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Taiwan Research Achievements Receive More Recognition

Researchers of Taiwan and UK Find Erosion Rate in Taiwan Has Spiked over Past Decades

Academic research in Taiwan has once again made the pages of the prestigious science journal *Nature* in late 2003 with the publication of a major paper on the evolution of the natural environment in Taiwan – "Links between Erosion, Runoff Variability and Seismicity in the Taiwan Orogen." This project was jointly conducted by teams from the Department of Geosciences at National Taiwan University (NTU) and the Department of Earth Science at the University of Cambridge, UK; both teams were led by Dr. Niels Hovius.

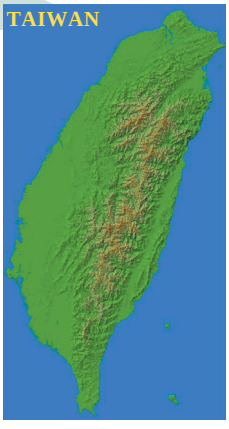
The researchers found that close to 384 million tons per year ($Mtyr^{-1}$) of suspended sediment has been delivered to the ocean between 1970 and 2000, accounting for an estimated 1.9% of global suspended sediment discharge. When an additional 160 $Mtyr^{-1}$ of bed-load sediment is included, total annual sediment transport exceeds 500 $Mtyr^{-1}$. This implies that the average erosion rate in Taiwan is a very high 5.2 mm per year. When considering that Taiwan occupies only 0.024% of the world's land area, it becomes evident that the island has been subject to the effects of rapid natural erosion.

According to Prof. Chen Hongye, convener of the Taiwan research team, when the erosion rate of 15 ~ 60 mm per year over the past thirty years in some of Taiwan's fastest-eroding areas is compared with the erosion rate over the past several millennia, it can be seen that this rate is three to five times higher than both the average rate of 5 ~ 12 mm over the past 10,000 years and the average rate of 3 ~ 6 mm over the past million years. The erosion rate is evidently not only connected with geological factors such as substrate strength and distribution of faults, but is also linked with seismicity and incidence of typhoons.

Besides major support from the NSC, this project has also received support and funding from the Ministry of Economic Affairs (MOEA), the Natural Environment Research Council of the UK, and the Royal Society. The project collected over a million items of on-site survey data over the course of a two-year period, including streamflow in Taiwan's 150 major rivers, earthquake records, geological survey records, and meteorological information such as typhoons and rainfall. The results of the project will provide an important reference for future research on the natural evolution of Taiwan.

The researchers found that the erosion rate in eastern, central, and southwestern Taiwan is especially high, while the rate in northern Taiwan is lower. The erosion rate in some areas near active fault zones is as high as 60 mm per year, as compared with the average rate of only 1~4 mm in northern and western Taiwan. These findings imply that seismicity has a very significant impact on erosion rate. Earthquakes are relatively frequent in eastern and southwestern Taiwan, and the erosion rate is much higher in these areas than in northern Taiwan, where earthquakes are relatively infrequent.

Another factor affecting the erosion rate is the occurrence of typhoons, which commonly cause landslides and debris flow. There is a significant increase in river channel incision when typhoons are frequent. For instance, channel incision is rapid in eastern Taiwan, which also has a high probability of being affected by typhoons. While northern and southern Taiwan are also subject to typhoons, though less so than the eastern part of the island, western Taiwan is sheltered from the full force of most typhoons by the Central Mountain Range, and thus has lower channel incision. And because the erosion rate is most closely correlated with channel incision, rapid channel incision implies a high erosion rate. As pointed out by Prof. Chen, the incidence of typhoons has been a major factor behind the high recent erosion rate in Taiwan.



Prof. Chen Hongye speaking at press conference.

New Era Begins in Aerospace Science

Taiwan Successfully Launches Sounding Rocket No. Three

With funding from the National Science Council, The National Space Program Office (NSPO) successfully launched Sounding Rocket No. Three (SR-3) at 23:25 on December 24 from the southern tip of Taiwan to perform sub-orbital space science experiments. The research team photographed the drifting trail of the combustion flame of the Trimethylaluminum (TMA) released by the science experiment payload, and successfully completed the nation's first spaceprobe mission by sounding rocket.

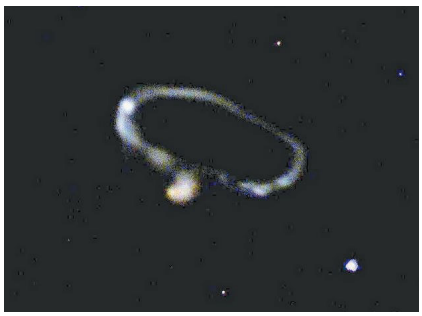
According to Dr. Lee Lou-chuang, President of the National Applied Research Laboratories and the Director of NSPO, this Sub-Orbital Science Experiment Project was managed by NSPO, and employed launch vehicles developed by the Chung-Shan Institute of Science and Technology (CSIST) in conjunction with science payloads from domestic academia. The main objectives of this project were to investigate the upper atmosphere, ionosphere, and neutral wind fields; to support microgravity experiments; and to conduct testing and verification of key satellite components in a space environment.

Dr. Lee has pointed out that the atmospheric stratum probed by sounding rockets is inaccessible by artificial satellites and radar, thus our knowledge of atmospheric conditions in this region is limited. To further explore this region, leading countries such as the US and Japan in recent years have been launching more sounding rockets, although all from high latitudes, and Taiwan has succeeded in launching a sounding rocket closest to the equator. This latest mission was jointly implemented by NSPO, CSIST, and the science team from the National Central University (NCU) to observe the ionosphere over Taiwan, including neutral wind fields and turbulence. The NCU science team was responsible for the TMA science payload carried by the sounding rocket. During the mission, TMA liquid was released from altitudes of 80 ~ 140 km, and then reacted with water vapor to produce visible flames. Cameras on the ground took continuous snapshots of the flames in the sky to calculate the moving speed of the flame trail and to obtain the velocity profile of neutral wind at various altitudes. In addition, by monitoring the dispersion of the spiral column of the TMA flame, the distribution of the strength of atmospheric turbulence at different altitudes could be calculated.

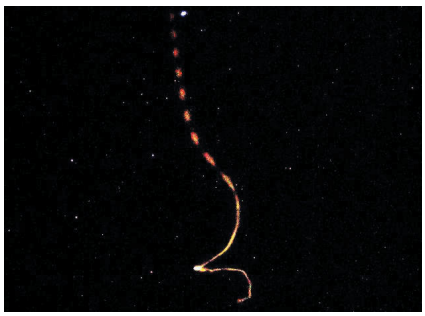
Based on drifting images of TMA flames taken by high resolution photographic equipments located at Kaohsiung, Taitung, and Pingtung, the NCU team found that an appreciably intense horizontal wind at velocities in excess of 120 m/s occurred at around 100 km, far greater than the threshold velocity of 51 m/s found in strong typhoons. Data also indicated that the average wind shear in the 3-km layer surrounding this vicinity of peak horizontal winds could reach as high as 25 m/s/km. Expectations that instability from this strong wind shear could generate waves and turbulence were confirmed by pictures of actual waves and turbulence associated with the intense wind shear. We believe this was the first time that a sounding rocket releasing TMA trails had been used to determine the three-dimensional structures of shear-related waves and turbulence in the lower part of the ionosphere. In addition, the team from NCU also analyzed the diffusion of the TMA flame trail and discovered that the diffusion rate of the atmospheric irregularity increased with height, consistent with theoretical expectations.

The SR-3 Sounding Rocket flew for 511 sec reaching an altitude of 269 km and a range of 142 km. Judging from preliminary analyses produced by telemetry data and TMA flame images, it is evident that this mission had achieved all of its objectives, demonstrating the capability of domestic aerospace technology in meeting the needs of space experimentation. In an interesting note, the TMA science payload originally designed in the US could not be imported due to trade restrictions; CSIST therefore assumed the task and built its own module with additional ball valves and enhanced solenoid valves, and yielded a new design that proved to be more reliable.

According to the NSPO, both the sounding rocket and science payload for this mission were completely developed and produced in Taiwan, and the ground observation equipment was also assembled locally, demonstrating great strides in domestic space technology capability. The successful launch of SR-3 not only marks a significant milestone in Taiwan's suborbital science research, but also represents a promising beginning of phase two of the Long-Term Space Technology Development Plan. This second phase calls for launches of 10 to 15 sounding rockets over fifteen years and gradually developing small launch vehicles capable of carrying 100-kg micro-satellites.



Circular trail of the TMA flame.



Spiral column of the TMA flame.

Private Sector Receives Recognition for Advanced Research

2003 Outstanding Achievement in Science and Technology Award Granted to a Private Company

After nine months of careful deliberation, nine individuals working in the fields of the humanities, life science, and engineering were chosen to receive the 2003 "Outstanding Achievement in Science and Technology Award." Six of the nine were members of the Taiwan Semiconductor Manufacturing Co. (TSMC) research team. The award ceremony was hosted by NSC Minister Wei Che-ho; Premier Yu Shyi-kun conferred the awards and TSMC Chairman Dr. Morris Chang was on hand.

According to NSC Minister Wei, the NSC has been in charge of the Outstanding Achievement in Science and Technology Award for 27 years since this activity was initiated by the Executive Yuan in 1976. A total of 176 individuals selected in 121 cases have received the awards over this period. After careful screening and review, nine individuals in four cases were chosen out of the 41 applications in 2003: Prof. Hwang Kwang-kuo of the Department & Institute of Psychology, National Taiwan University; Dr. Yu Su-may of the Institute of Molecular Biology, Academia Sinica; Prof. Chen Show-an of the Department of Chemical Engineering, National Tsing Hua University; and Dr. Chiang Shang-yi, Senior Vice President, TSMC; Dr. Chiang represented the six members of the TSMC 0.13-micron process technology research team. A prize of NT$600,000 was granted to each award-winning case.

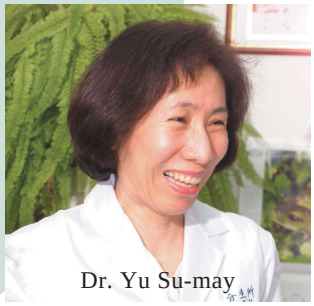
As for the achievements of this year's award winners, Prof. Hwang Kwang-kuo has made an extremely great contribution to sociology and localized psychology research. In particular, Prof. Hwang's study of "Confucius Relationism" has had a profound impact on the international academic community. Dr. Yu Su-may's innovative research is having a significant impact on worldwide rice production and efforts to increase the added value of cereal crops. Dr. Yu was the world's first scientist to successfully use the bacterium *Agrobacterium tumefaciens* to transfer genes to rice plants, and she also showed that the transferred genes could be passed down to subsequent generations. This internationally acclaimed work toppled the long-held theory that *Agrobacterium tumefaciens* could not be used to transfer genes to monocot plants. Prof. Chen Show-an's groundbreaking research on conducting polymers successfully applied polyaniline and solid polymer electrolyte (SPE) in rechargeable batteries. Prof. Chen's work is a world first, and has considerable commercial promise. Having long studied conducting polymers, Prof. Chen has published roughly 200 papers, received seven patents, and was the subject of the American Chemical Association's March 2003 special report on "*Chemical Innovation*." Prof. Chen's technological breakthroughs are having a big impact on the fast-growing areas of LCDs and OLEDs, and his contribution to industry is large.

A private company won the Outstanding Achievement Award for the first time in 2003. Not only has TSMC's pioneering work in 0.13-micron SoC processing technology had a big economic payoff, but it has also demonstrated the success of the nation's technological policies. TSMC's technological achievement has been applied to 8" and 12" wafers, and is significantly improving semiconductor process standards in Taiwan. It is no exaggeration to say that this work has enabled Taiwan to maintain its role as the world's semiconductor foundry and enhanced the nation's international standing. Since the results of this research can be applied to 90 nm and 65 nm processes, the work has tremendous commercial potential and can be expected to make a lasting contribution to the semiconductor industry. Several hundred patents resulted from the research, and the researchers have given numerous presentations at major international conferences. The work is yet another example of Taiwan's role as an hotbed of semiconductor technology.

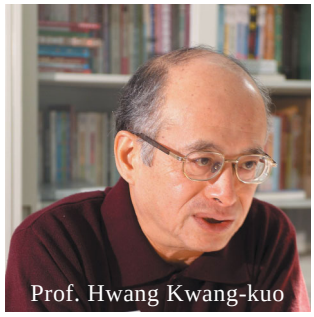
In his speech at the ceremony, Premier Yu Shyi-kun of the Executive Yuan noted that the World Economic Forum ranked Taiwan first in Asia and fifth in the world in terms of "growth competitiveness." In particular, Taiwan was ranked third in the world in the category of "technology." As Premier Yu reminded listeners, human resources are Taiwan's most valuable asset and the key to technological innovation.

Executive Yuan Premier Yu Shyi-kun (front row, third from left), NSC Minister Wei Che-ho (front row, second from left), with award recipients.

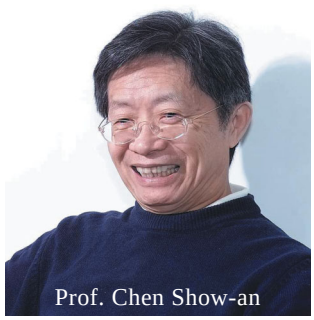
TSMC 0.13-micron process technology research team.



Dr. Yu Su-may



Prof. Hwang Kwang-kuo



Prof. Chen Show-an

Another Success for the NRPGM

NTU Medical Team's Genetic Research Leads to Marrow Transplantation Breakthrough

Working together for more than two years as part of a collaborative international project on genomic medicine, medical research teams from National Taiwan University (NTU) and the Fred Hutchinson Cancer Research Center (Seattle) have achieved the milestone finding that genetic polymorphisms at IL-10 may affect the prognosis of bone marrow transplantation. The recent findings of this project have been published in the *New England Journal of Medicine* – the world's leading journal of clinical medicine – as an original article. The project is the first ever large-scale, systematic study of the effect of genetic polymorphisms on prognosis of marrow transplantation. This work has both underscored the importance of genetic polymorphisms in disease prognosis, and also demonstrated that genetic polymorphisms can serve as excellent indicators of marrow transplant prognosis. The project has pioneered the clinical application of genetic medicine, and is one of the successes of the NSC's National Research Program for Genetic Medicine (NRPGM). The NTU medical team is led by Dr. Chen Pei-jer, chairman of the Institute of Clinical Medicine, NTU College of Medicine.

According to another leading participant in the study – Dr. Tseng Li-hui of the Department of Medical Genetics, NTU Hospital – patients eligible for marrow transplants include persons suffering from leukemia, lymphoma, aplastic anemia, marrow dysplasia syndrome, and thalassemia major, and range in age from six months to 65 years. Although a comparison of the patient's and donor's histocompatibility leukocyte antigen (HLA) is usually performed prior to marrow transplant, 20% of all patients may suffer severe graft versus host disease (GVHD) even when they have identical HLA with that of the host. The current project's breakthrough discoveries in genotype testing now give hope that GVHD can be predicted.

As Dr. Tseng pointed out, the project's findings will have a big impact on the future treatment of marrow transplant patients. Genotype testing prior to marrow transplantation can potentially to predict the likelihood of severe GVHD and thereby select treatments preventing GVHD or alternative treatments such as minitransplants.

We can look forward to the day when genotype testing of donors is used routinely to select marrow donors yielding the best post-transplant prognosis. When that time comes, simple test methods such as taking a blood sample or collecting buccal mucosa cells from the mouth of a donor can be used to obtain DNA for genotype tests. The results of genotype tests can prevent severe rejection and significantly raise the success rate of marrow transplantation.

According to Dr. Chen Pei-jer, this latest article is only one of a series of papers jointly published by the NTU and Fred Hutchinson teams. The article describes how the project's marrow transplant GVHD model can be used to find genetic variations that may affect gene functions, and study whether these variations affect the incidence and prognosis of common diseases such as cancer or allergic and inflammation disorders. One important question along these lines is whether the genotype of SARS patients affects the severity of the disease. The two research teams are continuing to work in close collaboration, and have every chance of making even more groundbreaking discoveries in the future.

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