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NASA Radar Reveals Hidden Remains at Ancient Angkor

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 Subject: NASA Radar Reveals Hidden Remains at Ancient Angkor

Douglas Isbell
 Headquarters, Washington, DC
 (Phone: 202/358-1753) February 12, 1998

Mary Hardin
 Jet Propulsion Laboratory, Pasadena, CA
 (Phone: 818/354-0344)

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NASA RADAR REVEALS HIDDEN REMAINS AT ANCIENT ANGKOR

New evidence of a prehistoric civilization and remnants of ancient temples in Angkor, Cambodia, have been discovered by researchers using highly detailed maps produced with data from an airborne imaging radar instrument created by NASA.

Experts say the findings, made possible by the Airborne Synthetic Aperture Radar (AIRSAR) developed by NASA's Jet Propulsion Laboratory (JPL), Pasadena, CA, may revolutionize the way archaeologists view the ancient city's development.

Angkor is a vast complex of some 1,000 temples covering about 100 square miles of northern Cambodia. Little is known of the prehistoric occupation of this fertile flood plain, but at its height the city housed an estimated population of one million people. The famous temples were built from the eighth to thirteenth century AD and were accompanied by a massive hydrological system of reservoirs and canals. Today, much of the civilization of Angkor is hidden beneath a dense forest canopy and is inaccessible due to poor roads, land mines and political instability.

"The radar data have enabled us to detect a distribution of circular 'prehistoric' mounds and undocumented temples far to the northwest of Angkor," said Dr. Elizabeth Moore, Head of the Art and Archaeology Department at the School of Oriental and African Studies at the University of London. "The site's topography is highlighted by the radar, focusing our attention on previously neglected features, some at the very heart of the city.

"The radar maps not only bring into question traditional concepts of the urban evolution of Angkor, but reveal evidence of temples and earlier civilization either absent or incorrect on modern topographic maps and in early twentieth century archaeological reports," she said.

"The radar images make apparent many features that are not readily identifiable on the ground," said Dr. Anthony Freeman, a radar scientist at JPL, who has collaborated with Moore for the past three years studying the use of radar on the Angkor site. "We can see differences in vegetation structure and some features

that are obscured by vegetation cover."

In December 1997, Moore surveyed a small mound on the perimeter of the famous 12th century AD temple, Angkor Wat, that Freeman had first noticed in the radar image. "Previous archaeological accounts from 1904 and 1911 note only two temples and make no mention of the distinct circular form of the mound. We found four to six temple remains, including pre-Angkorean structures," Moore said. "This suggests occupation of the 12th century site some 300 years earlier, radically changing accepted chronologies of Angkor."

Angkor's beauty is seen in its temples, but the greatness of the Khmer city lies in the multitude of water-related constructions, according to Moore. The Khmer kings nominally dedicated temples to Hindu and Buddhist deities, but the underlying significance was veneration of ancestral spirits, ensuring fertility of the land. Management of water was essential, both for control during the monsoon rains and conservation during the dry season and involved the construction of moats, dikes, canals, tanks, and reservoirs. The largest of these reservoirs, dated to the 12th century AD, is five miles long and its function remains a matter of archaeological debate.

"These new detailed topographic maps have shown us many more hydrological features and highlighted how they function in the rituals and daily life of the Khmer people," Moore explained.

"Using a technique known as radar interferometry, which combines two images to create a three-dimensional topographic map, we can construct a map of the area surrounding Angkor that is more accurate than most maps we have of the United States," said Dr. Scott Hensley, a radar engineer at JPL. "This map lets us see both natural and human-made water management features at the site with great clarity."

"Angkor is situated on the edge of the Tonle Sap lake, a unique body of water that doubles in size during the rainy season. These maps give us new insights into the human impact on this ecosystem, from the ancient Khmer to the present day, and are of importance in the study of our changing Earth," Freeman continued.

The Angkor radar images were taken in late 1996 as part of the AIRSAR Pacific Rim Deployment and were a follow-up to the 1994 study of Angkor with data collected by the Spaceborne Imaging Radar-C/X-band Synthetic Aperture Radar (SIR-C/X-SAR) that flew on NASA's Space Shuttle Endeavour.

Like SIR-C/X-SAR, AIRSAR transmits and receives three radar frequencies in both horizontal and vertical polarizations. While both systems use C-band and L-band wavelengths, AIRSAR has the added benefit of P-band, a longer wavelength that can penetrate below the forest canopy. In addition, AIRSAR can be flown in a mode called TOPSAR that allows it to measure topography and create three-dimensional images of the surface.

AIRSAR images of the Angkor region will be posted to the Internet at this address:

<http://www.jpl.nasa.gov/news/>

AIRSAR flies on a NASA DC-8 aircraft that is managed at NASA's Dryden Flight Research Center, Edwards, CA. The AIRSAR instrument is managed by JPL, a division of the California Institute of Technology, for NASA's Office of Earth Science, Washington, DC. This office manages NASA's Earth Science enterprise, an internationally coordinated effort to study natural and human-induced changes in the Earth's land, oceans, atmosphere, ice and life.

The AIRSAR flight over Cambodia was funded by the Government of Thailand. Ground verification has been made possible by Vann Molyvann, Minister of State for Culture and Fine Arts, Territorial Management, Urban Planning and Construction; and Dr. Ang Choul=8Ean of the Cambodian Authority for the Protection and Management of Angkor and the Region of Siem Reap.

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