Bob-san and High Pressure Science and Technology in Japan: A 40-Year History

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In this paper, the history of the relationship of Bob Liebermann’s laboratory at Stony Brook and high-pressure, multi-anvil laboratories in Japan over the past 40 years is recounted. As the field of high-pressure mineral physics in Japan has evolved during this period, the major players and their laboratory sites have changed, but this field is alive and well today and in the capable hands of the new young generation.

[High-pressure, multi-anvil or large-volume apparatus, mineral physics, Japan-U.S. seminars]

1. Introduction

From 1971 to 2010, I have had the opportunity to visit Japan 15 times and enjoy scientific discussions and personal contacts with my colleagues in the field of high-pressure science and technology. Through these visits, I have been privileged to develop friendships with four generations of Japanese colleagues and to observe the evolution of this field which we sometimes call “mineral physics” in the Earth science community. This objective of this paper is to recount this history over the past 40+ years; as such this is not a scientific paper, but a story. I wish to dedicate this paper to Syun-iti Akimoto. In 1983, I had the honor of nominating Akimoto-sensei for the Bowie Medal of the American Geophysical Union; this is the highest award of the AGU and he was the first Japanese scientist to receive an AGU medal. This paper is an outgrowth of a keynote lecture which I delivered at the JSHPST meeting in Sendai in October 2010.

2. Pre-1971 at Lamont

From 1964–1969, I was a graduate student at the Lamont Geological Observatory of Columbia University in both seismology and mineral physics. During that period, there was much interest in earthquake prediction in both the U. S. and Japan, and in 1964 there was a conference at Lamont on this topic, where I met many famous Japanese seismologists. While working in the mineral physics laboratory of Orson Anderson, I was tutored by Edward Schreiber and Naohiro Soga. It was Soga who recruited Mineo Kumazawa to a visiting scientist position at Lamont; in addition to working in the laboratory together, we all went on a “field trip” to the Mule Ear diatreme at the Four Corners area in southwestern U.S. - it was an unusual team for a geological excursion, as it included a solid-state physicist, a ceramist, a glass technologist and a seismology student. One of my first papers was on Fe2SiO4 and published in JGR in 1970 along with a one by Hitoshi Mizutani in the laboratory of Akimoto. Hideyuki Fujisawa and I were postdocs at Caltech in 1970.

3. First Visit to Japan in 1971

From 1970–1976, I was a research fellow in the laboratory of A. E. [Ted] Ringwood at the Australian National University. As I was attending the IUGG Congress in Moscow and making an exchange visit to
Czechoslovakia in 1971, Ringwood encouraged me to visit the high-pressure laboratories in Japan en route back to Canberra. My first stop was Tokyo; I had to meet Akimoto in a coffee shop as there was a student strike at Todai and faculty could not enter the campus; later graduate students [including Yoshiko Sato] showed me the ISSP laboratories in Roppongi and took me for my first sushi and sashimi dinner in the Ginza [Fig. 1]. During that trip with the guidance of Soga, I also visited the high-pressure laboratories of Kumazawa in Nagoya, Jiro Osugi in Kyoto, and Naoto Kawai and Shoichi Kume in Osaka. I also paid a visit to the Matsushiro Seismological Observatory, near the site of the large swarm of earthquakes in 1964.

4. Joint US-Japan Seminars on High-Pressure Mineral Physics

In 1976, Murli Manghnani and Akimoto convened

Fig. 1. Bob-san and students from Todai in 1971: Yoshiko Sato is second from right.

Fig. 2. Attendees at the first Japan-US joint seminar in 1976. Of those, only Eiji Ito and Takehiko Yagi also attended the lecture by Bob-san at the JSHPST meeting in Sendai in October 2010.
[Fig. 2] the first in a series of joint seminars on high-pressure research applications in geophysics [1]. In the subsequent 35 years, these seminars have been held at 5-year intervals 1981 in Hakone [2], 1986 in Turtle Bay [3], 1991 in Ise [4], 1996 in Maui [5], 2002 in Verbania-Italy [6], and the most recent being in Matsushima, Japan in May 2007 [7]. I missed the first seminar due to the birth of our son, but have attended all the others.

The most notable meeting for me and my col-
leagues at Stony Brook [Charles Prewitt and Donald Weidner] was held in Hakone, Japan in January 1981. In addition to many exciting scientific presentations, we all participated in a field trip to the surrounding volcanic region [Fig. 3] led by the noted ‘‘geologist”, Takehiko Yagi. Tours of the high-pressure laboratories in Nagoya, Tokyo and Tsukuba followed the seminar at Hakone [Figs. 4 and 5]. This 1981 visit was the most important event in my connection with high-pressure science and technology in Japan, as it led to a proposal to the NSF to establish the first multi-anvil, large-volume high-pressure laboratory outside of Japan. In the early 1980s, several Japanese scientists visited Stony Brook to conduct Brillouin scattering experiments on single-crystals of mantle minerals in the laboratory of Weidner [Fig. 6].

5. Establishment of Stony Brook High Pressure Laboratory

In 1984, I spent three months as a guest professor at the ISSP in Todai hosted by Akimoto and Yagi; my wife and three children accompanied me on this visit, which created a logistical problem for the gaijin Guest House in Roppongi because we had such a large family. During this stay at ISSP, and based on advice from many Japanese colleagues, the Stony Brook high-pressure yakuza [Charles Prewitt, Donald Weidner and I] went on a “shopping trip” to companies and laboratories in Japan to search for high-pressure equipment, including Tsukuba [Fig. 7 and 9], Tokyo, Nagoya [Fig. 8] and Misasa. An article on large-volume, high-pressure mineral physics in Japan based on this visit was published in EOS-Transactions of the AGU in March 1985 [Fig. 10].

In 1985, we imported two different types of high-pressure apparatus to Stony Brook: (1) a DIA-type, cubic-anvil apparatus named SAM-85 after Osamu Fukunaga who helped design it and Osamu...
Shimomura who helped install it [Fig. 11], modeled after MAX80 at the Photon Factory in Tsukuba [Fig. 12]; and (2) a Kawai-type, 2000-ton uniaxial, split-sphere apparatus modeled on the 5000-ton version in the lab of Eiji Ito [Fig. 13] and named USSA-2000 [Fig. 14].

These two-types of apparatus were installed in a new High Pressure Laboratory at Stony Brook with the guidance and assistance of Osamu Shimomura, Yoshiko Sato, Hisao Kanda, Manabu Kato, and Hiroshi Watanabe. Over the next 20 years, many Japanese scientists worked in our laboratory at Stony
Brook, including Yagi, Ito, Shigeho Sueno, Nozomu Hamaya, Hiroshi Sawamoto, Toru Inoue, Jun-ichi Ando, Keiji Kusaba, Yasuhiro Kudoh, Wataru Utsumi, Masami Kanzaki, Yuji Higo, Takamitsu Yamanaka, Takaya Nagai and Hiroyuki Kagi [Fig. 15], many with support from the NSF Science and Technology Center for High Pressure Research [CHiPR: 1991–2002]. Our Japanese colleagues have always been most welcoming of our visits to their laboratories and generously shared their ideas and experimental “secrets” with us. The Stony Brook yakuza [Prewitt, Weidner and Bob-san] owe them a large debt of gratitude and I wish to acknowledge their contributions again in this paper.

6. 1985–2010 Visits to Japan

In the ensuing 25 years, I have attended many high-pressure meetings in Japan including: 2nd Japan-USSR Conference in Misasa in 1989 [which included a geology field trip in southern Honshu and Shikoku Islands and an emotional stop at the Atomic Bomb site in Hiroshima]; the Japan-US high-pressure semi-

Fig. 14. Tibor Gasparik with USSA-2000 in 1986.

Fig. 15. Japanese visitors to Stony Brook during 1982–2007, the “Lattimore era”.

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Fig. 16. Charlie Prewitt, J. Smyth, Tomoo Katsura and A. Chopelas in Club 309 at Ise in 1991. Starting in Hakone in 1981 when Fukunaga had Room 309, each Japan-US seminar has designated one of the guest rooms as “Club 309” as a hospitality suite for evening discussions.

Fig. 17. Masao Wakatsuki, Shigeho Sueno and Don Weidner at Ise shrine 1991.

Fig. 18. Bob-san and Weidner in laboratory of Eiji Ohtani.

Fig. 19. Yasuhiro Syono in shock-wave laboratory.

Fig. 20. Akimoto and proteges, Takehiko Yagi, Hideyuki Fujisawa and Masaki Akaogi at JSHPST meeting in Hiroshima in 1994.

Fig. 21. Animation of a high-pressure shock experiment.

Fig. 22. Distribution of shock waves in a high-pressure apparatus.

In Ise in 1991 [Figs. 16 and 17], followed by visits to Tohoku University [Figs. 18 and 19] and ISSP the JPHPST meeting in Hiroshima in 1994 [Fig. 20];, highlighted by a memorial symposium for Ted Ringwood; 1997 in Kyoto for the AIRAPT conference [Figs. 21 and 22] preceded by a Pressure Calibration Workshop in Misasa.

Of course, one of the most important developments in high-pressure research in Japan in the past 30 years
has been the use of synchrotron X-radiation in conjunction with high-pressure, high-temperature experiments and I have been able to visit the Photon Factory and SPring-8 on several occasions to view these special facilities [Fig. 23].

One such visit was in 2000 with my long-time colleague Gabriel Gwanmesia; it was his first trip to Japan and a chance to visit with many scientists whom he had helped host at Stony Brook [Figs. 24 and 25].

During a 5-year period in the 21st century, I served on the Advisory Committee for the COE-21 Program of Okayama University in Misasa at the invitation of Eiji Ito [Figs. 26–28].
In 2009, I was a guest lecturer in Hiroshima University hosted by Jun-ichi Ando who invited graduate students from throughout Japan to attend [Figs. 29 and 30].

Most recently, I have become one of the participating scientists in the G-COE Program at Ehime Uni-

![Fig. 25. Gabriel at NIRIM with Hisao Kanda.](image)

![Fig. 26. Symposium in honor of retirement of Eiji Ito-Misasa in 2008.](image)

![Fig. 27. Bob-san with Eiji Ito and wife Michiko at symposium banquet 2008.](image)

![Fig. 28. Hideyuki Fujisawa with 6-axis apparatus-ISEI.](image)

![Fig. 29. Symposium in honor of retirement of Eiji Ito-Misasa in 2008.](image)
University in Matsuyama led by Tetsuo Irifune and in 2008 Stony Brook and Ehime have signed a formal collaborative agreement [Fig. 31].

In October 2010, I was invited to give one of the keynote lectures at the JSHPST meeting in Sendai, Japan [Figs. 32 and 33]. That visit gave me the opportunity to get re-acquainted with many of my old Japanese friends [Fig. 34] and to meet many of the new generation, as well as see the laboratories of the G-COE in Tohoku University.
7. Summary

In this talk, I have tried to highlight my 40-year “love affair” with high pressure science and technology in Japan. I have been privileged to know and develop friendships with almost 4 generations of Japanese colleagues and to observe the evolution of this field. Starting in the 1980s, we maintained a map of Japan in the Mineral Physics Institute at Stony Brook, with pins and labels for each of the major high-pressure laboratories. As time progressed, some labs closed and others were created, so we had to constantly update the map. My conclusion and message today is that high-pressure science and technology in Japan is alive and well and in the very capable hands of the new young generation.

8. Special Relationship

Of the persons attending my keynote lecture at the JPHPST meeting in Sendai in October 2010, the one whom I have known the longest is Takehiko Yagi [Figs. 35 and 36], and I wish to thank him for this special relationship.

Acknowledgments

This paper is primarily focused on multi-anvil, high-pressure laboratories as that is my principal interest. My apologies to the diamond-anvil cell labs which have proliferated in Japan after Akimoto sent Yagi to the Geophysical Laboratory in the late 1970s; on his return to ISSP, Yagi started his own DAC lab and this type of apparatus quickly spread throughout Japan. I thank Takehiko Yagi for his editorial suggestions in revising this manuscript for publication.

I thank Ken-ichi Funakoshi for the invitation to present a keynote lecture at the JSHPST meeting in October 2010, Eiji Ohtani for the invitation to visit the laboratories of the G-COE at Tohoku University, and Takahiro Kuribayashi for organizing the field trip to the Okama crater and Zao mountain. I am grateful to the JSHPST for support of my travel to Japan and the G-COE at Tohoku for support of my local expenses in Sendai.
References


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