National Science Council

ISSN: 1607-3509

Science Bulletin

February 2005/Vol. 37, No. 2

Taiwan Does its Part for Disaster Relief

FORMOSAT-2 Successfully Completes Photographic Mission over Earthquake-Stricken South Asia

A devastating earthquake with magnitude 9.0 occurred under the sea off the northwest coast of Sumatra at 7:58 AM (local time) on December 26, 2004. According to the US Geological Survey, this earthquake had an epicenter located near the intersection of the Indian and Burmese plates, and occurred at a depth of 7 km. The earthquake resulted from a thrusting fault movement, and aftershock data indicates that 1,200 km of plate margin slid in the event. Average displacement was approximately 15 meters, and the seabed of the region was raised by several meters. The earthquake inflicted severe damage to structures in nearby Sumatra, and the ensuing tsunami ravaged countries around the rim of the Indian Ocean. Towering nearly 10 meters in places, the tsunami reached as far as Somalia on the east coast of Africa, and wreaked exceedingly great destruction in many of the areas it affected.

To show its compassion, Taiwan quickly joined the international humanitarian relief effort that took shape right after the devastating earthquake and tsunami struck South Asia. Besides the search and rescue and medical teams sent by Taiwan, the National Space Program Office (NSPO), National Taiwan Normal University, National Cheng Kung University, and National Central University stepped forward on December 28, 2004 to volunteer the services of the FORMOSAT-2 satellite in photographing stricken areas and gauging the extent of damage.

According to the NSPO, the FORMOSAT-2 possesses a unique daily re-visiting capability, and its second daily orbit passes directly over the disaster area. The NSPO successfully took satellite imageries of Thailand's Phuket and Indonesia's Banda Aceh on the morning of December 28, and subsequently obtained clear images of Phuket, Ranong in Banda Aceh, India's Andaman Islands and Nicobar Islands, and the Maldives. The NSPO in conjunction with the satellite team immediately processed and analyzed the imageries taken by the FORMOSAT-2, and freely provided the most up-to-date satellite imageries and disaster reports via the Internet, media, and Ministry of Foreign Affairs to the affected countries for use in disaster relief work. Since the data was released, groups and organizations from over 60 countries have already downloaded this image set through the Internet. Since many current maps of the disaster areas can no longer serve as reference because of the enormous destruction to urban areas and landscapes, Singapore's search and rescue team made extensive use of FORMOSAT-2 imageries in their relief work on the Nicobar Islands.

Taking Banda Aceh, the main city of Aceh Province on the Indonesian island of Sumatra, as an example, high-resolution fusion color imageries taken by the FORMOSAT-2 clearly show the extent of damage in the city. Analysis of the remaining debris and rubble indicates that the effects of the tsunami extended several kilometers inland around Banda Aceh. In addition, the imageries reveal the scars left by the tsunami's scouring action when it swept collapsed buildings and piles of ruins into nearby rivers or directly onto the streets. The area affected by the tsunami generally paralleled the coast, but the coastal terrain and land gradient in certain areas extended the giant wave's effects inland for several kilometers. Apart from the tsunami's effects, Banda Aceh is located on an alluvial plain consisting largely of poorly cohesive soils with low bearing strength, hence many buildings quickly collapsed from the violent ground movements. Damage or distortion of buildings and streets were used to judge the severity of structural impairment and determine other important information concerning the disaster. An overall assessment of the disaster situation is important for planning humanitarian aid and relief efforts, and can help to avoid the confusion, poor planning, and slow progress that typically plague disaster relief efforts due to ignorance of the facts on the ground.

The Maldives photoed at 2005.01.01.

At present, the FORMOSAT-2 passes over Taiwan's Central Mountain Range each day around 9:45 AM and sends down panchromatic imageries with 2-meter resolution and multispectral imageries with 8-meter resolution. These imageries provide very useful information for monitoring various phenomena that may change on a daily basis, such as natural disasters, the environment, and crop growth. The use of FORMOSAT-2 imageries to analyze the effects of the South Asian earthquake shows that satel-

lites can be used to assist disaster relief efforts. This is very important in the initial phase of a disaster, when transportation to the affected area might be cut off and lines of communication severed, but a satellite with autonomous control, special orbital design, and global monitoring capabilities can be in position to obtain useful information. The recent South Asia earthquake shows that the FORMOSAT-2 is indeed a powerful tool for assessing the scope and damage of natural and man-made disasters. The FORMOSAT-2 will continue to perform various types of geological disaster survey and monitoring work in the future, and the experiences gained will help improve disaster prevention and relief capabilities and enhance safeguards against catastrophe.

Exploring a New Energy Resource

Research on Gas Hydrates Beneath the Seafloor off Taiwan

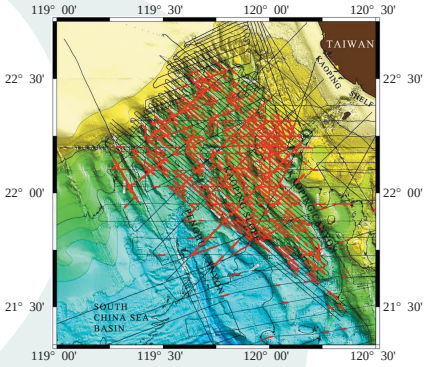
With funding from the NSC, a research team led by Prof. Liu Char-shine of the Institute of Oceanography at National Taiwan University (NTU) discovered "bottom simulating reflector" (BSR) signals after analyzing seismic reflection profile data collected offshore southwestern Taiwan. Since BSR signals are strong indicators of gas hydrates in sediments, this finding suggested the presence of gas hydrate deposits beneath the seafloor near Taiwan. Subsequent investigations yielded clear geophysical evidence of gas hydrates distributed throughout an area of over 20,000 square kilometers.

To harness basic research findings for economic benefit, the Central Geological Survey of the Ministry of Economic Affairs (MOEA) initiated a four-year project in 2004 to investigate gas hydrates off southwestern Taiwan. The project involves researchers from NTU, National Cheng Kung University, National Taiwan Ocean University, and National Central University. Preliminary investigation detected high concentrations of methane gas leaking out from seafloor sediment in many places where BSR signals have been found.

According to the NSC, Taiwan lacks its own energy resources and relies on imports for 97% of its conventional energy supplies, including coal, petroleum, natural gas, and nuclear energy. With petroleum prices on the rise and instability in the Persian Gulf, an energy crisis could break out at any time and disrupt energy flow into Taiwan. In response, the government has been promoting energy conservation and the NSC is providing long-term support for R&D in alternative energy such as solar and wind power.

According to Prof. Liu, a gas hydrate is an ice-like solid consisting of a cage of water molecules surrounding a gas (commonly methane) molecule under low-temperature, high-pressure conditions. Natural gas hydrates are found in permafrost layers in the polar regions and in continental slope sediments, and in fact can form wherever a sufficient supply of gas exists under the proper environmental conditions. But if the environment changes and temperatures or pressure exceed stability conditions, gas hydrates will dissociate into water and natural gas. Over 95% of naturally formed gas hydrates consist of methane, and they are commonly referred to as "methane hydrates."

Gas hydrates have been the focus of much international attention because of the vast quantities of hydrates believed to exist on earth. According to a US Geological Survey report, the dissociation of global gas hydrates could potentially yield twice as much energy as the world's known total reserve of fossil fuels, including coal, petroleum, and natural gas. The US and Japan began studying gas hydrates in the 1980s and have acquired extensive knowledge and experience in the distribution of gas hydrates, their physical and chemical properties, and possible problems with extraction. Canada, Germany, India, China, South Korea, and other countries have also begun devoting considerable funding into gas hydrate research. Worldwide research on gas hydrates focuses mainly on three areas: (1) its potential use as a future source of energy, (2) the impact on the global carbon cycle and climate changes, and (3) its role in catastrophic geological events.



Seismic reflection data collected offshore southwestern Taiwan from 2002 to 2004.

For its part, Taiwan's southwest offshore offers an ideal geological setting for research on gas hydrate deposits. The eastern half of this area is composed of an accretionary wedge formed by the subduction of the Eurasian plate eastward beneath the Luzon Arc, while the continental shelf and slope of the northern South China Sea lies to the west. According to recent findings of the Central Geological Survey, MOEA, high concentrations of gas hydrates have been found in both the accretionary wedge and continental slope sediments. This discovery gives rise to several important questions: Do the gas hydrates in these two completely different geological provinces come from the same source? Have they formed and migrated in different ways? What kind of geological environments will most likely to produce reservoirs with economic potential? Furthermore, high concentrations of BSR have been observed in the Tainan

Basin just north of the South China Sea continental slope where the Chinese Petroleum Corp. is developing natural gas fields – do the natural gases in the Tainan Basin and those in nearby gas hydrates come from the same source? What conditions are needed to form a gas hydrate reservoir?

The terrain in southern Taiwan also offers excellent opportunities to study gas hydrates. This part of the island is composed of old submarine sediments thrust up during the arc-continent collisions that formed Taiwan's mountains. The sedimentary strata in this area should therefore have previously held large amounts of gas hydrates, all of which would have dissociated as the seabed rose. The rapid rise of the submarine strata makes for interesting research into the process and mechanism of gas hydrate dissociation from environmental changes.

The NSC has pledged to cooperate with the MOEA to support explorations of gas hydrates as potential energy resources and to study the excellent geological conditions in offshore southwestern Taiwan. The NSC is also encouraging international collaborations to promote Taiwan's gas hydrates deposits as a high-potential field of research.

Taiwan and France Join Forces to Study Earthquakes

2004 French-Taiwan Science Prize Recipients to Study Earthquakes Offshore Eastern Taiwan

On November 24, 2004, the Sixth *Prix Scientifique Franco-Taiwanais* ceremony was held in Paris to honor researchers in the field of marine sciences. A prize of EUR 38,200 provided by the NSC was jointly awarded to Prof. Liu Char-shine of the Institute of Oceanography at National Taiwan University and Dr. Serge Lallemand of the University of Montpellier II, France. The award ceremony was held at the Maison des Polytechniciens and co-hosted by NSC Minister Dr. Wu Maw-kuen and Dr. Etienne-Emile Baulieu, President of the Academy of Sciences of the Institut de France.

Prof. Liu and Dr. Lallemand have for the past 14 years been leading a team of marine geoscientists to study Taiwan's geodynamic problems, and have made significant contributions to the tectonics and marine geology and geophysics of the offshore region surrounding Taiwan. The team has published over 40 scientific papers and trained five young scientists for their Ph.D. degrees in France and in Taiwan. The two laureates plan to initiate another project in 2005 using Taiwanese and French ocean bottom seismometers (OBS) to investigate tectonics and seismogenic processes in an earthquake-active area offshore eastern Taiwan. The two will also organize the Fifth Taiwan-French Joint Symposium on Earth Sciences in Taiwan in the fall of 2005. This symposium will present results from recent cooperative research, strengthen relationships among Taiwanese and French scientists, and expand the scope of their collaborations.

Dr. Lallemand described Taiwan as belonging to a unique geological location with very active tectonic processes. The French scientist had been studying various offshore areas surrounding Taiwan for more than a dozen years and now plans to focus on the eastern offshore, where tremblors are frequent and strong, often recording magnitudes of 6 or greater on the Richter scale. Dr. Lallemand intends to deploy OBS instruments to record earthquake activities from the seafloor in hopes of pinpointing earthquake locations and understanding the area's seismotectonics.

Prof. Liu added that Taiwan will be able to operate 18 self-owned OBSs in the year 2005. With the addition of French OBSs, the total number of OBSs to be deployed for this experiment could reach 40 or 50, adequate for complete coverage of earthquake activities from land to offshore areas. Since large tremblors occuring offshore can potentially cause severe damages to populated land areas, this cooperation is seeking to improve understanding of the region's seismogenic processes and contribute to earthquake prediction research. Prof. Liu further stressed that Taiwan-French cooperation in marine geosciences can bring benefits to both sides. For instance, Taiwan has for years been investigating high concentration of gas hydrates off its southwestern shore as a possible energy resource; as France is just entering this field, it stands to benefit from Taiwan's experiences.

According to NSC Minister Dr. Wu, the French-Taiwan Science Prize was founded in 1999 by the NSC and the Academy of Sciences as part of an agreement to establish the Taiwan-French Scientific Foundation. Each year, a review board consisting of representatives from the NSC, Taiwan's Academia Sinica, and the French Academy of Sciences selects one or more scientists from a designated field of research. In addition to recognizing researchers for scientific achievements and contributions to bilateral research and educational collaborations, the prize also encourages future cooperation activities among former prize laureates. Dr. Wu was particularly pleased to learn that the first prize laureate Prof. Jacques Angelier is still actively conducting cooperative research on crustal deformation in the Longitudinal Valley area in eastern Taiwan. The Minister also mentioned that the 2005 Prize will be awarded in the field of physics. Representatives from the NSC and Academia Sinica will join the review board in Paris this coming September to select recipients for the 2005 Prize.

Observing Living Cells

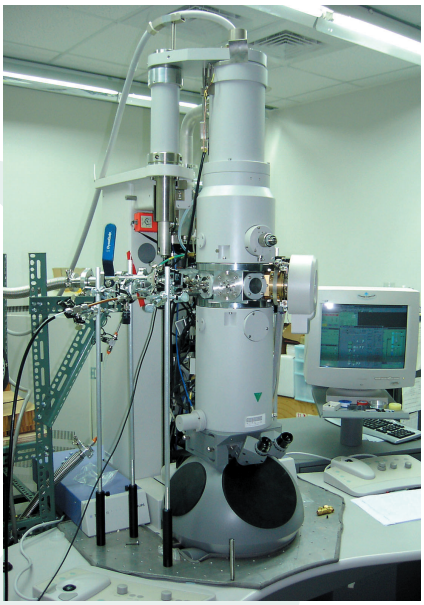
NTU Team Develops World's Only "Biological Electron Microscope" and Observes Water Molecules Passing Cell Membrane

A research team led by Prof. Chao Chih-yu of the National Taiwan University (NTU) Department of Physics announced on December 20 that it developed the world's only "biological environmental transmission electron microscope" and observed water molecules entering the cell membrane via osmosis. The team discovered that the passage of water molecules through the cell membrane weakens the force between molecules of the membrane's lipid film, and the resulting dynamic balance causes the membrane to exist in a new state unlike the three conventional states of matter. And because the team's findings prove that water molecules in fact do not need ion channels to enter or exit a cell, it settles the heated debate among biologists over the behavior of water. By revealing the physical characteristics of human cells, this microscope can open the door to new research areas combining physics, biology, and medicine and allow scientists to pioneer new studies, such as mechanisms by which viruses invade cells, etc.

According to Prof. Chao, the study of water channels in the cell membrane is currently attracting much international attention. For instance, the 2003 Nobel Prize in Chemistry was awarded to Peter Agre and Roderick MacKinnon for their research on water and ion channels in the cell membrane. Their research suggests that water molecules can react with sodium ions, potassium ions, and surface receptors on the cell membrane to form "channels" through the membrane. This view is currently widely accepted among scientists, although some have proposed other possible mechanisms by which water molecules can cross the cell membrane. For instance, it has been proposed that differences in osmotic pressure regulate water and ion concentrations on both sides of the cell membrane, but this theory has had little supporting evidence.

After many years of hard work, the "biological environmental transmission electron microscope" developed by Prof. Chao and his team represents the world's most advanced observational technology in this field, and has succeeded in the very challenging task of observing living cells. In contrast, the conventional electron microscopes used by biologists and medical researchers can only observe dead cells that have been frozen or dried and stained. Because these electron microscopes cannot be used to observe living cells, their results are not necessarily objective or accurate.

The new microscope technology developed at NTU will be used in the future by biologists and biochemists to observe the dynamic reactions of living cells. This form of microscopy will also allow medical researchers to observe how viruses such as AIDS and SARS pass through the cell membrane's lipid film, investigate the phenomena of myocardial and pulmonary edema, and study how antibiotics react with lipid film and kill bacteria. The discovery thus offers tremendous potential in disease research. Prof. Chao's research promises to bring together impressive interdisciplinary resources and open new perspectives in applied physical and biological research.



The NTU team published these impressive results in the second December issue of the prestigious *Physical Review Letters* – highlighting the great importance of their research. Prof. Chao has expressed particular gratitude to the NSC for its long-term support of this project, and stresses that the NSC's support is crucial to the advancement of basic research.

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http://nr.stic.gov.tw/ejournal/SciNews/scibulletin.htm
Subscription price for each copy: US$1.00
Payment must be made in US dollars by a check payable to National Science Council.

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ISSN 1607-3509
GPN: 2005800003