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Full Research in Society, for Society

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FEATURE

The 7th AIST Advisory Board Meeting

FEATURE

What Can Be Predicted from Records of Past Great Earthquakes?

Research Hotline

UPDATE FROM THE CUTTING EDGE（April–June 2012）

In Brief

The 7th AIST Advisory Board Meeting

AIST's mission is to contribute to social development towards the realization of a sustainable society by raising the standard of Japan's industrial technology.

AIST has an advisory board regarding its research activities and overall operation to realize its mission. The board members are leading experts in a variety of disciplines from Japan and overseas. The seventh advisory board meeting was held at AIST Tsukuba headquarters on February 6, 2012.

While the whole of Japan has prioritized recovery activities from the Great East Japan Earthquake and tsunami that occurred in March of last year, global R&D competition has gone forward without waiting for Japan to recover. AIST is proceeding with research in accordance with its Third Medium Term Plan, which began in fiscal year 2010, however the direction of research at public research organizations including AIST now needs to be viewed in accordance to the current situation.

The main theme of this year's meeting was "the role of public research organizations in an era of globalization". Arguments from various perspectives were offered regarding the direction of research at Japan's public research organizations amidst the trend of intense global R&D competition.

This report is the outline of the meeting, and the comments and advice from the board members.

Table 1 List of AIST Advisory Board Members

Junichi Hamada (Chair)	President, The University of Tokyo
Hiroyoshi Kimura	Chairman, Kimura Chuzosho Co., Ltd.
Sadayuki Sakakibara	Chairman of the Board, Toray Industries, Inc.
Waichi Sekiguchi	Editorial writer, Business News Department, Nikkei Inc.
Toichi Takenaka	Science Advisor, Astellas Pharma Inc.
Hajime Bada	President & CEO, JFE Holdings, Inc.
Sawako Hanyu	President, Ochanomizu University
Ei Yamada*	President & CEO, AnGes MG, Inc.
Nobuhiro Yamada*	President, University of Tsukuba
Alain Fuchs	President, National Center for Scientific Research (CNRS), France
Makoto Hirayama	Professor, College of Nanoscale Science and Engineering, State University of New York, USA
Thaweesak Koanantakool	President, National Science and Technology Development Agency (NSTDA), Thailand
Willie E.May	Associate Director for Laboratory Programs and Principal Deputy, Office of the Director, National Institute of Standards and Technology (NIST), USA
Jürgen Mlynek*	President, Helmholtz Association of German Research Centres, Germany

(* : Absent)

Table 2 Schedule

Monday, February 6, 2012

9:30	Opening of the meeting
	Introduction of AIST Advisory Board members and AIST participants
9:40	Welcome address
9:50	<Agenda 1> Actions taken by AIST following the 6th Advisory Board Meeting (presentation by AIST)
10:30	Discussion on Agenda 1
11:30	Lunch (Great East Japan Earthquake: damages and actions taken by AIST)
13:00	Laboratory tours
15:00	<Agenda 2> The role of public research organizations in the age of globalization (presentation by AIST)
15:45	Discussion on Agenda 2
17:15	Closing remarks
17:30	Closing of the meeting

Outline of AIST Advisory Board Meeting

This advisory board meeting boasted a wealth of knowledge: a new board member, Willie E. May from the National Institute of Standards and Technology (USA) was welcomed, and 11 of the 14 board members (Table 1) were present.

The meeting comprised a morning and an afternoon discussion sessions. The theme of the morning session was "actions taken by AIST following the 6th advisory board meeting," with AIST introducing its efforts based on the ideas and advice suggested at the previous meeting, upon which more ideas and advice were suggested.

Following a lunch on session on "damages to AIST from the Great East Japan Earthquake and how we acted", tours of research laboratories were conducted prior to the afternoon session. Attendees split into three groups and visited nine research sites, where through direct discussions with researchers they experienced firsthand the efforts of AIST focused on innovation creation. This in turn resulted as reference material for subsequent discussions.

In the afternoon session, the main theme of which was "the role of public research organizations in the age of globalization," board members discussed the desired direction of research at Japan's public research organizations, particularly from the viewpoint of research objectives, against a backdrop of recovery from the Great East Japan Earthquake and tsunami and the advance of global R&D competition.

Comments and Advice from Board Members

Junichi Hamada (Chair) (President, The University of Tokyo)

I believe that AIST is a research platform of an extremely high standard. However, the word platform has a somewhat passive air about it, so I would like AIST to step forward and create various models. For example, someone needs to create a model for the increased mobility of researchers, whereas right now, everyone is imposing responsibility for doing this on others. With this being the situation, I really want AIST to create a model. Regarding the bridging of basic research and products, mechanisms for research evaluation, and utilization of intellectual property, I request AIST to take one step further and create their models. If I were to offer a slogan, "from platform creation to model creation" is the expectation I have for public research organizations in the coming era.

Hiroyoshi Kimura (Chairman, Kimura Chuzosho Co., Ltd.)

Since last year's earthquake and tsunami, Japan's latent risk has become greatly apparent. Amid this situation, although AIST had been painstakingly investigating and researching the Jogan Earthquake, its findings could not be applied to last year's earthquake. I believe one method is to establish an open innovation hub for technology seeds to be planted and grown in industry and society, but I question whether this alone is sufficient. While the planning (Plan) and execution (Do) steps of the management cycle are making steady progress, there might be some shortcomings in the evaluation (Check) step when managing an enormous system. The process of research findings transfer to society might change through further strengthening this Check step. I strongly desire the creation of a system that deploys research findings in society, and announces findings quickly in the form of society's utilization of them.

Speaking of the role of public research organizations from the viewpoint of supporting industries, these are industries with long histories and they are complacent with the fact that the Japanese market was once large, while tending to ignore the rest of the world. Therefore, I would like AIST with its global links to take up the role of actively disseminating information. That is to say, with leading global companies wavering and with global advanced technology and information difficult to obtain, I expect AIST to disclose technologies in its possession and simultaneously compile overseas advanced technologies and information and actively disseminate them through various occasions such as academic meetings, exhibitions and lectures.

Sadayuki Sakakibara (Chairman of the Board, Toray Industries, Inc.)

Firstly, I would like to discuss two topics with regards to the efforts of AIST: exchange of personnel with industry; and research themes.

Regarding the personnel exchange with industry, Germany's Fraunhofer-Gesellschaft offers technology findings and personnel as a package to companies, and I hear that technology transfer proceeds extremely smoothly. I understand that transfer of personnel from AIST to outside companies does not proceed smoothly, so I would like AIST to consider introducing a system whereby researchers are simultaneously transferred to companies along with completed technology for a period of 3 to 5 years.

The second topic is research themes. When setting up the research areas, research institutes and research centers in each field, AIST takes national issues into consideration, and I think this is appropriate from the perspective of industry. On the other hand, I hear some views that research themes are extremely fragmented in each field and are inflexible. Companies rigorously review their themes on

an annual basis. Companies hold some themes that do not have the potential to bear results immediately and focus on the investment of human resources in the other important themes. I think it is important to consider such dynamic management.

Next topic is the role of public research organizations. Speaking from the perspective of the international competitiveness of Japan's manufacturing industry, the industry is currently confronted with the so-called "six sufferings*," and it has lost significant international competitiveness. Amid this scenario, the industry needs to develop overwhelmingly strong technology development capabilities for survival. In this respect, I have high expectations that AIST will maintain its R&D capability of the highest global standard and will lead to strengthen the foundations of Japanese industrial technology.

For example, Singapore is creating a water treatment technology hub as a national project, and it is assembling global intellectual leaders to promote technology development. Japan should also develop global R&D hubs that would greatly impact the economy and the society. I think the previously introduced Fukushima Renewable Energy R&D Center can be a candidate of the global R&D hub. By incorporating the public sector, industry, and universities, by introducing incentives involving deregulation and the tax system, and by developing all of the technologies associated with renewable energy in an integrated manner, Fukushima Renewable R&D Center will contribute to resolve the national issues of stepping up the competitiveness of industry and developing alternative energies. The center will also contribute to the recovery and the restoration of Fukushima as well. The industrial sector will wholeheartedly cooperate, and I hope that AIST will take the initiative and tailor Fukushima Renewable R&D Center as a major national project.

Glossary

＊ : strong yen, high corporate taxes, increased labor costs, restrictions for environmental protection, delays in economic partnerships, and constraints on power supply

Waichi Sekiguchi (Editorial writer, Business News Department, Nikkei Inc.)

I would like to mention three broad expectations of AIST.

The first is Japan's branding. Supply of Japanese components ceased due to the earthquake and tsunami, and factories throughout the world were halted. This once again highlighted the importance of Japanese technology. While up to now, Japan has possessed advanced technologies for hidden elements, such as materials and manufacturing equipment, it has been extremely weak when it comes to marketing of the visible portion. Nowadays, the Japan brand has been compromised due to the earthquake and tsunami, and my initial expectation of AIST is to create a strategy to bring these hidden elements to the fore, not exactly but somewhat like "Intel Inside".

The second point is the mechanism for distribution of intellectual property. Until now, Japan has tended to be pro-patent, namely protecting intellectual property; however, with the arrival of the Internet era, new added value and new products and services have been born through the refining and improvement of existing ones. For this reason, I believe that from now on not only is protecting intellectual property important but, under the assumption of protection, that a mechanism to facilitate its distribution is also important. I hope that AIST will establish such an open platform and create a structure to "fluidize" both intellectual property and personnel.

The third point is "traffic management" of the various technologies being developed in Japan. The home appliance industry is currently experiencing a dramatic collapse, and this is not because of technology but rather problems with their business processes. New business models need to be created that combine superior hardware with software and services. However, if we leave this to companies, their indefatigable assiduity would lead to mutual destruction, and for this reason, creating a single current where traffic is managed in a direction that is good for the industry as a whole is important. Environmental technology, medical technology, and IT are particularly important fields. In the environmental field, for example, electric vehicles are already at the commercial stage and what is now required is traffic management among the relevant parties to establish not only standards but also devise a master concept that links with housing and urban planning. In the medical sector, the strategic development of robots that can supplement the shortfall in the working population and respond to an era of an aged populace is important, while in IT, with an eye on Asia, promotion of standardization is important and a new profit model needs to be established that adds a service component to the hardware factor. I would like to think that AIST will manage the traffic in order for these to be realized.

Toichi Takenaka (Science Advisor, Astellas Pharma Inc.)

Firstly, I believe it would be good if there were a list that allows one to broadly view the overall status of AIST regarding its six research fields, including the situations of budget and staff allocation, the procurement of external funding, and collaborations with Japanese and overseas companies. Through this, I think it would be clear at a glance as to which fields possess strengths and which are important for society.

Among current research activities, there are several that occupy positions of global leadership, and as we saw when we visited the electron microscope this afternoon, there are many areas where we can anticipate new developments, such as not viewing biological processes and cells as mere substances but rather a return

to viewing them in their original forms. Furthermore, in addition to these individual elements, I hope that forming an R&D center for renewable energy in Fukushima Prefecture will result in technology development as well as in AIST taking an overall national leadership role to develop Fukushima into a special zone.

On the other hand, although various areas of research fostered by AIST have attracted attention since the earthquake and tsunami of last year, exactly what relationships does AIST maintain with Japanese organizations engaged in earthquake and tsunami research under the Ministry of Internal Affairs and Communications and the Ministry of Land, Infrastructure, Transport and Tourism, and with overseas organizations? My hope is that these links, including national ones, will not be vertically structured but rather that horizontal collaborative links between researchers in different organizations will be formed, leading to leadership positions.

Hajime Bada (President & CEO, JFE Holdings, Inc.)

Regarding the research fields for AIST, I would like AIST to make further efforts in the fields such as geophysics, a field where private sector rarely put effort into. I realized this from our experience of the earthquake and tsunami last year. Scientific research in fields that are not directly related to business and industry failed to contribute to the Japanese people's safety and security. In addition, in order to efficiently advance projects with future commercialization in mind, project planning from a broader perspective is important. Also, I would like AIST to consider a mechanism that would encourage returns for intellectual property including know-how and a more impartial and effective evaluation method to achieve substantial results.

Concerning the role of public research organizations, three main points are: advanced technology research that is recognized globally, the construction and embodiment of a system that gathers personnel and companies from around the world, and the development of personnel capable of playing an active global role.

With regards to advanced technology research, 90 % of private sector research is focused on improvement of technologies, and considering this situation, I expect AIST to play a leading role in effective realization of long-term research based on major alliances including those with universities, companies, and research institutes throughout the world.

Although there might be an anxiety that technologies, that are achieved by means of tax payer's money and which are essentially national assets, would flow out from Japan through personnel and companies from around the world which are working on such technologies, under global competition, I believe that it is better to make it easier for both personnel and companies to participate on a broader scale. For this reason, we should not really flinch because this is government-funded research, but instead, I believe that in order to make this technology accessible throughout the world we should do joint research with non-Japanese companies.

Sawako Hanyu (President, Ochanomizu University)

Firstly, I would like to discuss two points regarding the efforts of AIST.

The first is its role as an industrial technology development hub. Last year, we experienced a devastating natural disaster, and it triggered an emerging need for new perspectives in the branding strategy of Japan's industrial technologies, namely the necessity of the viewpoints of safety standards and risk management. I expect that AIST will play a leading role in establishing feasible standards and indicators that are a vital part of risk management.

The second point is the empowerment of women. I appreciate AIST's efforts to expand the employment of women since last year. However, the key issue should be promoting the participation of women in the decision-making process as stated in the Third Basic Plan for Gender Equality. Therefore, I look forward to AIST's further commitments toward a qualitative change in the utilization of women's capacity.

Next, I would like to mention the role of AIST as a public research organization. The Great East Japan Earthquake and the tsunami brought about massive changes in our society. Especially, it dramatically contracted the distance between advanced technology and our everyday life. Since the disaster made us realize that advanced technology has both benefits and risks, risk literacy education is essential in order that technology development does not come to a standstill. I think AIST, engaged in the development of advanced technologies through alliances between industry, academia, and the public sector, should speak out based on scientific grounds how it weighs the benefits and risks of a certain technology. At the same time, AIST should foster people who can handle risks effectively. As a university president, I assume that science literacy education is one of our missions. In this regard, I hope that we will work together to nurture the next generation.

Alain Fuchs (President, National Center for Scientific Research (CNRS), France)

Increasing the number of researchers taken in from external organizations as well as those placed out on secondment is important from the perspective of development of personnel, and I am all for it. Moreover, I would like to see a framework put in place for utilizing young

researchers, such as extending the duration of stays of doctoral students and utilizing them in innovation creation.

Open innovation will be an extremely important issue in the future, but at this point in time it has not been completely resolved. I believe that AIST is a facilitator (mediator) type of organization that possesses the strength and potential to combine the forces of governmental organizations, private sector companies, and universities and resolve the issue. In overcoming obstacles and unforeseen difficulties that might arise through combining different organizations, I would like the most efficient organizational form and its rationale to be clarified first before disseminating information throughout the world.

In France, historically speaking, universities that teach standard and fundamental knowledge have existed alongside grandes écoles that conduct top-level higher education centered on technology. Since the Second World War, however, from the necessity of enhancing various fields of fundamental research, public research organizations like the Centre National de la Recherche Scientifique (CNRS) have been set up as a third type of research institute. Today, strategic cooperation between these various entities has become an important issue, and a move has emerged to consolidate them into a single research-focused hub. For example, a new university is planned in the area of Saclay near Paris that combines the functions of a university, a grande école, and CNRS.

However, there are several issues that need to be addressed in order that such a composite university can exhibit a presence at an international level. For example, in a world where many young people want to shape careers in marketing and finance, how are we to ensure the availability of high quality, young talent with an interest in science and technology? Another issue with the integration of three types of organizations is skillfully dealing with international issues in a manner that is superior to that of a horizontal organization as well as appropriately dealing with comprehensive research themes. In this sense, an approach from all aspects of science including

fundamental science is indispensable. Why is this the case? Because we are confronted with people that fear the progress of science and technology, and it may be the case that citizens reject new technologies. Accordingly, whether the general population trusts scientists and engineers is an important issue, and it is thus important to discuss from all perspectives including sociology and the humanities.

Lastly, while it is important to define strategic areas of priority, we cannot forget that unimaginable new innovations come out of fundamental research. I would like to stress the importance of finding an appropriate balance between fundamental research and applied research.

Makoto Hirayama (Professor, State University of New York, USA)

As far as AIST's overall efforts, it is important to disclose their evaluation criteria for research outcomes. Once the criteria become available, I believe, that would motivate companies to get more actively involved in the projects, because the criteria, along with a timeline, give them a general idea of the projects about by when the outcomes are supposed to be commercialized and how they can contribute to industry and society. In this sense, I strongly request AIST to construct systems to make clear their staffing plans and budget allocations, as well as a system to explicitly show how effectively the resources have been utilized to produce the research outcomes. By fulfilling these agendas, AIST could prove that they have capable employees who can exercise their skills even outside AIST, such as at private companies, universities, and research institutes. As a result, AIST would be acknowledged as a producer of excellent human resources.

As a public research organization, I expect AIST to develop the concepts, based on the national strategy, for the promotion of science and technology and to take the lead in implementing the concepts. Photovoltaic cells or distributed energy management would be a good example. I hope AIST to be a playing manager, playing both roles successfully, and head the field.

One more thing I would like to mention is that I look forward to AIST's leadership in operation and management of the industry. As much as I admire their excellence in research, I think they need to take a step forward and capitalize on their ability in the fields other than research. In the development of photovoltaic cells, for example, we need to create a standardization system and set up standards for reliability.

Because chemical compounds used in CIGS (copper indium gallium selenide) solar cells are highly toxic, we need to develop safety regulations not only to manufacture but also to dispose those substances 20 years from now. These issues must be looked at on a global level. To handle these issues, I urge AIST to take a long-term view, looking to the future, and demonstrate firm leadership. By doing so, I anticipate AIST to be widely recognized and highly valued from around the world.

Thaweesak Koanantakool (President, National Science and Technology Development Agency, Thailand)

My understanding is that one of the roles of AIST is to link advanced technology with service. In other words, its mission is to deliver to society things that can actually be used. AIST possesses advanced technology development capabilities, but I believe that's not simply raising the quality of hardware but rather linking of this with service and marketing will boost utilization of technology by consumers and will also become a key to innovation.

R&D and innovation require a massive number of personnel, particularly young talents. However, with Japan's aging population, I believe that it will become difficult to secure excellent researchers in Japan without realizing open innovation or gathering personnel from throughout the world who can play active roles

on the front line. In order to achieve this, joint research in new formats and management, as well as the sharing of intents among companies and individuals will become inevitable. At the same time, greater cooperation with neighboring countries will play a more important role.

Thai investment in R&D is extremely small, accounting for no more than 0.2 % of GDP. We would like to lift this to 2 % over the next 8 years and the main target is to expand the R&D activities of the private sector. To this end, we are strongly supporting foreign direct investment in the manufacturing sector. We are also adopting various measures after the industrial estates being damaged by the great floods; this includes supply of new industrial land. The National Science and Technology Development Agency (NSTDA) would like to expand the level of joint research with Japan through AIST, and we would like to pursue further possibilities of joint research in the fields of photovoltaic cell/module evaluation, environmental purification catalysis, graphene manufacture, and green IT.

Willie E. May (Associate Director for Laboratory Programs, National Institute of Standards and Technology, USA)

The situations at National Institute of Standards and Technology (NIST) and AIST are similar with respect to having selected members of our research staff assigned to work temporarily in industrial settings; there are not many researchers that take sabbatical leaves or secondments with industry. However, to accurately assess the situation and its potential impact, it is important to note not only the number of staff involved, but also the lengths of their stays. In other words, I recommend looking at the number of personnel multiplied by the period of the secondments.

NIST recently restructured its laboratory program to allow it to more effectively respond to the increasing and diverse needs of industry and government. It moved from nine discipline-based laboratory organizations to six "mission-based organizational units. The six AIST focus areas roughly match these, indicating that the major societal issues that drive AIST's scientific programs are similar to those that drive NIST's efforts in the U.S., and provides the basis for increased future collaborations.

NIST's Mission is focused on providing the underpinning measurement science, standards and technology required to promote U.S. industrial innovation and industrial competitiveness, economic security and enhanced quality of life. This mission, as stated, is intentionally broad and rather encompassing. To assist in focusing its activities, NIST uses an external review committee (Visiting Committee on Advanced Technology, VCAT) to review and make recommendations regarding general policy for NIST, its organization, its budget, and its programs, within the framework of applicable national policies as set forth by the President and the Congress, and submit an annual report to the Secretary of Commerce for submission to the Congress. The VCAT is comprised of senior leaders in industry and academia who are appointed by the NIST Director. VCAT assembles three times a year to provide input as to what are the paramount standards, technology, and research areas on which NIST should focus during a given time period in the framework of NIST's mission. An additional panel of experts appointed by the US National Academy of Science evaluates the quality and adequacy of NIST research and measurement service activities with respect to national needs within these areas.

Likewise, it is perhaps important for AIST to closely evaluate whether the correct programs/actions are being strategically selected, planned, and executed and whether they are progressing in a timely fashion with activities/services of appropriate quality.

Tamotsu Nomakuchi (President, AIST)

I would like to thank you very much for participating in today's discussions. I feel that your opinions were very valuable even more than these of last year.

You pointed out that high quality research was primal. This is also the first priority for me. Without this we cannot go forward. Amid intense global competition, AIST will continue endeavoring to raise the quality of research.

You also mentioned supporting industries. The strength of Japanese industry is the presence of the extremely wide range of supporting industries. In recent years, the supporting industries have been weakened by the "Six Sufferings" and the hollowing-out phenomena. If they are further weakened, osteoporosis of Japanese industry may occur. To prevent this, it is important that we firmly support them. In this context, AIST would like to deepen its ties with supporting industries and technology-based small and medium-size enterprises.

You raised many comments about renewable energy. AIST will conduct advanced research in our Fukushima Site, and, aligning with national projects of 'smart communities' located throughout Japan and region activation programs, we will elaborate it to a form whereby it is utilized widely by industry and regional societies. We will promote this as a group of researchers to realize a renewable energy hub that attracts researchers from throughout the world.

I believe that 'branding Japan' is an extremely important mission, but right now I don't have a definitive answer. Regarding 'risk allergy', there is an argument among us AIST researchers that "the days of research that simply made partner companies happy has gone; our role as a research institute won't be accomplished unless we provide associated risk control for society." In an era where science and

technology have progressed this much, I think this philosophy is extremely important.

You also mentioned that R&D today is not viewed simply from the aspect of technology; rather, we are in an era whereby we must formulate R&D strategy with the view of humanities researchers, then we must propose it to society. I totally agree with this. AIST will implement your valuable opinions into our work. We will diligently engage in developing personnel with operation and management capacities as Chairman Hamada pointed out, formulating our research roadmap with even more proactive stance, and realizing it.

Finally, I would like to express my sincere thanks for your contributions over what was a long day of discussions.

Laboratory tours conducted in three groups

Board members were split into three groups and toured research facilities covering nine research themes. The objective was to offer the opportunity of direct discussions with researchers and to experience firsthand the efforts of AIST focused on innovation creation.

Course A

"Practical application of single-walled carbon nanotubes"
Nanotube Research Center

"Reconstruction and historical analysis of massive tsunami that occurred in the Japan Trench"
Active Fault and Earthquake Research Center

"System for monitoring electricity consumption and photovoltaic panels"
Information Technology Research Institute

Course B

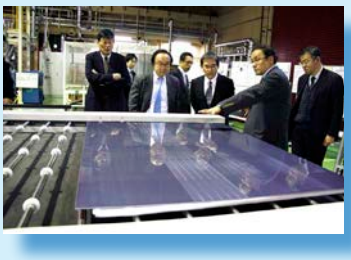
"Development of an atmospheric pressure scanning electron microscope capable of directly observing cells in a fluid"
Biomedical Research Institute

"Spintronics technology research"
Spintronics Research Center

"Measuring shapes with X-ray CT"
Measurement Solution Research Center

Course C

"Creation of a new robotics industry"
Intelligent Systems Research Institute



"R&D of advanced photovoltaic technologies"
Research Center for Photovoltaic Technologies

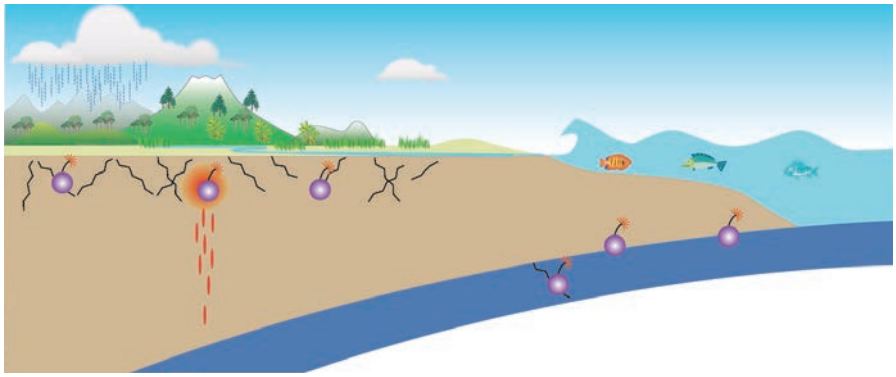
"Transparent conductive graphene sheet of use for photovoltaic cells and touch panels"
Nanotube Research Center

What Can Be Predicted from Records of Past Great Earthquakes?

Lessons of the 2011 Off the Pacific Coast of Tohoku Earthquake

The magnitude of natural phenomena

Every single researcher in the field of geoscience must have been fully aware that the Japanese archipelago could be hit, at any time, by natural disasters such as earthquakes and volcanic activity. Despite this knowledge, however, we came to learn the relentless power of Mother Earth first-hand on March 11, 2011. As a result of the off the Pacific Coast of Tohoku earthquake, it is estimated that the ocean floor off the Pacific coast of the Tohoku region shifted up to several tens of meters to the east and also rose by several meters. Although this may seem to be an insignificant change when compared with the overall size of the Japanese archipelago, which is several hundred kilometers wide, the generated tsunami completely destroyed the coastal area and vividly showed the difference in scale between natural phenomena and human activities.



The beautiful scenery of the Japanese archipelago and its abundant fruits of nature are the products of active crustal movements. While enjoying the riches that the land has to offer, we must not forget that many dangers are hidden underground.

Knowledge of the past is vital

However, it is also true that this was not an unexpected phenomenon as there are several historical records of huge tsunamis that occurred in the past in the area near Sendai, in the Tohoku region. The *Nihon Sandai Jitsuroku*, an official historical record compiled by the Imperial Court in Kyoto early in the Heian Period (794-1185), refers to a great earthquake and a huge tsunami that hit the land of Michinoku on May 26, 869 (the 11th year of Jogan). Nature has also given us warnings. In the Pacific coastal plains of the Tohoku region, evidence of past huge tsunami events remains in the form of tsunami deposits. However, we never suspected the possibility of a magnitude 9 (M 9) earthquake, through our research on these tsunami deposits. Moreover, we have never made it clear that it was difficult to make assumptions on the maximum size of a tsunami based on these tsunami deposit surveys. We should have made clear distinctions between what could be known and what could not be known from our research.

Until the Japanese archipelago assumed its present shape, it was subjected to numerous crustal movements and seismic and volcanic activities that were at times gentle and at other times abrupt and violent. The ground on which we are standing may seem stable, but it has undergone dramatic changes over a long span of time. These changes are recorded in the topography and geology of Japan in various forms and shapes. It is thus indispensable to elucidate and deepen our understanding of how the Japanese archipelago has been created over time, based on geological and geophysical surveys.

Living on the Japanese archipelago

The people of Japan have created a highly developed society that is rare in the world by making full use of science and technology. However, perhaps because of our comfortable daily lives in cities, have we not forgotten the severity of the natural world that we live in? No matter how advanced our society, if we do not understand the dangers of natural disasters and take sufficient countermeasures against them, it may not be an overstatement to describe such a society as merely a castle in the air. To be called a truly advanced country, all probable disasters must be anticipated with a certain degree of margin and preparations made for their occurrence. We must therefore steadily and diligently continue our investigations and advance our research so as to enhance our understanding of the activities that are taking place in the

For inquiries about this article : Active Fault and Earthquake Research Center http://unit.aist.go.jp/actfault-eq/english/index.html

Japanese archipelago.

At times of disasters, only the negative characteristics of the Japanese archipelago stand out. However, it is these very earthquakes as well as volcanic activities that have formed the mountains and plains of Japan. Clouds accumulate around these mountains, bringing rain, and the beautiful landscape of Japan is thus created. We must not forget that it is these natural conditions that provide us with land covered with greenery, with fresh and abundant water resources, with fertile land, and with a variety of food from both the mountains and the sea. I believe that a society in which these rich fruits of nature are utilized to the maximum, while never forgetting to prepare for disasters, is the ideal form of Japanese society for the future.

Director
Active Fault and Earthquake
Research Center
Yukinobu OKAMURA

Evidence of Past Crustal Movements and Tsunamis Recorded in Geological Deposits

A natural archive: coastal peat beds

A geological formation called “peat” exists in wetlands all over the world. Such formations were composed of plants in a certain area that died and accumulated without fully decomposing. Peat contains not only macrofossils of plants that grew at a given time, but also microfossils of minute animals and plants. These fossils tell us about the environment at the time of the accumulated peat and are also materials for radiocarbon dating to determine the age of the tsunami deposits. In other words, we can say that peat is a “natural archive” that maintains a record of the environment at a particular time. By deciphering these archives, I have been reconstructing crustal deformations connected to earthquakes and the intervals of recurrence of past large-scale tsunamis.

Tsunami deposits discovered in Chile
The successive stripes of brown and gray are alternating layers of peat bed (brown) and tsunami deposit (gray). Our two Chilean joint researchers are seen in the center of the photograph.

Reconstruction of crustal movements

The reconstruction of crustal deformations is available using diatom fossils assemblages in samples from peat. Diatoms are one of the unicellular algae groups with a hard siliceous cell wall that have the ability to adapt and live in any environment as long as there is water and light. Diatoms respond to relative changes in the sea level that occur following a crustal deformation and exhibit significant changes in species composition in the area. Since these changes are preserved in deposits as fossils, by examining fossil diatoms we can estimate various changes that have taken place in the past.

In the eastern region of Hokkaido, crustal deformations accompanying a multi-segment earthquake that occurred in the 17th century were reconstructed. When the modern and the fossil diatom assemblages were statistically compared, it was found that there was a slow coastal uplift over several decades around the area between Akkeshi Town and Nemuro City.[1] We are currently searching for similar crustal deformations in other regions. For example, in Chile and on the Pacific Northwest of the United States, coastal subsidence events generated by earthquakes were discovered using similar techniques to those used in the Hokkaido

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case.[2][3] In addition, in the Tohoku region of Japan, coastal subsidence generated by a great earthquake (the Jogan earthquake) that occurred along the Japan Trench in 869 was also discovered. The quantitative, continuous, and high-temporal-resolution reconstruction of crustal deformations based on fossils is beginning to be recognized as paleogeodesy.

Records of unusually large tsunamis preserved in peat beds

When a tsunami hits a coast, sediments that are eroded and carried by the tsunami waves from the surrounding areas remain as "tsunami deposits." Since peat is formed in a calm environment and tsunami deposits are also more likely to be preserved in such an environment, areas where peat beds are found are more advantageous when searching for the past tsunami deposits. In a recent study, ages of tsunami deposits found in peat in Hokkaido were carefully examined, it was revealed that unusually large tsunamis have invaded the coastal lowlands in the past in fluctuating intervals of between 100 and 800 years.[4] In addition, in Miyagi and Fukushima prefectures, tsunami deposits associated with the Jogan earthquake were discovered in peat and were used for estimating the tsunami source and their recurrence intervals.[5][6] Moreover, in a study linked to an international joint research project, evidence of prehistoric tsunamis has also been found in Chile and in Thailand[2][7] (see figure).

Through continued efforts in search of these traces of the past, we are hoping to contribute to the estimation of recurrence intervals of unusually large earthquakes and tsunamis.

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References

[1] *AIST TODAY*, 5 (3), 29 (2005) (in Japanese).
[2] *AIST TODAY*, 5 (12), 26-27 (2005) (in Japanese).
[3] A. Nelson *et al*.: *Quaternary Sci. Rev*., 27, 747-768 (2007).
[4] Y. Sawai *et al*.: *J. Geophy. Res*., 114, B01319, DOI: 10.1029/2007JB005503 (2009).
[5] *AIST TODAY*, 9 (11), 27 (2009) (in Japanese).
[6] *AIST TODAY*, 11 (10), 10-11 (2011) (in Japanese).
[7] *AIST TODAY*, 9 (2), 19 (2009) (in Japanese).

Shedding Light on the History of Past Great Subduction Earthquakes — Decreasing "Unexpectedness" through the study of Coastal Paleoseismology —

The past is the key to forecasting the future

The Great Off-Tohoku Earthquake (M 9.0) of 2011 turned out to be an unprecedented disaster due to the huge tsunami that invaded the Pacific coast, and it is often said that its magnitude was "unexpected." However, from geological surveys at the coast it was known that the plate boundary along the Japan Trench, which was the source of this earthquake, had repeatedly been a source of earthquakes accompanied by huge tsunamis from long ago, including the Jogan Earthquake (greater than M 8.4) of 869.[1] For example, the inundation area of the tsunami in 2011 was very similar to the estimated tsunami inundation area of the Sendai Plain at the time of the Jogan Earthquake (Fig. 1). What this implies is that if the magnitudes of past earthquakes and tsunamis are elucidated and if histories of occurrence are reconstructed, we will be able to make a rough assumption of

the magnitude and imminence of future probable earthquakes and tsunamis.

In this field of research, called paleoseismology, information on the past is sought using various approaches beginning with delving into historical documents and into evidence left in topography and strata of the land.[2] One such approach is the utilization of tsunami deposits that became widely known due to the 2011 earthquake. Other approaches utilize, for example, uplifting and subsidence of the ground and evidence of liquefaction. Ever since its establishment in 2004, the Subduction Zone Paleoearthquake Research Team of the Active Fault and Earthquake Research Center has been consistently conducting topographical and geological surveys of coastal regions both at home and abroad, and has been uncovering past records of great subduction earthquakes.

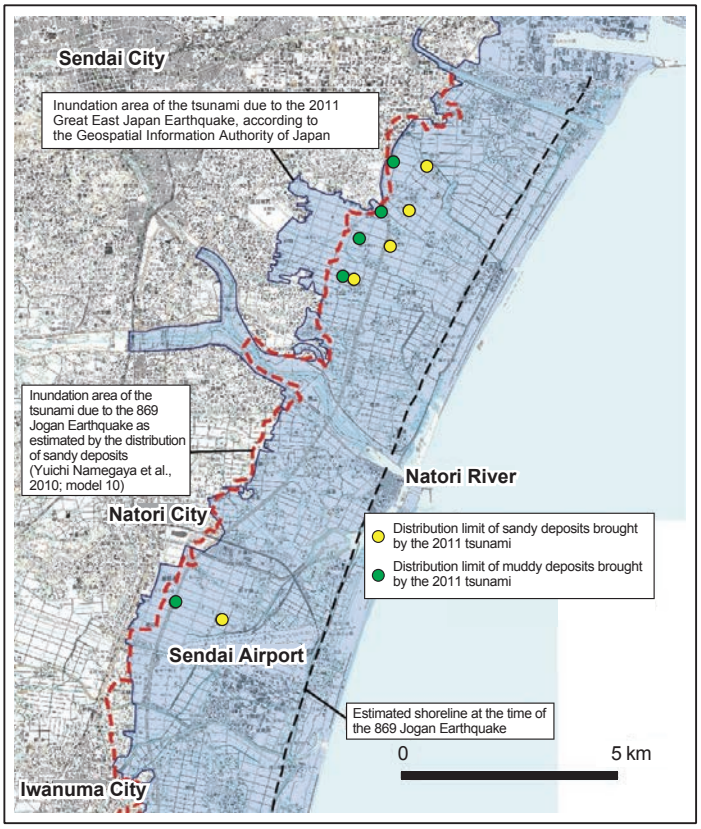

Fig. 1 Comparison of the estimated inundation limit of the tsunami in the Sendai Plain caused by the 869 Jogan Earthquake (red dashed line)[7] and the inundation area of the tsunami due to the 2011 earthquake (area shaded in blue)[8]

Investigation of giant earthquakes that occurred overseas

The occurrence of an M 9-class earthquake is very rare. Even in Japan, until the country was hit by the earthquake in 2011 there was not a single observation record of an earthquake exceeding M 9. For this reason, to understand the various phenomena associated with giant earthquakes it was necessary for us to directly investigate locations that had actually been subjected to such an earthquake. Therefore, we have been conducting investigations throughout the world jointly with foreign researchers.

Chile was hit by a giant earthquake of M 9.5 in 1960, and tsunami deposits from this earthquake can be observed in the wetlands along the shores of South-central Chile. It was known that the area along the ocean trench in this region had historically been causing earthquakes at approximately 100-year intervals. However, the evidence of tsunami left in the strata clearly indicated that earthquakes as large as the one in 1960 have been occurring less frequently, at intervals of between 300 and 400 years.[3]

The 2004 Sumatra-Andaman Earthquake, which is still fresh in our minds, was also a giant earthquake of M 9.1, and when it was investigated, tsunami deposits, uplifted coral reefs, etc. were observed. When we conducted excavations in southwestern Thailand and the Andaman Islands of India, it also became apparent that tsunamis and crustal movements of similar magnitudes had been repeatedly occurring from the past in a much longer cycle than ordinary earthquakes.[4][5] The knowledge we accumulated through investigations of these areas helped us to understand the evidence of past earthquakes and tsunamis discovered in Japan.

The feared near-future earthquakes along the Nankai Trough

The Pacific coast of Japan is always facing the danger that any part of the coast could be hit by a tsunami generated by a subduction earthquake. The area along the Nankai Trough in particular has historically been the source of huge earthquakes at intervals of between 100 and 150 years, and it is feared that the next

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What Can Be Predicted from Records of Past Great Earthquakes?

one could occur during the 21st century. However, the range of magnitudes of past earthquakes has been wide and there has been a lack of detailed information on past tsunami inundation areas as well as the extent of the fault rupture and other details. Geological information is indispensable for more accurate estimation of these points. We have therefore been conducting paleoseismological surveys of the coastal area between Shizuoka and Kochi prefectures. The results of our already completed surveys of various locations and analyses of tsunami deposits and the fossils of uplifted sessile organisms are beginning to reveal that larger than typical tsunamis and earthquakes that involve crustal movements seem to have been occurring at intervals of around 400 to 600 years.[6] One such earthquake is the 1707 Hōei Earthquake (M 8.6), which is considered to have been the largest earthquake in the history of Japan until the 2011 earthquake. More than 300 years have passed since the occurrence of this earthquake, and fears are mounting that the next earthquake could be a large earthquake. To make certain that the coming earthquake will not be an unexpected event, efforts need be continued so that we can estimate the magnitudes of past earthquakes and tsunamis as accurately as possible.

The present is the key to uncovering the past

Based on the belief that in order for us to be able to further improve our ability to forecast the future it is essential that we accurately understand the phenomena of the 2011 earthquake and tsunami and learn whatever we can for the future, we are again conducting surveys of the area along the Japan Trench.

After the earthquake in March 2011, the deposits carried by the resultant tsunami were studied in the Sendai Plain. The results showed that a layer of sand had reached up to about 3 to 4 km inland from the shoreline (Fig. 2). However, it was also discovered that the waters of the tsunami actually reached farther inland, about 1 to 2 km farther than the most inland location of the sand layer (Fig. 1). What these findings show is that a tsunami inundation area reconstructed based on the distribution of tsunami deposits can only indicate the minimum area of inundation, whereas in reality, the inundation can reach much farther than that indicated by the tsunami deposits. Such a possibility had been suggested before, and the 2011 tsunami confirmed it. What this means is that it is highly important that we not only focus on the distribution of past tsunami deposits in estimating future tsunami inundation areas, but also evaluate the scale of tsunami inundation via methods such as tsunami inundation simulations so as to be able to take highly probable estimations of the actual extent of water invasion into consideration in the formulation of reliable countermeasures against disasters.

Unexpectedness can be reduced if we explore the past from the present and estimate the future from the past. We are determined to continue with our present investigations of past tsunami inundation areas and the history of crustal movements and to carefully examine the resulting fault models built upon these findings, so as to be able to provide data that can contribute to effective disaster prevention planning.

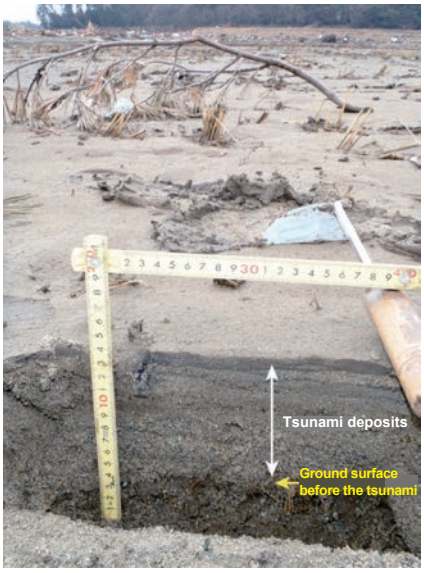

Fig.2 Tsunami deposits formed by the 2011 tsunami (Yamamoto Town, Miyagi Prefecture)

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References

[1] *AIST TODAY*, 9 (11), 27 (2009) (in Japanese).
[2] *AIST TODAY*, 11 (10), 10-11 (2011) (in Japanese).
[3] *AIST TODAY*, 5 (12), 26-27 (2005) (in Japanese).
[4] *AIST TODAY*, 9 (2), 19 (2009) (in Japanese).
[5] Malik *et al*.: *Geology*, 39(6), 559-562, DOI:10.1130/G31707.1 (2011).
[6] *AIST TODAY*, 8 (9), 22 (2008) (in Japanese).
[7] Y. Namegaya *et al*.: *Annu. Rep. Active Fault Paleoearthquake Res*., 10, 1-21 (2010).
[8] Geospatial Information Authority of Japan: http://www.gsi.go.jp/common/000060133.pdf (2011).

Integrated Groundwater Observation Stations for Forecasting the Tokai, Tonankai, and Nankai Earthquakes

Introduction

In the Suruga-Nankai Trough, located off the coast of the Tokai and Shikoku regions, M 8-class large earthquakes have repeatedly occurred at intervals of around 100 to 200 years. According to the Japanese government's Headquarters for Earthquake Research Promotion, the probabilities of the following earthquakes occurring within the next 30 years are as follows: 87 % (reference value) for the Tokai earthquake, about 70 % for the Tonankai earthquake, and about 60 % for the Nankai earthquake.

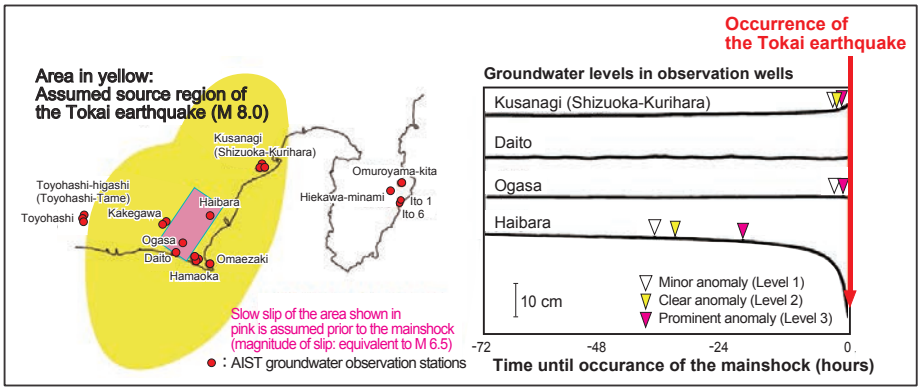

Fig. 1 Map indicating the locations of groundwater observation wells in and around Shizuoka Prefecture and estimated changes in groundwater levels in the observation wells prior to the Tokai earthquake when an M 6.5-class pre-slip is assumed

Prediction of the Tokai earthquake through observation of groundwater levels

The Tokai earthquake is the only earthquake in Japan that may be predicted because a coordinated structure for observations related to this earthquake has been prepared centering around the Japan Meteorological Agency (JMA). The Active Fault and Earthquake Research Center (AFERC), AIST is monitoring 15 groundwater observation wells in 10 locations near the presumed source region of the Tokai earthquake (Fig. 1 left). The groundwater observation data are sent to JMA, and AFERC, AIST also plays a role in Japan's earthquake prediction project by providing explanations to the Earthquake Assessment Committee for Areas under Intensified Measures against Earthquake Disaster that is convened to examine whether or not an observed anomaly is a precursor to the Tokai earthquake.

The groundwater observations are conducted using deep wells ranging between 150 and 270 m in depth. The observed data are immediately sent via telecommunication line to AIST Tsukuba Center. The received observation data are then sent to JMA and are monitored 24 hours a day to predict the Tokai earthquake.

Groundwater levels can also change due to atmospheric pressure, the Earth tide*, and rainfall. Thus, using an advanced statistical approach, we have developed a method that can eliminate fluctuations in the observed groundwater levels caused by atmospheric pressure, Earth tide, rainfall, etc. and correct the observed data.[1][2] When assessing whether or not the observed data are anomalies, the data on groundwater levels corrected using the above method are used.

A recent study revealed that prior to the Tokai earthquake, there is a possibility that, deep underground, a "detachment" between the upper and lower plates might occur, resulting in a "pre-slip" at the plate boundary without causing an earthquake.[3]

According to the "Information about the Tokai Earthquake"[4] released by JMA, when an "anomaly" is observed by volumetric strainmeters due to the above-mentioned pre-slip, one of the following is issued: a Tokai Earthquake Report (extra announcement), Tokai Earthquake Advisory, or Tokai Earthquake Warning.

Figure 1 (right) shows an example of the estimated changes in groundwater levels in the wells observed by AIST due to a hypothetical pre-slip.[5] If a pre-slip corresponding to an earthquake of M 6.5 occurs directly below the Haibara observation well, the groundwater level of that well can be expected to decrease while the groundwater level of the Kusanagi (Shizuoka-Kurihara) observation well can be expected to increase. It was estimated that anomalies

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similar to those detected by the volumetric strainmeters of JMA would be detected 20 hours prior to the occurrence of a mainshock at the Haibara observation well and 2 hours prior at the Kusanagi observation well. As mentioned above, the groundwater level observation data are used as reference data when releasing information about the Tokai earthquake.

Forecasting of the Tonankai and Nankai earthquakes through observations of groundwater and crustal strain

The Act on Special Measures for Promotion of Tonankai and Nankai Earthquake Disaster Management was enforced in 2003 and the establishment of observation facilities was mandated. AIST has created 14 new observation stations since 2006 in the area between the Kii Peninsula and Shikoku.[6]

As a result of recent advances in seismological studies, the occurrence of "deep low-frequency tremor," which is continuous with lower frequency than a usual earthquake, was discovered at the deep extension (at a depth of between 30 and 40 km; the transition zone shown in Fig. 2) of the presumed earthquake source region of the plate boundary of the Tokai, Tonankai, and Nankai earthquakes (the locked zone - shown in Fig.2). Moreover, it was also discovered that a " slow slip event" that continues for a few days up to about a week has been occurring at approximately the same location as and in synchronization with the deep low-frequency tremor.[7][8]

Computer simulations show that when the occurrence of the Tokai, Tonankai, or Nankai earthquakes is approaching, the activity patterns of the deep low-frequency tremor and the slow slip event can change or these activities that occur in the transition zone under normal conditions can shift to the source region of a large earthquake (i.e., the locked zone).

Through the observation data obtained from AIST's integrated groundwater observation network, the distribution of the deep low-frequency tremors and the occurrence of slow slip events can be monitored (Fig. 3).[9] Our goal is to detect changes in the activities of the deep low-frequency tremors and the slow slip events that are assumed to occur prior to an anticipated large earthquake.

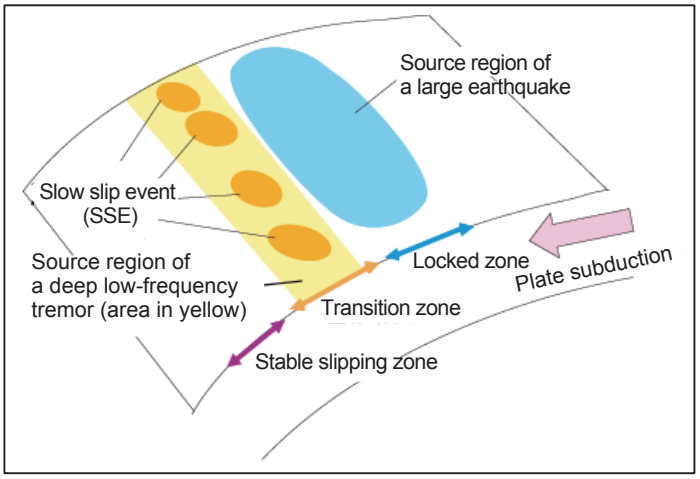

Fig. 2 Schematic diagram showing the source region of a large earthquake, the source region of a deep low-frequency tremor, and the region of slow slip event on a plate boundary

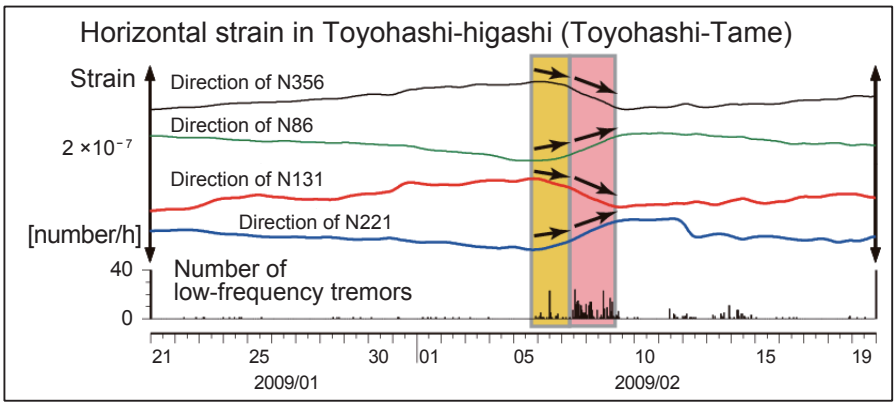

Fig. 3 Example of observation data of a slow slip event detected via a multi-component borehole strainmeter installed at the Toyohashi-higashi (Toyohashi-Tame) observation point between January and February 2009 (areas shaded in yellow and pink) and the number of deep low-frequency tremors observed in areas close to the observation station
A strain of 10^{-7} indicates that there is a 1 mm extension (or contraction) per 10 km of linear distance.

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References

[1] N. Matsumoto: *Geophys. Res. Lett.*, 19, 1193-1196 (1992).
[2] N. Matsumoto *et al.*: *Geophys. J. Int.*, 155, 885-898 (2003).
[3] N. Kato, T. Hirasawa: *Bull. Seismol. Soc. Am.*, 89, 1401-1417 (1999).
[4] Cabinet Office, Government of Japan and the Japan Meteorological Agency http://www.seisvol.kishou.go.jp/eq/tokai/index_leaflet.html (2011) (in Japanese).
[5] N. Matsumoto *et al.*: *Pure Appl. Geophys.*, 164, 2377-2396 (2007).
[6] *AIST TODAY*, 9 (3), 25 (2009) (in Japanese).
[7] K. Obara: *Science*, 296, 1679-1681 (2002).
[8] H. Hirose, K. Obara: *Geophys. Res. Lett.*, 33 DOI:10.1029/2006GL026579 (2006).
[9] S. Itaba *et al.*: *Pure Appl. Geophys.*, 167, 1105-1114 (2010).

* Earth tide: Extension and contraction of the Earth's shape caused by the gravity of the Moon and the Sun.

Evidence of Inland Large Earthquakes Remaining in Geomorphic and Geological Features — Investigation of Timing and Displacements due to Past Earthquakes —

Single- and multi-segment earthquakes of various magnitudes caused by active fault systems

The assumption of the traditional research approach has been that, from a given active fault system, a large earthquake with a certain magnitude will recur regularly over a time interval of between several hundred and several thousand years. However, in a large-scale active fault system (or an active fault zone) composed of multiple active faults, simultaneous displacement of multiple faults can actually cause an earthquake with a much larger magnitude than that of an earthquake caused by displacement of only one active fault. This type of earthquake is called a multi-segment earthquake, and gaining a deep understanding of its mechanism of earthquake generation is a highly important subject in predicting the magnitude of future earthquakes.

For example, it has been suggested that if the approximately 150 km-long Itoigawa-Shizuoka tectonic line active fault system, which is one of the longest active fault systems with the highest probability of an earthquake, is displaced all at once, an M 8-class great earthquake is likely to occur.[1] On the other hand, since this active fault system is composed of multiple active faults, there is also the probability that only one part of the active fault system will be displaced and that an M 7-class large earthquake will be generated as a result. In addition, looking at active fault systems over the world, as exemplified by a fault system in Turkey that will be described later, there have been cases in which multiple large earthquakes were successively caused by one active fault system over a period of a few days to several decades. As shown by such cases, it is now beginning to be understood that earthquakes of a wide range of magnitudes can be caused by a single active fault system. We are advancing our research activities so as to contribute to the improvement of accuracy in predicting the magnitude of future earthquakes.

Measuring the displacements caused by past large earthquakes

One investigation method utilized for this objective involves reconstruction of the displacements caused by large earthquakes based on geomorphic and geological features. When a large earthquake occurs on an active fault, displacement appears on the ground surface along the active fault. The amount of displacement can vary from several tens of centimeters to more than 10 m. The displacement generally increases in relation to the magnitude of the earthquake. As an example of such a relationship, the displacement from an M 7 earthquake is about 2 m, whereas in the case of a greater earthquake of M 8, the

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What Can Be Predicted from Records of Past Great Earthquakes?

displacement increases to around 10 m. Displacements are formed in succession each time an earthquake occurs, and remain as a long-term accumulation of displacements in the topography and strata created between several thousand years and tens of thousands of years ago. In field surveys, we have been digging many paleoseismic trenches three-dimensionally, measuring the accumulated displacements of several large earthquakes in topography and strata, and extracting the amount of displacement for each large earthquake.[2]

Reconstruction of a multi-segment earthquake based on the amount of displacements

We are currently examining methods that could be used to reconstruct the magnitude of a multi-segment earthquake based on the amount of displacement resulting from each earthquake. The results of research on the North Anatolian fault system, Turkey, can be cited as a typical example. Along the 1,200 km-long North Anatolian fault system, a succession of M 7-class large earthquakes occurred over a period of several decades in the 20th century and the fault system became the source of a string of numerous large earthquakes[3][4] (Fig. 1). In addition, in 1668, a movement involving multiple fault segments in the central region of the North Anatolian fault system triggered a chain reaction and the movement eventually became over 600 km long. As a result, based on historical records, it is estimated that an M 8-class great earthquake probably occurred at the time.[5] Building on these findings, we are hoping that the differences between single-segment and multi-segment earthquakes can be clarified by comparing the amounts of displacement caused by the single-segment earthquakes of the 20th century, which were caused by a displacement of a short segment of the fault system, and the amounts of displacement caused by the multi-segment earthquake in 1668, which is presumed to have been a great earthquake.

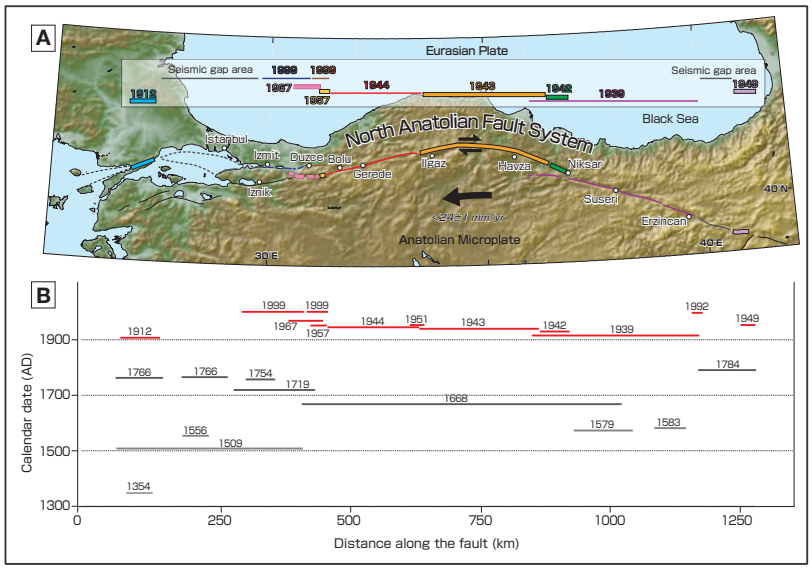

Fig. 1 (A) Distribution of the North Anatolian fault system, Turkey, and the succession of large earthquakes that occurred in the 20th century
(B) Spatial and temporal distribution of past large and greater earthquakes estimated from historical records
The areas of displacement of the successive earthquakes of the 20th century and those before the 20th century differ from each other. The 1668 Anatolian earthquake is considered to have been a multi-segment great earthquake caused by the displacement of fault segments totaling more than 600 km.

Our joint research with the General Directorate of Mineral Research and Exploration of Turkey revealed that as a result of a 1942 earthquake (M 7) in the central region of the North Anatolian fault system, an approximately 48 km-long segment of the fault was displaced and a displacement of approximately 3 m was created on the ground surface. Moreover, the results of the three-dimensional trench investigation and the topographic survey revealed that the displacement caused by the 1668 earthquake was about 7 to 8 m, more than double that caused by the earthquake in 1942 (Figs. 2 and 3). These results provide us with rare data showing evidence of significant differences in displacements caused by single- and multi-segment earthquakes measured at the same location.

Learning from and making use of past multi-segment earthquakes in forecasting future earthquakes

The findings showing that the amount of displacement was different for each earthquake cannot be explained by the conventional understanding, which assumes that successive earthquakes caused by the same active fault system would be of the same magnitude. Further investigations should be conducted in the future on active fault systems both

within Japan and in other countries. The findings also imply that if the reconstructed amount of displacement due to an earthquake in a given active fault system was large, the probability that the magnitude of the earthquake itself might have also been great must be examined, whereas a reverse case must also be similarly examined. To implement these evaluations, accurate information on the amounts of displacement due to past earthquakes, which serve as the basis of these evaluations, is indispensable. In addition, since geomorphic and geological data may not be fully obtainable in some cases, it is also highly important to incorporate methods used in other research fields such as numerical analysis and to collaborate with researchers in other fields. As described above, the reconstruction of past multi-segment earthquakes based on the displacements caused by them is expected to assist in the estimation of magnitudes and probabilities of occurrence of future earthquakes occurring along active fault systems.

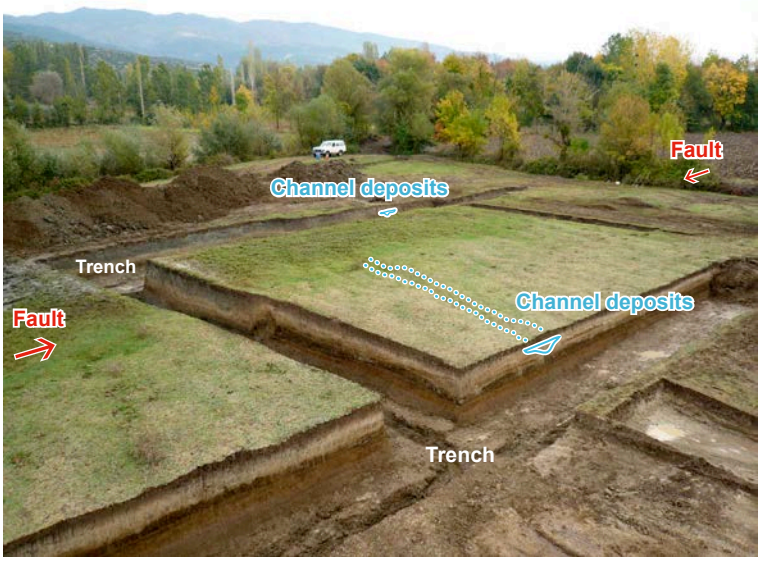

Fig. 2 Scene of a three-dimensional trench investigation of the North Anatolian fault system
To reconstruct the displacements due to past large earthquakes, multiple trenches cutting across and running parallel to the fault were dug and the distribution of the fault and of the strata are grasped three-dimensionally.

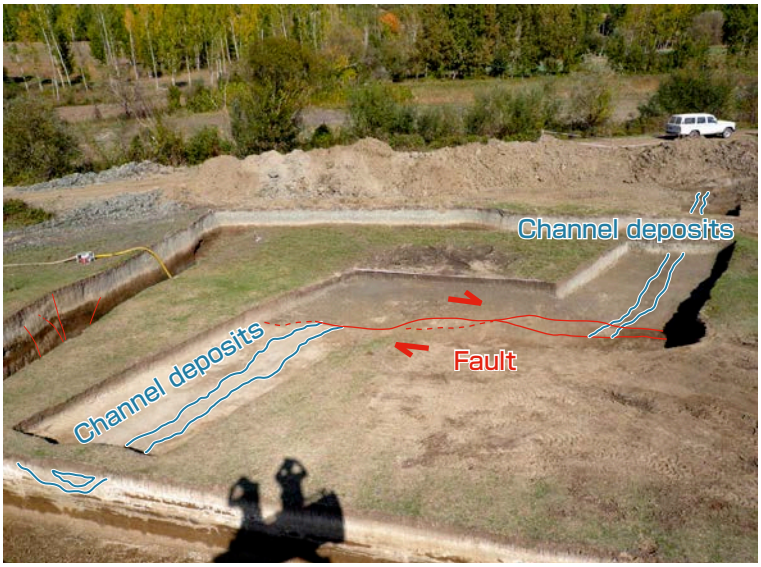

Fig. 3 Accumulated displacement of two earthquakes shown using river deposits (channel deposits) as indicators
The deposits of a river that was running straight across the fault were broken at the boundary of the fault and moved approximately 10 m to the right. This is the result of the accumulation of an approximately 3 m displacement from the 1942 earthquake and an approximately 7 m displacement from the 1668 earthquake, and indicates that the 1668 earthquake was an M 8-class great earthquake.

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References

[1] Earthquake Research Committee of the Headquarters for Earthquake Research Promotion (2001) (in Japanese).
[2] H. Kondo *et al*.: *J. Geophys. Res*., 115, B04316, DOI: 10.1029/2009JB006413 (2010).
[3] A. Barka: *Bull. Seismol. Soc. Am*., 86, 1238-1254 (1996).
[4] R.S. Stein *et al*.: *Geophys. J. Int*., 594-604 (1997).
[5] N.N. Ambraseys, C.F. Finkel: *Historical Seismograms and Earthquakes of the World*, Academic Press, 173-180 (1988).

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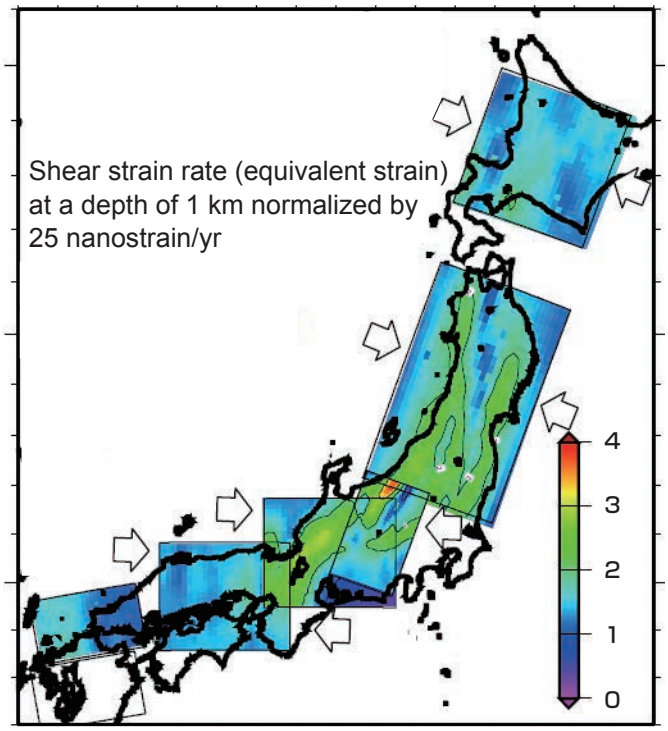
Physical Model of Earthquake Generation Processes for Forecasting Inland Large Earthquakes

Current state of the physical model of earthquake generation processes

For forecasting earthquakes based on numerical simulations, as is the case for weather forecasting, it is necessary to not only elucidate the physical principles of earthquake generation, but also to obtain actual information on the deep structure of the active fault in question, the crustal viscosity of the surrounding area, the amount of stress on the fault, and so on. Presently, however, there is no method to obtain this information directly. In addition, since the recurrence intervals of inland earthquakes are in the range of a thousand years, even if we succeeded in creating a model, the problem exists that it is difficult to verify the model's accuracy. Since there are almost no directly measured data on the deep structure, the structure needs to be inferred from laboratory experiments and geological observations, and a model has to be constructed based on our expertise. When verifying the model, we must utilize all available data such as topographical and geodetic data in addition to the records of past earthquakes for which data are scarce.



Distribution of strain rates obtained by a finite-element-method simulation based on a three-dimensional viscoelastic crustal structure model of the Japanese Islands[4]

Modeling of the Itoigawa-Shizuoka tectonic line active fault system

AIST is focusing in particular on a probable large earthquake along the Itoigawa-Shizuoka tectonic line. The formation process of the geological structure in this area is highly complex and the fault structure is very complicated. Strong inhomogeneity in the structure exists in both the east-west and north-south directions and the modeling of its deep structure is not an easy task. For this reason, we first collected tomography data[1] on the crust beneath the entire Japanese Islands and then constructed a model of the three-dimensional viscosity structure.[2] The formation of a stress field due to interactions between the oceanic and continental plates was also numerically simulated.[3] The modeling of the crustal structure and the stress field at the whole-Islands scale makes it possible to perform verifications based on observation data for areas other than the Itoigawa-Shizuoka tectonic line. This also demonstrates the general applicability of our modeling plan. In fact, we were even able to obtain a simulation result that seemed to reproduce the well-known strain-rate concentrate zone in the Japanese Islands, the Niigata-Kobe tectonic zone[4] (see figure).

Aiming to reproduce seismicity

We are planning to embed the deep structure of active faults into this model so that it will have the capacity of earthquake generation and its repetition. So far we have never had a physical model that could be used for forecasting inland earthquakes, so we are starting one step at a time, from

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the very beginning, to construct such a physical model. We believe that we are in the process of creating the very first basis for identifying various problems associated with forecasting inland earthquakes.

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Active Fault and Earthquake
Research Center
Ikuo CHO

References

[1] I. Cho *et al.*: *Proc. Fall Meeting Seismol. Soc. Jpn.*, P2-01 (2010) (in Japanese).
[2] I. Cho *et al.*: *Proc. JPGU Meeting*, SSS021-12 (2010) (in Japanese).
[3] I. Cho *et al.*: *Proc. JPGU Meeting*, SCG063-11 (2011) (in Japanese).
[4] I. Cho *et al.*: *Proc. Fall Meeting Seismol. Soc. Jpn.*, A22-08 (2010) (in Japanese).

Toward the Evaluation and Forecasting of Ground Surface Deformation Caused by a Fault Movement — Closing in on Future Disasters via Field Surveys and Numerical Calculations —

Damage caused by ground surface deformation due to a fault movement

An earthquake is caused when the displacement of bedrock occurs along a fault plane. The energy of the earthquake is transmitted through the bedrock as seismic waves, shakes the Earth's surface, and if the ground shaking is strong, causes severe damage. Triggered by various types of damage caused by earthquakes, research on the forecasting of earthquake shaking is progressing and contributing to the advancement of earthquake-resistant design. On the other hand, in some cases, displacement of the bedrock itself can appear on the ground surface. In the cases of the 1999 Chi-Chi Earthquake in Taiwan and the 2008 Sichuan Earthquake in China, displacement close to 10 m appeared on the ground surface and destroyed dams, buildings, and other structures. However, research on the forecasting of displacement has not progressed as much as research on the forecasting of earthquake shaking. While direct damage from displacement is confined to the area directly above a fault, if it destroys important infrastructure such as railroads and roads, the associated impact could be far-reaching. Since active faults are everywhere in Japan, we must also pay attention to ground surface deformation phenomena such as displacement and deflection that could be caused by a fault movement.

Locating deformation bands through field surveys

In some cases, ground surface deformation due to an earthquake is clearly seen in the local topography. In the fields of geomorphology and geology, active faults and active folds are identified using evidence left on the topography and geology and the activity levels of these faults and their past activities are researched. On the other hand, in the forecasting of displacement, the location and scale of displacement that can occur has to be pinpointed. Since a survey of a single representative location along a fault is not sufficient for this purpose, we are developing a method that can complement geomorphological and geological surveys and can be easily used to investigate a wide area.

Quantification of future displacement by numerical calculation

In addition to conducting field surveys, we are also promoting research that will make it possible to quantify future displacement by numerical calculation. Information necessary for such numerical calculation, such as the geometry of underground fault planes and the deformation characteristics of sedimentary layers, will be estimated based on geophysical and geological information and on boring and other field surveys and used to construct a model. Using this as a basis, predictive calculations of fault movements and detailed calculations of ground surface deformation will be performed. In calculations for the

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quantification of deformation, sound computation techniques are required when handling, for example, problems of large deformation and/or solid friction. Development and improvement of the method are therefore also major issues. In any case, the real charm of numerical calculation lies in parametric studies. By adjusting various physical and media parameters, we are expecting to be able to identify parameters that closely reflect reality and also to be able to estimate variance in the forecasting.

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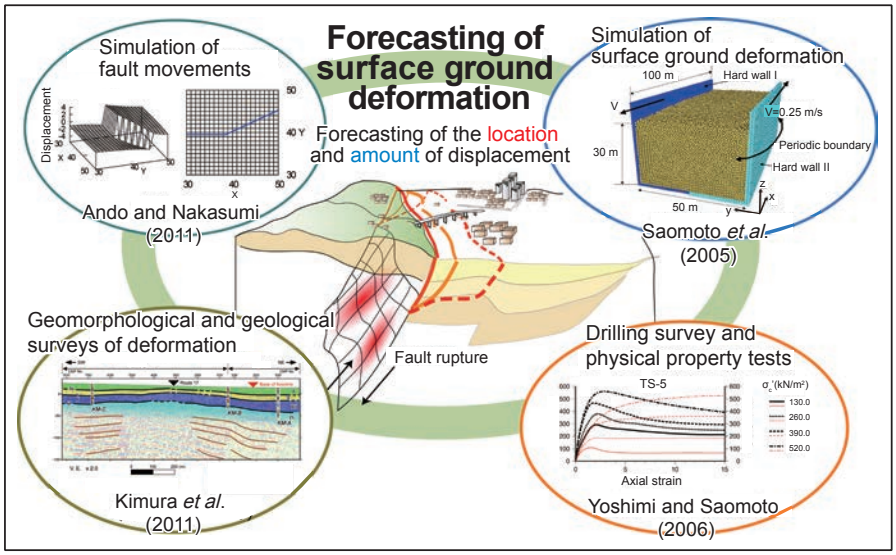

For the evaluation of surface ground deformation, integration of field surveys of the area near a fault (geomorphological and geological surveys of deformation[1]), a boring survey, and physical property tests[2]) and numerical calculations (simulations of fault movements[3] and surface ground deformation[4]) is necessary.

References

[1] H. Kimura *et al*.: *Zishin (J. Seismol. Soc. Japan)*, 117-131 (2011) (in Japanese).
[2] M. Yoshimi, H. Saomoto: *Annu. Rep. Active Fault Paleoearthquake Res*., 1-9 (2006) (in Japanese).
[3] R. Ando, S. Nakasumi: *Proc. JPGU Meeting* (2011) (in Japanese).
[4] H. Saomoto *et al*.: *JSCE J. Earthquake Engineering*, 28 (2005) (in Japanese).

Research Hotline

UPDATE FROM THE CUTTING EDGE

Apr.-Jun. 2012

The abstracts of the recent research information appearing in Vol.12 No.4-6 of "AIST TODAY" are introduced here, classified by research areas.
For inquiries about the full article, please contact the author via e-mail.

Environment and Energy

An oxygen gas barrier film that self-repairs minor damages
Development of a food packaging film using clay

We have developed a transparent film with a high gas barrier property by applying a mixed paste of hydrophilic clay and a water soluble plastic on a polyethylene telephthalate (PET) film. In addition to the flexibility of the gas barrier layer, this film self-repairs pin holes caused by deformation because it absorbs water vapor in the air and swells. Accordingly, the oxygen gas barrier property of the film deteriorates less easily than conventional products when it is damaged.

Moreover, we have established the technology to apply the paste quickly onto a film by printing and succeeded in the production of rolls 50 cm in width. The developed film is promising as a food packaging film since forming polypropylene layer on the film made it easy to make the film into a bag and to print the letters on its surface.

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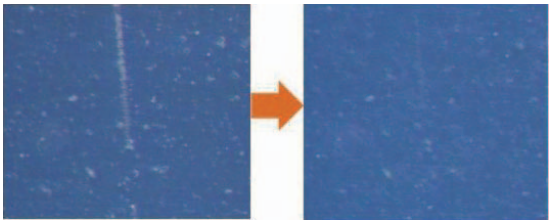
AIST TODAY Vol.12 No.5 p.10 (2012)

Optical microscope images (height 0.50 mm, width 0.62 mm) of the self-repairing process of the scratched gas barrier layer
left: just after being scratched, right: after being left for 60 minutes in humidity



Life Science and Biotechnology

Discovery of non-translational role in the ribosome
Specific inhibition of Ribonuclease T2 by helix41 of 16S rRNA

AIST has discovered that the ribosomes have a function of inhibiting the activity of a ribonuclease (RNase) T2. Ribosomes play a major role in the “translation” of genetic information to protein. RNase T2 is an RNA-degrading enzyme, which is involved in the inhibition of extracellular RNA invasion. In *E. coli*, RNase T2 is present in the periplasmic layer and is isolated from intracellular RNA. However, RNase T2 enters cells and self-RNA can be degraded during the stationary phase or under stress. Accordingly, cells need a mechanism for protecting RNA from RNase T2. Through mutation analysis of 16S rRNA, it has been discovered that an inhibition-determining site exists in 16S rRNA in a 30S ribosomal subunit and prevents intracellular self-RNA degradation by sequestering RNase T2.

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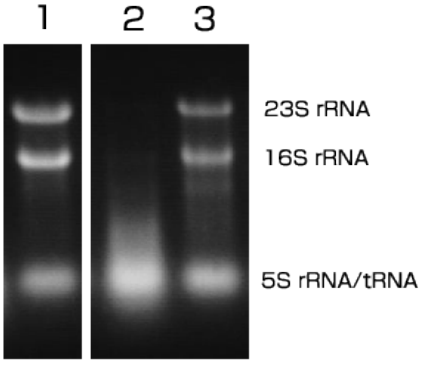
AIST TODAY Vol.12 No.6 p.20 (2012)

Evaluation of activity of inhibiting RNase T2 using intracellular RNA degradation as an index (lane 1 (KT103/Eco), lane 2 (KT103/Rpi), and lane 3 (KT103 *rna*-/Rpi))
RNA degradation (lack of bands indicating 23S rRNA and 16S rRNA) is seen in lane 2 (KT103/Rpi). KT103 *rna*- is the strain that lacks RNase T2 in the genome and shows no RNA degradation irrespective of the origins of helix41.



Transforming service fields into laboratories
Virtualization of indoor environments and behavior of customers and employees

We have developed SDF (Sensor/Data Fusion) for human-behavior sensing and geometric-modeling techniques for indoor service fields. SDF can measure the position and orientation of customers and employees with wearable self-contained sensor modules which contain accelerometers, gyroscopes, magnetometers, and a barometer. The relative position and absolute orientation are estimated by PDR (Pedestrian Dead-Reckoning). Measuring the absolute position and correcting estimation errors accumulated by PDR are done with IMES/Wi-Fi/RFID/VLC (Visible Light Communication) and with 3D environmental maps. The massive cost for initial installation and maintenance is inevitable if we densely cover indoor environments only with positioning infrastructure. The combination of PDR, sparse positioning infrastructure, and map information realizes cost-effective and adaptive measurement. Also using interactive 3D indoor modeler makes it possible to create virtualized-reality models of service fields only from a set of photos while reducing the creation cost. Moreover, the indoor models have high re-usability since they can be used not only for maps in SDF, but behavior analysis, ethnography, navigation, etc.

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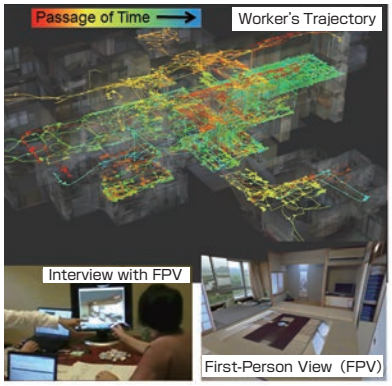
AIST TODAY Vol.12 No.4 p.16 (2012)



Retrospective interveiw support using virtual first-person views based on human-behavior measurement

Flexible, film-like thermoelectric devices fabricated through printing processes
Improvement in the usability of thermoelectric devices making possible the application to energy harvesting field

To innovate the usability of thermoelectric devices, we have developed a novel printable active material based on a carbon nanotube/polymer composite and fabricated film-like devices on flexible plastic substrates. The film-like thermoelectric devices offer technical advantages over the BiTe-based ordinary counterpart in terms of the characteristics in the fabrication and the usage; employing rare-metal-free materials, possible low-cost, large-area and high volume production by the use of printing technology, and a greater degree of freedom in installation due to mechanical flexibility. We succeeded in generating electric power from a prototype device in contact with low-temperature thermal sources such as the human body.

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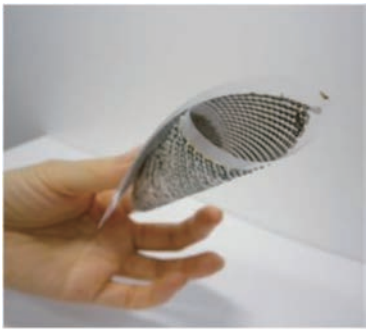
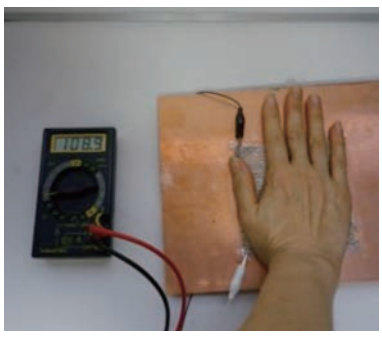
AIST TODAY Vol.12 No.4 p.17 (2012)





A flexible thermoelectric conversion film fabricated by using a printing process (left) and its electrical power-generation ability (right)
A temperature difference created by placing a hand on the film installed on the 10 °C plate generated voltage of 108.9 mV.

High-quality 64 kb ferroelectric NAND flash memory array

Towards the industrial production of the next-generation nonvolatile semiconductor memory

We have developed a 64 kilobit (kb) memory cell array of a ferroelectric NAND (Fe-NAND) flash memory where each memory cell is a ferroelectric gate field effect transistor (FeFET). The first 64 kb Fe-NAND flash memory array with all cells accessible has been produced by developing a FeFET circuit integration technology. We also demonstrated the good data retention of the memory array by investigating a block (2 kb) of the memory cells for at least 2 days. The Fe-NAND flash memory is a promising next-generation nonvolatile semiconductor memory of high-density large-scale integration with a good endurance property and low power dissipation because it has the same cell-area scalability, about 1/7 as low power dissipation, and about 10,000 times as many endurance cycles as the conventional NAND flash memory.

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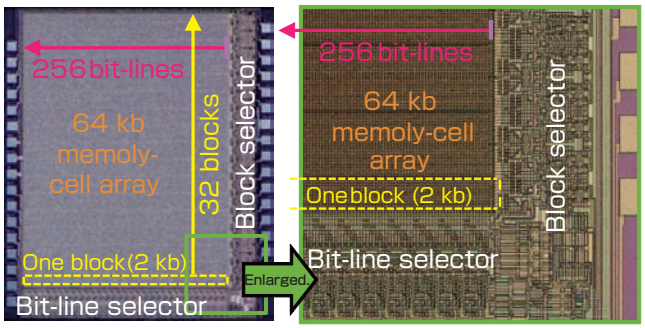
AIST TODAY Vol.12 No.4 p.18 (2012)



The 64 kb Fe-NAND flash memory array developed in this study
Microscopic photos of the whole chip (left) and an enlarged area around a corner (right)

PodCastle: a spoken content retrieval service based on speech transcriptions

Improving speech recognition performance through cooperation from many users

PodCastle (http://en.podcastle.jp for the English version and http://podcastle.jp for the Japanese version) is a spoken content retrieval service that uses automatic speech recognition technologies to provide full-text searching of speech data in podcasts, individual audio or movie files on the web, and video clips on video sharing services (YouTube, Nico Nico Douga, and Ustream.tv). PodCastle enables users to find English and Japanese speech data including a search term, read full texts of their recognition results, and easily correct recognition errors by simply selecting from a list of candidate alternatives. The resulting corrections are used to improve the speech retrieval and recognition performance. In our experience with its use over the past five years (since December 2006), over five hundred eighty thousand recognition errors in about one hundred sixty thousand speech data were corrected by anonymous users and we confirmed that PodCastle's speech recognition performance was improved by those corrections.

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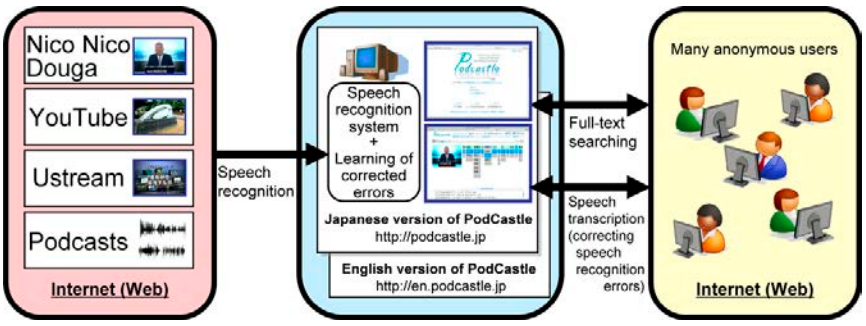
AIST TODAY Vol.12 No.5 p.11 (2012)



Overview of PodCastle, a spoken content retrieval service based on speech transcriptions

Development of a copper paste for crystalline silicon solar cells

Replaces silver pastes and accelerates the reduction in the cost of high-efficiency solar cells

We have developed a copper paste to replace silver pastes for crystalline silicon solar cells. Our developed copper paste features an addition of a low melting point (LMP) alloy. After melted, the LMP alloy can diffuse into the inside of copper particles as well as the spaces between copper particles so that it may cover the whole copper surfaces forming metal bonding with copper. It can be expected not only to enhance the conductivity, but also to prevent oxidation of copper and migration of copper atoms into substrates. The inexpensive copper paste achieves a performance nearly equivalent to those of conventional silver pastes, i.e., low resistance (3×10^{-5} Ω•cm) and low contact resistance (5.3×10^{-4} Ω•cm^2). In addition, by controlling the composition of the alloy paste, these technologies can be applied to the formation of wiring and electrodes for various cell structures, including flexible displays and sensors.

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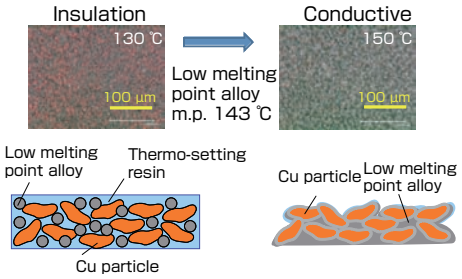
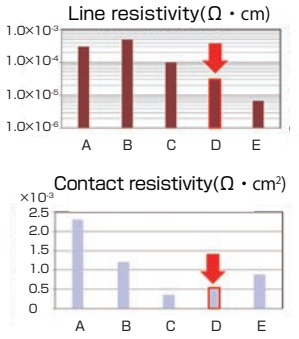
AIST TODAY Vol.12 No.5 p.12 (2012)



Optical micrographs and schematic description before and after melting of the low melting point alloy



Comparison of resistivity with the copper paste we developed
Commercially available copper paste: A, B, C
Developed copper paste: D
Commercially available silver paste: E

Electrically induced giant magneto-resistance from non-magnetic phase-change memory

Magneto-resistance ratio of over 2,000 % at room temperature

We have developed a new phase-change memory device with magneto-resistance ratio of more than 2,000% using an artificially designed superlattice of Ge-Te and Sb-Te crystalline alloy sub-layers. Even without any magnetic element, it was found that the superlattice has a giant magneto-resistance, which is probably induced by its topological invariance with a special band structure known as Dirac cone. The discovery of the magneto-resistance from a non-magnetic phase-change superlattice may have the potential to combine a phase-change memory and a magnetic memory together into one multi-functional memory device in the future.

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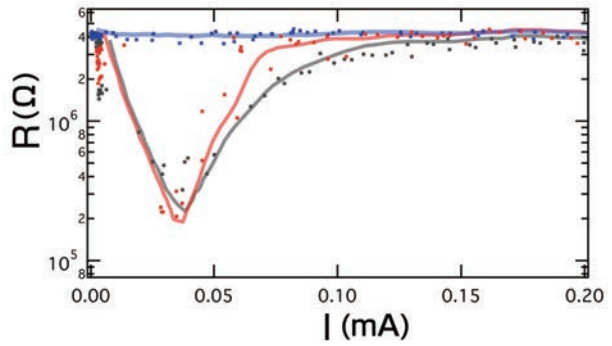
AIST TODAY Vol.12 No.6 p.21 (2012)



Switching curves of the superlattice phase-change memory device
The curves are initial switching (red), switching under a magnetic field (blue) and a switching after the magnetic field is removed (grey). The magnetic field is 0.1 T in plane.

High-performance isotropic sintered magnets without addition of dysprosium

Contribution to resolution of resource problem in high-performance magnets by advanced sintering technique

We have developed dysprosium (Dy)-free hard magnets with high performance. The developed magnets were produced from compound powders of samarium (Sm), iron (Fe), and nitrogen (N). The key technique for our achievement was a pulsed current sintering with an optimum control of powder compaction. This technique was able to consolidate the poor-sinterable Sm-Fe-N powders into the bulk magnets with relatively high density of more than 90 %. The obtained Sm-Fe-N magnets exhibited the world's highest level of maximum energy product as an isotropic magnet, 129 kJ/m^3 (16.2 MGOe). Expanding eco-friendly industries such as hybrid/electric vehicles are demanding further supply of high-performance bulk magnets for electric motors, which currently depends on Dy-added neodymium magnets. The developed hard magnets must contribute to resolution for the resource problem of Dy.

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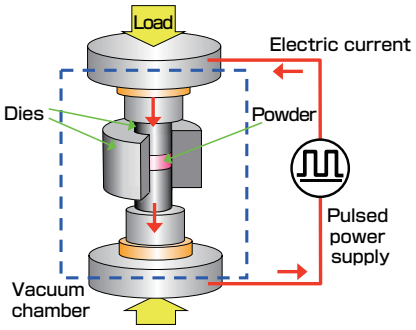
AIST TODAY Vol.12 No.6 p.22 (2012)



Schematic of the pulsed current sintering

Developed Sm-Fe-N sintered magnet without heavy rare earth
High-performance magnets attract 40 of 4-g iron balls.

Compact inspection apparatus for nonuniformity in the luster of gold plating

Digitization of nonuniformity in the luster of gold plating and automatic acceptance recognition based on objective criteria

A versatile compact inspection system has been developed to enable automatic recognition of nonuniformity in the luster of gold plating through measurement of the surface of a flexible printed circuit board (FPC). The system has two main processes. The first process involves imaging by polarization analysis to determine the distribution of the surface roughness of the gold plating that causes the nonuniformity. The other involves the quantification of the nonuniformity in the luster through calculation of the discriminant function, which is obtained using shape feature-quantity computations and statistical methods. The evaluation criteria are created through learning of the teacher data for normal and abnormal products. These criteria can be aligned easily with different boundary samples for each product. Currently, through the verification of actual samples, we are attempting to standardize the testing methods.

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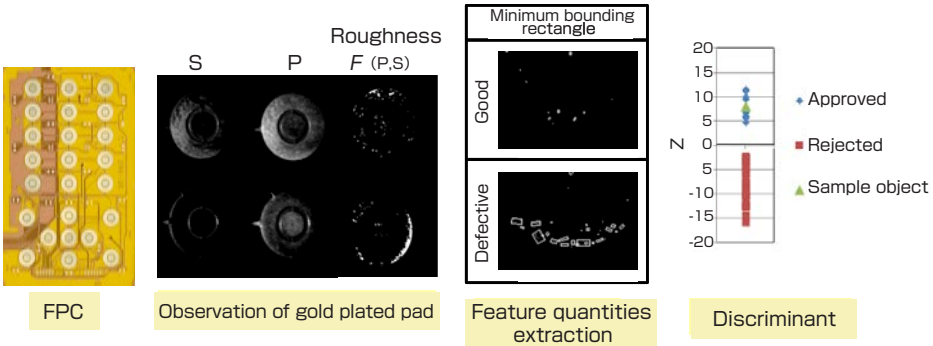
AIST TODAY Vol.12 No.4 p.19 (2012)



Outline of inspection process for the nonuniformity in the luster of gold plating

Technology for measuring static electricity using sound waves

Visualization of static electricity distribution on flat surfaces by scanning focused sound waves

We have developed a novel technology for detecting static electricity by using sound waves and an electromagnetic field. The electromagnetic field is generated by vibrating a charged object with sonic irradiation. Static electricity is measured with an antenna that detects the changes in the electromagnetic field. This technology can detect the induced electric field omnidirectionally from the object vibrated by sound waves, and it can be installed flexibly in various environments with simple device configuration. The non-contact static electricity measuring technology is expected to be applied flexibly at production sites with spatial restrictions. In addition, the technology allows flat-surface static electricity distributions to be visualized by utilizing the scanning of focused sound waves on the objects. This is a promising technology that has a possibility of visualizing static electricity in moving objects at production sites, such as persons and products, within short periods of time.

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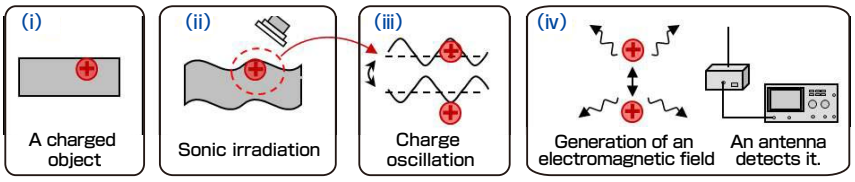
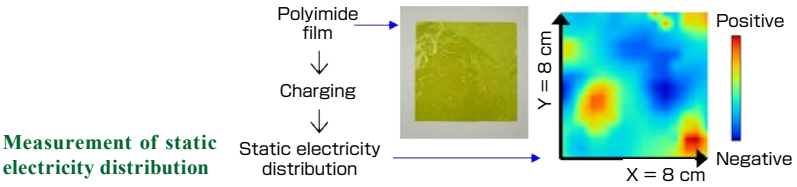
AIST TODAY Vol.12 No.6 p.23 (2012)



Schematic illustrations of the developed technology



Measurement of static electricity distribution

Influence of 2011 Off the Pacific Coast of Tohoku Earthquake on sea floor environments

Wide distribution of sea floor disturbance around the earthquake source area

We collected 13 surface sediment samples from off Sanriku area, and found wide distribution of turbidite deposition around the source area of the 2011 Off the Pacific Coast of Tohoku Earthquake. Multiple erosion was recognized in some sediment samples, suggesting multiple occurrences of turbidity current and submarine slope failure. Another characteristic evidence of the earthquake was sediment deformation. Vertically oriented deformation structures were found in mud just below the turbidite at the outer shelf in the Sendai Bay. Strong ground shaking by the earthquake deformed the sea bed. Wide distribution of turbidites and sediment deformation suggests that the sea floor was largely influenced by the earthquake and the tsunami.

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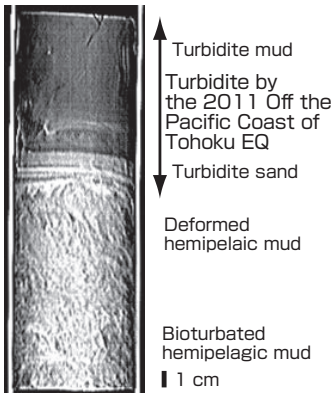
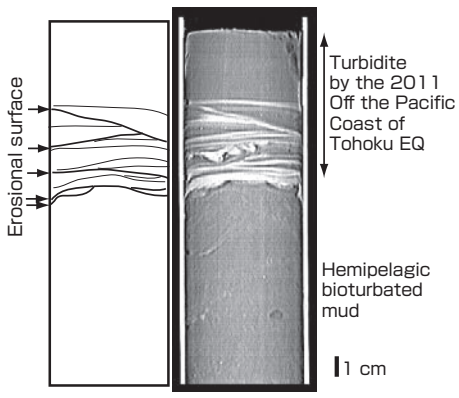
AIST TODAY Vol.12 No.5 p.13 (2012)



X-radiograph of sediment core collected from off Sendai



X-radiograph of sediment core collected near the epicenter of the earthquake

Re-extension of Memorandum of Understanding on Comprehensive Research Cooperation with CSIRO of Australia and Workshop

On March 5-6, 2012, Vice-President Seto and 20 persons from AIST visited the Commonwealth Scientific and Industrial Research Organization (CSIRO), the largest national institute in Australia with which AIST has concluded a memorandum of understanding on comprehensive research cooperation (MOU). A signing ceremony for the re-extension of the MOU and a workshop were held in Brisbane.

At the workshop, there was an exchange of opinions centered on the fields of environment and energy, geology, and life science, and in addition, information concerning the innovation promotion strategies and the public relations activities particular to each institution was exchanged.

Prior to the workshop, the AIST group visited the Global Carbon Capture and Storage Institute (GCCSI) in Canberra on March 2. There was an exchange of opinions regarding AIST joining GCCSI to promote further carbon capture and storage research of AIST.

(Reference) GCCSI: At the 2008 G8 Toyako Summit, the Australian Government led in establishing GCCSI, an international organization, to promote CO_2 capture and storage.

At the signing ceremony for re-extension of the MOU
CSIRO Executive Director Bloom (left) and AIST Vice-President Seto (right)

Group photo at the workshop

Conclusion of Memoranda of Understanding on Comprehensive Research Cooperation with Chinese Academy of Sciences and with Shanghai Jiao Tong University

AIST has renewed the memorandum of understanding on comprehensive research cooperation (MOU) with Chinese Academy of Sciences (CAS) and concluded a new MOU with Shanghai Jiao Tong University (SJTU) during the visit to China of AIST President Tamotsu Nomakuchi from June 3 to 6, 2012.

CAS was established in 1949 and has been conducting research generally classified into the following four major fields: basic sciences, life sciences and biotechnology, resources and environment, and high technology. With 112 research institutes at various locations in the country under it, CAS is China's top-level research institution. Since the conclusion of the MOU in 2004, five joint workshops were held and information and personnel exchanges have been carried out. These activities have led to the renewal of the MOU on this occasion.

SJTU was established in 1896 and is one of China's leading universities in the field of science and engineering. In recent years, it has been actively building networks through joint projects in multidisciplinary fields, including the establishment of a Japan-China joint research laboratory for glycomics with AIST.

AIST and each of these organizations will hold regular meetings in order to further develop the cooperative relationships.

AIST President Tamotsu Nomakuchi (2nd from the left) and CAS President Chunli Bai (3rd from the left)

AIST President Tamotsu Nomakuchi (left) and SJTU President Jie Zhang (right)

Cover Photos
Above: Tsunami deposits discovered in Chile (p. 10)
Below: Tsunami deposits formed by the 2011 tsunami (p. 13)

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