-term, deep space flights, presents many challenges. One of those is a concern about the long-term exposure to the radiation found there.

Astronauts are exposed to galactic cosmic rays – heavy charged particles and energetic protons zipping through space at high speed – and also to solar radiation, composed of protons, heavy ions, and electrons.

Mars Mission Estimates

It has been estimated that during one year on a Mars mission, one-third of an individual's cell nuclei would be hit by a heavy charged particle. Another estimate suggests that on a three-year Mars Mission, 13 to 46 percent of the neural cells in certain brain areas will be traversed by heavy ions.

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These estimates, our inability to shield effectively against heavy ions, and the potential for a significant effect on non-dividing cells, such as neurons, has made it critical to conduct research into how cosmic rays affect astronauts and their spacecraft, defining damage that might be caused by heavy-ion exposure.

Earthbound Research

In November, a team of NASA-sponsored researchers from several institutions conducted a number of radiobiology, dosimetry and space-material testing experiments at the Alternating Gradient Synchrotron located at Brookhaven National Laboratory. This is the only machine in the United States and one of only four in the world able to simulate the heavy-ion component of cosmic rays.

The team of scientists irradiated worms, cultured cells from humans and mice, and DNA in solution. In addition, they tested industrial materials considered for use in space suits and for shielding the walls of the space station and shuttle.

Research Aims

Scientists on the team are hoping that the studies will expand our knowledge of the effects of cosmic radiation on both humans and materials. Armed with more knowledge, scientists hope to be able to develop effective new countermeasures for use in space exploration. In addition, the research may tell us more about the structure and repairability of genetic material and about any links between ionizing radiation and biological effects such as cancer, aging, and neurodegeneration.

Future experiments by the NASA-sponsored team may involve materials that could be used to develop special radiation-hardened "smart" circuits for space computers. These "smart" circuits would know how to pass their functions to a backup circuit, should they take a hit from a charged particle.

Note: This article is based on information in the Brookhaven Bulletin, December 3, 1999.

Nuclear Sciences

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Research Activity

Career Information

Nuclear science and technology are used in or affect many career fields. Listed on the back are just some job titles or career fields where a knowledge and understanding of radiation and/or nuclear science or technology is needed or used.

Having students research a few of these career fields can help provide motivation for learning about radiation topics and nuclear science, particularly as they learn of practical applications.

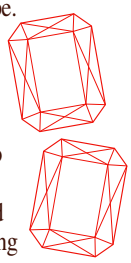
Students should look for:

- a job description explaining what someone in one of these fields does (the nature of their work — responsibilities and duties)
- qualifications (length of training, type of education, etc.)
- where they are likely to work (employment locations and conditions)
- job prospects now and the outlook for the future
- pay scale

Continued next page

Isotopes Help Determine the Source of Emeralds

Turning green with envy takes on new meaning when emeralds are involved. These brilliant gems were popular with the Egyptians and prized as a symbol of immortality. Later, the emerald trade was dominated by the Romans. Still later, conquistadors shipped these gems from Colombia to Europe.



The Colombian gems have a unique clarity and an intense color that make them relatively easy for gem experts to identify. But, it has been tougher – even for experts – to determine the source of "old world" emeralds which have less clarity and brilliance. Now, scientists are utilizing a special technique (ion microprobe oxygen isotopic analysis) to determine the source from which emeralds were mined. This approach relies on the ability to separate and quantify two isotopes of oxygen.

Emeralds are made of beryl, a silicate of beryllium and aluminum ($Be_3Al_2Si_6O_{18}$). While examining the factors that might explain the distinctive radiance of Colombian emeralds, scientists discovered that the Colombian gems have unique ratios for the isotopes of oxygen ($^{18}O/^{16}O$) which are found in the lattice.

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Nuclear Sciences

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Useful resources include library materials and a web browser.

Career Fields to Research:

- accelerator operator
- chemical radiation technician
- gamma astronomy
- hazardous waste technician
- health physicist
- health physics technician
- nuclear engineer
- nuclear medicine technologist
- nuclear pharmacist
- nuclear physician
- radiation therapist
- radiographer
- radiologic technologist
- radiologist

Isotopes Help...

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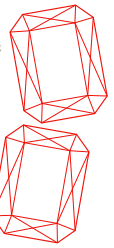

The researchers use a cesium ion primary beam and electron bombardment to vaporize a tiny bit of the emerald, leaving a tiny hole, so small (about 10 to 20 micrometers wide and only a few angstroms deep) that it can't be seen by the naked eye. The vaporized portion of the emerald is analyzed to determine the $^{18}O/^{16}O$ ratios.

Researchers found that the ratios for these isotopes vary in emeralds, depending upon where they are mined. They also found that within a specific emerald deposit, the ratios of these isotopes vary by only about 1%. As a result, this data can serve as a good identifier or "fingerprint" for the origin of emeralds.

The research has already helped identify early routes used in the emerald trade. And, it is helping determine the origin of the gems in many artifacts. In one case, research suggests that an emerald in a 13th century French crown came from an Austrian mine and that the emerald was obtained more than 500 years before the mine's documented discovery.

For more information, see *Science* (p. 562 and p. 631 - 633), January 28, 2000. Or, visit their web site <www.sciencemag.org>

Accelerator Scientists Contribute...

Continued from page 1

was dated to between 1429 and 1483. Since the wax would have been formed sometime before the letter was written, scientists believe the dates they obtained lend support to the date on the letter.

Investigators obtained two dates for the wax receptacle found with the documents. The dates came in at between 1445 and 1511 or between 1600 and 1616, with the earlier range more likely.

The results, announced at a conference in Rome, are expected to cause a great deal of interest in historical and scientific communities.

"Of course, our dates alone do not authenticate the documents or verify their contents," said Dr. Claudio Tuniz, Director of ANSTO's Physics Division. "But they certainly support the argument that the documents are real, and that the conquest was far more violent than previously imagined."

February 2000

The Future is in the Atom

Teacher Workshops Coming Soon to an Area Near You!

Details In This Issue!

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