GROUND WATER

Historical Note

József Tóth: An Autobiographical Sketch

by József Tóth[1]

I was born in Békés, a large rural town of southeastern Hungary, on June 22, 1933. My father was an agricultural engineer, and my mother was one of seven children of a prominent lawyer. The country had lost two-thirds of its territory to the seven states surrounding it 13 years earlier, after the Great War.

Figure 1. Photo for mining school graduating class from which I never graduated, courtesy of the Soviet invasion, Sopron, Hungary, October 1956.

Ten years later, shortly after I started secondary school, Hungary was occupied by the Soviet Union during World War II. Partly because my family was on the wrong end of the Soviet communist-dominated political spectrum and partly because I was not a fawner, I had no hope of ever entering a university. Yet, although my marks at school were only slightly above average and I had more interest in gymnastics, gypsy music, wood carving, and bike tours than in academic subjects, I resisted my mother's pleas to enter a newly started wood-working trade school. At the age of 13 or 14, I had a strong feeling that I wanted to earn my living by thinking; thus, I needed a university education.

The dream continued, but reality prevailed. Like every student graduating from secondary school, I was required to apply for admittance to a university to make statistics look good. I started as a gauge- and template-making apprentice in the country's largest metal works in Budapest immediately after matriculation in 1951. This route seemed my only chance to academe: become a proletarian. Well, perhaps not the only. My gym teacher was an internationally renowned gymnast, captain of the Hungarian team at the 1936 Olympics, and he had contacts. He offered to have me admitted to the National Sports University. Hesitantly, fearing that it would hurt him, I declined: "I am very grateful to you, but, while I hope to continue gymnastics until body and soul hold together, I cannot see myself as a sport professional." (Yes, I still work out three times a week.)

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In the steel works, I became a journeyman in a year and earned some money that I spent on clothing. Even if I would get to a university, I would still have no income or support. My parents were ruined by the communists; their farm confiscated, pension taken away, employment denied. They could not have possibly helped me. Halfway through 1952, it was time to try my luck and apply for university admission, now as a member of the laboring class, the favored social stratum. The stakes were high. If I failed, I would be drafted into military service, most likely into forced labor, like most of my cousins and friends with my family background. Who knew if, once out of service two or three years later, I still would have the desire, strength, or chance to enroll at a university? The stress was high enough that it made me start smoking, on my own, no peer-pressure, and at times to look longingly at the approaching wheels of the Rapid Rail, the train that whisked me to and from my factory on the island of Csepel every day.

I applied. However, before sending off the required letter of recommendation from my factory's Party Secretary to the School of Mining and Geodesy of Sopron, I opened it, just to be on the safe side. It said I was a highly skilled and very productive worker, that I related famously to my co-workers, only I was "a little argumentative." I resealed the letter, sent it away, and was overjoyed by the reply calling me in for the entrance examination. By passing the written part—math, physics, and chemistry—I advanced to the oral, which focused on personal views, politics, party history—topics requiring a very careful approach. At the end of the interrogation, the Party Secretary committe-chairman, possibly with a 9th grade education, declared: "Comrade Tóth, your thinking is awfully slow, but it will improve with time." (Tóth 1967). I could have hugged him. From his tone, it was obvious: I was admitted! Back in the factory I wanted to quit the next day. They were perplexed: "You don't need to quit to attend." I replied that it would be difficult to commute daily to the west end of the country, 230 km away. It turned out that their favorable recommendation was based on their misbelief that I would be a correspondent student in one of the capital's universities. How lucky can you get?! I stayed on to finish the templates I was in the process of making for heavy cannon shells ordered by the Lamp Factory of Székesfehérvár. In September 1952, my postsecondary education started in exploration geophysics at the School of Mining and Geodesy of Sopron (Figure 1).

I knew I could not trust anybody, that I had to hold my tongue and simply try to demonstrate that I was a promising evolving geophysicist. But I still could not believe that anyone would take the philosophy and propaganda of the Party seriously, including those who taught it. My naiveté led to disaster: I flunked the very first university exam of my life, the history of the Soviet Communist Party. After the exam month, the personal director summoned me and menacingly demanded: "How come, Comrade Tóth, that you get 'excellent' in math, physics, descriptive geometry, and chemistry, and yet fail political science?" I assured him that the latter subject was far too difficult for my simple technically oriented mind, and that I would do my utmost to bone up on the important matters. I did pass my supplementary exam. I knew also that I was being watched, as most people were, and that my comings and goings, statements, and social contacts were reported. So, just in case I would have to act quickly, I kept the original documents nominating my father for all the medals and distinctions, including the highest in the country, the Order of Bravery, he had earned as an officer on the Russian and Italian battlefields during World War I. Without exception, he received them for saving the lives of single soldiers and whole companies, at great risk to his own. We hoped that these papers would save me from being expelled from school, if the Party should make a case of his military past.

One day, all these papers disappeared from the little, locked wooden box in my dormitory cabinet. It took a classmate and myself more than half a year, studying alone at separate tables every night in a large and ice-cold room of the students' residence, before we would trust each other enough to speak about our families and views. Subsequently we moved out and roomed together until we both left the country in 1956. Our caution was well founded. Before the end of the first year, more than a dozen of our class of 40 was expelled on the basis of being "antisocialist," "anti-working class," "class enemy," "kulak" (rich peasant), "bourgeois," "intellectual," and similar grounds.

After Stalin's death in 1953, Khrushchev, the new party boss of the USSR, loosened the reins a bit, thereby triggering an accelerating spiral of demand by the people and concessions by the Party. The spiral exploded in our bloody fight for freedom in 1956. The Russians had to send in fresh troops because most of the occupants already in Hungary either refused to fight or took our side. Finally, we were beaten, 10 million against 250 million, a great victory! Thousands of Hungarians died, and about 150,000 fled the country. After four and a half years at the university, with less than a half year remaining to graduation, Erzsi, my forestry-engineering student fiancée of four years, and I were among those who left. I crossed the border to Austria with a submachine gun and a briefcase full of ammunition, in the back of a pickup truck loaded with hand grenades, rumbling along a rutted forestry dirt road. When I became aware of the grenades, we continued on foot.

The Dutch were among the first who came to our refugee camp in Austria. They came with an empty train to offer political asylum and transport to Holland for 300 university students and some people with serious health problems and disabilities. Bona fide students would also receive scholarships from a fund set up and maintained by Dutch university students. One of my reasons for accepting their offer was the Dutch language; it is at the center of gravity of an equilateral language triangle: English, German, and French. Who knew where I might end up? Dutch would prepare me for the major languages.

Once in Holland, my fiancée and I tied the knot and hoped to continue, indeed quickly to finish, our university studies. That was not to happen. Saying that they knew nothing about Hungarian universities, the Dutch Ministry of Higher Education gave us credit for our high school diplomas but decreed that those wanting to study at a university must start from Year 1. No arguments. I had two choices: to quit the academic pursuit or buckle down. I elected the latter and stood up four years later, with two infant daughters and a "Doctorandus" degree (Ph.D. without thesis) in geophysics from the State University of Utrecht. I also had a total of one year geologic field experience in various mountains of Europe and the Dutch coal mines; virtual fluency in Dutch; a working knowledge of French, English, Spanish, and German; and was some 15 kilograms overweight.

Finally ready to tackle life, I had a tempting offer from the Royal Dutch Shell Co., to be groomed as a well-logging specialist in a research laboratory at their headquarters in The Hague. Instead, at the suggestion of a former schoolmate from Utrecht, I chose to join the Research Council of Alberta in Edmonton, Canada, to do geophysical exploration in their budding ground water division. An important factor in my decision to move to North America was the incessantly tumultuous and violent history of Europe for centuries; I wanted to save ourselves and our descendants from its continuation. Another, more immediate reason was the need to support my parents, whom the regime had deprived of any livelihood. With seemingly better economic conditions in the New World than in Europe, which was still suffering the aftermath of the war, and with a considerable student loan debt I had incurred to allow my wife to stay at home with the children, my chances of making ends meet appeared better in Canada than in the Netherlands. My parents arrived from Hungary 18 months after we landed in Canada, with me having to pay with "hard currency" for their permit to leave the country, issued on the condition that they never return.

On October 7, 1960, with wife and two kids, I set foot on the promised land with a firm resolve not to touch a textbook or scientific paper for at least a year. Fortunately, things again did not turn out that way. Very soon we realized that the kind of electrical sounding with which I was supposed to search for ground water could not differentiate between the shaley-silty Cretaceous bedrock of buried valleys and their reworked fillings used as aquifers. I had a job but no work to do. I decided to retread myself. I started by reading *Ground Water Hydrology* (Todd 1959), on a very cold and snowy night in December 1960, on the way to a municipal pump test I was asked to conduct—as if I would know how to do it.

I was then assigned to an area of approximately 200 × 200 km in central Alberta, as "groundwater geophysicist," to look after the ground water problems and requests of farmers, towns, and industries in the region—talk about being thrown into deep water! I thought the best and quickest way to lay a general background for this task was somehow to depict the path of a drop of rain water from the spot and moment it infiltrates the ground to where and when it resurfaces. I was advised that the best guide to develop this understanding was the 1940 paper written by M. King Hubbert; thus, I read and tried to apply it. Soon, however, I noticed a discrepancy between what I expected and what I observed. Hubbert's figure 45 shows all infiltrated water to discharge in the thalweg of the river valley, as though it functioned as a drainage ditch. In reality, the numerous creeks in my area, while running parallel at 10 to 15 km spacings in well-developed valleys of 150 to 200 m relief, cut into sandstones and siltstones, and with water tables no deeper than 3 m below surface even on the divides, were all misfit, dry at many places, and frozen to the bottom in the winter. I wondered, where does all that water go, driven by the steep gradients

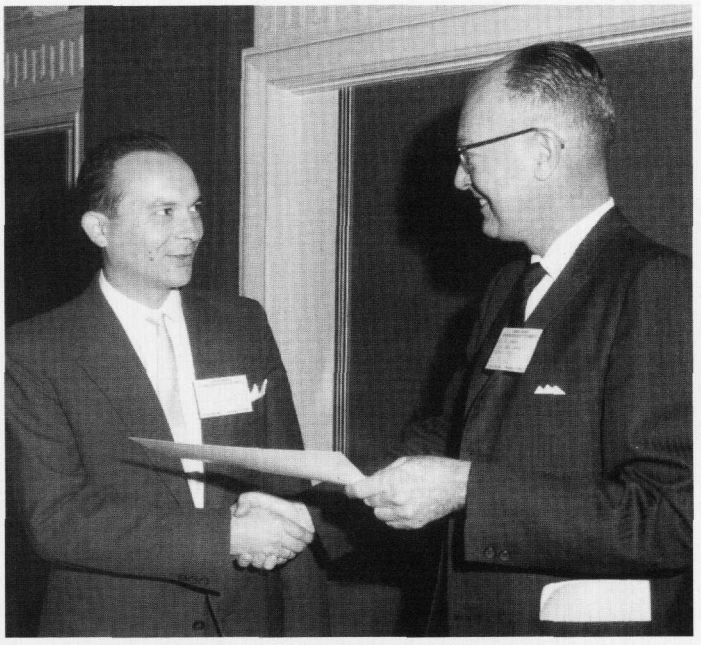

Figure 2. Receiving the Geological Society of America's first O.E. Meinzer Award from Stan W. Lohman (right), Chairman, Hydrogeology Division, Kansas City, Missouri, November 6, 1965.

Figure 3. Testing a successful well, sited on the basis of flow-system theory, Olds, Alberta, 1964 (J. Tóth standing far left).

through permeable rock, providing sufficient supplies to farms and towns, if not to the thalweg? Then one day, I realized that convergence of the flow lines in Hubbert's picture was *a postulate, not a result*! Let me see where the water wants to go by itself, I decided, and solved the Laplace equation, for the "unit basin's" geometry (Tóth 1962). With the solution the light went on: the entire lower half of the basin turned out to be a "discharge area." This simple discovery opened up a new world for me and was a determinant in my professional future. Perhaps more important, it made me realize that this is what I have always wanted to do since my early teens but could not label it. This was why I refused to go to the wood-working trade school or to become a gym teacher; why I risked military service, and was willing to recommence my studies in Holland. Without knowing it, I wanted to *find out things*. The superposition of a sinusoidal surface onto the unit basin made the picture one step more realistic and resulted in the concept of composite flow patterns (Tóth 1963) that Engelen so aptly called the "hierarchically nested flow systems" (Engelen and Jones 1986, p. 9). The members of the newly established "O.E. Meinzer Award" committee of the Geological Society of America must have sensed some merit in the theory, because they chose the 1963 paper as the winner for the first time the award was given in 1965, "In Recognition of Distinguished Contribution to Hydrogeology" (Figure 2).

Apparently, and gratifyingly for me, the concept's appearence happened to be fortunately timed; the hydrogeological world of the day was ready for it and receptive. Many well-known or to be well-known hydrogeologists took notice and developed various aspects of it to high levels of theory or practical application; for instance, Freeze and Witherspoon (1967), Williams (1968, 1970), Deere and Patton (1971), Domenico and Palciauskas (1973), Schwartz and Domenico (1973), Galloway (1978), Winter (1978), Garven and Freeze (1984), and Garven (1989), to name a few. I have myself continued to explore its possible consequences. First, I applied it to the chronic water-supply problem of a central Alberta town and, with a good deal of luck, I found water (Figure 3).

The town was happy enough to erect a commemorative bronze plaque in the town hall. Ultimately, the entire project of research, exploration, and development of ground water supplies for Olds formed the basis of my Ph.D. thesis, which I defended in Utrecht, in 1965 (Tóth 1966). Then I looked for relations between flow systems, on the one hand, and soil types, soil salinity, soil mechanical conditions, erosional features, and ground water chemistry, on the other (Tóth 1971, 1999). Later came the ideas of geologically transient gravity-driven flow (Tóth 1978), the generalized hydraulic theory of petroleum migration (Tóth 1980), elastic dilation of the rock framework due to erosional unloading as cause of subhydrostatic pore pressures (Tóth and Corbet 1986), the role of ground water flow in creating the petroleum geologist's "geochemical chimney" (Tóth 1996), and the safe disposal of nuclear-fuel wastes based on flow-system analysis (Tóth and Sheng 1996).

In 1965 I was asked to introduce hydrogeology at the Geology Department of the University of Alberta as a sessional lecturer, and I taught a one-term course for four years. However, when I was appointed head of the Groundwater Division of the Research Council in 1968, I felt that I could not do justice simultaneously to administration, research, counseling obligations in my region, and teaching, and thus gave up the latter. By that time I had come to realize that for effective counseling and successful theoretical research in hydrogeology, a comprehensive knowledge of a region and a well-organized data base are indispensable. The best vehicle to accomplish both, I argued, is a hydrogeological mapping program covering all the 660,400 km^2 (255,000 square miles) of Alberta. It took me some months to formulate and organize the 10-year program (Tóth 1977). We started it in 1969 and completed 48 full-color hydrogeological maps of scales varying between 1:125,000 and 1:500,000, on time and within budget. We showed off the first maps during a hydrogeological field trip through western Canada, organized in conjunction with the 24th session of the International Geological Congress held in Montreal in 1972 (Cherry et al. 1972, p. 7). At the same congress, I volunteered to organize the Canadian National Chapter of the International Association of Hydrogeologists, of which I remained the president until 1984.

I was always happy to do international work; initially on loan to the Canadian International Development Agency, later as supervisor of graduate students. These projects enabled me to see many parts of the world from the inside, working and often living with local colleagues, as well as to try, apply, and develop ideas and approaches in new hydrogeologic environments. Instead of holidays, I have much preferred to go on foreign assignments. My wife would regularly join me, even on field parties, after I had settled down and started the work. What better holidays could I have?

Seeing the world not as a tourist but as part of the place, being useful at the same time, and being pampered by local colleagues, and all this for free! Thus I have formulated, directed, and/or personally carried out projects in various parts of India, Sri Lanka, Kenya, and Ghana. The understanding of how ground water moves regionally, what its natural effects are, and how to recognize them stood me in good stead in these projects, which were all characterized by little available time, sparse data, and urgent expectations for results.

In early 1978, I attended a short course in Calgary, which promised to deal with hydrogeological applications to petroleum exploration. My dissatisfaction with what I learned was manifested by my call then and there to the head of the Department of Geology and Geophysics of the University of Calgary, whom I had never met. I told him on the phone that it was high time that the university of Canada's oil capital started to teach hydrogeology, which is germane to petroleum exploration even though oil companies don't know it. He took me up on it, asked for my proposed syllabus, and I introduced the topic to the University of Calgary in the fall that same year. It would involve commuting by air once a week for one and a half days, for two years. Today, the University of Calgary has a fully fledged hydrogeology program.

In the meantime, the style of management at the Research Council was changing in a way I did not like. As division head, I saw myself as director of research, but I was expected to be a manager. To assuage my restlessness, I was appointed, as the first one, to the newly created position of "research fellow," without administrative duties but with administrative pay. For me it was not about money and, thus, it was time to move on. I joined the University of Alberta, now full time, in late 1980.

It was a fortunate decision. The situation enabled me to develop my thoughts on the application of hydrogeological principles and techniques to petroleum exploration into a full university course; to do research and give courses in Canada, the United States, Mexico, Australia, China, and Thailand, and in various European countries; and to work with a rewarding string of enthusiastic and bright graduate students.

A retinal detachment in 1986, followed by a long series of subsequent eye problems and surgeries, forced me into retirement from active classroom teaching in 1996, two years prior to our mandatory time. In the meantime, the USSR collapsed in 1989 and the occupying Soviet troops went home, albeit reluctantly. Hungary became free and democratic, but was saddled with the legacies of more than 40 years of ruthless oppression. One of these was isolation from the Western world. When offered, my potential contributions in my specialty were welcome by a younger generation. Thus, commissioned by the Hungarian Oil and Gas Co. in 1995, I started a three-year petroleum hydrogeological research-cum-exploration project on the Great Plain, the region of my youth (Tóth and Almási 1998, 2001). Also, I have introduced my hydrogeological views at the flagship Eötvös Loránd Science University in Budapest through many short courses and as a visiting professor during a full-term course in 1996.

My retirement in 1996 resulted in the dearest professional award I have ever received. My former graduate students threw a big party for me in Calgary, at the house of one of them who by then had become a very successful petroleum hydrogeological consultant. Some of them came from faraway parts of Canada, others wrote from all parts of the world—Europe, Thailand, Australia, and the United States. Among various kind mementos, they expressed

Figure 4. "Continuity" stone, a retirement present from former graduate students.

their appreciation for the fine cuisine to which my wife would treat them at numerous house parties we used to give, by a "Cordon Bleu (Hons.)" diploma, certified with the seal: "In Goulash We Trust." But above all, they had the 1963 flow pattern "carved in stone," titled "CONTINUITY . . . ," on a heavy slab of sandstone from the productive Paskapoo Aquifer of Alberta (Figure 4). More recently, as if by capping 40 years of pleasure, the International Association of Hydrogeologists chose me, by surprise, for their "1999 President's Award," presented annually to a senior hydrogeologist who has made outstanding contributions to the advancement of hydrogeology."

What was the key to a satisfying and rewarding working life? My guess is that it was the understanding, intuitive and latent at first and conscious later, of what I was destined to do, combined with my tenacious insistence on doing it, sometimes against considerable odds, and without regard to possible rewards. For me, work has never been a means to an end; it has been the end itself. To paraphrase the guiding principle held by the "Greatest Hungarian," Duke István Széchenyi of the 19th century: "Know yourself and create accordingly!" But I admit, life has been kind enough to let me be that stubborn!

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