A Quest for Ancient Egyptian Air

Scientists to use space technology for nondestructive probe of 4600-year-old boat chamber at the foot of the Great Pyramid

In 1954 archeologists discovered two nearly identical chambers, roofed with 5-foot-deep chunks of limestone, near the base of the Great Pyramid of Khufu (named Cheops by the British) on the Giza Plateau in Egypt. One of these was excavated and found to contain the disassembled but remarkably well-preserved pieces of a "solar barque" or funerary boat believed to have been designed to carry the pharaoh west after death. The 4600-year-old boat, made of wood and ropes, was eventually assembled and has been on view since 1982 in a museum built over the pit in which it was found.

The 142-foot-long boat is already showing signs of deterioration. To find out what could be done, Ahmed Kadry of the Egyptian Antiquities Organization called on Farouk El-Baz, an Egyptian born geologist who heads Boston University's Center for Remote Sensing. Kadry wanted to know if it would be possible to measure the environment in the second chamber, which is still intact, to find out what could be done to prevent further deterioration of the boat.

From that request sprang a 2-year project, to be culminated next fall—"a quest for ancient Egyptian air." Jointly sponsored by the antiquities organization and the National Geographic, it will entail the pioneering use of space-age technologies—including a drill like that used for moon probes—for a nondestructive archeological investigation. The plan is to drill a vertical core from the limestone, gather air samples, take pictures, and insert environmental monitors—all without violating the chamber's hermetic seal. When the information is gathered, the chamber will be resealed as if nothing had happened, says El-Baz.

El-Baz, who formerly directed lunar science planning at Bell Telephone Laboratories, has assembled a science council, including representatives from the National Oceanic and Atmospheric Administration (NOAA) and the National Aeronautics and Space Administration, to develop the project. Some of the technology has been custom-designed for the investigation. The air lock for the drill, for example, has been conceived, designed, and manufactured "from scratch" at the National Geographic machine shop, says El-Baz.

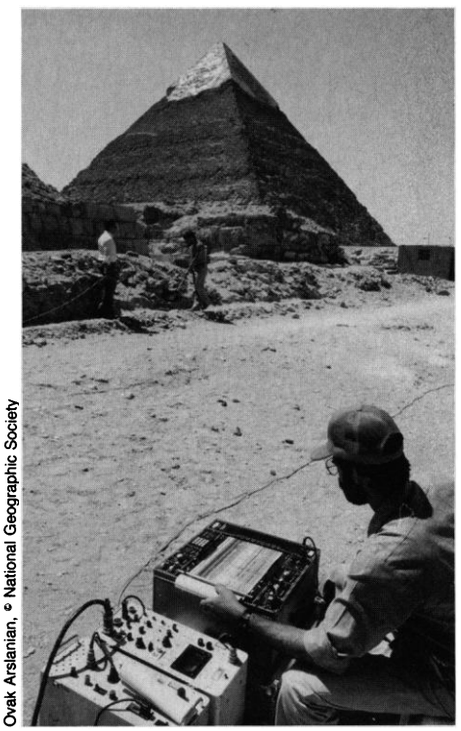
The investigators are convinced that the chamber is airtight because when the first chamber was entered in 1954 the explorers could smell the cedar the boat is made from. Also, says El-Baz, the Egyptians used a very effective sealant made of gypsum and potsherds. When gypsum cools, it crystallizes and the crystals penetrate the smallest voids.

Everything in the $150,000 project is being planned as minutely as a moon probe. Chunks of limestone from the first boat pit have been analyzed for hardness and porosity at the Massachusetts Institute of Technology. Imaging instruments are being pretested in a simulated chamber in the National Geographic warehouse, and a "dress rehearsal" at a real limestone pit will be held at the site in July. "We don't want any of this to fizzle," says El-Baz, who was science adviser to former Egyptian president Anwar Sadat.

Work at the site will begin in July, with a survey by a ground-penetrating radar which will map the shape of the chamber and the profile of the objects (presumably a second boat) within. After image enhancement has been performed at the BU center, the exact location for drilling will be selected.

The drill is being manufactured by Black and Decker, makers of the instrument used to get core samples from the moon. This is a battery-powered rotary drill that will require no water, oil, or air pressure that might pollute the inside of the chamber. With a diamond-toothed brass bit, it will drill a core 3.5 inches in diameter, moving slowly, so as not to create vibrations, at 375 revolutions per minute. The air lock, bolted to the limestone surface, will be filled with nitrogen and the bit will be withdrawn every few inches to purge and repressurize the drill chamber. Limestone dust will be continuously vacuumed out.

A manometer will monitor the pressure and indicate whether nitrogen is escaping into cracks or whether the drill is making premature contact with the chamber. When the drill reaches the pit it will be withdrawn into the air lock and a steel plate will slide across the bottom of the air lock. The last 2 inches of limestone above the ceiling of the chamber will probably be pushed into it, says El-Baz. This may stir up any pollen resting on the floor so that it can be captured in the air samples.



Ovak Arslanian, © National Geographic Society

Radar profiling. *Ground-penetrating radar is used to get a fix on the buried chamber, which is about 40 feet long, 8 feet wide, and 8 feet deep.*

The planners, after discussions with NOAA, have taken care that nothing containing Freon will come in contact with the ancient air. This is intended to cast light on the ongoing debate about whether chlorofluorocarbons have always been around (perhaps unleashed by volcanic activity) or whether they have only been introduced into the atmosphere by refrigeration and spray cans. Therefore, the O-rings connecting metal parts of the drill will be made of lead instead of rubber, since all rubber made in the past 60 years contains Freon.

Once the chamber is reached, the drill will be removed, a probe will be inserted through an adapter sleeve at the top of the air lock, and the steel plate retracted. Air samples will be taken, using a steel tube attached to a vacuum bottle on the surface. If the air has stagnated, says El-Baz, it may be stratified with heavier molecules, such as carbon dioxide, falling to the bottom. So samples will be taken from the bottom, middle, and top of the pit.

NOAA will perform most of the air analysis; any pollen found will be scrutinized at the Smithsonian Institution, and wood par-

Drug Trial for Parkinson's

Twenty-eight medical centers in the United States and Canada are to join in what will be the most ambitious prospective clinical trial ever in the fight against Parkinson's disease. The 5-year trial, which has just been funded by a $10-million grant from the National Institute of Neurological and Communicative Disorders and Stroke (NINCDS), will determine whether two drugs—Deprenyl and tocopherol—can slow or even arrest progression of this neurodegenerative disease.

More than 1 million people suffer from Parkinson's disease in this country, most of whom are over the age of 60. And each year nearly 61,000 younger people with the disease become unemployed as a result of progressive disability. As John Penny of the University of Michigan points out, "the overall cost savings to society would exceed $10 million annually if Deprenyl and/or tocopherol prove effective in maintaining work capacity in the early Parkinson patient for *just an additional week*." For this and other reasons, the 800 participants in the clinical trial will be persons in the early stages of the disease.

The impetus for the Deprenyl/tocopherol trial comes from the remarkable revolution that has swept Parkinson's disease research in recent years. In 1983 it was discovered that a chemical by the shorthand name of MPTP, which is a contaminant of a certain "synthetic heroin," rapidly and selectively destroys the same group of brain cells that slowly degenerate in natural Parkinson's disease. The explosion of research on MPTP-induced parkinsonism gave birth to the idea that natural Parkinson's disease may be caused by prolonged exposure to low levels of an environmental toxin, perhaps MPTP or something akin to it.

In fact, it turned out that MPTP itself does not kill brain cells, but a metabolic derivative of it that goes by the name MPP+. The key discovery that led eventually to the planned clinical trial was that the conversion of MPTP to MPP+ could be prevented by the drug Deprenyl, which blocks the activity of monoamine oxidase. If natural Parkinson's disease is caused by an environmental chemical like MPTP, then Deprenyl might prevent the production of the toxic agent and therefore protect the susceptible brain cells.

In addition, some researchers believe that the brain cell degeneration seen in Parkinson's disease may be inflicted by certain chemicals generated by the activity of monoamine oxidase on the neurotransmitter dopamine, which is normally produced by the degenerating cells. The administration of Deprenyl might therefore be protective in this way too, as would tocopherol, a derivative of vitamin E, which mops up harmful oxidative chemicals of the sort that might be a culprit here.

Treatment of parkinsonian patients in North America currently focuses on symptoms, not prevention. Patients are given L-dopa, which makes up some of the deficit of dopamine that results from brain cell degeneration, and thereby eliminates the muscle stiffness and tremors that characterize the disease. Meanwhile, the loss of brain cells continues, and symptoms become more and more difficult to alleviate. Eventually L-dopa therapy has to be stopped, because the side effects become worse than the disease, sometimes including horrible hallucinations. Prevention of brain cell degeneration, even by a modest amount, could therefore extend the useful life of L-dopa, once it became necessary.

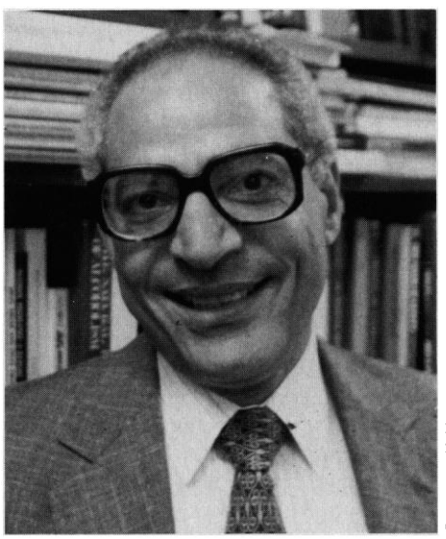
Deprenyl has been part of the treatment of Parkinson's disease for some years in many European countries, often in combination with L-dopa. Although this experience shows that Deprenyl is no miracle cure, so far there is insufficient information to determine what, if any, effect the drug has in slowing down the disease. One retrospective study, published in 1983, seemed to indicate significant beneficial effects, including prolongation of life. But in Europe, no prospective trial has been conducted that would give the necessary degree of control over drug dosage, drug combination, and careful monitoring of symptoms and so on that would unequivocally determine the true efficacy of the treatment.

The idea for the North American prospective study of Deprenyl and tocopherol was conceived in 1985, with the formation of the Parkinson Study Group, a coalition of researchers and clinicians involved with the disease (*Science*, 1 November 1985, p. 527). Ira Shoulson of the University of Rochester and Stanley Fahn of Columbia University were instrumental in setting up the group and are principal investigators for the NINCDS-funded project. ■ ROGER LEWIN

ticles will be sent to the Netherlands for analysis by a world expert on the microstructure of wood.

Next, the contents will be photographed with a compact television camera designed for looking into nuclear power plants. Heat-free light will be supplied by a fiberoptic light source which will also contain no infrared or ultraviolet. Still pictures, some in stereo, will be taken by a $32,000 camera designed by Emory Kristof of the National Geographic, who designed the photography for the Titanic expedition. The BU center will use these to make a map of the contents.

Finally, sensors will be inserted into the chamber to measure humidity, temperature, and air pressure at different levels. The chamber will then be resealed with epoxy resin. An environmental sensor may be left to ascertain whether there are changes as a result of the probe. There are no plans at present to retrieve the second boat.



Constance Holden

Farouk El-Baz. *The project director says if anyone has a better idea about how to proceed with the probe into the boat pit, he wants to hear about it.*

El-Baz calls the expedition "a pioneering effort in applying new remote sensing technology to the science of archeology." He says the techniques could be used, for example, for probing the cavities in Mayan structures in Guatemala, and exploring tombs in China that the Chinese do not want to excavate because they lack the museum space to properly preserve the contents.

El-Baz wants other scientists to know about the Giza project before the site work begins—"If anybody out there has a better idea about doing any of these steps please let us know so we can modify the plan. We can do this only once." ■

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