The Russian-American author Vladimir Nabokov allegedly once said, “Curiosity is insubordination in its purest form.” We have no evidence that he knew today’s Reid Medal recipient, Tatyana Glebovna Rautian, or Tanya as most of us call her, but she typifies all elements of that aphorism.

Born in Leningrad and a teenager during its siege by Nazi Germany, Tanya went on to study physics at the University of Leningrad. She then moved with her new husband, Vitaly Ivanovich Khalturin, to Garm, Tajikistan, to establish a seismograph, which grew into a network of them, while they reared their five daughters. As some of you know, her talents include choosing a remarkable husband.

So, imagine a curious seismologist, with no access to, or even knowledge of, the Bulletin of the Seismological Society of America. What does she do in a setting where household water has to be bucketed from an irrigation channel behind the house and diapers are not even a concept? Everyone here would agree that to quantify our knowledge of local earthquake activity and risk, we first must decide how to quantify the sizes of earthquakes themselves. So, before giving birth to the last two of her five daughters, Tanya had devised her “energy scale,” or “Rautian’s $K$-scale,” which resembles Richter’s magnitude scale but offered a direct measure of the energy radiated by an earthquake as seismic waves. Soviet seismologists promptly adopted her formalism for quantifying earthquakes and she is sometimes called the “Charles Richter of the Soviet Union.”

Like Richter’s Magnitude, her $K$-scale bore witness to years of study of earthquakes at different distances and in different environments. As a byproduct of that experience, according to Garm legend, she learned how to locate felt earthquakes in real time from the timing between P and S waves and the spectral characteristics of their audible signals.

Her curiosity reached beyond seismology. Folks in Garm raised much of their food. Curious about what is innate and what is learned, she switched the eggs laid by a duck and by a young hen. The hen showed no surprise when infant ducklings hatched beneath her, until they dove into a pool along the irrigation channel, but the hen soon adapted, wading knee deep to oversee swimming lessons. Frustration, if not dismay, came the following year, when her newly hatched chicks wanted no part of a swim. Such experiments continued for a few years, until earthquakes and seismograms offered too many questions.

As seismologists in the west gradually developed digital recording, Tanya gained access to remarkable analogue data. A collection of seismometers, sensitive to different periods, sent signals that were bandpass filtered to allow optical recording of a set of simultaneous wavelets centered at different periods: a continuously recorded spectrum of the ground motion. With these data, she and Khalturin first attacked the seismic coda, and in 1978 they published a paper in the BSSA that had Kei Aki nearly dancing in the hallways at MIT. In the early 1980s, during an informal conversation with Scott Phillips when he was a student, Aki told him: “There are many good scientists in the Soviet Union, and the best is Tanya Rautian. Please get to know her work.”

The seismic source attracted Tanya’s curiosity most, in particular the spectral content of both body waves and the coda. She found that despite many exceptions, the amplitude spectrum could be treated as three segments separated by two corner frequencies. The low-frequency part, of course, scaled to the seismic moment, and the lower corner frequency scaled to dimensions of the entire rupture. Her higher corner frequency, however, showed no relationship to the size of the earthquake, whether measured with the moment, her $K$, or the value of the lower corner frequency. She interpreted it in terms of small regions of localized stress accumulation where the rupture nucleated or broke through barriers.

In the early 1990s she brought this experience to the United States, and with Khalturin, Paul Richards, and others, she applied it to the problem of discriminating earthquakes from nuclear explosions. For periods, Tanya served as Vice-Chief of the Complex Seismological Expedition in Garm and as the Vice Director of the Tajik Institute of Seismology and Earthquake Engineering in Dushanbe, tasks that would have challenged anyone in the Soviet Union’s hierarchical system, especially a
woman. She managed her tasks, almost surely, because of her commitment to avoiding deception and to standing up for human rights. That commitment reached its nadir in 1991 shortly after Boris Yeltsin stood on tanks in Red Square to prevent a coup d'état. She wrote a letter to Yeltsin and other leaders in Moscow and gathered signatures to it. It began: “The staff of the Seismological Expedition of Institute of Physics of the Earth of the USSR Academy of Sciences that is conducting research in the territory of Tajikistan is deeply offended by the unlawful actions of the self-proclaimed ‘State Committee of the State of Emergency...’” and it continued in the same no-nonsense tone. Needless to say, this act of insubordination would have cost her more than the Reid Medal if that “State Committee” had gained power.

Conversations with Tanya invariably consist more of questions than opinions. She looks more for doors to scientific inquiry that can be opened than to drawers of them that can be shut. She epitomizes how seismology benefits when curiosity does not become subordinate to ideology or to wisdom received uncritically, but remains pure.

Harry Fielding Reid Medal Response

Dear President von Hillebrandt, colleagues, and friends!

It is so amazing to stand here before you to receive the Reid Medal. I feel that Vitaly Khalturin, my dear late husband, friend, and collaborator, stands here next to me. We lived and worked together for more than half a century. He would be so happy today.

Both of my parents were scientists. As a child listening to their stories, it seemed that curiosity was the essential ingredient of scientific work.

I recall that when I was 6 my father explained the idea of positive and negative numbers, the Earth as a sphere, Archimedes’ Principle, color vision, and the endlessness of Space.

When I was about 13, my mother explained some details of her work. In particular, some puzzling contradictions in her data. I’ve learned that those contradictions are the key to solving problems on a deep level. At this point I lost interest in mystery novels. Scientific mysteries seemed to be so much more interesting.

Later I read an intriguing book about nuclear fusion inside the Sun. I decided to study nuclear physics at the University in 1948. Soon, however, I realized that being a nuclear scientist meant working on a Big Bomb. I did not like the idea and did not want to work on it.

While university education was free in USSR, we were not free to choose our work. I was about to be sent to East Siberia as an employee of the KGB. At that critical moment, Vitaly appeared in my life. We married. He said: “KGB? No way! I know the best place in the world—it is Garm in Tajikistan.” He conducted lengthy negotiations on my behalf, and finally I was released.

From cold, windy, wet Leningrad with its flat-as-a-table relief, I moved to a fantastic mountainous country, with 350 sunny days per year. There was no running water, no electricity, no washing machines, no traffic, no theaters, no libraries, no professors, but there were earthquakes! And earthquakes were not only something on photographic paper, but tremors and sometimes a good shaking. I liked it!

I knew almost nothing about seismology at that time. My mother used to say: “If you have a good general education in physics—you can do research in any science related to physics.” At first my job was mostly traditional: developing methods for data processing. At this point we were not ready to study earthquakes as physical processes.

In 1954 Garm had evolved from a seismic station into a Seismological Center. Famous seismologists from Moscow started visiting us. One of them, Vladimir Keilis-Borok, asked:
“At the very moment, when a rupture starts, does the earthquake know whether it will be large or small?” My inner voice pushed me to answer: “Yes!” As I remember, his opinion was closer to “No.” But that question (“What does an earthquake know about itself?”) quietly lingered in my mind like a lighthouse.

“The Berlin Wall” collapsed in Garm in 1971. We met and briefly talked with a few American scientists. Lynn Sykes told us about plate tectonics, about which we knew nothing. We discussed our study of the coda with Kei Aki.

Frank Press was specially informed about all of our work in Garm. I remember this scene, which was very emotional for me at that time: Frank Press sat in the center of the room, his foot on his knee. All the walls were covered with posters. I moved slowly from one poster to another explaining by my (far from the best) English. Press was rotating along. Igor Nersesov silently listened trying to sense Press’s opinion. It was followed by a few days of one-on-one discussions between Nersesov and Press. All of us in Garm had a premonition of something important brewing behind the scenes.

Soon we began regular work with Americans. More than just new professional contacts, we came to understand and appreciate each other’s culture and way of thinking.

My work in Garm could not have been possible without the “band pass filtered instrumentation” developed by Konstantin Zapolsky. Each earthquake was no longer just a name and address, but became something more, a description of physical process, promising something, still uncertain, but ultimately important. Zapolsky invented this instrument in the late 1940s, but only in 1970s did Vitaly create a controlled system of observation that exploited it. Eventually we obtained a huge collection of seismograms. They became the basis of my most favorite study: of source spectra and source parameters of earthquakes. It led to my understanding of the distribution of cracks and fault sizes, and of stress and strength of them in a fragmented crust. It took 20 years for Zapolsky’s instrument to provide an abundance of data sufficient to reveal earthquakes’ secrets. I am now sure that “an earthquake knows from the very beginning what it will be.”

For 40 years I lived and worked in the Seismological Center in Garm. This Center was a creation of Igor Nersesov, the result of his work and his worries, the source of his happiness and his disappointments. He created wonderful conditions for life and work there. In Garm we never worried about writing proposals—that was his duty. I disagreed with Nersesov about earthquake prediction, and I avoided working on it. Even though he was not happy about this, he tolerated my independent style.

The analog photographic-paper seismograms collected during 40 years of work unfortunately burned in the flames of civil war in Tajikistan from 1992 to 1997, but all my favorite earthquakes, their spectra, all the questions and answers, doubts and riddles are still spinning in my head.

Then, thanks to Paul Richards, Vitaly and I had the opportunity to live in America-the-beautiful and to work at Lamont for 11 years, from 1994 to 2005.

I am grateful to all the wonderful people mentioned earlier, my colleagues in Garm, and many others, who helped me to go my own direction and made life so good. I also thank my children and grandchildren, who had to spend their childhood in Garm’s wilderness, and allowed me to be more of a scientist than a regular mother, or grandmother. I hope they forgive me. My work has been my hobby, my pleasure, my lovely toy. I am lucky that I had the opportunity to discover unknowns, to be curious enough to see the beauty of science and to share it with friends. Thank you again for the great honor to stand before you today.

Tanya Rautian
April 13, 2011