Newsletter of the Global COE program

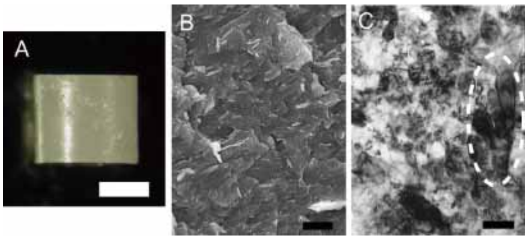
Deep Earth Mineralogy

Center for Advanced Experimental and Theoretical Deep Earth Mineralogy
先進的実験と理論による地球深部物質学拠点

No. 9, December 25, 2011

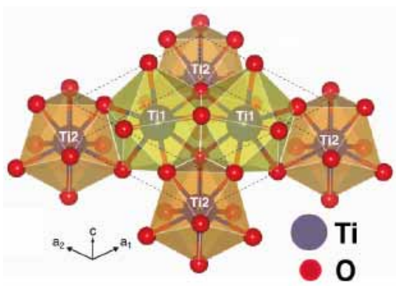
News & Events

Synthesis of Nano-Polycrystalline Stishovite



Dr. Norimasa Nishiyama, an associate professor at Geodynamics Research Center (GRC), and his colleagues have succeeded in synthesizing polycrystalline stishovite (SiO_2) with both a very high hardness and toughness. Stishovite, a high-pressure polymorph of SiO_2 that exists over ~10 GPa, is known as the hardest oxide, although synthesis of high-quality consolidated polycrystalline stishovite has not been achieved. The newly synthesized material is found to consist of granular and columnar fine crystals with typical grain sizes of up to several hundred nanometers and is called "Nano-Polycrystalline Stishovite (NPS)". The Vickers hardness of NPS was determined to be 28 GPa, while the fracture toughness was estimated to be 13 MPa·m$^{1/2}$. These values indicate that NPS has both high hardness and toughness unlike conventional super hard materials, since harder materials tend to be more fragile. Thus, NPS is expected to be highly useful in some industrial applications, such as cutting tools, and is also environmental-friendly, since SiO_2 is the major component of crustal rocks.

The densest phase in metal dioxides



Dr. Haruhiko Dekura at the Senior Research Fellow Center (SFRC), a virtual research center for tenure-track faculty members relevant to the advanced research centers at Ehime University, Prof. Taku Tsuchiya, Dr. Yasuhiro Kuwayama at GRC, and Dr. Jun Tsuchiya at the SFRC, found a new high-pressure form of TiO_2, which turned out to be the densest metal dioxide ever synthesized. This achievement was made in a joint effort among scientists in both theoretical and experimental mineral physics, and was reported in *Physical Review Letters* in July. The new high-pressure phase with an Fe_2P-type structure was predicted by first-principles calculations, and *in situ* X-ray observations using a laser-heated diamond-anvil cell (DAC) have verified that this phase is actually formed under high-pressure and temperature conditions of ~200 GPa and 4,000 K. The discovered new phase of TiO_2 transforms from the lower-pressure phase with a cortunite-type structure, which is also predicted to occur in SiO_2, a major mineral in the Earth and rocky planetary bodies including super Earths. This result highlights the concept of "collaboration of theory and experiment" advocated in our global COE program on Deep Earth Mineralogy.

Prof. Irifune elected as new president of AIRAPT

Prof. Tetsuo Irifune, the director of GRC, has been elected as president of the International Association for the Advancement of High Pressure Science and Technology (AIRAPT) at the general body meeting of AIRAPT held on the 28th of September 2011 in Mumbai, India. Prof. Irifune is the first president from Japan in the nearly 50-year history of AIRAPT and is expected to be appointed for the next 2 terms (4-year) which began in October 2011 together with the newly elected executive committee members. AIRAPT is the interdisciplinary international association for high-pressure science and technology, and the general assembly meeting is biennially held in various countries. The next meeting is scheduled to be held in Seattle, USA, in 2013, followed by the subsequent meeting in Madrid, Spain, in 2015.

Inter-institutional symposium at Geophys. Lab, CIW

An inter-institutional symposium was held at the Geophysical Laboratory (GL) of the Carnegie Institution of Washington (CIW) on 19-21 September 2011, and was attended by about 30 members from GRC and the allied institutes of the global COE program in addition to comparable numbers of members from GL. Keynote lectures were given by Profs. Tsuchiya and Yagi on the GRC side and by Profs. Cohen and Hazen on the GL side. Young scientists (i.e. mainly postdoctoral fellows and PhD students) from both sides gave oral and poster presentations, while senior staff members evaluated the presentations and research achievements. The evaluation committee granted the outstanding presentation award to Drs. Nishi, Dekura and Metsue and to Ms. Yang from the GRC and to Drs. Kono, Stagno, Lazar and Kebukawa from the GL sides, respectively. Some of the GRC members visited the Advanced Photon Source in Chicago, the University of California, Berkeley, and Stony Brook University in New York before/after the symposium, where they had seminars for training to further their academic experiences and for mutual scientific discussions and interactions with these world-level laboratories.

Global COE
DEEP EARTH MINERALOGY
EHIME UNIVERSITY JASRI, UNIV.TOKYO, SBU

News & Events

Awards to young scientists at GRC

Dr. Hiroaki Ohfuji, an assistant professor at GRC, received the Award for Young Scientists from the Japan Association of Mineralogical Sciences (JAMS) during the JAMS 2011 annual meeting (9-11 September) held at Ibaragi University. The JAMS annually grants the prize to one or two outstanding young scientists for their research achievements. Dr. Ohfuji was highly ranked for his works on the application of transmission electron microscopy to the formation of micro-structures in minerals and to high-pressure mineral physics and materials science. In addition, Dr. Masayuki Nishi, a JSPS Postdoctoral Fellow working at GRC, was selected as one of two awardees of the JAMS Research Paper Award for his paper on the transformation kinetics of minerals under high pressure and temperature. Meanwhile, the annual meeting of The Geological Society of Japan was also held at the same venue as the joint meeting with the JAMS, and Dr. Yoshio Kono, the former COE Research Fellow at GRC (now at the HPCAT of the Geophysical Laboratory of the Carnegie Institution of Washington) received the Sakuyama Masanori Award for his studies on the applications of ultrasonic techniques to the measurements of elastic velocities of mantle minerals, rocks, and magmas at high pressure and temperature. Both Drs. Ohfuji and Kono gave special talks in a ceremony session held during the joint meeting.

Drs. Ohfuji and Kono

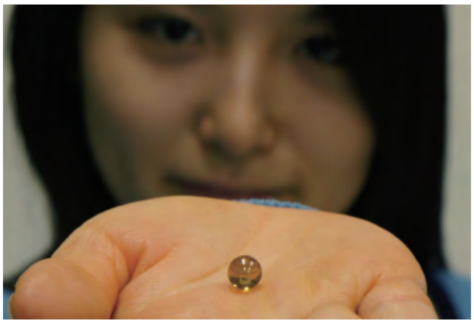
Dr. Nishi

4th YESA Workshop at GRC

This year's workshop organized by the YESA (Young Earth Scientist Association) of our global COE program was held on 1-2 September at GRC under the leadership of the current YESA president, Dr. Hiroki Ichikawa (COE Postdoctoral Fellow of GRC). The title of the workshop was "Effect of heterogeneities on mantle dynamics", and various topics based on laboratory studies, seismic observations, and numerical simulations were provided in order to discuss the dynamics and the evolution of the Earth's and other planetary deep interiors. Attendees of about 30 young scientists, including 9 invited speakers from JAMSTEC, The University of Tokyo, Tokyo Institute of Technology and Hiroshima University, made intensive discussions on these subjects in friendly atmosphere. Yearly YESA workshop is organized by the young scientists (postdoctoral fellows and PhD students) at GRC entirely at their own initiative, and plays an important role in the mutual understandings and communications among the young scientists in various research fields relevant to deep Earth mineralogy.

The first spherical diamond

Nano-Polycrystalline Diamonds (NPD=HIME-Diamond) have been successfully fabricated using a pulsed laser into an almost perfect sphere with a diameter of 7.5 mm (~4 carats) and a deviation from the true sphere being less than several microns (< 0.1%), which is, to our knowledge, the first spherical diamond ever formed. Cutting of single-crystal diamond into a spherical shape is extremely difficult, as its hardness varies substantially depending on the crystallographic planes/directions. In contrast, the isotropic hardness of the NPD, made of homogeneously distributed fine-grained diamond particles, enables it to suffer such fabrication. The spherical NPD sample is used for the measurement of its elastic properties using the ultrasonic resonance method, and is also expected to be applied to optical lenses. This technique also allows us to make arbitrary shapes of anvils for high-pressure apparatus, and pressure generations using both diamond anvil and multianvil apparatus have been attempted with some promising preliminary results.



International Frontier Seminar

23rd (12th July)
"Thermal conductivity of Earth's liquid outer core from first principles calculations"
Lecturer: **Dr. Nico de Koker** (Bayerisches Geoinstitut, Universität Bayreuth)

New Members

Tomoaki Kimura (COE Postdoctoral Fellow)

I moved to GRC from Osaka University this October. Previously, my research was on the equation of state of water compressed by laser-driven shock waves. My current research interests are mainly the thermal and electrical properties of water at pressures of ~100 GPa and temperatures of several 1000 K. Water at these conditions is expected to be a dense fluid found in the icy layer of giant planets such as Uranus and Neptune. The fluid water is considered to be a major contributor to the generation of a magnetic field on this type of planet. I will approach the challenge of the generation of such conditions using a diamond anvil cell and a ten nanoseconds pulse laser. I am pleased to have the opportunity to explore this exciting new research at GRC.

Shin-ichi Machida (GCOE Research Fellow)

I visited the Spallation Neutron Source (SNS) at the Oak Ridge National Laboratory (ORNL) in Tennessee, USA as the internship program from September to November. In the SNS, high intensity pulsed neutron is used for the neutron scattering researches. I learned the technical skill of the neutron diffraction experiments at the high-pressure beam-line in the SNS, Spallation Neutrons and Pressure Diffractometer (SNAP). The SNAP diffractometer allows the researches of powder and single-crystal samples under the conditions of high-pressure and/or low-temperature. During this internship at the SNS, I studied about the low-temperature properties of icy materials such as amorphous ice with Christopher A Tulk and member of the SNAP. They are investigating the structure of an amorphous solid solution of water and carbon dioxide.

Carbon dioxide forms a solid structure, a clathrate hydrate, when mixed with water. The formation of the clathrate hydrate has been considered as a potential store house for the CO_2. However, the characteristic properties of the CO_2 clathrate hydrate are different from other known hydrates. In order to examine the formation of clathrate hydrate from a disordered mixture of water and carbon dioxide, the neutron diffraction experiments for an amorphous solid solution mixture of carbon dioxide and water were performed. They gave me a chance to make the sample of amorphous ice and CO_2, and to perform the neutron diffraction experiments. The sample was synthesized at atmospheric pressure and 10 K by vapor deposition of water vapor and CO_2 gas. Then, the sample was loaded into a vanadium can under the cold condition by using the liquid nitrogen. The vanadium can was set to a cryostat in the SNAP. The neutron diffractions from the sample were collected by the 48.5 and 90 degrees banks. The experiments were performed with increasing temperature, and data were collected at 20 to 220 K. The collected data were analyzed by the Rietveld analysis using GSAS program. This method of the neutron diffraction experiment will be very useful for the studies about the icy materials.

I am so grateful to the global COE grant for overseas scientific program to give me great opportunity for visiting the SNS. Also, I appreciate Dr. Christopher A Tulk, Dr. Malcolm Guthrie (Geophysical Laboratory, Carnegie Institution of Washington), and the member of the SNAP for their kind supports.

Cuiping Yang (PhD student)

The first travel to the U.S. left a deep impression on me, not only on the nice natural environment and different culture but also on the scientific atmosphere. During the Geophysical Laboratory - Geodynamics Research Center (GL-GRC) symposium, I found that people from the Geophysical Laboratory (GL) side were quite active, and they asked more questions during presentations than I expected. And because of this tendency, I was able to discuss with several people, and got some important questions from them. And I also had the chance to look at the powerful analysis techniques at the Geophysical Lab.

After the GL-GRC symposium, we went to APS and attended the APS seminar, which went very well under Yanbin's management. Seven people gave talks in the seminar, and active discussion occurred for all of the talks. After the presentations, we discussed future collaboration in a nice atmosphere. Besides that, the smart-designed D-DIA which was designed by Yanbin, really impressed me very much, as well as the huge space of the Argonne National Laboratory.

Both the GL-GRC symposium and APS seminar gave us young people a good chance to learn the importance of communication between different institutions. During my stay in the US, I also realized the importance of learning English.

Yongtao Zou (PhD student)

Prof. Irifune, Prof. Inoue, and I made a short visit to the Mineral Physics Institute of Stony Brook University and Brookhaven National Laboratory from September 15, 2011 to September 17, 2011. Prof. R.C. Liebermann, the former president of COMPRES and a famous professor of Stony Brook University, which has an official collaboration agreement with the GRC and is an important partner of the global COE program, invited us to visit both facilities. After the laboratory visit, which was quite interesting, I attended a seminar held by the Mineral Physics Institute, Stony Brook University. In this seminar, I gave a talk entitled, "Synthesis and elastic wave velocities of polycrystalline $Mg_3Al_2Si_3O_{12}$ garnet up to 20 GPa and 1700 K: ultrasonic measurements in conjunction with X-radiation techniques". During this seminar, I had a heated discussion with the on-site teachers and/or researchers about the results of the current ultrasonic measurement data for pyrope. Especially, Dr. Matthew L. Whitaker, the former assistant professor of GRC, now serving as a beamline scientist at Brookhaven National Laboratory, as well as Prof. Gabriel Gwanmesia have given me some good suggestions for the current research results process. After this seminar, I also discussed with my supervisor Prof. Irifune and Prof. Li about some suggestions for my next research project about sound velocity measurements.

Internship & Seminar Report

Yusuke Usui (COE Postdoctoral Fellow)

I visited the department of Earth and Planetary Sciences, University of California, Berkeley with Prof. Tsuchiya, Dr. Kuwayama, and Dr. Dekura from GRC and Dr. Kawai from Tokyo Tech. after the GL-GRC symposium. UC Berkeley is the 10th university in the world, according to university rankings published by the *Times Higher Education* in 2011-2012, which is the United Kingdom's leading higher education news publication. UC Berkeley has a lot of top class researchers in the field of Earth science. The traditions of the university, which is one of the most popular in Japan, are liberal and the atmosphere is friendly. So we could see that the students were lively and active in the university.

In this short visit, the seminar and laboratory tour were organized by Prof. Bruce and Dr. Matsui from UC Berkeley. There were a lot of good presentations and I had many useful discussions with young researchers. In particular, Dr. Matsui showed the study of dynamo simulations in the outer core, which no people study at GRC, and it was very interesting that he showed the existence of the temperature and chemical heterogeneity in the outer core. For my presentation, I was favorably impressed by many people and I also got a lot of useful comments especially from Prof. Bruce. I think I should improve some presentation slides and future plans for the AGU fall meeting.

In the laboratory tour, we visited the seismological laboratory, and Prof. Allen who is the director of the laboratory and Dr. Peggy introduced some seismic sensors and the seismicity in the San Francisco Bay Area. This area is located at the subduction zone and earthquakes often occur. Therefore, it is very important to construct a system for the Earthquake Early Warning. This situation is very similar to Japan, especially in the Kanto region. However, I felt that we have progressed further with construction than the USA.

Finally, through this short overseas visit, I have been favorably impressed, and I would like to study at UC Berkeley. I would like to thank Prof. Bruce and Dr. Matsui for holding the meeting, and I also thank the global COE International Scientist Training Program at Ehime University for giving me a chance to participate in the international seminars.

Facility at GRC (III): BOTCHAN-6000

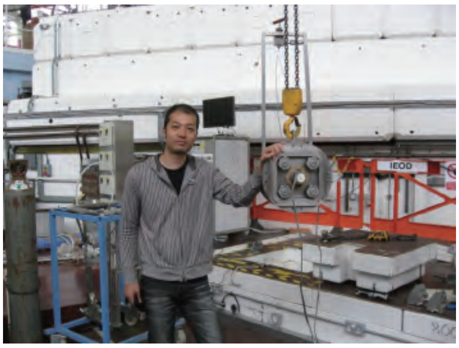
BOTCHAN-6000 is a large Kawai-type multianvil apparatus operated in a 6000-ton press, about 5.3 m high and 90 tons in weight, which was constructed at SOSEKI laboratory at GRC in 2009. BOTCHAN (young master, in Japanese) stands for "Beyond Observable Toughness and Conceivable Hardness of Artificial Nano-diamond", but is also taken from the title of the famous novel written by Soseki Natsume during the Meiji era, where Botchan and Madonna are the major characters in the novel. A new 1500-ton D-DIA type press, MADONNA (Multi-Anvil Device ON Newer Applications), is also sitting beside the BOTCHAN in the SOSEKI lab. SOSEKI is taken from the author of the novel, but this word also means "creation of new gem stones" in Japanese. Actually, BOTCHAN has mainly been used for producing large consolidated bodies of nano-polycrystalline diamond (NPD or Hime diamond) and also for high-pressure synthesis of these new materials that are potentially important for industrial and scientific use.

COLUMN: A mysterious statue at Garyu Sanso

Ozu city is located some 100 km south of Matsuyama city, the latter being the capital of Ehime prefecture and the hometown of GRC. In Ozu city and also in the neighboring historic town of Uchiko, buildings in Meiji and Edo eras (100-200 years ago) are well preserved and attract many tourists, particularly in late autumn when tree leaves turn beautiful red or yellow. Garyu Sanso, a mountain villa facing the Hijikawa river, was constructed over 100 years ago in Ozu city and is one of the best spots to enjoy the autumn color in Ehime prefecture. People can also enjoy the tea ceremony in a relaxed atmosphere, while appreciating the beautiful Japanese garden. A mysterious statue is sitting in the garden of Garyu Sanso, which also attracts many tourists but nobody really knows what this statue is. Its face looks like that of a fox, but its body and the standing figure are likely those of typical raccoon, or "tanuki", statues common in Japanese gardens. Most likely, this is a pregnant fox, considering the image of the fox that Japanese people generally have; fox is the incarnation of a rather clever female, while tanuki is a kind of symbol for a stupid male. It is also believed that the fox is the messenger/symbol of a god (we have many gods in Japan) and a couple of fox statues are placed in front of many shrine temples, where a number of people visit at the beginning of the new year for prayer. Let's pray to this misterious statue that GRC will continue to be productive in the coming year.

A design of backing seat and gasket assembly in a DAC for accurate single crystal x-ray diffraction

Kazuki Komatsu
(Project Lecturer,
The University of Tokyo)



The difficulty in crystal structure refinements using single crystal x-ray diffraction data taken under high pressure is caused by limited and inaccurate intensities, i.e., the limited opening angle restricts accessible reciprocal space, and the accuracy of collected intensities and their estimated standard deviations are adversely affected by anvils, gaskets, backing seats, etc. Therefore, the way to obtain more accurate structural parameters are with a widely opened x-ray window for both incident and diffracted x-rays and to use less-absorbed and less-scattered materials in the x-ray traveling path. Following these two points, a modified design of diamond anvil cells was designed for an accurate structure refinement (Fig.1). The features of the assembly are 1) the platy anvil and unique-shaped backing seat (called a 'Wing seat') allowing an extremely wide opening angle up to ±65° and 2) the PFA - bulk metallic glass composite gasket allowing easy attenuation correction and less background. Thanks to the designed assembly, the Rint values after attenuation corrections are fairly good and the errors of the refined parameters are satisfactorily small even for hydrogen positions, those are comparable to the results which were obtained at ambient conditions. The result for ice VI are in excellent agreement with previous study, and that for ethanol HP phase has remarkable contributions to the revision to its structure; the H12 site, which makes gauche molecules with O1, C2, and C3 sites, may not exist so that only trans conformers are present at least at 1.95(2) GPa. The accurate intensities using the cell assembly allows us to extract the electron density for ethanol HP phase by the maximum entropy method (Fig. 2).

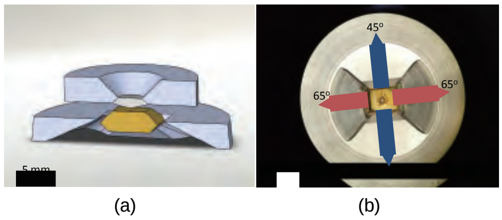


Fig. 1. (a) Slice image of newly designed (lower, so-called 'Wing') and conical (upper, so-called 'Boehler-Almax') anvil and backing seat. (b) Picture of the Wing seat with anvil.

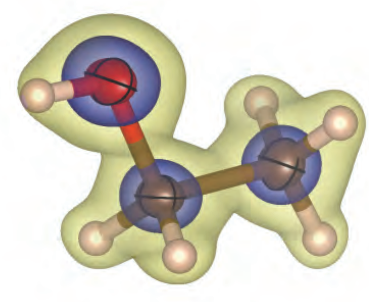


Fig. 2. Composite images of ball-and-stick model of ethanol molecule in the HP phase and isosurfaces of electron density obtained by the maximum entropy method.

Synthesis and elastic wave velocities of polycrystalline pyrope $Mg_3Al_2Si_3O_{12}$ garnet up to 20 GPa and 1700 K

Yongtao Zou
(PhD Student)

Silicate garnets are one of the most abundant constituent minerals of the mantle transition zone, comprising of about 40% by volume of the pyrolite composition. It is thus of geophysic importance to study the elastic properties in order to interpret the seismic tomographic images and elastic wave velocities/density profiles from a seismological viewpoint. Pyrope garnet is one of the most significant magnesium end-members of this group. However, to date, earlier studies on the elastic properties of pyrope have been limited, either to room temperature, or to pressures restricted to 9 GPa at high temperature by Brillion spectroscopy and/or ultrasonic measurements. Here, we report elastic wave velocities as well as elastic properties for synthetic polycrystalline pyrope up to 20 GPa and 1700 K, equivalent to the middle part of the mantle transition zone, by using ultrasonic interferometry combined with energy-dispersive synchrotron X-ray diffraction in a cubic-anvil DIA-type apparatus.

Polycrystalline pyrope has been prepared at 11 GPa and 1200 °C from a homogeneous glass with pyrope composition. Elastic wave velocities for the synthetic polycrystalline pyrope were successfully measured to 20 GPa and 1700 K. TEM image of the recovered sample after our ultrasonic measurement, as an inset in Fig. 1, shows that the sample is well-sintered and equilibrium texture formed with an average grain size of about 1-2 μm, without any observable porosity or micro-cracks. Fig. 1 shows the elastic wave velocity changes as a function of pressure and temperature. In addition, a quasi-linear pressure and temperature dependence in both Vp and Vs are observed, in contrast to the significantly non-linear temperature dependences of Vp and Vs observed for majorite (Irifune et al., 2008). A two-dimensional (P-T) linear fitting of the present data also yields the following parameters: K_{0S} = 170.0 (2) GPa, $\partial K_S/\partial P$ = 4.51(2), $\partial K_S/\partial T$ = -0.0170(1) GPa/K, G = 93.2(1) GPa, G_0' = 1.51(1), and $\partial G/\partial T$ = -0.00107(1) GPa/K, which is in good agreement with earlier results by Sinogeikin et al. (2000 & 2002) and Gwanmesia et al. (2006).

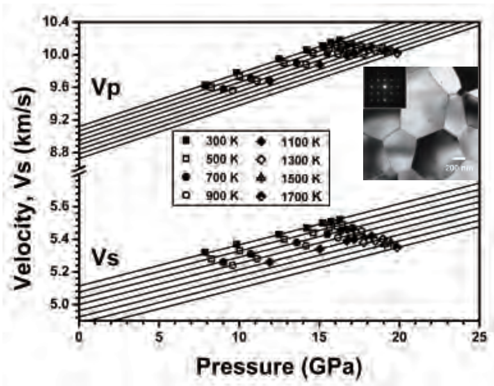


Fig. 1. Elastic wave velocities of pyrope garnet at high pressure and high temperature determined from the present ultrasonic measurements. The solid lines are the two-dimensional linear fitting results of the entire P-T range. TEM image of the recovered sample after the present ultrasonic mearuements, as an inset in Fig. 1, shows that the sample is well-sintered and equilibrium texture formed with an average grain size of about 1-2 μm, and without any observable porosity or micro-cracks.

News & Events

Plenary talk and exhibition at AIRAPT in Mumbai

Prof. Tetsuo Irifune gave a plenary talk on nano-polycrystalline diamonds (NPD, HIME-Dia) at the AIRAPT-23 held in Mumbai in September, 2011. A lot of attention was attracted by his talk on mechanical and optical properties, fabrications into arbitrary shapes, and applications to high-pressure sciences of the NPDs, together with a greeting message as the new president of the AIRAPT. Meanwhile, a GRC exhibition booth was open during the AIRAPT to show actual NPDs with several types of cutting (sphere, cubic, and brilliant), in addition to introduction of facilities at GRC and activities at our global COE program. Coupled with the plenary talk by Prof. Irifune, many attendees dropped by the booth and had interests in the NPD itself along with the other activities at GRC.

Visitors from NCKU to GRC

Prof. Jennifer Kung of the National Cheng Kung University (NCKU) visited GRC with two master course students for training multianvil techniques for higher temperature generation at high pressure, under the supervision of Prof. Toru Inoue and Dr. Toru Shinmei, during the period of 21-28 November, 2011. Two students stayed at GRC for about one week and conducted some synthesis experiments using multianvil apparatus. Department of Earth Sciences at NCKU is one of the 8 institutions that GRC has a mutual agreement for research collaboration and exchange of researchers and students, and Prof. Kung recently introduced a D-DIA type multianvil apparatus at her laboratory for high-pressure mineral physics studies of mantle materials.

Seminar at RSES, ANU

Prof. Tetsuo Irifune gave a talk on nano-polycrystalline diamond at the School Seminar of Research School of Earth Sciences (RSES), the Australian National University, on 7 July with Prof. Shun-ichiro Karato of Yale University, after their trip to Melbourne, where the general assembly meeting of the International Union of Geodesy and Geophysics (IUGG) was held. GRC and RSES have had a mutual agreement for inter-institutional research collaborations and exchange of researchers/students since 2008.

Internship student from Peking Univ. to GRC

One graduate student from Peking University, Ms. Meili Wang supervised by Dr. Qiong Liu, stayed at GRC from October 2011 to January 2012 for an internship program and for collaborative research. She conducted high-pressure and high-temperature experiments on the melting of K_2CO_3 carbonate and CO_2 solubility in silicate magma under high pressure under the instruction of Prof. Toru Inoue of GRC. Based on the agenda of TANDEM on mutual educations, GRC accepts such internship students from Asian countries, and four students from Peking University visited GRC for several months this year. These internship programs availabe through GRC focus on deep earth mineralogy using high-pressure experiments and theoretical calculations.

The first PhD in the special course at GRC

Dr. Leiming Fang received his PhD on 26 September as the first student enrolled in the Special PhD course on Deep Earth Mineralogy, since it was founded at Ehime University in 2008, relevant to the global COE program. Dr. Fang focuses his research on the phase relations of C_3N_4 at pressures of 27 GPa and temperatures up to 2000 ºC, and found that the ultrahard phase predicted by theoretical studies does not exist at these pressure and temperature conditions. Moreover, he showed C_3N_4 decomposes into an assemblage of liquid nitrogen plus diamond at certain pressures and temperatures. Dr. Fang accepted an offer of a tenured position at the China Academy of Engineering Physics immediately after he received his PhD.

Call for Special PhD course at GRC

A special PhD course at GRC, Ehime University, for enrollment in September 2012 is open for Asian students who have strong interests in the research fields of deep Earth mineralogy and relevant science/technological fields. Students of the course, with financial support from the university, will be provided with educational programs for advanced studies of high-pressure experiments and theoretical calculations. The examination will be scheduled in May, 2012. An application guideline will be announced soon via the TANDEM mailing list and on the global-COE website:

http://deep-earth-mineralogy.jp/g-coe2008/english/positions

Contact: Prof. Toru Inoue (inoue@sci.ehime-u.ac.jp)
Dr. Akira Yamada (yamada@sci.ehime-u.ac.jp)

High-Pressure and Thermochemistry Laboratory, Department of Chemistry, Gakushuin University

The campus of Gakushuin University is located in the north-western part of metropolitan Tokyo. Though it is near center of Tokyo, the campus is in a quiet district with a number of tall trees. Gakushuin University was founded in 1949, but the origin of the university goes back to the imperial educational institution established in 1847 in Kyoto. Now, the university has four faculties and seven graduate schools, and has a total student body of about 9,000 in undergraduate and graduate courses.

The Department of Chemistry in the Faculty of Science has nine research groups in which two are geoscience-oriented groups having a background in chemistry. The research group led by M. Akaogi started in 1990. Currently, our group has two faculty members, M. Akaogi and H. Kojitani, four graduate students and four undergraduate students. Our research interest is high-pressure mineral physics and chemistry. In particular, we focus our research interests on high-pressure phase transitions of minerals and related inorganic materials and on thermodynamic properties of the high-pressure phases. Both research interests are closely related. In the laboratory, we intensively use a 700-ton and a 1000-ton Kawai-type multianvil apparatus to generate pressures up to 30 GPa and temperatures to 2500 °C for phase equilibrium studies and high-pressure material synthesis. We also have two Calvet-type calorimeters for enthalpy measurements of several-mg samples, and a differential scanning calorimeter for heat capacity measurements. Although a number of high-pressure laboratories are working in the world, our laboratory is a very unique one where both high-pressure experiments and thermochemical measurements can be made in a single laboratory. We produce large amounts of high-pressure phases with the multianvil apparatus and consume them in the calorimeters. During the past twenty years, we have determined phase equilibrium relations and thermodynamic properties of various high-pressure silicate minerals such as $MgSiO_3$ perovskite, akimotoite and majorite, Mg_2SiO_4 ringwoodite, etc. by using both of the above techniques. The results have been applied for the understanding of mineralogy of the deep mantle. We synthesized a new hexagonal aluminous phase called the NAL phase and analyzed the structure for the first time. The stability relations of some high-pressure aluminous phases were applied to some shocked meteorites to estimate the P, T conditions of the shock events.

For characterization of high-pressure phases, we intensively use a powder X-ray diffractometer and a microfocus X-ray diffraction apparatus both of which are operated with a rotating anode. A scanning electron microscope with an energy-dispersive spectrometer is used for chemical analysis, and a Raman microprobe to measure Raman spectra at room pressure and at high pressure with the diamond-anvil cell is used.

Current researches include the investigation of the high-pressure post-perovskite transition of a variety of ABX_3 compounds, analogous to $MgSiO_3$ but quenchable at ambient conditions; precise determination of phase transitions in mantle rocks of various compositions; high-pressure phase relations and structure refinements of several different aluminous silicates presumably stable in the deep mantle; calorimetry of ferrous-iron bearing minerals under an oxidative atmosphere; measurements of heat capacity of mantle minerals and calculation of C_P using high-pressure Raman spectroscopy, etc. Recently, we have found several ABX_3 post-perovskite phases at high pressure, and measured the characteristic physical properties. In the Faculty of Science, we collaborate with other groups from the Departments of Chemistry and Physics such as a group investigating new inorganic functional-materials for the physical properties measurements.

Further information is available on our web site
(http://www-cc.gakushuin.ac.jp/
~901334 /homepage/AkaogiHP-English.htm).

In the last several years, we made fruitful collaborations with scientists at important institutions including the National Institute of Materials Science in Tsukuba, the Tokyo Institute of Technology, Hokkaido University, Ehime University, Bayreuth Geoinstitut, Moscow State University, and Peking University including TANDEM researchers. We hope for productive collaboration with TAMDEM members to make further developments in high-pressure mineral physics and chemistry.

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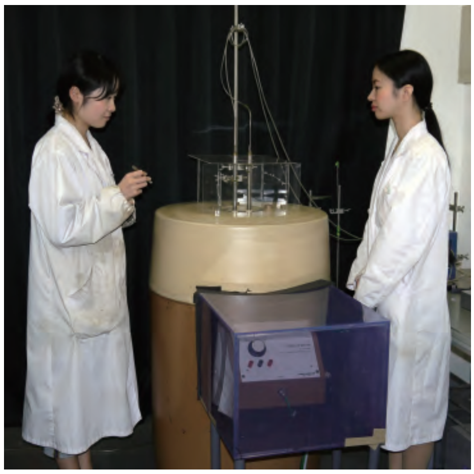

State Key Laboratory for Inorganic Synthesis and Preparative Chemistry (ISPC) of Jilin University, China

The members of the Group of High Pressure Research at ISPC of JLU, China in 2011

Jilin University (JLU) is one of the leading universities and the largest national university under the direct jurisdiction of the Ministry of Education of China. JLU is located in Changchun, the capital city of Jilin Province in Northeastern China. There are eight campuses which are home to forty-three colleges covering twelve academic disciplines, and a total of 68,580 full time students among whom more than 25,000 are graduate students, and 1,638 full professors. The State Key Laboratory of Inorganic Synthesis and Preparative Chemistry (ISPC) at Jilin University was established in 2001 upon the approval of the Ministry of Science and Technology of China. Its precedent was the Key Laboratory of Inorganic Hydrothermal Synthesis affiliated with the Ministry of Education of China founded in 1993. The goal of the ISPC is to develop into a first-class teaching and research center in inorganic synthesis and preparative chemistry, and to build a high-level, well-balanced, and vigorous research team. Since its establishment, the ISPC has achieved significant advancements, which include development in the fields of molecular engineering, hydrothermal and solvothermal synthesis chemistry, novel microporous compounds and related single crystals, low-dimensional phosphates, solid strong correlation materials, and host-guest chemistry and new catalysts.

High Pressure Lab at ISPC of JLU, China

Since the beginning of 2004, ISPC began to set up a new lab for high pressure research, and Prof. Xiaoyang Liu has been serving as the Director of High Pressure Research since then. The faculty members in the Group of High Pressure Research are Prof. Jiuhua Chen (Earth Sciences), Prof. Xudong Zhao (Condensed Matter Physics), Associate Prof. Xiaofeng Wang (High Pressure Solid State Chemistry), Associate Prof. Zhanhui Ding (Condensed Matter Physics), Dr. Benxian Li (Earth Sciences), and Dr. Weiguang Shi (Life Sciences). Up to now, the high pressure equipment at the ISPC include a Bruker APEX II QUAZAR *in-situ* High Pressure X-ray Diffractometer, a Renishaw *inVia* Reflex *in-situ* High Pressure Raman Spectrometer, a 1000-Ton two-stage Walker Multi Anvil High Pressure Apparatus, a 1000-Ton two-stage Cubic Multi Anvil High Pressure Apparatus, a 150-Ton 3.0 QuickPress Piston-Cylinder High Pressure Apparatus, a LECO TEM-PRES HR-1B Hydrothermal Research Units, an *Initiator*™ EXP Eight Microwave Hydrothermal System, a Parr Model 4021 Rocker Type Hydrothermal Reactor, a Parr Model 4571 Stirred Hydrothermal Reactor, and a Nikkiso THP-BI-100 Hydrothermal Unit. The following analytical instruments are available at the ISPC: powder and single crystal X-ray diffractometers, SEM, TEM, PPMS, SQUIDS, XPS, IR, ESP, and ICP.

Current high pressure research at the ISPC focuses on: a) geochemistry and mineralogy of gold, nickel, and platinum-group elements through laboratory experimentation and study of ore minerals and ore deposits; b) the synthesis, structural chemistry, and atomic bonding in crystalline silicates, phosphates, sulfides, analogue materials, and synthetic glasses; c) high-pressure synthesis of silicates, superhard and superconductor materials; d) crystal chemistry of transition metal oxides; and e) in-situ high pressure research.

Upholding the principle of openness, mobility, cooperation, and competition, the ISPC welcomes domestic and international researchers to visit and carry out collaborative research.

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