

# Radar from space finds ancient center of frankincense trade

*Students at Sacred Heart and Menlo School hear fabulous tale of how radar on the space shuttle located ancient "Sin City," long lost under the sands of Arabia's Empty Quarter*

By MARION SOFTKY

The Koran described it as "the many towered city ... whose like has not been built in the entire land," and says a windstorm sent by Allah buried "Sin City" under the sands.

The lost city of Ubar, once the center of the lucrative frankincense trade, evaded the most intrepid explorers for almost two millennia. Now - thanks to radar and rockets - archaeologists are excavating a buried city, thought to be Ubar, under the sands of Oman in the fabled "Empty Quarter" of the southeastern Arabian Peninsula.

Recently, science students from Sacred Heart and Menlo schools listened raptly as Dr. Charles Elachi, assistant director of the Jet Propulsion Laboratory (JPL) of Pasadena, recounted the discovery of Ubar through radar pictures taken from the space shuttle.

The discovery, combining space technology and traditional archaeology, is a dramatic example of how we can bring scientific research to bear on day-to-day kinds of things, Dr. Elachi said.

Actually Dr. Elachi's main job is directing science experiments on the space shuttle. He has also designed and headed many of the experiments on planetary spacecraft.

Dr. Elachi's presence at Sacred Heart was a coup for Dean of Faculty Connie Solari, who used to practice her French with the Lebanese-born scientist when she

## Ducks in the desert

Fresh meat was just one of the logistical problems of supporting a team of 40 for months in the Egyptian desert.

According to Dr. Charles Elachi, ducks were a form of portable fresh meat favored by the Egyptians. The expedition ducks shared a tent with the Egyptian cook, he said, and they were very noisy.

Dr. Elachi asked the cook how he could stand living in the tent with all the quacking.

The cook's solution was simple. Each night they ate the noisiest duck for dinner. Soon they weren't so noisy.

was an intern at JPL 20 years ago.

### Discovery by radar

The modern road to Ubar started over Egypt in 1981.

Dr. Elachi was heading a radar experiment on the space shuttle Columbia to study the Sahara desert. "We were interested in why the desert was expanding in Africa," he said.

The "Shuttle Imaging Radar" employed in the experiment uses radio waves - very similar to television or police radar - to map the earth's surface. Unlike photographs taken with regular light, radar can penetrate cloud cover and vegetation and take pictures of underlying features, Dr. Elachi explained.

The scientists were surprised when their radar showed an extensive network of drainage channels in the arid desert of southern Egypt. It turned out the radar was penetrating more than 6 feet below the flat sand surface to show a historic landscape marked by water.

Dr. Elachi later joined a desert expedition that dug under the desert sand and verified what the radar showed: What is now featureless sand, "flat as a pancake" where it rains once every 50 or 60 years, had a much wetter climate several thousand years ago. The scientists found river beds marked by rounded pebbles, and shells of ostrich eggs. Carbon dating of the eggshells indicated they were laid some 6,000 years ago, "roughly when the pyramids were built," Dr. Elachi said.

When the radar discoveries became known, archaeologists recognized a new tool to discover roads and ruins beneath the desert. Documentary filmmakers Nicholas Clapp and George Hedges, who had been researching the legendary lost city of Ubar, approached Dr. Elachi and his colleagues to apply the new technique to the search for Ubar.

### Huge sand dunes

Roman maps show Ubar. English explorers trying to follow ancient caravan routes by camel were foiled by endless sand dunes. "These are huge sand dunes 1,000 feet high; they cross the desert like ripples," said Dr. Elachi.

His interest caught, Dr. Elachi arranged for shuttle flights in 1984 and 1987 to make radar images of the Arabian desert. Sure enough, study of the images from space showed traces of ancient roads pass-

ing beneath the sand dunes. They converged on the oasis of Shisr in the deserts of Oman.

It took several years to enlist the support of the Sultan of Oman and mount an expedition to look for ruins on the ground at Shisr.

Just a year ago, archaeologists started digging. Within a few days they began turning up evidence of an octagonal castle, multiple towers, massive walls, an impressive network of storerooms, and pottery dating back to 2,000 B.C.

### The frankincense trade

The key to Ubar's wealth was the frankincense trade.

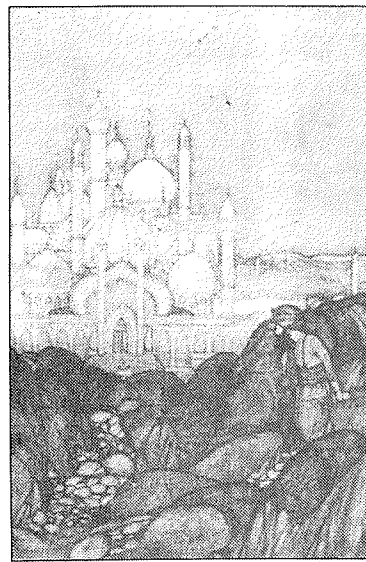
The familiar Christmas story gives an idea of the value the ancients placed on frankincense, Dr. Elachi noted. Frankincense comes right after gold in the gifts the three kings brought to the baby Jesus.

Frankincense is an aromatic balm which was in constant demand as perfume, as medicine, and particularly as incense for religious ceremonies and embalming oil for cremation. It comes from the sap of a scrubby desert bush that grows only on the edge of the Oman desert - near the ruins.

Ubar, the world center for the frankincense trade, was notorious in the ancient world for its opulence and decadence. Then it disappeared.

The tale of Allah's vengeance in the Koran is mirrored on the ground. Much of the city collapsed into a limestone cave. Dr. Elachi speculated that Ubar drew so much water from the cave that the ground gave way under it. "When you take a lot of water, the land can collapse," he said.

About the same time, the frankincense trade may also have col-



CALTECH NEWS

UBAR was one of the "enchanted cities" of Arabia described in "The Thousand and One Nights," from which this rendering by a medieval Islamic artist is taken.



CONNIE SOLARI, dean of faculty at Sacred Heart School in Atherton, scored a coup when she persuaded Dr. Charles Elachi, assistant director of the Jet Propulsion Laboratory of Pasadena, to speak at the school.

lapsed. When the Emperor Constantine converted to Christianity in the 4th century A.D., and took the Roman Empire with him, cremation went out of fashion, and with it the market for frankincense.

While the excavation of Ubar will probably take five or six years,

Dr. Elachi and his colleagues have set their sights on finding still more exotic ruins. The next space shuttle mission planned for 1993 will turn the radar onto the western desert of China in hopes of finding lost forts and cities along the famous Silk Road.

## Sculley calls for overhaul of public school system

John Sculley of Woodside, CEO of Apple Computer Inc., called for a major overhaul of America's public education system during remarks last week at President-elect Bill Clinton's economic conference in Little Rock, Ark.

Mr. Sculley was among three local executives participating in the conference.

The others were Carol Bartz of Atherton, CEO of Autodesk Inc., a software company based in Sausalito; and Sandra Kurtzig of Atherton, founder and chairman of ASK Cos. Inc. of Mountain View.

During the conference, Ms. Bartz urged Mr. Clinton to move

ahead with decisions on economic policy and not spend too long building a consensus behind his views.

In his talk at the conference, Mr. Sculley said that the old industrial model of the economy is being replaced by a rapid move toward customization of goods and services and decentralization of work.

"Our public education system has not successfully made the shift from teaching the memorization of facts to achieving the learning of critical thinking skills," he said. "We are still trapped in a K-12 public education system which is preparing our youth for jobs that no longer exist."