

My Research Connections with Russian Scientists over the Past Half Century

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Abstract

Over the past half century, I have maintained research connections with Russian scientists during investigations in seismology and mineral physics. These studies have focused on detection and discrimination of underground nuclear explosions and measurements of the physical properties of minerals at high pressures and temperatures. During this period, I have also visited many research laboratories in Russia, including Moscow, Chernogolovka, Novosibirsk and St. Petersburg. The objective of this paper is to relate this history.

Keywords

Mineral Physics, High Pressure, High Temperature, Seismology, Underground Nuclear Explosions

1. Introduction

Over the past decade, I have concentrated on writing papers on my history pursuing a scientific career in mineral physics. The first 3 of these papers appeared in a Special Issue of the journal “**Minerals**” and were later included in the book volume on “Mineral Physics: In Memory of Orson Anderson”: these included “The Orson Anderson era of mineral physics at Lamont in the 1960s” [1]; “The birth of mineral physics at the ANU in the 1970s: [2]; and “My career as a mineral physicist at Stony Brook: 1976-2019: [3]. More recently, I have also published papers on my collaborations and connections with French, Czech and Chinese scientists in the *International Journal of Geosciences* [4] [5] [6]. This new paper is of a similar genre.

2. Early Studies in Seismology

In the summer of 1964 before enrolling as a graduate student at Columbia Uni-

versity, I worked with Gary Latham and George Sutton at the Lamont Geological Observatory on the development of seismometers to be deployed on the ocean bottom. During coffee breaks each day, I used to meet Jim Brune who had just published a paper in the *Journal of Geophysical Research* using an ARea (AR) method to compare the relative excitation of surface waves by earthquakes and underground explosions in the California-Nevada region [7].

In October 1965, the U. S. conducted detonated the underground nuclear explosion Long Shot beneath Amchitka Island in the Aleutians. Jack Oliver suggested that someone look into the surface waves excited by this man-made event. Paul Pomeroy recruited me for this project and Brune began to teach me how to employ the AR method [in which one determines the long-period spectrum of seismic events by measuring the sum of the areas of the envelopes of the surface waves on three-component, long-period instruments].

In the pre-digital age, we found this AR technique difficult to apply and calibrate, inasmuch as it involved photocopying the seismograms and then cutting out and weighing the surface-wave trains. So, we decided to see if a simpler measure of the surface-wave excitation would work as well as Brune's method. Following the earlier work of Press *et al.*, [8], we determined the surface-wave magnitudes (M_S) and body-wave magnitudes (m_b) at 56 stations throughout the world. When we compared the M_S vs m_b data for Long Shot with the expected empirical M_S - m_b relationship for earthquakes of Gutenberg and Richter [9], we found that all of the Long Shot M_S data fell well below the G-R relation. To verify that this was not due to regional variation, we also compared the M_S vs m_b data for Long Shot with those for 29 earthquakes in the Aleutian Island region, and conclusively showed that Long Shot generated long-period surface waves which were significantly smaller than those generated by earthquakes of comparable body-wave magnitude from the same geographical and tectonic region (see details in Liebermann *et al.* [10]).

In February and December 1965, two seismic events in southern Algeria were recorded; based on newspaper reports and geographical coordinates which placed these events in aseismic areas, these events appeared to be underground explosions. As these Algerian events had comparable body-wave magnitudes ($m_b = 4.9$ and 5.8) to Long Shot ($m_b = 6.1$), Pomeroy and I decided to apply our M_S vs m_b approach to determine their excitation of surface waves. We found that the Algerian events exhibited smaller M_S values than would have been expected by earthquakes of comparable m_b , a result which closely paralleled our findings for Long Shot.

Support for both the Long Shot and Algerian studies was provided by the Advanced Research Projects Agency [ARPA]. When we showed our Algerian data to our monitor at the Air Force Cambridge Research Center, ARPA decided to classify our results and prohibit publication, which was not good news for a young graduate student. Fortunately, in 1966 these results were declassified due to the intercession of Frank Press, who wanted to use them in presentations during negotiations with the Russians in Geneva for a nuclear test ban treaty,

and were ultimately published in Science [11].

Subsequently, Pomeroy and I wanted to extend our studies to other nuclear test sites, including the Nevada Test Site in the U.S. and those in the Soviet Union near Semipalatinsk in central Asia and Novaya Zemlya on the Arctic Circle. While the dates and origin times of the U. S. tests were public information, those in the Soviet Union were not. Lynn Sykes suggested that we search the ISS database for events with zero focal depth and origin times on or near the hour mark. This somewhat unscientific approach yielded two events in 1965-66, near the known test sites. In a 1969 paper in JGR, we demonstrated that the M_s vs m_b discriminant worked well in five distinct geographical and tectonic regions of the world: the western U. S. (5 events), the Aleutian-Kamchatka area (1), southern Algeria (2), central Asia (1) and Novaya Zemlya (1) [12]; the results for the Aleutians were later confirmed for the underground nuclear explosion Milrow [13].

I recall two personal anecdotes from this period of work on the detection and discrimination of underground nuclear explosions and earthquakes:

In 1967, Jack Oliver and Paul Pomeroy provided financial support for me to attend the IUGG General Assembly in Zürich, Switzerland and present our paper on “Relative excitation of surface waves by earthquakes and underground explosions” in those five regions (Liebermann and Pomeroy JGR 1969 [12]). On the morning of my paper at the IUGG, I noticed that a senior Soviet seismologist, Acad. Yu. Risnichenko, was seated in the front row of the audience with a camera focused on my slides on the screen. As a child of the Cold War and a student supported by the Air Force, I was a little disconcerted but managed to finish presentation of our paper.

When in 1967, I decided to move my dissertation research from seismology to mineral physics, my father (a high-school biology teacher) expressed some disappointment. While he had enjoyed telling friends and colleagues that his son was doing geophysical research which had the possibility of reducing the number of nuclear tests, he could find no societal benefit in studies of the properties of minerals in the laboratory at the elevated pressures and temperatures which exist in the Earth’s interior.

3. Studies in Mineral Physics

In 1967, I was encouraged by fellow graduate students Art McGarr and Peter Molnar to shift the focus of my research from seismology to the new field of mineral physics, then being introduced to Lamont Geological Observatory by Orson Anderson [1]. Over the next 4 years, I conducted experiments on the sound velocities of minerals at high pressures and temperatures under the guidance of Edward Schreiber [1] [14].

In 1970, I moved to Canberra, Australia and 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 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 [2].

In 1971, I attended the IUGG General Assembly in Moscow, Russia and presented the first results from our ultrasonics laboratory at the ANU (my Czech friend Vladislav Babuska taught me how to say “next slide please” in Russian: “*следующий слайд пожалуйста*”).

We reported results for rutile-structure oxides using polycrystalline specimens hot-pressed at pressures up to 3 GPa in a piston-cylinder apparatus [15]; see also [16]. These rutile oxides of TiO_2 , GeO_2 and SnO_2 are structural analogues of SiO_2 (stishovite), but we were not able to reach the pressures necessary to synthesize specimens of stishovite at that time (circa 9 - 10 GPa).

At the IUGG in Moscow, Sergei Stishov gave a paper in Russian on his discovery of stishovite—see 1961 paper in *Geokhimiya* with Svetlana Popova [17]; his colleague, Madame Popova provided a simultaneous translation in English. Stishov preferred to speak in Russian so that his personality was in full display, but he left translations in English on a table in front of room.

During the meeting in Moscow, discussions with Sergei Stishov provided information on extending our hot-pressing experiments to the 10 GPa range so that we could hot-press specimens of stishovite. His advice later served useful in synthesizing polycrystals at pressures of 12 GPa in a modified belt apparatus in our laboratory at the ANU [18]. (Figure 1)



Figure 1. Sergei Stishov in laboratory conducting high-pressure experiments.

When I was attending the IUGG in Moscow in 1971, I stayed at Gostinitisa Rossiya near Kremlin Square. I shared a room with Ted Lilley my colleague from the ANU, but could not find his name on the hotel register when checking in, as he had used his formal family name. With Lynn Sykes from Lamont, I took a side trip to Zagorsk, site of the 15th century monastery Trinita Lavra; also known as Sergiev Posad (see photo below of author there with Yuriy Litvin in 2013).

For another tourist experience, Vladimir Zharkov took me to a soccer (football) match in Moscow Stadium. When I made the mistake of cheering for the opponent of the home team, Zharkov shouted to me “Stop”.

In 1975, Nikolai (Nick)_Sobolev, Professor at the Institute of Geology and Mineralogy of the Siberian Branch of the Russian Academy of Sciences in Novosibirsk visited the ANU as a guest of David Brown. While there, he performed high-pressure petrological experiments with David Green in the laboratory of Ted Ringwood. Nick Sobolev is the son of Academician Vladimir Stepanovich Sobolev, who is famous for first predicting the probability of diamonds in Yakutia in northern Siberia (**Figure 2** and **Figure 3**). He is one of 3 Sobolev brothers who are geologists (including Alex and Stefan); See **Figure 4**. During Nick’s stay in Canberra, his father visited and we took him to see the kangaroos at the nearby Tidbinbilla Nature Reserve in the Brindabella Mountain Range. We also took Nick to the Pacific Coast beach at Lillipilli (**Figure 5**), but he declined to use sunscreen and thus acquired a severe sunburn (which made it uncomfortable to wear a shirt at a formal dinner at University House that night).

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 Eastern Europe could attend. Vláda Babuška, Jarka Plomerová, Vlastislav Červený and I convened the first of these workshops in 1976 at the Castle of Liblice in central Bohemia on “Anisotropy and Heterogeneity of the Lithosphere” (Babuška and Liebermann [19]). Using the 1976 model, we convened two other meetings in 1986 at the Castle of Bechyně and in 1996 at the Chateau of Třešť.



Figure 2. Nikolai Sobolev.



Figure 3. Vladimir Sobolev.



Figure 4. Photo of Stefan and Alexander Sobolev (twin brothers of Nikolai) with Priscilla Grew at Fall AGU in 2019 when Alexander was elected a Fellow of the AGU.



Figure 5. My daughter Karen and Nick Sobolev playing football at Lillipilli Beach.

The main objective of this workshop series was to bring together geoscientists—geophysicists, geochemists, mineral and rock physicists, geologist to evaluate various techniques of geoscience disciplines for mapping/modelling the inner structure of the Earth, to jointly interpret results from different datasets aiming at reducing the family of plausible models and to be able to understand development of the Earth in the past.

There were many Russian scientists at the Liblice workshop as seen in the group photo below. (**Figure 6** and **Figure 7**)

Since 1971, I have attended many high-pressure meetings in Japan including the 2nd Japan-USSR Conference in Misasa in 1989 [which included a geology field trip in southern Honshu and Shikoku Islands and a stop at the Atomic Bomb site in Hiroshima—a visit that was particularly emotional for the scientists from the USSR and the US]. It was in Misasa where I met Yuriy Litvin again and Oleg Kuskov for the first time and invited them to spend some time at Stony Brook as visiting scientists to the NSF Center for High Pressure Research (CHiPR).

Subsequently, I resumed correspondence with Sergei Stishov, who had written a memoir on the discovery of high-density silica (subsequently published in High Pressure Research in 1995 [20]. At the time of the fall of the Soviet Union,

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



Figure 6. Attended by 75 scientists from 12 countries. Additional Russian IDs: Yuriy Litvin to left of Kumazawa; Lebedev (from Ukraine) behind Kumazawa, Vladimir Zharkov behind right shoulder of Froidevaux; V. Kalinin to right of Babuška (who is to right of Murli Manghnani). For the author, it was the first time to meet Yuriy Litvin, marking the start of a longstanding friendship. The Russians did not stay in the Castle of Liblice, but in a separate hotel with their KGB minders. See details in Babuška and Liebermann [19].



Figure 7. André Lacam, Olivier Jaoul, V. Kalinin, Vladimir Zharkov, Syun-iti Akimoto and unidentified Russian queueing for lunch at Liblice 1976.

funds for scientific research decreased in Russia and Stishov expressed an interest in taking up the offer to visit Stony Brook. He spent 6 months at Stony Brook in 1991, during which our students and postdocs profited from several seminars delivered in excellent English. He also consulted with graduate student Baosheng Li on synthesizing large polycrystals of stishovite, which led Baosheng's important study with Sally Rigden from the ANU [21].

Much to the delight of those of us at Stony Brook, Stishov also recounted the history of the first synthesis of SiO_2 -rutile in 1961 and the naming of this mineral as "stishovite" by Ed Chao and others who discovered it in the Meteor Crater in northern Arizona (which Stishov had visited during a research visit to the Los Alamos National Laboratory in 1993). (Figure 8)

Recently, Yuriy Litvin published an article entitled "A guest from the Earth's mantle" in *Nezavisimaya Gazeta*, 28 April 2021, [22] which is very entertaining and includes some additional details in the saga of the first synthesis of SiO_2 -rutile and the naming of it as "stishovite" by Chao *et al.*, [23] who discovered it in Meteor Crater (see website [HTTPS://WWW.NG.RU/SCIENCE](https://www.ng.ru/science)).

In the early 1990s, CHiPR also hosted another visiting scientist from Russia: Oleg Kuskov from the Vernadsky Institute in Moscow, an expert on the thermodynamics of minerals (whom my children christened "the Russian Bear" due to his impressive stature).

During a conference in Novosibirsk in 1992, I met Olga Fabrichnaya, who later recommended Yegor Sinelnikov to study with me at Stony Brook. Yegor initially worked with Ganglin Chen to develop dual-mode ultrasonic interferometry in our multi-anvil apparatus using single-crystal olivine as the pressure

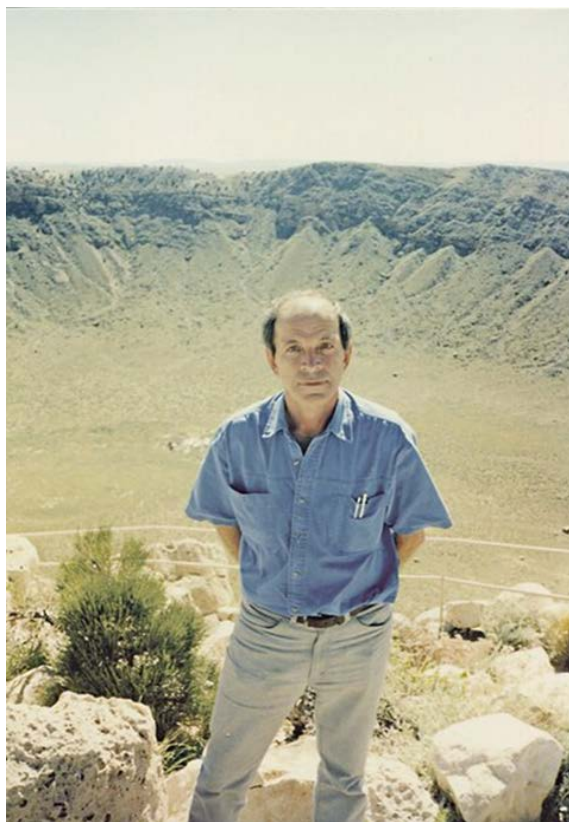


Figure 8. Sergei Stishov at Meteor Crater in Arizona, site of first discovery of “stishovite” in nature.

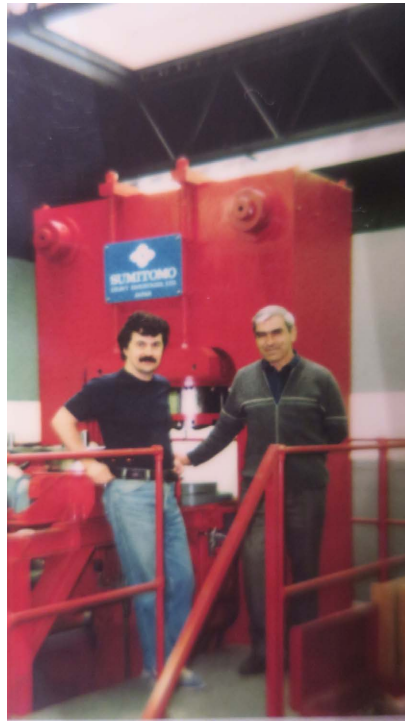
standard [24]. For his M.S. and Ph.D. degrees, Sinelnikov studies the high-pressure elastic properties of perovskites, including CaTiO_3 - CaSiO_3 solid solutions and MgSiO_3 -perovskite (bridgmanite) [24] [25] [26] [27].

In 1991 and 1993, Yuriy Litvin came to Stony Brook for extended research visits during which he conducted high-pressure petrological experiments with Tibor Gasparik. These initial experimental studies were successful [28] [29] and were continued by Vlad Litvin [30] and later in Chernogolovka. Previous data on the olivine+jadeite interaction with formation of garnet among the reaction products were modified with discovery of a peritectic reaction of olivine and melt and the formation of a garnet-bearing assemblage [31]. The reaction is important as the key mechanism of the ultrabasic-basic evolution of magmatic and diamond-parental melts [32] at upper mantle depths. (**Figure 9**)

The Litvin visits also led to Yuriy’s son Vlad enrolling as a graduate student in our Department of Geological Sciences. During his stay at Stony Brook, Vlad also was one of the Summer Scholars supported by CHiPR. (**Figure 10**)

4. Personal Connections

In 1992 after the 9th High-Pressure Mineral Physics Seminar in Verbania, Italy, I visited Nick Sobolev in Novosibirsk and gave an invited talk at an international conference. Litvin remembers that in my talk, I said that I was going to speak



(a)



(b)

Figure 9. (a) and (b) Yuriy Litvin with Tibor Gasparik and the USSA-2000 multi-anvil apparatus in the Stony Brook High-Pressure Laboratory.



Figure 10. Vlad Litvin, pictured here with Summer Scholars of CHiPR in early 1990s.

slowly for Japanese colleagues, which seemed a funny thing to say in front of the Russians. When my return flight to New York was delayed by more than one day due to a strike by Aeroflot; I survived on vodka and watermelon at the airport in Novosibirsk.

On back way to Stony Brook from Novosibirsk, I stopped in Moscow and visited the flat of Natalia Sretenskaya, a friend of Yuriy Litvin, who presented me with a picture painted by her father—professional painter Grigory Sretenskii, which now hangs in our home in Setauket, New York. (Figure 11)

During the years of Yuriy Litvin’s research stay at Stony Brook, we became good friends with him and his wife, Svetlana, and subsequently enjoyed meeting them on many occasions. (Figure 12 and Figure 13)



Figure 11. Grigory and his wife Nina (also an artist) belonged to the Russian vanguard as the successors and students of Peter Konchalovsky, a post-Impressionist and leading person in the well-known art group “Knave of Diamonds”.



Figure 12. 1991: Barbara and Svetlana in our garden in 1991.



Figure 13. 1991: Bob and Yuriy examining the vintage of a bottle of wine.

In May 2013, we flew to Russia for Barbara's first visit, hosted by Svetlana and Yuriy Litvin. This was particularly significant for Barbara, who had been a double major in French and Russian at Elmira College in the 1960s

First stop was Chernogolovka, a science city northeast of Moscow, where we spent a long weekend, which included a family picnic at their dacha and tourism in Sergiev Posad [formerly Zagorsk which Bob had seen in 1971]. (**Figure 14** and **Figure 15**)

I visited the Institute of Experimental Mineralogy in Chernogolovka with Yuriy, and met the Director, Academician VILEN Zharikov with whom I discussed some problems of high-pressure experimental geophysics and geochemistry.

Yuriy also shepherded my wife Barbara and me on tourist visits to Zagorsk (Sergiev Posad), Moscow and St. Petersburg. (**Figure 16**)

To the northeast of Moscow lies the town of Sergiev Posad (Zagorsk in the Soviet era). Although it is nowadays an industrial center with a population of over 100,000, its fame rests on the Trinity Lavra of St. Sergii (a Lavra is the highest rank of Orthodox monastery, and there are only four in all Russia), the Russian Orthodox equivalent of the Vatican, which has a complex of medieval buildings to rival those of the Kremlin.

Then Yuriy accompanied us to Moscow for a week during which we indulged in major sightseeing. Finally, Yuriy took us by train to St. Petersburg to see the Hermitage and the castles of Peter the Great and Catherine the Great. Last night was a special dinner in Moscow with Svetlana, Yuriy and their son Vlad. (**Figure 17**)

The Cathedral of Vasily the Blessed, commonly known as Saint Basil's Cathedral, is an Orthodox church in Red Square of Moscow, and is one of the most



Figure 14. 2013: Svetlana Litvin and Barbara Liebermann at the Litvin dacha outside of Chernogolovka.



Figure 15. 2013 Barbara and Svetlana on the deck of the Litvin apartment in Chernogolovka.

popular cultural symbols of Russia. It was built from 1555 to 1561 on orders from Ivan the Terrible and commemorates the capture of Kazan and Astrakhan. (**Figure 18**)

The Dormition Cathedral (or the Assumption Cathedral) of the Moscow Kremlin was the key Orthodox cathedral of the Russian state in the 15th-19th

centuries. In the neighboring Archangel Cathedral Tsar Ivan the Terrible is buried. All the emperors of the Romanov dynasty starting with Peter the Great are buried at the Saint Peter and Paul Cathedral in Saint Petersburg. (Figure 19)



Figure 16. Bob and Yuriy in front of 15th century monastery Trinita Lavra in ancient Zagorsk [also known as Sergiev Prosad].



Figure 17. Bob and Vlad Litvin at restaurant in Moscow in 2013; Vlad a former grad student at Stony Brook.



Figure 18. 2013: Bob and Yuriy in front of St. Basil's Cathedral in Red Square in Moscow.

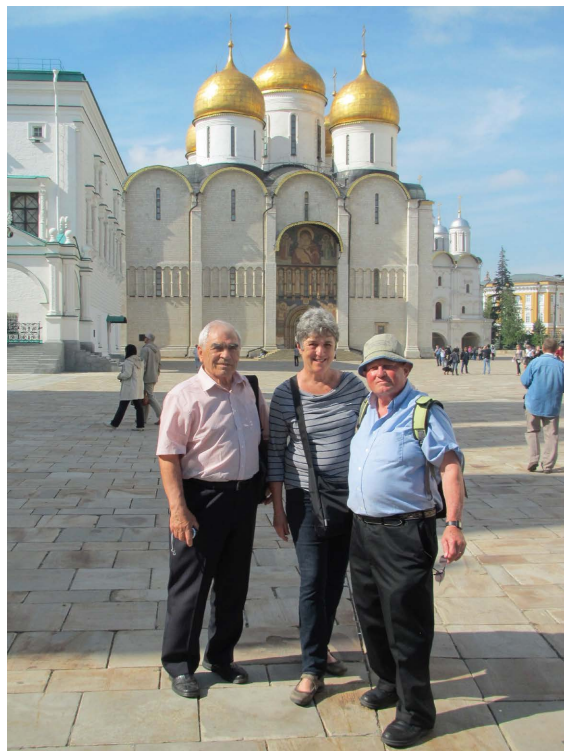


Figure 19. Bob, Barbara and Yuriy in front of the Dormitian Cathedral in Moscow in 2013.

The **Peter and Paul Cathedral** (Russian: Петропавловский собор) is a Russian Orthodox Cathedral located inside the Peter and Paul Fortress in St. Petersburg, Russia. It is the first and oldest landmark in St. Petersburg, built between 1712 and 1733 on Hare Island along the Neva River. Both the cathedral and the fortress were originally built under Peter the Great and designed by Domenico Trezzini. The cathedral's bell tower is the world's tallest Orthodox bell tower. Since the belfry does not stand alone, but an integral part of the main building, the cathedral is sometimes considered the highest Orthodox Church in the world. There is another Cathedral of Saints Peter and Paul Church in Petergof. (Figure 20)

In the subsequent years, the Litvins and Liebermanns have had rendezvous in Europe at scientific meetings of the EGU in Vienna and the EHPRG in Bayreuth. (Figure 21 and Figure 22)

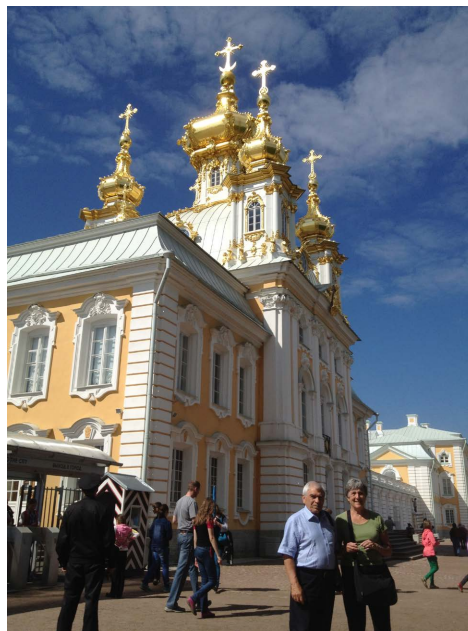


Figure 20. 2013: Yuriy and Barbara in front of Peter and Paul Cathedral in St. Petersburg.



Figure 21. 2015 Svetlana Litvin and Barbara Liebermann in forest of L'Hermitage, Bayreuth, Germany during EHPRG meeting.



Figure 22. Litvins and Liebermanns in Bayreuth 2016.

5. Conclusion

This paper summarizes my research connections with my Russian colleagues over the past 50+ years. I have presented both the scientific achievements and the personal connections which resulted from and facilitate these collaborations.

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Conflicts of Interest

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

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