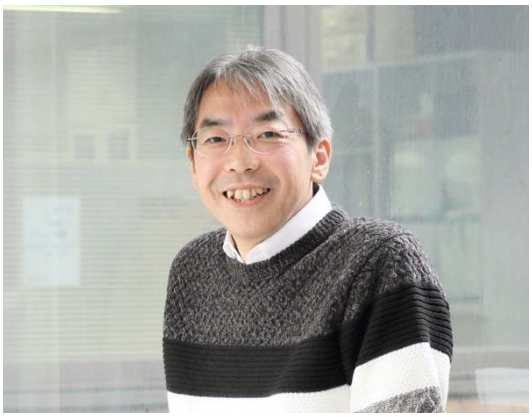
Kei Hirose



Present position and address:

Director & Professor
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The University of Tokyo
7-3-1 Hongo, Bunkyo, Tokyo 152-8550, Japan
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Education:

B.S. (Geology) The University of Tokyo, 1990
M.S. (Geology) The University of Tokyo, 1992
Ph.D. (Geology) The University of Tokyo, 1994
Title: Partial Melting of the Earth's Upper Mantle and the Genesis of Basaltic Magmas
Adviser: Professor I. Kushiro

Appointments:

1994	Post-doctoral fellow at the Geological Institute, The University of Tokyo
1994-1999	Assistant Professor, Department of Earth and Planetary Sciences, Tokyo Institute of Technology
1996-1998	Visiting Researcher of the Geophysical Laboratory, Carnegie Institution of Washington
1999-2005	Associate Professor, Department of Earth and Planetary Sciences, Tokyo Institute of Technology
2006-2012	Professor, Department of Earth and Planetary Sciences, Tokyo Institute of Technology
2012-present	Director & Professor, Earth-Life Science Institute, Tokyo Institute of Technology
2017-present	Professor, Department of Earth and Planetary Science The University of Tokyo

Other Appointments and Affiliations:

2003-present	Visiting Scientist of Japan Synchrotron Research Institute/SPring-8
2004-2016	Senior Visiting Staff Scientist, Japan Agency for Marine-Earth Science and Technology (JAMSTEC)
2009-2012	Member of Advisory Board of *Earth and Planetary Science Letters*
2009-2015	Member of the Board of Reviewing Editors of *Science*
2010-present	Editor of *Physics of the Earth and Planetary Interiors*

Ph.D. Student supervision

Naoto Takafuji (graduated 2003)
Motohiko Murakami (graduated 2004)
Tetsuya Komabayashi (graduated 2005)
Yasuhiro Kuwayama (graduated 2007)
Shigehiko Tateno (graduated 2007)
Ryosuke Sinmyo (graduated 2010)
Kenji Ohta (graduated 2010)
Emiko Sugimura (graduated 2011)
Haruka Ozawa (graduated 2012)
Hitoshi Gomi (graduated 2014)
Ryuichi Nomura (graduated 2014)
Yuki Kudo (graduated 2015)
Saori Imada (graduated 2015)
Shoh Tagawa (will graduate in 2020)

Awards and honors:

"2005 Commendation by the Minister of MEXT, Japan, The Young Scientists' Prize"
For contribution in the study of Earth's deep interior
"2007 **Inoue Prize for Science**"
For contribution in the discovery of post-perovskite
"2007 Thomson Scientific Research Front Award"
For contribution in the discovery of post-perovskite and the study of core-mantle boundary region
"2007 **Japan IBM Science Prize**"
For contribution in the discovery of post-perovskite and the study of core-mantle boundary region
"2009 **Japan Society for the Promotion of Science (JSPS) Award**"
For contribution in the experimental studies of Earth and planetary materials at ultra-high pressure and temperature
"2009 **Fellow of American Geophysical Union (AGU)**"
"2011 **Science Innovation Award – Ringwood Medal** (European Association of Geochemistry)"
For contribution in the discovery of post-perovskite and relevant studies
"2011 **Japan Academy Prize**"
For contribution in the discovery of post-perovskite and relevant studies
"2014 **Geochemical Fellow** (European Association of Geochemistry and Geochemical Society)"
"2016 **Fujihara Award**"
For contribution in the study of deep Earth materials and dynamics
"2017 Fellow of Japan Geoscience Union (JpGU)"

Publications:

Kei Hirose is author or co-author of 189 publications in refereed journals and books. For journal publications: http://www.researcherid.com/rid/C-2165-2009

Selected publications:

1. Hirose, K., Kushiro, I., Partial melting of dry peridotites at high pressures; determination of compositions of melts segregated from peridotite using aggregates of diamond, ***Earth and Planetary Science Letters***, 114, 477-489, 1993.

2. Hirose, K., Kawamoto, T., Hydrous partial melting of lherzolite at 1GPa: the effect of H_2O on the genesis of basaltic magmas, ***Earth and Planetary Science Letters***, 133, 463-473, 1995.
3. Hirose, K., Melting experiments on lherzolite KLB-1 under hydrous conditions and generation of high-magnesian andesitic melts, ***Geology***, 25, 42-44, 1997.
4. Hirose, K., Fei, Y., Ma, Y., Mao, H., The fate of subducted basaltic crust in the Earth's lower mantle, ***Nature***, 397, 53-56, 1999.
5. Hirose, K., Fei, Y., Ono, S., Yagi, T., Funakoshi, K., In situ measurements of the phase transition boundary in $Mg_3Al_2Si_3O_{12}$: implicationts for the nature of the seismic discontinuities in the Earth's mantle, ***Earth and Planetary Science Letters***, 184, 567-573, 2001.
6. Murakami, M., Hirose, K., Yurimoto, H., Nakashima, S., Takafuji, N., Water in Earth's lower mantle, ***Science***, 295, 1885-1887, 2002.
7. Hirose, K., Phase transitions in pyrolitic mantle around 670-km depth: implications for upwelling of plumes from the lower mantle, ***Journal of Geophysical Research***, 107, 10.1029/2001JB000597, 2002.
8. Isshiki, M., Irifune, T., Hirose, K., Ono, S., Ohishi, Y., Watanuki, T., Nishibori, E., Sakata, M., Stability of magnesite and its new high-pressure form in the lower mantle, ***Nature***, 427, 60-62, 2004.
9. Murakami, M., Hirose, K., Kawamura, K., Sata, N., Ohishi, Y., Post-perovskite phase transition in $MgSiO_3$, ***Science***, 304, 855-858, 2004.
10. Hirose, K., Shimizu, N., van Westrenen, W., Fei, Y., Trace element partitioning in Earth's lower mantle and implications for the geochemical consequences of partial melting at the core-mantle boundary, ***Physics of the Earth and Planetary Interiors***, 146, 249-260, 2004.
11. Iitaka, T., Hirose, K., Kawamura, K., Murakami, M., The elasticity of $MgSiO_3$ post-perovskite phase at the Earth's lowermost mantle, ***Nature***, 430, 442-445, 2004.
12. Takafuji, N., Hirose, K., Mitome, M., Bando, Y., Solubilities of O and Si in liquid iron in equilibrium with $(Mg,Fe)SiO_3$ perovskite and the light elements in the core, ***Geophysical Research Letters***, 32, L06313, doi:10.1029/2005GL022773, 2005.
13. Hirose, K., Takafuji, N., Sata, N., Ohishi, Y., Phase transition and density of subducted MORB crust in the lower mantle, ***Earth and Planetary Science Letters***, 237, 239-251, 2005.
14. Kuwayama, Y., Hirose, K., Sata, N., Ohishi, Y., The pyrite-type high-pressure form of silica, ***Science***, 309, 923-925, 2005.
15. Hirose, K., Postperovskite phase transition and its geophysical implications, ***Reviews of Geophysics***, 44, RG3001, doi:101029/2005RG000186, 2006.
16. Ohta, K., Hirose, K., Lay, T., Sata, N., Ohishi, Y., Phase transitions in pyrolite and MORB at lowermost mantle conditions: implications for a MORB-rich pile above the core-mantle boundary, ***Earth and Planetary Science Letters***, 267, 107-117, 2008.
17. Ohta, K., Onoda, S., Hirose, K., Sinmyo, R., Shimizu, K., Sata, N., Ohishi, Y., Yasuhara, A., The electrical conductivity of post-perovskite in Earth's D" layer, ***Science***, 320, 89-91, 2008.
18. Ozawa, H., Hirose, K., Mitome, M., Bando, Y., Sata, N., Ohishi, Y., Experimental study of reaction between perovskite and molten iron to 146 GPa and implications for chemical equilibrium at the core-mantle boundary, ***Physics and Chemistry of Minerals***, 36, 355-363, 2009.
19. Tateno, S., Hirose, K., Ohishi, Y., Tatsumi, Y., The structure of iron in Earth's inner core, ***Science***, 330, 359-361, 2010.
20. Nomura, R., Ozawa, H., Tateno, S., Hirose, K., Hernlund, J., Muto, S., Ishii, H., Hiraoka, N., Spin crossover and iron-rich silicate melt in the Earth's deep mantle, ***Nature***, 473, 199-202, doi:10.1038/nature09940, 2011.
21. Ozawa, H., Takahashi, F., Hirose, K., Ohishi, Y., Hirao, N., Phase transition in FeO and stratification in Earth's outer core, ***Science***, 334, 792-794, 2011.
22. Murakami, M., Ohishi, Y., Hirao, N., Hirose, K., A perovskititic lower mantle inferred from high pressure and temperature sound velocity data, ***Nature***, 485, 90-94, doi:10.1038/nature11004, 2012.
23. Ohta, K., Yagi, T., Taketoshi, N., Hirose, K., Komabayashi, T., Baba, T., Ohishi, Y., Hernlund, J., Lattice thermal conductivity of $MgSiO_3$ perovskite and post-perovskite at the core-mantle boundary, ***Earth and Planetary Science Letters***, 349/350, 109-115, http://dx.doi.org/10.1016/j.epsl.2012.06.043, 2012.

24. Gomi, H., Ohta, K., Hirose, K., Labrosse, S., Hernlund, J., The high conductivity of iron and thermal evolution of Earth's core, ***Physics of the Earth and Planetary Interiors***, 224, 88-103, doi:10.1016/j.pepi.2013.07.010, 2013.

25. Nomura, R., Hirose, K., Uesugi, K., Ohishi, Y., Tsuchiyama, A., Miyake, A., Low core-mantle boundary temperature inferred from the solidus of pyrolite, ***Science***, 343, 522-525, DOI: 10.1126/science.1248186, 2014.

26. Tateno, S., Hirose, K., Ohishi, Y., Melting experiments on peridotite to lowermost mantle conditions, ***Journal of Geophysical Research***, Solid Earth, 119, 4684–4694, doi:10.1002/2013JB010616, 2014.

27. Nakajima, Y., Imada, S., Hirose, K., Komabayashi, T., Ozawa, H., Tateno, S., Tsutsui, S., Kuwayama, Y., Baron, A. Q. R., Carbon depleted outer core revealed by sound velocity measurements of liquid Fe-C alloy, ***Nature Communications***, 6:8942 doi: 10.1038/ncomms9942, 2015.

28. Ohta, K., Kuwayama, Y., Hirose, K., Shimizu, K., Ohishi, Y., Experimental determination of the electrical resistivity of iron at Earth's core conditions, ***Nature***, 534, 95-98, doi:10.1038/nature17957, 2016.

29. Hirose, K., Morard, G., Sinmyo, R., Umemoto, K., Hernlund, J., Helffrich, G., Labrosse, S., Crystallization of silicon dioxide and compositional evolution of the Earth's core, ***Nature***, 543, 99-102, doi:10.1038/nature21367, 2017.

30. Ballmer, M., Houser, C., Hernlund, J., Wentzcovitch, R., Hirose, K., Persistence of strong silica-enriched domains in the Earth's lower mantle, ***Nature Geoscience***, 10, 236–240, doi:10.1038/ngeo2898, 2017.

31. Hirose, K., Sinmyo, R., Hernlund, J., Perovskite in Earth's deep interior, ***Science***, 358, 734-738, 2017.

Achievements and highlights of past research activities:

Kei Hirose is a high-pressure mineral physicist, with interests in the material property and the evolution of the Earth's deep interior.

The current main interest is identification of the core light element, primarily based on high-pressure experiments on iron alloys to determine melting phase relations and the sound velocity and density of liquids.

2001~present

K. Hirose has established ultra-high pressure and temperature (*P*-*T*) laboratory in 2001 at Tokyo Tech. At the same period, Kei was deeply involved in a reconstruction of using laser-heated diamond-anvil cell (DAC) system at the beamline BL10XU, SPring-8. Since 2003 until now, Kei has been appointed as a Power (or Partner) User of SPring-8 and extensively working on ultrahigh-pressure XRD measurements. In 2004, together with his student Motohiko Murakami, he discovered $MgSiO_3$ post-perovskite (Murakami *et al*., 2004 Science), which is believed to be a primary constituent in Earth's lowermost mantle (D" layer). Kei and his colleagues also measured the properties of post-perovskite such as elasticity, electrical and thermal conductivity, element partitioning, Clapeyron slope, and deformation mechanism, which all contributed greatly to our understanding of this mysterious hidden layer. In 2010, Kei together with his post-doc Shigehiko Tateno succeeded in the XRD measurements up to 377 GPa and 5700 K corresponding to the condition beyond the center of the Earth, and reported a phase diagram of iron at the inner core (Tateno *et al*., 2010 Science). More recently, Kei's group discovered high thermal conductivity of the Earth's core, three times as high as traditional estimates, suggesting core rapid cooling and high initial temperature as well as young inner core (Gomi *et al*., 2013 PEPI). Such high conductivity has been confirmed by measurements at core high *P*-*T* conditions (Ohta *et al.*, 2016 Nature). On the other hand, Kei has recently proposed that liquid core convection has been driven by compositional buoyancy rather than thermal buoyancy even before the birth of the inner core, as a consequence of SiO_2 crystallization at the top of the outer core (Hirose *et al.*, 2017 Nature). It also suggests that the core is now poor in Si and O, leaving large room for other light element in the core, possibly hydrogen.

1996~2001

Kei started ultrahigh-*P* experiments using both DAC and multi-anvil apparatus during his stay at

the Geophysical Lab in 1996-1998. He determined the majorite-perovskite phase transition boundary and melting curve of MORB in the lower mantle and discussed the fate of subducted oceanic crust (Hirose *et al*., 1999 Nature). After returning back to Tokyo Tech, Kei worked on a multi-anvil press with special interest in the nature of 660-km seismic discontinuity. Hirose (2002 JGR) argued that phase transition assists plume upwelling through the 660-km boundary at high temperature, while it resists downwelling at normal temperature and below. He and his colleagues also pointed out the large uncertainty in pressure scales widely used in the high-*P* experiments (Hirose *et al.*, 2001 EPSL).

1993~1996

Kei started his career with piston-cylinder experiments below 3 GPa. Hirose and Kushiro (1993 EPSL) first succeeded in determining the chemical compositions of melts directly formed by partial melting of natural peridotite, which significantly contributed to our understanding of the origin of basaltic magmas. Kei also examined the effect of H_2O and CO_2 on mantle melting.