Newsletter of the Global COE program

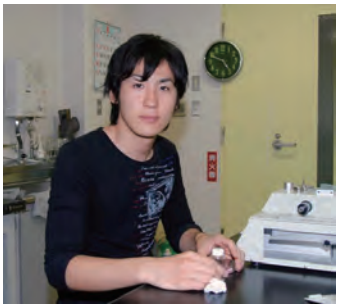
Deep Earth Mineralogy

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. 6, September 30, 2010

News & Events

Article of "New Scientist"



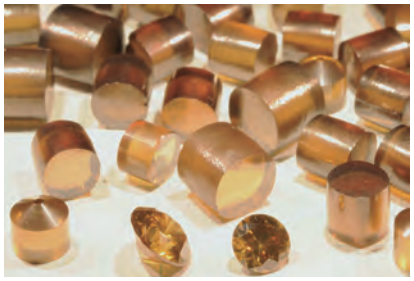
Dr. Masayuki Nishi, a JSPS Postdoctoral Fellow recently joined to the GRC, and his colleagues published their research in a recent issue of Geophysical Research Letters (GRL). They determined the ascending speed of diamonds from the mantle transition zone to the Earth's surface based on experimentally observed transformation kinetics of majoritic garnet found as inclusions in some natural diamonds. The speed was concluded to be unexpectedly fast compared with that of typical mantle convection. This paper has been introduced in New Scientist, a famous popular science magazine published in the UK (http://www.newscientist.com) and distributed world-wide, immediately after it was published in GRL. The article in this magazine is entitled "Diamonds travel at freeway speeds inside Earth".

JAMS award to Prof. T. Inoue

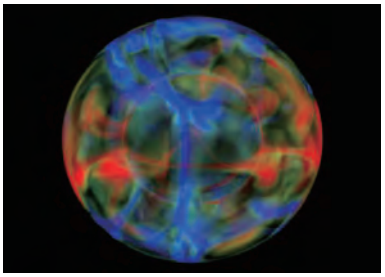
Professor Toru Inoue of the GRC received the JAMS award (the most prestigious award of the Japan Association of Mineralogical Society) during the annual meeting of the JAMS held in Matsue, Shimane Pref., on 23-25 September, for his outstanding research achievements in high-pressure mineralogical studies of water-bearing systems. Prof. Inoue is the only awardee among about 1000 members of the JAMS this year who plays an important role as the leader of the education programs of our Global COE. He received the certificate of the award and a supplementary prize of a tiepin made with a jadeite crystal, and gave an award lecture after the ceremony. The JAMS is a scientific society in mineralogy and petrology in Japan, which was established in 2008 by amalgamating two major Japanese societies in Earth sciences; The Mineralogical Society of Japan and the Japanese Society of Mineralogy, Petrology, and Economic Geology.

Mass production of HIME-DIA

After the completion of the world-largest Kawai-type multianvil apparatus (BOTCHAN-6000) in March 2009 at the SOSEKI Lab of the GRC, efforts have been made to standardize the procedures for synthesis of nano-polycrystalline diamond (NPD = HIME-DIA) rods. As a result, a large number of HIME-DIA rods with dimensions of 7-8 mm have been successfully synthesized by Dr. Toru Shinmei, the Lab manager, and Mr. Futoshi Isobe, a PhD student of the GRC, under the supervision of Prof. Tetsuo Irifune. Some of the flawless NPD rods, now with more than 50 pieces available, are processed with a pulse laser to form various shapes for their use as anvils for some high-pressure apparatus. Moreover, technical developments in producing even larger HIME-DIA rod have been made by Mr. Isobe, who has just succeeded in synthesizing rods with dimensions of 1 cm in both diameter and length.



Visualization Award to Prof. M. Kameyama



Masanori Kameyama, an associate professor of GRC, received the Visualization Award (Flash of the Year) from the Visualization Society of Japan (VSJ) on 20 July during its annual meeting at Kogakuin University for Visualization of mantle dynamics. This award was shared with Dr. Nobuaki Ohno of Japan Agency for Marine-Earth Science and Technology (JAMSTEC), and the related graphic animation based on this result was demonstrated on the website of the society as the “Flash of the month”. The VSJ started as the Society for Flow Visualization in about 30 years ago, and now advances researches in visualization in various research fields.

Setting-up a D-DIA at SPring-8

A D-DIA type guide block system, which has been tested in the MADONNA-1500 press at the GRC, has been installed at BL04B1 of SPring-8, replacing the existing DIA-type guide block of SPEED-MkII, by the GRC and Sumitomo Heavy Industries team lead by Drs. Yu Nishihara and N. Nishiyama. The guide block system is designed for deformation experiments at very high pressure, as well as for high P-T studies using sintered diamond anvils, and such studies under the lower mantle conditions are to be carried out by using this system combined with a synchrotron X-ray source.

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

Meeting with the MEXT minister

Dr. Jun Tsuchiya, a Senior Fellow at the Senior Research Fellow Center of Ehime University and who works closely with GRC members, had an opportunity to talk with the headquarters of the Ministry of Education, Culture, Sports, and Technology (MEXT) of Japan, including the minister, Mr. Tatsuo Kawabata, in the forum held in Takamatsu city of Kagawa prefecture on 29 August. Seven young researchers from the major universities in the western part of Japan gathered at the meeting, and Dr. Tsuchiya gave a talk on the current status of female researchers and related issues, representing young scientists from Ehime University. The results of the hearings by the ministry members should be reflected in the future planning of the science and technology policy of the Japanese government.

3rd YESA Workshop at GRC

The third workshop of the Young Earth Scientist Association (YESA) of the Global COE program was held in Matsuyama in 2-3 September, entitled "Properties of hydrogen and water in the Earth and planetary interiors". About 30 young scientists in experimental and theoretical mineral physics, including those from outside the GRC, such as Univ. Tokyo, Tohoku Univ., Osaka Univ., Okayama Univ., and Japan Atomic Energy Agency, etc. attended the workshop and had comprehensive discussion on the properties and roles of hydrogen-bearing systems in the Earth and planetary interiors, followed by a BBQ party in front of the SOSEKI Lab of the GRC. YESA (current leader; Dr. Shin-ichi Machida of global COE Postdoctoral Fellow) is organized by the young scientists at the GRC for mutual communications and interactions within the COE and with the young scientists of other institutions in Japan.

2nd COE Summer School

The second COE Summer School was held in a small village near the border between Ehime and Kochi prefectures during 2-4 August, focusing on the modeling of the structure and dynamics of the Earth's lower mantle and the core. About 10 participants with various backgrounds in theoretical and experimental studies, mostly from the GRC, gathered and had extensive discussions, while avoiding the hot summer in the city regions. Dr. Satoru Tanaka of IFREE, JAMSTEC, was invited as the special guest speaker, who gave a keynote talk on the structure and dynamic processes of the inner core.

Display at the Museum of Ehime University

The new University Museum was opened last November, where the GRC has a booth in the Deep Earth Section. This booth was recently renewed, and a brilliant cut HIME-DIA about 8 mm in diameter and the guide block system of the former ORANGE-1000 are being displayed to the public, as well as the activities of GRC and the Global COE program. The museum is divided into four zones: (1) Evolving Space and Earth, (2) History of Ehime University and Ehime province, (3) Variations of Life, and (4) Human Activities. The research outcomes and activities from the major research centers, including the GRC, Center for Marine and Environmental Sciences (CMES; another global COE hub in Ehime University), and the CSTRC (Cell-free Science and Technology Research Center; internationally famous for its very original protein synthesis technology) are also exhibited. The museum also has a Café and attracts many students, citizens, tourists, etc., and the number of visitors already exceeded 50,000 in the 9 months after opening.

Activities during 2010 JpGU meeting

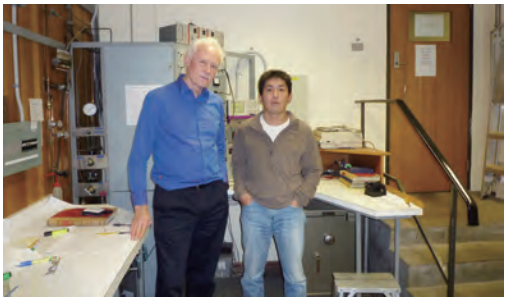
At the Japan Geoscience Union (JpGU) Meeting 2010 in Makuhari during the period of 23-28 May, two sessions were organized by the members of the present Global COE program. The first was an international session entitled "Mineral physics and dynamics of deep mantle", which was convened by Dr. M. Kameyama, Assoc. Prof. of GRC, together with Dr. Takashi Yoshino at ISEI of Okayama Univ. and Dr. Dapeng Zhao of Tohoku Univ. In this session, twenty-nine (22 for oral and 7 for poster) papers from various disciplines on mineral physics and geodynamics of the planetary interiors were presented by researchers from many countries. Intensive discussions were made by more than one hundred attendees, focusing on (1) thermal/chemical structure, (2) behaviors of fluids and/or hydrous minerals, and (3) rheology of the deep mantle.

The second session was entitled "Interpretations of seismic observations in subduction zones", convened by Drs. Yoshio Kono and Yusuke Usui, the members of the Young Earth Scientist Association (YESA) of the GRC. The session aimed at an interdisciplinary discussion on the interpretations of seismological observations from the viewpoint of several research fields, such as geological, experimental, and simulation studies, with particular emphasis on the understanding of the nature and dynamics of subduction zones. In this session, eighteen (3 for invited and 15 for contributed) papers were presented by students and researchers from various universities/institutes in Japan.

During the meeting, an exhibition booth was run by GRC members to advertise the activities of the GRC and global COE. At the booth, hot research products by the GRC were also displayed, including the nano-polycrystalline diamond (HIME-DIA) and facilities installed at the GRC. The materials displayed in the booth successfully attracted many participants/visitors, in spite of the absence of "Botchan" or "Madonna", the main characters of a Japanese novel written by Soseki Natsume, as were performed in the previous year.

Overseas internship at RSES, ANU

Dr. Yoshio Kono, a COE Research Fellow, left GRC in late September for Australia for collaboration with Prof. Ian Jackson at the Research School of Earth Sciences, Australian National University. Dr. Kono is planning to work on elastic and inelastic properties of partially molten rocks at high pressure, as one of the Long-term Overseas Internships of the Global COE program and will stay in Canberra for about three months. The GRC holds a mutual agreement on the exchange of researchers/students and collaborations with RSES, and Prof. Jackson is appointed as the guest professor of the GRC during the period of the COE program.



Invited talks at international symposia

Prof. Taku Tsuchiya gave an invited talk on the thermal structures and chemical compositions in the mantle-core boundary region based on ab initio calculations during the 12th SEDI symposium (SEDI2010) held at UC Santa Barbara during 18-23 July. He also gave a seminar at Prof. Bruce Buffett's Lab at UC Berkeley after this symposium. Meanwhile, Prof. Tsuchiya and one of his colleagues gave invited talks at the Western Pacific Geophysics Meeting (WPGM) held in Taipei on 22-25 June. These facts indicate that Prof. Tsuchiya's group at the GRC is now truely one of the leading teams in theoretical mineral physics in the world.

International Frontier Seminar

19th (31st May)
"**Melting of peridotite to 140 GPa**"
Lecturer : **Prof. Guillaume Fiquet**
Institute de Minéralogie et de Physique des Milieux Condensés, UMR CNRS 7590, Université Pierre et Marie Curie Paris 6)

Career Advancement Lecture Series

1st (5th March)
"How to write scientific papers for high IF journals"
Lecturer: **Prof. Tetsuo Irifune** (Geodynamics Research Center, Ehime University)

2nd (16th April)
"Common Mistakes in English for a Non-Native Speaker (Don't Worry, We Make Them, Too)"
Lecturer: **Ms. Sabrina ARA Whitaker** (Geodynamics Research Center, Ehime University)

3rd (12th May)
"Researches in companies and required abilities"
Lecturer: **Dr. Hitoshi Sumiya** (Advanced Materials R&D Laboratories, Sumitomo Electric Industries, Ltd.)

4th (26th July)
"Making proteins"
Lecturer: **Prof. Yaeta Endo** (Cell-Free Science and Technology Research Center, Ehime University)

COLUMN: Chinese Festival at Ehime University

An out-door party was held at the Museum of Ehime University organized by Chinese and Japanese students/residents in Matsuyama to celebrate the founding of the new country of China on 3rd October and also to enhance mutual communications and friendship among the people in the two countries. The GRC now has 5 Chinese PhD students and 2 postdoctoral fellows, who contributed to the performance of Chinese traditional dance and preparing Chinese foods for the participants, including some staff members of the GRC. We happen to have a Japanese traditional festival for harvest in the Matsuyama region in early October where a number of portable shrines or "Mikoshi" of individual towns are carried on people's shoulders and march in every street. Matsuyama is known for the violent bumping ceremony of such Mikoshis', occasionally causing some serious injuries and even deaths of the participants. Meanwhile, Japan and China have some common traditional festivals. The Moon Festival in September is one of them, and people in both countries share the same idea of appreciating the beautiful full moon in Autumn while eating traditional sweets of rounded shapes that model the moon with family members. We do hope to maintain and develop our mutual understanding and collaboration between the two countries with similar and common traditions.

Forthcoming Events

Workshop "Hydrogen Quantum Atomics"

Date: 27- 28 October, 2010, Venue: Ehime University

The 8th Workshop of the Hydrogen Quantum Atomics will be held in Matsuyama on the 27th and 28th of October, partially supported by the Global COE program. This workshop is organized by Dr. Jun Tsuchiya of the Senior Research Fellow Center, and various aspects of the behavior of hydrogen will be discussed by the researchers with experimental and theoretical backgrounds. This workshop is annually held by the members of a Japanese research group with various backgrounds who are working on the phenomena relevant to hydrogen (Representative persons: Prof. Shinji Tsuneyuki, Univ. Tokyo; Prof. Yu Fukai, Chuo Univ., and Prof. Susumu Ikeda, KEK). For further details:

(http://white.phys.s.u-tokyo.ac.jp/hydrogen/index.htm).

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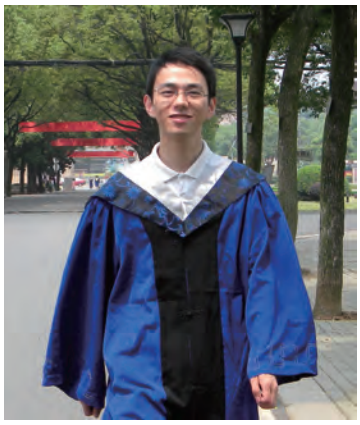
2nd TANDEM symposium at CUG in Wuhan

The second TANDEM symposium will be held at China University of Geoscience in Wuhan during the period of 5-7 November, partly supported by the Global COE program. About 40 researchers/students are expected to attend the symposium from Japan, including 30 people from the GRC, where they will discuss the current status of the TANDEM activities and on-going researches in individual research groups. Profs. T. Irifune (GRC), Y. Wang (GSECARS, Chicago Univ.), Y. Fei (GL, Carnegie Inst.) will give keynote talks, and about 70 oral/poster presentations will be given by the participants from China, Japan, Taiwan, Korea, USA, and Germany. The best presentation will be selected from those by the young scientists and awarded during the symposium. The first TANDEM meeting was held in Matsuyama in 2008 to enhance mutual understandings and communications among the leading institutes in Deep Earth mineralogy and related fields in the Asian region. For further details:

(http://deep-earth-mineralogy.jp/tandem/index.html).

New Members

Zhou Chunyin (PhD Student)



I joined the GRC after I received my Master's degree from China University of Geosciences (CUG) in Wuhan, China. In my Master's research, I worked on the phase relations in a composition of $(Mg_{0.93}Fe_{0.07})SiO_3$ by using a 2000-ton press of the GRC. We found that the stabilities of minerals are affected greatly by the component of iron. By calculating the seismic velocities, we suggested some new explanation for the cause of the high velocity anomaly in the deep subduction zone in the mantle transition region. Now my research interests focus on the phase transformations in those minerals and rocks in the mantle. I would like to learn more about the ultra-high pressure techniques by training programs here. My continuing work is to study the phase relations in the minerals of the mantle using the multi-anvil press. I hope to carry out in-situ X-ray diffraction experiments with synchrotron radiation in the future and that would advance my knowledge of mineral physics and geodynamics in the mantle.

Yang Cuiping (PhD Student)

I have been here several times, so I am not a new character to the GRC exactly. However, my doctor course is just beginning this October.

I received my master's degree at the end of this June from China University of Geosciences (CUG) (Wuhan), under the direction of Prof. Inoue in GRC and Prof. Jin in CUG. The topic of my thesis is "Equation of state of antigorite under high pressure and high temperature determined by in-situ X-ray diffraction", and the experiments were done in PF, Tsukuba, Japan, when I was here as an internship student between Sep. 14th, 2009 to Feb. 1st, 2010. Before that, I did some work on the water content and micro fabric of mantle xenoliths, such as peridotite, using Electron backscatter diffraction (EBSD) and FTIR.

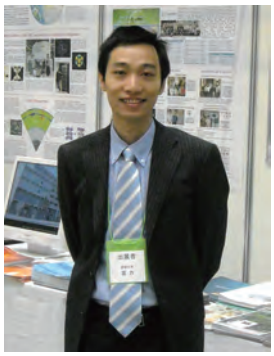
As for my PhD course at the GRC, my research interest focuses on the hydrous phase in the deep mantle, under the direction of Inoue-sensei, and I want to learn how to use the high pressure apparatus at the GRC.

Qin Jiaqian (JSPS Postdoctoral Fellow)

My name is Jiaqian Qin and I started working at the GRC in July 2010 as a JSPS postdoctoral fellow. I received my Ph.D from Sichuan University in June 2010. My doctoral dissertation research focused on the phase stability of materials under high pressure and high temperature, and high pressure synthesis of novel materials. During my Ph.D, I investigated the phase stability of MAX phases under high pressure and high temperature, and first reported the phase segregation of Ti_2AlC at high pressure and high temperature. In addition, I also synthesized the nearly full-densified phase-pure ReB_2, WB, WB_2, and WB_4 compacts under high pressure and high temperature, and first measured the asymptotic-hardness region and elastic properties of bulk samples, and suggested that the ReB_2 is only a hard material but not a superhard one. Then I calculated the elastic modulus, Debye temperature and hardness of WB, WB_2, ReB_2, and WB_4 using first-principle calculations. My current research interest is high pressure synthesis of novel materials. During my stay at the GRC, I would like to design and synthesize some novel Boron-rich transition metal borides and Si-C-N compounds under high pressure and high temperature. This project will be performed by using the multianvil press and supercomputers at the GRC and synchrotron radiation at SPring-8.

Discovery of True Path of Wurtzite under High Pressure

Li Lei
(COE Postdoctoral Fellow)



The transformation of the hexagonal wurtzite-type structure (B4) to the cubic rocksalt-type structure (B1) is a significant transition pathway in A^NB^{8-N} binary semiconductors. Because of the need to understand the microscopic mechanism for this structural transformation and the wide range of technological applications of A^NB^{8-N} binary semiconductors, the general B4-B1 pathway, which itself cannot be observed directly, has stimulated many studies for the last few decades. So far, at least four possible paths have been proposed, among which two pathways involving different intermediate phases have been attracting much more attention. One of these pathways is the transition path through an "*h*-MgO-type" intermediate phase, in which the ratio of the *c* axis to the *a* axis in the primitive cell first decreases from c/a = 1.63 (wurtzite) to c/a = 1.2 (*h*-MgO), and then increases to $c/a = \sqrt{2}$ (rocksalt). The other is the path via a "tetragonal-type" intermediate phase, in which the value of c/a first increases to c/a = 1.74 (tetragonal), and then decreases to $c/a = \sqrt{2}$ (rocksalt).

In our recent work, the stoichiometric mixed-metal oxide $LiGaO_2$, has been used as the ternary wurtzite-type model to elucidate the mechanistic details of the B4-B1 pressure-induced transitions in pure and deficient wurtzite-type semiconductors. Different from the binary wurtzites, as shown in Fig. 1, there exist two different cation relaxations in $LiGaO_2$, the layer-rocksalt-type (*R*-3*m*) and the newly-discovered disordered-rocksalt-type (*Fm*-3*m*) phases, which are different products of the B4-B1 transition from ternary wurtzite-type ($Pna2_1$), and another newly-discovered metastable tetragonal *I*4/*m* structure $LiGaO_2$ with c/a = 1.46 (slightly larger than $\sqrt{2}$) is found to be the intermediate phase between the ternary wurtzite-type ($Pna2_1$) and the rocksalt-type phases (*R*-3*m* and *Fm*-3*m*). The B4- to B1-type path in binary wurtzite is generally not observed, but in the case of ternary wurtzite $LiGaO_2$, the direct experimental observation of the tetragonal-type primitive cell structure with c/a = 1.46 after static compression of the wurtzite-type structure is undoubtedly strong evidence for the "tetragonal-type" transformation pathway scheme, in which the "tetragonal-type" structure should be an intermediate step on the way from the B4- to B1-type structure in wurtzite-type semiconductors.

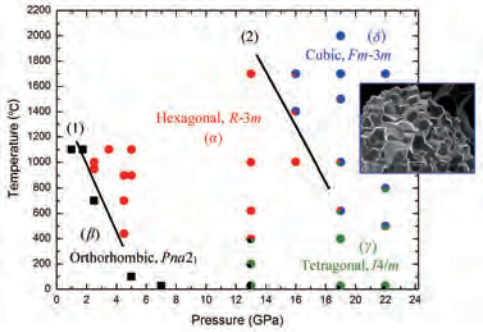


Fig. 1. The P-T phase relations of $LiGaO_2$. The symbols indicate the conditions for the following key observations: black circles for the pure orthorhombic β-$LiGaO_2$, red circles for the pure hexagonal α-$LiGaO_2$, green circles for the pure γ-$LiGaO_2$, and blue circles for the pure cubic δ-$LiGaO_2$. Two or more colors on one circle stand for the mixed phases. The colorized area in the circle indicates the estimated content of the single phase in the high-pressure recovered sample by means of comparison of the strongest powder X-ray diffraction lines. Line 1 is the boundary between the stable regions of orthorhombic β-$LiGaO_2$ and hexagonal α-$LiGaO_2$, and line 2 is the boundary between the stable regions of hexagonal α-$LiGaO_2$ and cubic δ-$LiGaO_2$. The inset is the typical SEM image of newly discovered cubic δ-$LiGaO_2$.

Theoretical investigation of the thermodynamic properties of $(Mg,Fe^{2+})SiO_3$ post-perovskite

Arnaud Metsue
(COE Postdoctoral Fellow)

$(Mg,Fe)SiO_3$ post-perovskite is thought to be the most abundant phase in the D" layer. Mineral physical studies on this phase are important in investigating the structure and dynamics of the Earth's deep mantle. However, experimental investigations of the thermodynamic properties of the post-perovskite phase remain difficult, due to its high pressure and high temperature ranges of stability.

In this work, we have investigated the thermodynamic properties of $(Mg_{0.9375}Fe_{0.0625})SiO_3$ post-perovskite theoretically. We conducted density functional theory (DFT) calculations within the LDA+*U* framework since the conventional DFT do not accurately reproduce the interactions between the *3d* orbitals of iron. We introduce ferrous iron, which can be present in the high or low spin state, as a substitution defect in a pure $MgSiO_3$ post-perovskite supercell.

The thermodynamic properties are derived from the Helmholtz free energy in the quasi-harmonic approximation. The vibrational contribution to the Helmholtz free energy is obtained from the phonon frequencies spectra. Here, we developed a new technique combining a direct determination of the phonon dispersion curves and an internally consistent LDA+*U* method, where the Hubbard *U* parameter was optimized for each volume and spin state.

We have determined the pressure-volume equations of state, the isothermal bulk modulus B_T, the thermal expansion coefficient α, the heat capacities C_V and C_P and the vibrational contribution to the entropy S_{vib} up to 150 GPa and 4000 K. The data are compared to those reported for pure $MgSiO_3$ post-perovskite. The results in Fig. 1 show that a low concentration of iron, irrespective of the spin state, has minor effects on the equations of state of the post-perovskite phase, especially at the pressure-temperature conditions of the D" layer. α and B_T increase slightly with the incorporation of iron while S_{vib}, C_V and C_P are not clearly affected.

This work is the first attempt to take into account complex chemical compositions in the theoretical determination of the thermodynamic properties of minerals. The effects of ferric iron or other impurities, such as aluminum, are directions for further studies for a complete understanding of the physical properties of the post-perovskite phase.

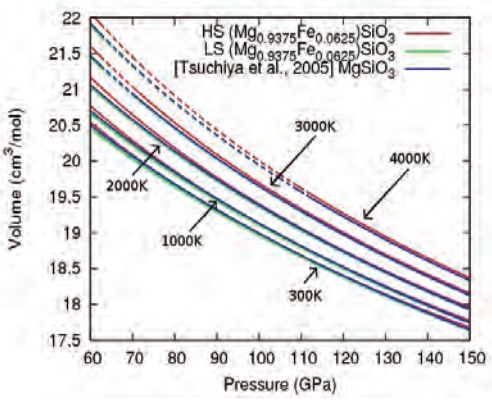


Fig. 1. Pressure-volume relations for high spin/low spin $(Mg_{0.9375}Fe_{0.0625})SiO_3$ and pure $MgSiO_3$ [Tsuchiya et al., 2005, J. Geophys. Res.] post-perovskite at 300, 1000, 2000, 3000 and 4000 K up to 150 GPa. The dashed lines represent the pressure-temperature range where the validity of the QHA is questionable.

News & Events

2nd TANDEM symposium at CUG (Wuhan), China

Date: 5-7, Novemver, 2010
Venue: China University of Geosciences (Wuhan), China
Tentative schedule:

5th (Friday)	
08:30-17:30	Oral sessions
6th (Saturday)	
08:30-12:00	Oral sessions
14:00-17:00	Poster sessions & Laboratory tour
(16:00-17:00	Meeting of TANDEM representatives)
18:00-	Banquet
7th (Sunday)	
09:00-17:00	Excursion

The detailed schedule and abstracts will be informed via the mailing list of TANDEM members and in the web site below: (http://deep-earth-mineralogy.jp/tandem/index.html)

A special volume for Prof. Zenmin Jin

The contributions to a special volume of Journal of Earth Sciences were called on the occasion of the upcoming birthday anniversary of one of the outstanding scientists in field of mantle rheology and rocks deformation, Prof. Zhenmin Jin of China University of Geosciences in Wuhan, to celebrate his scientific life achievements. The volume consists of series of papers that highlight versatility of Prof. Jin's scientific interests emphasizing his life-long fascination with rheology and rock deformation, and edited by Profs. L. Dobrzhinetskaya, J. Zhang, H.W. Green, and T. Irifune. The papers are written by his colleagues, collaborators, former and current students, as well as some of the contributors to the 2nd TANDEM meeting to be held in Wuhan in 5-7 November. Prof. Jin plays important roles in the enhancement of scientific collaborations and exchange of researchers/students among the high-pressure mineral physics and rock chemistry laboratories in Asian regions, as the representative of the Chinese community of the TANDEM.

PhD students to Special course of GRC from CUG

Two students, Mr. Chunyin Zhou and Ms. Cuiping Yang, from China University of Geosciences (CUG), Wuhan, have started on their PhD studies in Special PhD course in deep Earth mineralogy at the GRC (See Page 4 for their self-introductions). The special course of the GRC was established last year to foster PhD students from Asian countries for world-leading scientists/technicians in scientific fields relevant to deep Earth mineralogy. They follow two students enrolled in the course last autumn from Sichuan University, China. At present, 7 young scientists from China, 5 PhD students and 2 PD Fellow, join the GRC, which indicates steadily conduct of TANDEM agenda aiming for the exchange of young scientists in Asian countries.

Last year, the GRC offered the opportunity of several months' internship at the GRC for Mr. Zhou and Ms. Yang (master course students from the CUG at that time). They experienced practical experiments with the advanced facilities in the GRC and SPring-8 for studies of the deep Earth mineralogy. The internship opportunity is provided for master course students, who are strongly interested in enrollment in the special PhD course, as preparatory experiences of research activities at the GRC and living in Japan.

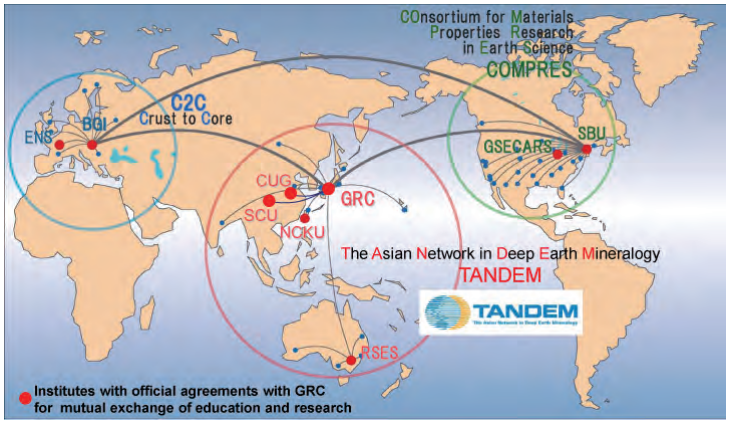
Call for Special PhD course and internships at GRC

Special PhD course in deep Earth mineralogy at the GRC, Ehime University, is open for students from Asian countries with financial supports from the University. The course offers educational programs for advanced experimental, theoretical and computational studies on Earth's deep structure and related sciences and technologies. The exam and enrollment for FY2011 will be May and September, 2011, respectively. In addition, the GRC offer the internship experience before the special course examination for some selected strong candidates. GRC will support the travel fee and living cost during their visit.

The detailed information on the Special PhD course and the internship opportunities at the GRC will be indicated at the forthcoming TANDEM symposium at Wuhan by a poster presented by Dr. Akira Yamada. On the application of the Special PhD course for FY2010, see

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)



Department of Earth Sciences, National Cheng Kung University

Cheng Kung University was reorganized in 1965 from a pre-existed body established as Tainan Technical College in 1931, located in Tainan. The Department of Earth Sciences was established in 1968 and now has 14 full-time faculty members. Research fields include geochemistry, marine chemistry and physics, mineralogy, petrology, paleontology, oceanography, hydrogeology, geophysics and structural geology, lately added space physics and nano-technology. Major analytical facilities of the department include laser-ablation ICP-MS, TIMS, XRD, SEM and TEM.

Dr. Jennifer Kung of the Department of Earth Sciences is representative person of TANDEM at Cheng Kung University and is interested in the chemical and physical properties of earth materials and related materials. High pressure research program has been seeded in this department in early 1990's. The high pressure experiments have been carried out using diamond anvil cells to study phase transition, equation of state and lattice dynamics of Earth materials or related materials in conjunction with X-ray diffraction or/and Raman spectroscopy. Kung continues leading the diamond anvil cell program in the department after taking the faculty position in 2005. The studied materials included the perovskite-structured and NaCl-structured materials and pyroxenes.

In the October of 2009, a large-volume multi-anvil press was installed in the Department of Earth Sciences for studying Earth materials at high pressure conditions. The apparatus is equipped with a 1000-ton hydraulic press and a double-sided rail system to accommodate two sets of multianvil modules which can be interchanged on a run-to-run basis. The current installed device is a 250-ton DIA-type module. With built-in hydraulic actuators, called differential rams, it is possible to control displacements of the upper and lower anvils independently. In this case, the press can provide either a quasi-hydrostatic pressure environment or a differential stress field on the sample to be studied. A Walker module is planned to be installed in the future to extend the experimental pressure range to the top of the lower mantle (25 GPa, 2500 K). This large-volume press is the first multi-purpose high pressure apparatus installed in Taiwan, i.e. synthesis and in-situ measurements. The research interests within the groups of geochemistry, mineralogy and petrology can be extended to the experimental conditions up to high pressure and temperature regime. Interfaced with the other experimental modules, we expect to perform the in-situ measurements on the materials interested. Moreover, when differential load is applied under desired experimental conditions, the D-DIA enables us to conduct rheology studies for upper mantle minerals. The cell assembly testing and pressure calibration for the press are under way collaborating with Drs. Kurt Lienenweber of Arizona State University and Yanbin Wang of University of Chicago, primarily.

Contrast to the materials in the Earth's interior, the presence of micropores within the crustal rock has significant influence on its elastic anisotropy and transport properties. Studying the physical properties of crustal rock is another developing research program within the group. A 400 MPa pressure vessel was installed and has incorporated instrumentation to measure the elastic wave velocities (P and S wave) under controlled pore fluid pressure. To understand the elastic anisotropic behavior in rocks, the study of pore fabric is carried out in parallel. Our current investigated material is the permeable reservoir sandstones.

The group members at NCKU in 2010 include two senior Ph. D students who study lattice dynamics of materials at high pressure and high temperature, two first-year MS students who are interesting in experimental petrology and rock physics, few undergraduate students who are working along graduate students with various research subjects, and a project research assistant. NCKU team is a fairly young group compared with the well-established laboratories within TANDEM network and is at the stage of in-house instrumentation setting up and development. We expect the major development and setting up of the laboratory completing sometime in 2011. In parallel, the utilizing synchrotron facility to study the physical and chemical properties of materials at high pressure and temperature is another research direction for NCKU team. At the same time, NCKU team is looking forward to collaborating with TANDEM network teams.

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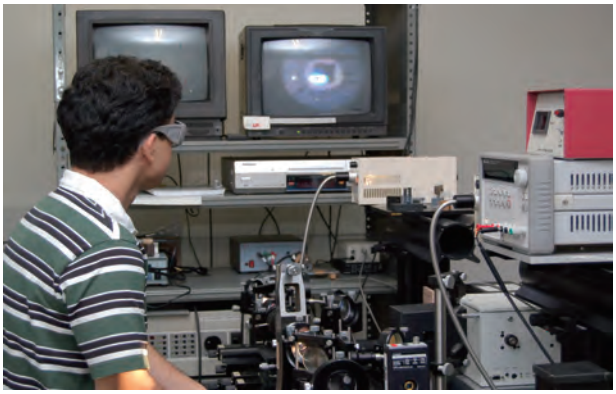
1000 ton press frame with 250 ton D-DIA module and pressure and temperature controlling system.

The Insutitute for Solid State Physics (ISSP), The University of Tokyo

At the farewell party of students in the group in March, with some guests

High-pressure groups in ISSP, the University of Tokyo, were founded in 1961 by Professors S. Akimoto and S. Minomura. Since then, they have been playing an important role as one of the leading high-pressure laboratories in Japan. Current high pressure and temperature group led by T. Yagi has started in 1986 and it is the only laboratory in ISSP where the graduate students from geophysics major are learning. It is one of the laboratories in the New Materials Science Division of ISSP and various studies, not only in the field of Earth and planetary science but also in the field of materials science, are carried out. The number of in-house scientific member now is only three staffs, one post doc and two graduate students, but ISSP has various programs to invite outside scientists. As a result many outside scientists, not only from inside Japan but also from various countries, are staying with us and carrying out the collaboration researches.

Our laboratory is one of a very few laboratories in the world where both large-volume presses and diamond anvils are working. We have made many efforts since 1970's to extend the pressure and temperature ranges of in situ X-ray diffraction study using both multi-anvil apparatus and diamond-anvil apparatus. Using DIA-type cubic-anvil apparatus combined with laboratory X-ray source, experimental techniques up to 100 kbar and 1400 K was developed at late 1970's which was further developed as MAX-80 apparatus by combining with a synchrotron radiation at the Photon Factory in Tsukuba in 1980's. Using diamond anvil, we have started the high-pressure in situ X-ray diffraction above 1 Mbar from 1980's. Development of the techniques to use sintered diamond as anvil material was also performed intensively in 1980's and we have succeeded, for the first time, to make in situ X-ray observations of silicate perovskite under the lower mantle conditions. Further extension of the pressure range above mega bar at elevated temperature was achieved by developing a new laser-heated diamond anvil system at the Photon Factory in 1990's. This system was copied at SPring-8, further developed and finally resulted in the finding of "the post-perovskite phase", in 2004 by Murakami et al.



Laser-heating diamond-anvil laboratory

Using these experimental techniques, various studies to clarify the structure and property of materials relevant to the Earth's deep interior, such as silicate spinels, silicate perovskites, a new high-pressure form of silica, and post-perovskites, together with iron, have been carried out. Other than these subjects in Earth science, many studies from a view point of materials science, such as graphite-diamond transition and super-hard materials, have been also carried out. Synthesis of new materials under extreme condition is also an import field in our group. The list of the works is available at our web site (http://yagi.issp.u-tokyo.ac.jp/).

Current major facilities are three large-volume presses which cover from 3 GPa to 30 GPa for material synthesis. Diamond anvil laboratory has three different types of laser (YAG, fiber, and CO_2), and we can heat a variety of samples to several thousand degrees under pressure up to about 2 Mbar. High-pressure in situ X-ray system using rotating anode Mo radiation and Raman spectroscopy system for high-pressure in situ measurements are also working. We are also working hard to construct a new beam line for high pressure and temperature neutron measurements at J-PARC, Tokai. The detail of this high-pressure neutron project is available in the following web site:
http://yagi.issp.u-tokyo.ac.jp/shingakujutsu/en/index.html.

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Large-volume press laboratory with 700 ton Kawai-type apparatus (left) and 500 ton DIA-type apparatus (right)

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