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Original Paper

My Research Collaborations with Australian Scientists over the Past Half Century

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Abstract

Over the past half century, I have maintained research collaborations with Australian scientists while pursuing an academic career focusing on scientific investigations of the physical properties of minerals at high pressures and temperatures. From 1970-1976, I was a member of the research faculty of the Australian National University; initially in the Department of Geophysics and Geochemistry and later in the Research School of Earth Sciences. In subsequent years, I have maintained connections with many laboratories in Australia in addition to the ANU, including those in Brisbane, Hobart, Melbourne, Perth and Sydney. The objective of this paper is to relate this history.

Keywords

mineral physics, Australian scientists, research collaborations

1. Introduction

Over the past decade, I have concentrated on writing papers on my history pursuing a scientific career in mineral physics. Recently, I have published papers on my research collaborations with French, Czech, Chinese, Russian and English scientists in the International Journal of Geosciences (Liebermann, 2021a, 2021b, 2021c; 2022a, 2022b) and with German scientists in the Journal of Energy and Earth Sciences (Liebermann, 2022c). This new paper is of a similar genre. Finally, I document my personal history with Australia and Australians.

In 1970, I established the first mineral physics laboratory in Australia at the Australian National University [ANU] under the auspices of A. E. (Ted) Ringwood. Over the next 6 years, we published 25 research papers in peer-reviewed journals, many of them in collaboration with my graduate students Ian Jackson and Leonie Jones. This research was focused on measurements of sound velocities in minerals [and their structural analogues] at high pressures and temperatures, as well as studies of

melting and elastic shear instabilities in materials and applications of these experimental data to interpreting seismic models of the Earth's interior. I have documented this birth of mineral physics in Australia in a previous paper (Liebermann, 2020); this new paper extends this history for another 46 years to the present day.

2. The Lamont Years in the 1960s

In 1969, when I was a graduate student at Columbia University's Lamont Geological Observatory, my advisor Orson Anderson attended an international conference at the Australian National University [ANU] in Canberra, Australia to deliver our joint paper on lattice dynamic calculations of the elastic moduli of cubic lattices (Anderson & Liebermann, 1970); this was the meeting at which A. D. Wadsley collapsed on the stage and died while Frank Press was delivering his talk (T. Takahashi, personal communication, March 2013). During that meeting, Ted Ringwood informed Anderson that he was looking for a postdoc to set up an ultrasonics laboratory; subsequently, Richard O'Connell declined to apply for this job and I was offered the post. Enroute from Lamont to Canberra, I spent 10 months as a postdoc at the Seismological Laboratory at Caltech; during that period, I profited from advice and guidance on equipment for my new ultrasonics lab at the ANU from Hartmut Spetzler and O'Connell.

While I was still at Lamont, Frank Stacey from the University of Queensland was a visiting scientist. He strongly encouraged me to accept the post at the ANU; but he cautioned me to avoid the wife-swapping which was then rampant at the University flats in Garran, a suburb of Canberra, where non-tenured scientific staff often resided.

At the Birch Symposium at Harvard University in 1970, I met Ted Ringwood and we laid plans to purchase equipment so that it would be on campus when I arrived in late September. John Jaeger [then the Chair of the Department of Geophysics and Geochemistry at the ANU] visited the Anderson lab at Lamont later that year and told me that he hoped I knew how to operate and maintain all that electronic equipment as the ANU did not have suitable staff to do so; that turned out to be apocryphal as the Department not only had an excellent machine shop but several very talented electronic staff. In addition, Ringwood and David Green were blessed with two superb Senior Technical Officers, Alan Major and William Hibberson, who were tremendous assets to my new research program (Figs. 1a, b).

Figure 1a. Alan Major at Lathe Fabricating Cell Parts for High-pressure Experiments Inn Laboratory of Ted Ringwood

Figure 1b. Bill Hibberson (right) and Paul Willis Preparing for High-pressure Experiment in Laboratory of Dave Green

3. The ANU Years from 1970-1976

In September 1970, I set off for Canberra with my wife and one-year old daughter Karen.

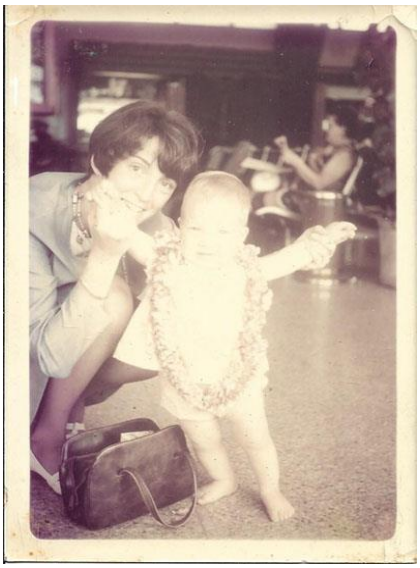

Figure 2. My Wife Barbara and Our Daughter Karen [wearing her new lei] during a Layover in Honolulu Enroute to Australia in September 1970

a. Arrival and first years at the ANU

In October 1970, my wife Barbara and I arrived in Canberra with our one-year old daughter Karen in tow. As Ted Ringwood was overseas, David Green welcomed us and installed us in Apt. #1 of the Garran university flats in the Woden valley. John Cleary led the search for a car, ending in a 2-door Datsun coupe [a little difficult to install a baby carrier in the rear seat].

On one of my first days in the Department of Geophysics and Geochemistry, "Prof" Jaeger introduced me to the faculty and students and offered me a yard of ale with instructions to down it in one gulp; with some difficulty, I passed this initiation rite. The ultrasonic equipment ordered when I was still at Lamont had been delivered, and with the help of electronics specialist Eddie Penikis, I began to set up the new ultrasonics laboratory.

The primary objective of this new laboratory was to perform ultrasonic measurements of sound velocities in polycrystalline specimens of mantle minerals or their crystal chemical analogues [principally germanates]. With Alan Major, we began to learn how to hot-press polycrystalline specimens suitable for ultrasonic measurements of elastic wave velocities, using synthetic powders prepared by Alan and Bill Hibberson. The first specimens were fabricated in a piston-cylinder apparatus at pressures less than 35 kbar [3.5GPa] and temperatures up top 1200 ℃; we initially focused on germanate analogues of silicate mineral phases. We tested the polycrystals in the ultrasonics lab using a polishing jig and specimen holder fabricated in the Department machine shop [both of which are still currently in use in our lab at Stony Brook].

Figure 3. Polishing jig Used to Prepare Polycrystalline Specimens for Ultrasonics Experiments

The fabrication of these polycrystalline samples was initially done in a piston-cylinder apparatus at pressures up to 35 kbar (3.5 GPa); subsequently we used girdle, belt and simple squeezer apparatus, eventually achieving pressures above 100 kbar in these hot-pressing experiments (Gwanmesia *et al*., 1993).

While awaiting the arrival of a hydrostatic high-pressure vessel from the Harwood Company in the U. S., Mervyn Paterson generously offered me the use of one of his pressure vessels to conduct my initial experiments. The first velocity experiments at high pressure were conducted in a liquid-media apparatus to 7.5 kbar (0.75 GPA) in his laboratory with assistance of Bill McIntyre, Prof Jaeger's personal machinist; Bill had been assigned by Jaeger to work with me while Jaeger was "wintering" in Northern Hemisphere summer. Ringwood was VERY surprised to learn about this assignment but had no basis to object.

The first results on rutile and spinel compounds were obtained by the pulse transmission ("time-of-flight") technique and reported at the IUGG Meeting in Moscow, Russia in August 1970, less than one year after establishing new ultrasonics lab at the ANU, with technical assistance of new electronics technician Doug Mayson (Liebermann, 1972). In these "time-of-flight" measurements were collected to 7.5 kbar at room T and the data at highest P were taken to represent pore free specimen (Liebermann, 1973, 1974, 1976; Liebermann & Mayson, 1976; Lieberman, Ringwood & Major, 1976; Lieberman & Ringwood, 1977; Jackson, Liebermann & Ringwood, 1978). On the night before I left for Moscow, Alan Major, Bill Hibberson and Bill McIntyre invited me to the tea room in the Department to play bridge and drink beer as a goodwill send-off.

The next advance in ultrasonics was to employ the pulse superposition technique to obtain more precise measures of travel times to 7.5 kbar. Values reported were those "back-extrapolated" to 1 bar to obtain velocities representative of a pore-free specimen; these data were then compared with results from

single crystals in other labs (Liebermann, Ringwood & Major, 1976; Jackson, Lieberman & Ringwood, 1978; Lieberman, 1972, 1973; Liebermann & Mayson, 1976). In later experiments, the measurements of velocities using the pulse superposition technique were sufficiently precise to allow determination of the pressure derivatives.

My six years at the ANU were a fantastic period of exposure to high-pressure geosciences. In early 1971, Frank Stacey from the University of Queensland Stacey invited me to give a paper at the Australian-New Zealand Association of Science [ANZAS] in Brisbane. Later, he recommended to Ian Jackson and Leonie Jones, both graduates of the Physics Department of the University of Queensland, that they apply for a graduate fellowship to study at the ANU under my supervision. When they arrived to begin their graduate research programs, Ringwood was nervous about their lack of exposure to Earth sciences, so he insisted that they take "remedial" courses in the geology department. After both completed introductory geology, Jackson took the 3rd year mineralogy course and topped the class; Ringwood never raised the issue again. Both Leonie Jones and Ian Jackson can be seen in the photo of the RSES staff in Figure 4.

In 1973, the ANU established the Research School of Earth Sciences [RSES] which provided the opportunity for the Department of Geophysics and Geochemistry to move out from under the control of the Research School of Physical Sciences. Anton Hales arrived from the University of Texas at Dallas to become the Founding Director of the RSES; over the next three years, I learned much from Hales about scientific leadership and administration.

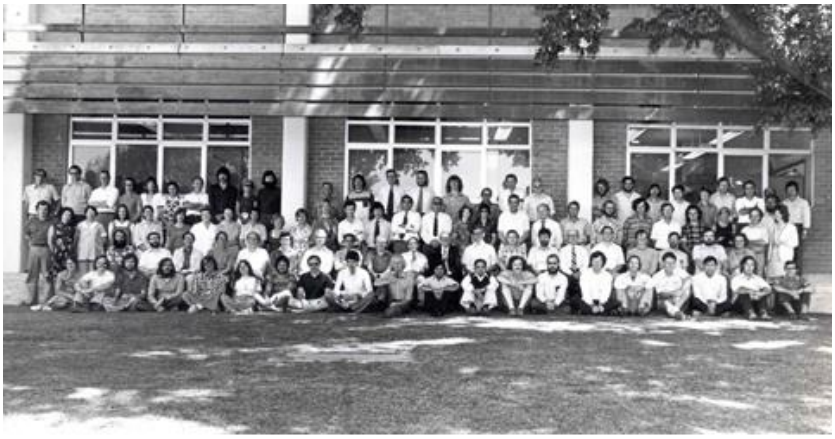

Figure 4. Group Photo of Staff at the Research School of Earth Sciences in the Hales era circa 1975

Note. Leonie Jones (fifth from left) and Ian Jackson (8th from the right) in front row and Bob in second row. Anton Hales in first seated row in suit jacket.

When the Department of Geophysics and Geochemistry evolved to become the Research School of Earth Sciences [RSES] in 1973, it became necessary to establish a Faculty Board and produce bylaws; I helped Ian MacDougall to draft these bylaws and we served together on the Faculty Board. During one of the board meetings, some members challenged Director Hales on the appropriateness of his contract with the U. S. Department of Defense [to install and operate seismic stations on the Australian continent]; Hales abruptly adjourned the meeting and deputized me to talk to Faculty Board members and convince them that it was Hales' right to hold such a contract.

With Ian McDougall, I also initiated an annual summer school to encourage undergraduates from Australian universities to consider pursuing graduate study at the RSES. This recruiting effort involved trips to the geology and geophysics departments of universities in Melbourne, Brisbane, Adelaide and Sydney. As a result of this program, more than a half dozen undergraduates came to Canberra to pursue PhDs in the School of Earth Sciences.

As there were no formal courses required for graduate students in the Institute of Advanced Studies at the ANU, I initiated a series of informal seminars on Monday evenings for Ian Jackson and Leonie Jones. In addition to reading and discussing current geophysical literature, we profited from participation of visiting scientists, including Don Anderson, Adam Dziewonski and Ralph Lapwood. It was during that era that geophysicists were exploring use of inverse theory to analyze observational data to obtain velocity and density models of the Earth's interior. To help us understand this approach, Prof. Lapwood kindly offered a set of tutorial lectures on inverse theory, using the book by Cornelius Lanzcos. During these seminars, I also had extensive contact with John Cleary and others in their seismological group.

After arriving in 1973 to become the first Director of RSES, Anton Hales became a regular attendee at our weekly seminars. In addition to bringing his decades of geophysical knowledge, he provided funds for me to buy cheese and crackers to sustain us through the evening [and to leaven the beer which we drank].

b. Research of graduate students Ian Jackson and Leonie Jones

Ian Jackson initially worked on melting and elastic shear instabilities in alkali halides (Jackson & Liebermann, 1974) and engaged in some hard-sphere modeling of melting with Bob Watts of the Research School of Physical Sciences.

Ian later studied the disproportionation of spinels into mixed oxides and revealed significance of cation configuration and implications for the mantle (Liebermann, Jackson & Ringwood, 1977) and the elastic properties of ($Mg_xFe_{1-x}O$) solid solutions (Jackson, Liebermann & Ringwood, 1978).

His Ph. D. dissertation in 1976 was entitled "Phase equilibria and elastic properties in silicate analogue systems: studies of melting and polymorphic phase transformations".

Leonie Jones initially worked on the elastic and thermal properties of fluoride and oxide analogues with the rocksalt, fluorite, rutile, perovskite structures (Jones & Liebermann, 1974) and later the elasticity of aluminate, titanate, stannate and germanate compounds with the perovskite structure (Liebermann, Jones & Ringwood, 1977).

Her Ph.D. dissertation (1976) was entitled "High-temperature elastic properties of fluoride and oxide analogues".

We also worked on a number of other mineral physics projects:

Elasticity systematics and applications to interpretation of Earth models (Liebermann, 1973a, 1973b, 1973c).

Hot-pressing of polycrystalline specimens of high-pressure phases (Liebermann et al., 1974)—presented 4th International Conf. High Pressure-25-29 Nov. 1974, Kyoto, Japan. See also Gwanmesia *et al*. (1993).

Elasticity of anorthite and nature of the lunar crust (Liebermann & Ringwood, 1976).

Elasticity of stishovite—most challenging project to hot-press and measure sound velocities in polycrystalline stishovite (Liebermann, Ringwood & Major, 1976; Liebermann & Ringwood, 1977). No elastic anisotropy was observed in these specimens; their velocities were consistent with later Brillouin scattering data from Don Weidner's laboratory (Weidner et al., 1982).

c. Related research [1971-1976]

In 1976, I worked on phase equilibria and elastic properties of pyrolite model for the oceanic upper mantle with David Green, who presented our paper at the IUGG international congress in Grenoble, France (Green & Liebermann, 1976). Ringwood expressed surprise that I was collaborating with his colleague and competitor when I was working "under the supervision of Ringwood" (Figure 5). Dave later moved to Hobart to become the Chair of Geology at the University of Tasmania, and subsequently returned to the ANU to take up the post of Director of the Research School of Earth Sciences.

While I was conducting mineral physics experiments in the laboratory of Ted Ringwood, Ian Nicholls (my friend and junior faculty colleague) was pursuing high-pressure petrology experiments in the laboratory of Dave Green. Ian later moved to Melbourne to join the faculty of the new Department of Geology at Monash University (the department established by Bruce Hobbs—see below). Our family visited Ian's family in Melbourne in the 1970s and later in 1992 (see photos with Australian animals below).

In 1975, Professor Kenzo Yagi from the Hokkaido University visited the ANU as a guest of Ted Ringwood (see Figure 5). I subsequently met Yagi-sensei (sometimes referred to as "Big Yagi") at many international conferences. He was a dedicated photographer and my photos do not do justice to his talents.

Figure 5. Visit of Professor Kenzo Yagi of Hokkaido University to RSES in 1975

Note. L to R: David Green, Ted Bence from Stony Brook, Don Anderson from Caltech, Ted Ringwood, Nobuko Yagi-wife of Kenzo Yagi and mother of Takehiko Yagi, and Bob.

During my time at the Australian National University from 1970 to 1976, Don Anderson spent a study leave in the laboratory of Ted Ringwood in 1975. See photo above of Don and Ted with others on the ANU campus. Don and his family (wife Nancy, daughter Lynn and son Lee) rented a house across the street from ours in the university complex in Garran. We had the opportunity to introduce their kids to kangaroos, cockatoos and koalas at the Tidbinbilla Nature Preserve, skiing in the Snowy Mountains and beach trips to the south coast of Australia. See photo of our families at a picnic on Lake Burley-Griffin in Canberra (Figure 6).

Figure 6. Left to Right: Karen and Barbara Liebermann, Lynn and Lee Anderson, Erica Liebermann, Don and Nancy Anderson

Lynn reminded us that we had to abort one picnic at Tidbinbilla when we were threatened by mating kangaroos and intimidated by the chest-thumping of the males. Lee recalls games of American touch football in the commons of the Garran compound and a homemade cassette of bawdy Australian songs we sent them home with so they wouldn't get homesick.

During his visit to the ANU, Don gave me some important career advice. Although I was having a very productive period in Ringwood's lab and with Ian Jackson and Leonie as graduate students, I was still in a non-tenure track position after 5 years with no apparent chance of promotion to tenure. Don urged me not to stay too long and to explore opportunities for returning to the U. S. in a tenure-track position. I took his advice and joined the faculty at Stony Brook University in 1976, from which I formally retired in 2014, but continue as a Research Professor.

At the 1973 meeting of the International Association of Seismology and Physics of the Earth's Interior (IASPEI) in Lima, Peru, Charles Drake encouraged me to organize a workshop in Eastern Europe, so that young scientists from countries in the Eastern Bloc could attend. With my Czech colleagues, Vladislav Babuška, Jaroslava Plomerova and Vlastimil Červený, I convened the first of these workshops in 1976 at the Castle of Liblice in eastern Bohemia on "Anisotropy and Heterogeneity of the Lithosphere" (Babuška & Liebermann, 1977).

Anisotropy and Heterogeneity of the Lithosphere at Castle of Liblice, Czechoslovakia, June 1976

Conveners: V. Babuška, J. Plomerová, V. Červený and R.C. Liebermann.

The only Australian attendee at Liblice was Frank Stacey, who engaged in a vigorous debate with other theoreticians on the subject of the volume dependence of the elastic Gruneisen parameter.

From the presentations by Orson Anderson, Francesco Mulargia, Enzo Boschi, Frank Stacey, and Vladimir Zharkov, the audience concluded that:

> "Thermal regime of Earth's interior depends on definition of Grüneisen's parameter gamma, the correct formulation of which is one of the principal unsolved problems in high-pressure physics. Some indications from debate that gamma depends more critically on author than volume".

d. Interactions with other research groups in the RSES

I was welcomed into the rock mechanics research group of Mervyn Paterson and Bruce Hobbs. There I met and interacted with Jim Boland and John Fitzgerald, specialists in transmission electron microscopy, as well as Rob Coe (visitor from Santa Cruz), and graduate students Gordon Lister and Ide Van der Molen. Boland later spent a sabbatical year at Stony Brook bringing a dedicated introduction of electron microscopy to my research group; his tutelage of my graduate student, Anne Remsberg, was one of the first experiments performed in our new High-Pressure Laboratory.

On several occasions, Mervyn and his wife Katalin hosted dinners at their home to which my wife Barbara and I were invited and where we enjoyed sampling the excellent wines in Meryvn's cellar; Bruce Hobbs had a cellar too, but it was always empty because he could not afford to keep the wine long enough.

Hobbs ultimately left the ANU to set up a geology department at Monash University in Melbourne (mainly seduced by Alec McLaren); after a few years, he became tired of administration and joined the CSIRO and later on to become the Chief Scientist of Western Australia in Perth.

Although I never worked directly with Ross Taylor, he was a constant source of encouragement as I pursued my career at the ANU; first in the Department of Geophysics and Geochemistry and later in the Research School of Earth Sciences. I am grateful for his wise counsel, especially when we served together on the Faculty Board of the RSES, then chaired by Anton Hales. I remember one tense board meeting when the members challenged Director Hales right to hold a research contract from the U. S. Department of Defense; Hales abruptly adjourned the meeting and tasked me with the job of convincing the other Board members that he could accept the DOD funding (Ross was a valued ally in that lobbying effort). I also appreciated the advice Ross would offer me in understanding how best to deal with the generous but domineering personality of Ted Ringwood.

Barbara and I had the pleasure of hosting Ross and his wife Noel at our university apartment in the Garran flats on several occasions; I always marveled at Ross' manner of speech, which was often somewhat garbled early in the evening, but seemed to get smoother after we imbibed some wonderful Australian wine.

In December 1976, I departed Canberra with my family to take up a faculty appointment in the Department of Earth and Spaces Sciences at Stony Brook University. When we were leaving Canberra, Ted Ringwood unexpectedly appeared. I thanked him for coming to see us off, to which he replied: "I wanted to be sure you left the country".

4. Post-1970 Research Collaboration between ANU and Stony Brook

After six years at the ANU, I began to think about longer term career opportunities. As there were no options open at the ANU for tenure-track positions (until the last moment), I began to explore jobs back in the US, and I was lucky enough to be offered a position at Stony Brook following a search led by Donald Weidner (who apparently was not afraid to recommend hiring another mineral physicist). Charles Prewitt, who was then on sabbatical leave at Monash University in Melbourne, strongly encouraged me to accept, as did his colleague A. E. (Ted) Bence, who was visiting the ANU at that time, and Orson Anderson, my Ph.D. advisor.

When I arrived at Stony Brook, two of my first purchases were a hydraulic press system from Harwood Engineering and a girdle-anvil high-pressure apparatus from Pressure Systems Research. This equipment was delivered in September 1977 and installed in Room 375 of the ESS Building with the help of Tony Vidmar (our new technician), Al Catalano (machinist) and Alan Major (consultant from Ringwood's lab at the ANU (see Figure 7]). With this system, we could achieve pressures of 60 kbar (6 GPa).

Figure 7. Al Catalano [machinist extraordinaire] and Alan Major from ANU with Tony Vidmar Checking Hydraulic Connections to Press

After a postdoctoral appointment in the laboratory of Thomas Ahrens at Caltech, Ian Jackson returned to the ANU in the late 1970s to take up a faculty position in Ted Ringwood's Petrochemistry Research Group, later transferring to the Petrophysics Group of Mervyn Paterson in the Research School of Earth Sciences. Ian and Mervyn adapted Paterson's gas-medium deformation apparatus to perform acoustic attenuation experiments (Figure 8).

Figure 8. Ian Jackson and Mervyn Paterson with Apparatus to Measure Acoustic Attenuation Circa 1990

In the ensuing years, I have continued my association with the RSES at the ANU, especially during a period of the 1990s when Ian Jackson and I had an international cooperative grant between the Australian Research Council and the National Science Foundation (NSF) in the US. This grant supported collaborative research using the ultrasonic interferometry techniques developed by Jackson and his colleagues to measure sound velocities in polycrystalline specimens of mantle minerals to 3 GPa in their modified piston-cylinder apparatus. From the Stony Brook side, the specimens were fabricated by Gabriel Gwanmesia and Baosheng Li in our High Pressure Laboratory and the ultrasonic data obtained by Sally Rigden at the ANU during visits by Gwanmesia and the author (Figures 9a, 9b); (Rigden et al., 1988; Gwanmesia et al., 1990; Rigden et al., 1991, 1992, 1994; Li et al., 1996).

With regard to Gwanmesia's visits to Australia, the first in 1989 was to measure the wadsleyite and ringwoodite that resulted in the Science and Nature publications, respectively (Gwanmesia et al., 1990; Rigden et al., 1991). He returned to Australia in 2003 for his sabbatical during which he studied the elasticity of pyrope to 1000 K at 300 MPa in the internally heated gas-medium apparatus reported in Gwanmesia et al. (2007).

Figure 9a. Gabriel Gwanmesia and Sally Rigden in Ian Jackson's laboratory at the ANU

Figure 9b. Sally Rigden from the ANU with Gabriel Gwanmesia and Bob in High Pressure Laboratory at Stony Brook in 1991

In 1993, I was a candidate for Director of the RSES, but the administration at Stony Brook convinced me to stay and thus I was able to continue my role as the Co-Director of the NSF Center for High Pressure Research (CHiPR). That also led to the second phase of our collaboration with the Jackson team at the ANU.

In 1994, Baosheng Li, then a graduate student and now a Professor in the Department of Geosciences, developed techniques to incorporate ultrasonic interferometric measurements of sound velocities *in situ* in the Kennedy-Getting high-pressure apparatus in collaboration with Ian Jackson (my first graduate student and subsequently the Director of the Research School of Earth Sciences at the ANU; see Figures 10a, 10b). This pioneering development provided the opportunity to conduct sound velocity experiments to pressures of 10 GPa and was exploited over the next few years by many graduate students and postdocs.

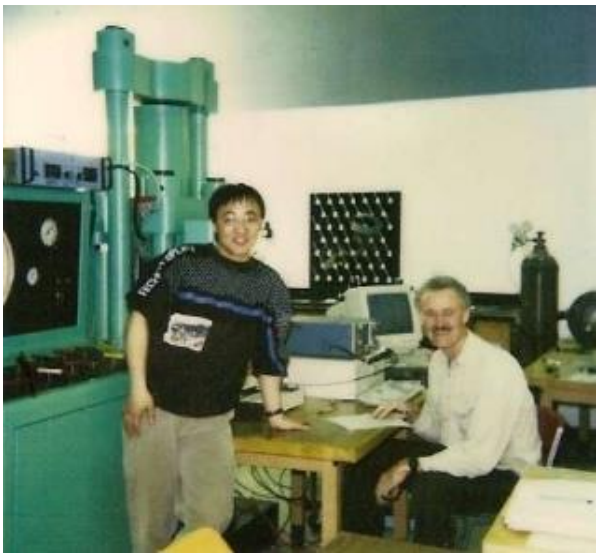

Figure 10a. In the following year, Ian Jackson spent 6 weeks in our laboratory working with Baosheng Li on interfacing the ANU ultrasonic interferometry system with the 1000-ton split-cylinder apparatus of the Kennedy-Getting type (Li, Jackson, Gasparik & Liebermann, 1996)

Figure 10b. Baosheng Li and Kennedy-Getting Press with Walker-type Module in High Pressure Lab in 1994

On a sabbatical leave in 1976 at the James Cook University in Townsville, Queensland, my Stony. Brook colleague Charlie Prewitt met a young Australian graduate student, John Parise, with whom he enjoyed a long period of collaboration (and who later succeeded Charlie in the crystallography chair at Stony Brook). With Ken Schwartz, Bob Shannon from DuPont and Dave Cox from Brookhaven National Laboratory, Parise and Prewitt pursued the high-pressure synthesis of platinum oxides for fuel cell cathodes and characterization by X-ray and neutron diffraction.

In 1995, Jennifer Kung spent six months at Stony Brook working with Gabriel Gwanmesia on the synthesis of polycrystalline specimens of $ScAlO_3$-perovskite for her thesis at the ANU with Sally Rigden and Ian Jackson (Kung et al., 2000a, 2000b). During her postdoctoral stay at Stony Brook from 2000-2005, Jennifer returned to the ANU to perform a high-temperature acoustics study of orthoenstatite in Jackson's lab (Figure 11) (Kung et al., 2011); she was accompanied by one of John Parise's graduate students Sytle Antao who performed similar high-temperature studies on magnesium ferrite spinel (Antao et al., 2007).

In the most recent collaboration between the ANU and Stony Brook, Ting Chen and her colleagues measured the sound velocities of polycrystalline coesite at high pressure and temperature in Baosheng Li's laboratory (Ting Chen et al., 2017). using a specimen hot-pressed by the author in a girdle—anvil apparatus in 1975, and so very "well-aged" (Liebermann et al., 1974).

Figure 11. Jennifer Kung with High-temperature, Ultrasonic Apparatus in Laboratory of Ian Jackson at the RSES at the ANU

In the my most recent visit to Australia in 2006, my wife and I. were hosted by Maggie and Ian Jackson at their cottage on Lilli Pilli beach, which we remember fondly from our many family visits there in 1970 to 1976 (Figure 12).

Figure 12. Ian Jackson and Bob at Lilli Pilli Beach, Australia 2006

2008-2013—Global Center of Excelllence (G-COE) at Ehime University in Matsuyama.

From 2008-2013, Ian Jackson and I (the author) of the Advisory Committee for the Global Center of Excellence (G-COE) Program at Ehime University in Matsuyama led by Tetsuo Irifune (Figures 13-15).

Figure 13. Advisory Committee and Japanese Members of the Global Center of Excellence (G-COE) at Ehime University. Bob in Front Row with Ian Jackson Standing Behind

Figure 14. Lunch for Advisory Committee of G-COE in 2013

Note. Seated: Shun-ichiro Karato, Takehiko Yagi, Bruce Buffett, Ian Jackson, Bob and Zhenmin Jin; Standing: Craig Bina and Tetsuo Irifune.

Figure 15. Bob and Ian at Advisory Committee Meeting in Matsuyama of Global Center of Excellence in 2013

5. Personal Life in Australia

As documented above, our family of 3 moved to Canberra in October 1970 and lived in the university flats in Garran for the next 6 years. During that period, we had two more children, a daughter Erica born in 1973 and a son Mark born in 1976; both of whom now bear dual citizenship in Australia and the United States. Our oldest daughter Karen, who spent 6 of her first 7 years in Australia, is very jealous of this dual citizenship.

Among the highlights of our time is Australia were regular visits to the wildlife refuge at the Tidbinbilla Nature Reserve in the nearby Brindabella mountains. The principal attraction at the Tidbinbilla was the presence of numerous kangaroos who were sufficiently tame that our children could pet them and be photographed with them, as you can see in the following photos when they were infants and later when they were young adults.

Figure 16. Baby Karen with Her Favorite Kangaroo in 1971 at Age 2

Figure 17. Karen Scratching the Chin of a Kangaroo in 1974, at Age 5

Figure 18. Karen Sharing One of Her Kangaroos with Her Uncle Tom in 1974

Figure 19. Erica at Age 1 with Barbara and Uncle Tom in 1974

Figure 20. Bob with Son Mark, Age 3 Months, in 1976

Our other favorite family activity while living in Canberra were regular trips to the beaches of the Atlantic coast, which were only a 2-hour drive away. One of our favorites was Lilli Pilli beach, where Karen and her sister Erica enjoyed playing in the sand.

Figure 21. Barbara in the Woods Overlooking Lilli Pilli Beach (see also Figure 12 above)

Figure 22. Erica and Karen on Lilli Pilli Beach in 1974

Figure 23. Our Family on Lilli Pilli Beach in 1975

In 1992, we returned to Australia with our young adult children and, once again, enjoyed seeing the wildlife of our adopted country, as well as visiting our friends, Ian and Chris Nicholls, in Melbourne. It was a pleasure to introduce our kids to the crimson rosellas and kookaburras, as well as the kangaroos at park on Wilson's Prom in Victoria (Figures 24-25).

Figure 24a. Karen with Crimson Rosellas

Figure 24b. Kookaburras

Figure 25a. 1992: Erica at Age 19 with Kangaroo

Figure 25b. 1992: Mark at Age 16 with Kangaroo

6. Dedication

I would like to dedicate this paper to Alan Major and Bill Hibberson, Senior Technical Officers in the Department of Geophysics and Geochemistry of the Australian National University, who were instrumental in ensuring the success of the experiments in our new ultrasonics laboratory in Canberra in the 1970s.

7. Conclusion

This paper summarizes my research collaborations with Australian scientists over the past six decades. I have presented both the scientific achievements and the personal connections which resulted from these collaborations.

Acknowledgements

I am grateful to Ian Jackson, Leonie Jones, Jennifer Kung, Gabriel Gwanmesia Jim Boland, Bruce Hobbs, Frank Stacey, Sally Rigden, Hiroyuki Kagi, Eiji Ohtani and Tetsuo Irifune for their correspondence and contributions to this historical paper. My collaboration with my Australian colleagues has been supported by research grants from the NSF Geophysics Program and the NSF Science and Technology Center for High Pressure Research (CHiPR). This report was written with support from a research grant to Baosheng Li and myself from the National Science Foundation (EAR-1524078).

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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