My Years at NMIMT (later known as NMT)
and
How I Became a Ground-Water Hydrologist

by

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Introduction

I did my undergraduate studies in civil engineering at Robert College, an American school in Istanbul, Turkey. The engineering school at Robert College had a 4-year program, like that in U.S. universities, leading to a B.S. degree. Most of the Turkish engineering schools, however, had a 5-year program leading to an M.S. degree. It was, therefore, customary for those graduating with a B.S. from Robert College to go to the U.S. and obtain an M.S. so that, when they returned to Turkey, they would be accepted as being equivalent to engineers educated at the Turkish universities. My interest was in the design of structures and at the start of my senior year, I applied to several U.S. universities which had a good program in this field. By early Spring I received an acceptance letter from the University of Michigan at Ann Arbor.

Two things, that affected my plans to go to Michigan, happened soon after that. First, the Turkish lira was devaluated; this almost quadrupled the cost of a year of study in the U.S. My father, who was prepared to send me to the U.S. for a year before the devaluation, made it clear that he could not afford to do it anymore. Second, Robert College established a graduate school for awarding M.S. degrees. I had, therefore, to decide whether I should continue my studies at Robert College or whether I should go to work for a few years, save some money, and then go to the U.S. for graduate school.

One evening, as I was leaving the campus for home, I ran into the Chairman of the Civil Engineering Department. As we were walking towards the exit from the campus, he asked me about my plans for next year and when I explained my situation, he suggested that I stop by his office next day. He said he had received a pamphlet from a college in New Mexico which was offering assistantships in a Ground-Water Hydrology program. When I asked what Ground-Water Hydrology was, his reply was "it has to do something with hydraulic engineering." I stopped by his office next day to pick up the pamphlet and spent that weekend writing a letter to a Professor Mahdi Hantush at the New Mexico Institute of Mining and Technology (NMIMT), in Socorro, New Mexico. In my letter, I stated that I was very much interested in Hydraulic Engineering and that I wanted to apply for acceptance and financial assistance at the institution. He replied in a few weeks pointing out that this was a program in Ground-Water Hydrology, not in Hydraulic Engineering; the needed applications were enclosed. My goal was to attend graduate school in the

[1] Officially known as Istavros and unofficially as Steve during my years at NMIMT and for many years thereafter, until I became a U.S. citizen and took the opportunity to change my name to its Greek original "Stavros."

U.S., so I filled out the applications and sent them, thinking that once I got there, I could easily switch to structural engineering.[2]

Since I had not heard from NMIMT by late Spring, I accepted a job with the U.S. Army Corps of Engineers, which was building military bases at several locations in Turkey; I was assigned to a project in the town of Sinop on the Black Sea coast of Turkey and moved there in mid-June 1959. By Turkish standards, the pay for the job was very good and I decided to stay with the Corps, at least until this construction project was over. Then, in late July my father called to inform me that I had received a letter from NMIMT with an acceptance and an assistantship of $1,800 per academic year. I handed in my resignation the next day and returned to Istanbul within a week to prepare for my departure to the U.S.

My Years at NMIMT

My arrival to Socorro, NM in September 1959 was a disappointment as I found out that NMIMT did not have a civil engineering department. My immediate thoughts were to find some way of transferring to another school where I can pursue my goal of becoming a structural engineer. The opportunity to do so arose within a few months. In November of 1959 a water-related conference was being held at the New Mexico State University (NMSU) in Las Cruces.[3] Hantush had a few of his graduate students, including me, attend the conference. While in Las Cruces, I visited the Civil Engineering Department and, much to my surprise, I found out that one of my former professors at Robert College was now on the faculty of that department. I explained my situation to him and solicited his help in transferring to NMSU. He promised to help and gave me all the application forms that I needed to submit for transferring to NMSU.

The courses I was taking during that first semester at NMIMT included two graduate courses, one on Applied Mathematics and one on Ground-Water Hydrology, both taught by Hantush. He was an excellent teacher and did a wonderful job in teaching his back-to-back math and ground-water courses. He would lecture on a mathematical approach for solving partial differential equations during the first hour and then demonstrate the application of that approach in solving a specific ground-water flow problem during the next hour, or sometimes during the next few days. Besides being an excellent teacher, Hantush was also a very nice person that cared a lot for his students. He would help us with any personal problems we had, co-sign loans for those of us that wanted to buy a car, and often invite us to his house for an excellent Middle Eastern meal prepared by his wife Iqbal. For me, who was not yet used to the Tex-Mex fare that was often served at the school cafeteria, dinner at the Hantush's was a real treat. By the end of the first semester, I started to find ground-water hydrology very interesting, appreciated having a good teacher like Hantush, and made so many good friends that any thought of transferring from NMIMT completely disappeared. I decided to stay in Socorro and continue my studies in ground-water hydrology. In retrospect, that was one of the best decisions of my life.[4]

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[2] I had not received a catalog and, hence, I did not know that the school did not have a Civil Engineering Department at that time.

[3] I can't remember what this conference was, but according to Google, it was the Fourth Annual New Mexico Water Conference, Water and Water Law, held on November 5-6, 1959, at NMSU, University Park, NM.

[4] My original statement here was: "In retrospect, that was the best decision of my life." My wife Annie reminded me, however, that I made other decisions in my life that also qualified as "best."

One of my first assignments as a Research Assistant to Hantush was to tabulate the function H(u, β) which he needed for a paper he was writing on the modification of the theory of leaky aquifers.[5] The function consisted of an integral, from the value of the parameter u to infinity, the integrant of which included the exponential function, the complementary error function, and the square root of several parameters. The function was evaluated by using the Simpson's rule to do the integration. This was prior to the proliferation of digital computers and to accomplish this task, I was provided with tables of the exponential and of the complimentary error functions and a Marchant calculator (see picture below), which did not have a key for calculating the square root of a number. (A rather complex approach, like that used for calculating the square root by hand, had to be used.)

It took most of my free time during the first two semesters and part of the early summer to finish the tabulation of H(u, β) for a rather wide range of the parameters u and β. About a week after I had completed the task, Hantush asked me to come to his office. When I arrived in his office, there was another young man with him and Hantush was holding a stack of rather large papers with holes on both sides and a lot of numbers on them. After looking at the numbers for a little while, he turned to me and said, "you did a good job in tabulating H of u and beta, your numbers are good to the fourth decimal place." He then introduced to me the young man as a former student who was working at Sandia.[6] Hantush had apparently asked him if he could tabulate H(u, β) using the computers at Sandia, and here he was a few days later with the computer results of the tabulation. Besides being amazed that this could be done so quickly, my reaction was that I should have spent more of my summertime at the pool rather than the office at the Research Building (also known as the Workman Building at that time).

During my second year at NMIMT, I had another remarkable experience with Hantush. I was expecting to complete my M.S. thesis by the end of that academic year and started thinking about finding a job; therefore, I asked Hantush if he would recommend any companies that I should

[5] Hantush, M. S., 1960, Modification of the Theory of Leaky Aquifers, Jour. Geophys. Res., 65(11): 3713-3725.
[6] I don't remember his name and I am not sure if he was working at Sandia Base or at Sandia National Laboratories.

apply to for a job. His response was that if my plan was to work after I got my M.S., I was on my own; if, on the other hand, I was interested in continuing my studies towards a Ph.D., he would be prepared to help. After thinking about it for a few days, I concluded that I should take his advice on continuing my studies. When I informed him of my decision, he recommended that I apply to Caltech. Although I was new in the U.S., I had heard of Caltech's reputation, and I told him that applying to Caltech would probably be stretching it too much. He insisted, however, telling me that his Ph.D. advisor in Utah, C. E. Jacob, was now teaching at Caltech and that he was expecting him to help. I went ahead and applied to Caltech. I don't remember how long it was before I heard back from them, but the response was disappointing, both for me and Hantush.

After that, I gave up on the thought of going for a Ph.D. and concentrated on completing my thesis, which was taking longer than I expected, and on looking for a job. I believe it was a few weeks, or maybe a month, later when I was at Hantush's office, he told me that he had good news for me. The news was that the Geological Engineering Department at Princeton University had started a program in Ground-Water Hydrology and that they were looking for graduate students. He continued by telling me that they were offering good research assistantships and he urged me to apply. My reaction was: Dr. Hantush, you made me apply to Caltech and you know the results, now you want to apply to Princeton? If I could not make it into Caltech, why would Princeton even consider me? I wasted $30 to apply to Caltech and, given my current financial condition, I don't want to waste another $30, or whatever their application fee is, for applying to Princeton. He reached to his pocket, took out $30 and told me: Here are $30, go ahead and apply. I declined to accept his money, although he insisted, but it was clear that he felt very strongly about it, so I went ahead and applied. Lo and behold, about a month later I got a response from Princeton with an acceptance and an offer for a very generous assistantship. I completed my M.S. thesis by mid-summer of 1961,[7] defended it, and was on my way to Princeton by late August 1961.

My Years after and my Return to NMIMT

During my second semester at Princeton, at the request of my advisor, Dr. Roger J. M. DeWiest, I taught a course on Ground-Water Hydrology, based on my notes from Hantush's classes. The course was also audited by two members of the United States Geological Survey's (USGS) Trenton, NJ office. As the summer of 1962 approached, they asked me if I would be interested in a summer internship at the USGS offices at the Federal Center in Denver, CO. I was and I ended up spending the summer of 1962 in Denver under the supervision of Robert W. Stallman. My assignment for the summer was to develop type curves for determining the hydraulic diffusivity of a wedge-shaped aquifer from the response of observation wells to a sudden water-level change in the streams that formed the wedge.[8] The development of the type curves consisted of the evaluation of a rather complex equation developed by Jaeger[9] for an analogous heat flow problem. During one of our conversations, Mr. Stallman asked me what I was planning to do for my Ph.D. thesis, and I told him that I was thinking about doing something on the nonsteady flow

[7] Hence, my degree was officially granted at the Commencement of 1962.

[8] The data to be analyzed were from three observation wells completed in a wedge-shaped aquifer formed by the intersection of the Plower River and Little Plower River in Portage County, WI.

[9] Jaeger, J. C., 1942, Heat conduction in a wedge, or an infinite cylinder whose cross-section is a circle or a sector of circle, Philos. Mag. And Jour. Sci., 33(222): 527-536.

of ground water to wells penetrating multiple aquifers; he indicated that the USGS would probably be interested in financially supporting such research and he said that he would look into it.

He got me financial support from the USGS[10] and as soon as I returned to Princeton at the end of the summer, I wrote a proposal for my thesis on the "Nonsteady Flow to Multiaquifer Wells"; the proposal was approved by DeWiest and by the Department of Civil Engineering[11] and between the additional courses I had to take, I started slowly working on my thesis. A few months later, DeWiest told me that it was time for me to start thinking about a subject for my Ph.D. thesis. I was surprised and reminded him that I had already submitted a proposal for my thesis, that it was approved by both the Department and him, and that I had started working on it since its approval; he didn't seem to remember it but when he checked his records, he realized that he had indeed approved the subject of my thesis. I was relieved but that was also the end of any help that I expected from him on my thesis. When I realized that I would not be getting any help, I called Dr. Hantush in the Spring of 1963 and explained to him the problem I was having. Without hesitation, he told me that he would be happy to help me wrap up my thesis if I complete my course requirements for the degree and come to Socorro for the summer. Between that call and the end of June 1963, I took my Qualifying Exams, completed my course work, married my girlfriend Annie, attended the 1963 Commencement to get an M.A. degree in Civil Engineering,[12] and left Princeton, in my 1956 Chevy Belair,[13] to take my new bride for a honeymoon in Socorro!

We passed the summer in Socorro in a studio apartment on the hill where married student apartments were located, and by the end of the summer, with Hantush's help, I had completed all the mathematical aspects of my doctoral thesis; the only thing that remained was the writing of it. During that summer, I also attended a Symposium on Transient Ground-Water Flow held at the Colorado State University in Fort Collins, CO. Other attendees from NMIMT included the late Miguel Marino, who taught at the University of California, Davis, and Dennis Williams, the Founder and President of Geoscience Support Services, Inc., a ground-water consulting firm in Claremont, CA.[14] The Symposium was also attended by C. E. Jacob, who taught at NMIMT for several years after Dr. Hantush had left, and several potential employers including members of the USGS and of the Illinois Water Survey. A few weeks after I attended the Symposium, I received a call from the USGS asking me if I would be interested in working for them on the Pecos River Study and, when I said that I was interested, inviting me for an interview in Washington, DC.

The Start of my Professional Career as a Ground-Water Hydrologist

Annie and I were already planning to go back to Princeton to collect a few belongings that we had left with friends there, so the invitation for an interview in Washington was perfect for our

[10] This was on top of my assistantship income and made my second year at Princeton financially very comfortable.

[11] During my second year at Princeton the Department of Geological Engineering was incorporated into the Department of Civil Engineering.

[12] Doctoral students that passed their Qualifying Exams were automatically entitled to receive an M.A. degree by paying a fee of $15.

[13] This car was a purchase from another NMIMT student, Ahmad Hassan, who, after getting his Ph.D., drove with his wife from Socorro to Princeton. He sold me his car at a ridiculously low price, and I drove him and his wife to New York to take a boat to return to his native Egypt.

[14] There may have been other NMIMT students that attended the Symposium, possibly John Halepaska and some others, but my memory is not as good as it used to be.

plans. We left Socorro near the end of August and headed to Princeton via Washington, DC.[15] The interview at the USGS went very well; my interviewers included Robert R. Bennett and Hilton H. Cooper, Jr.[16] who, at that time, were leading the USGS ground-water research group at the Regional Offices of the USGS located in Arlington, VA. During the interview, nobody mentioned the Pecos River Study and I was offered a position as a Research Hydrologist with the ground-water research group.

Annie and I went to Princeton to collect whatever we had left there and returned to Washington to look for an apartment. We were lucky to find an apartment in Arlington, at a building that was in the same complex as the USGS Regional Offices, and I reported for duty on the first Monday that followed.

And that is how a 60-year career as a Ground-Water Hydrologist started. I am grateful to all those that helped me along the way and, particularly, to Dr. Mahdi Hantush and to my wife Annie who supported and/or encouraged me in making critical decisions that shaped my career. I also would like to take the opportunity to thank Dr. Raul Deju, whose endowment for the establishment of the Hantush-Deju Hydrologic Innovation Center at the New Mexico Tech will keep Hantush's memory eternal.

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[15] In later years, I revisited NMT on several occasions. One of these was in 1970 when I went to be interviewed for the position of head the graduate program in ground-water hydrology; my day-time interview with Dr. Stirling A. Colgate, the then President of NMT, resumed later that night over a few glasses of beer when he joined a few others and me at the Capitol Bar. (I was offered the position, but I declined for personal reasons.) Another occasion was in May 1998 when I attended the Commencement with my wife Annie to receive The Distinguished Achievement Award presented to me by the NMIMT Alumni Association.

[16] Of the Cooper/Jacob straight-line method of pumping test analysis fame.