ground water

Historical Note/

David Deming, History Editor

Zhang Hongren and the Introduction of Transient Flow Theory to China

by Chunmiao Zheng

Puzzled over a Pumping Test

Zhang Hongren (Figure 1) was trained in the 1950s as a classical geologist, first in China and then in the former Soviet Union. From 1959 to 1962, he worked on mineral exploration and geological mapping in Yunnan Province, southern China. After a 3-year stint in the field, he moved to the capital city of Beijing and became a technical specialist in the Ministry of Geology. Then, in 1970, Zhang was sent to the Hydrogeological Survey of Beijing to work on water resource evaluation for the rapidly growing city. For those who are familiar with recent Chinese history, 1970 was still at the height of the ''Cultural Revolution,'' a chaotic period from 1966 to 1976 during which many intellectuals were sent to the remote countryside or factories to receive ''reeducation'' from peasants and workers. But everyone needed drinking water no matter what they did. So Zhang was assigned the responsibility to do whatever it took to solve the water supply problem quickly.

With little background in hydrogeology, Zhang and his coworkers decided to conduct a pumping test in a river basin not far from Beijing. At that time, the ground water texts available in China were mostly translated from Russian, and they only discussed the theory of ground water flow to wells under steady-state conditions. Having read some of these texts, Zhang expected to observe a stable radius of influence and then use that information to establish the long-term pumping rate for the water supply well. However, it became immediately apparent that things were not adding up. Head measurements at the observation wells indicated that the cone of depression continued to expand. A small creek near the pumping well went dry not long after the start of the pumping test, causing some fish to be out of water. Zhang and his colleagues managed to complete the pumping test. But the experience planted a seed of doubt in the mind of Zhang about the validity of the prevailing theory of well hydraulics that assumed steady-state conditions.

A Discovery at a Used Bookstore

Some time after the pumping test in 1970, Zhang was causally browsing some old books one day at a secondhand bookstore in downtown Beijing. To his great amazement, he found a copy of David Keith Todd's classic text *Groundwater Hydrology*, first edition, published in 1959 by John Wiley & Sons. Zhang gladly paid an equivalent price of $.60 and took this treasure home. In Todd's book, Zhang was exposed to transient flow theory for the first time, including the Theis solution (1935) for transient flow to a well and Meinzer's (1928) concept of transient ground water storage. At long last, Zhang found satisfactory explanations for the puzzling phenomena that he had observed during the pumping test conducted earlier for the Hydrogeological Survey of Beijing.

Zhang diligently studied Todd's *Groundwater Hydrology*. During the heyday of the ''Cultural Revolution,'' reading an English book was viewed with contempt and suspicion. So, Zhang, in a preemptive move to ward off any accusation of being a liberal bourgeoisie, wrote on the inside book cover two famous quotes from Chairman Mao, founder of the People's Republic of China. One said: ''Chinese people have the will and capacity to catch up with and exceed the advanced level of the world in the foreseeable future.'' The other quote was: ''The present can learn and profit from the past; China can learn and profit from the foreign countries.'' With these solemn declarations from the great Chairman Mao, who would dare to accuse Zhang of not doing exactly what Chairman Mao would have wanted him to do?

A Collection of Translated Works

After a thorough study of Todd's book, Zhang decided to get his hands on the original and key papers cited in the book that dealt with transient flow. He was fortunate to find most of them in the Geological Library of China in Beijing. It is quite interesting to note that although China was largely isolated from the outside

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Figure 1. A recent photo of Professor Zhang Hongren.

world during the Cultural Revolution, one could still find copies of some international journals such as *Transactions of the American Geophysical Union* and *Ground Water*. They were mostly gathering dust, but those determined to find them, like Zhang, could do so with little problem.

As he became more and more familiar with the original papers in English, Zhang concluded that it was important that they be introduced to Chinese hydrogeologists. In the early 1970s, transient flow theory was still essentially unknown in China. Although some texts did make a few passing references to transient flow theory, the materials were translated secondhand from the literature in Russian and treated as an afterthought. Having been frustrated by the inability of steady-state flow theory to explain the pumping response that he observed in the field, Zhang decided that the time had come to do a systematic introduction of transient flow theory to Chinese ground water hydrologists. With some help from a few colleagues, Zhang translated a set of classic papers on transient flow theory directly from English. In 1975, after some considerable efforts by several individuals, the translated papers were published by the China Geological Press in book form with the title *Development and Application of Transient Groundwater Flow Theory* (Zhang 1975). Figure 2 is a scan of a portion of a page from the book illustrating type curves for transient analysis of an unconfined aquifer.

This collection of translated works included such classic papers as Meinzer (1928), Theis (1935, 1941), Wenzel (1936), Jacob (1940, 1946, 1947), Cooper Jr. and Jacob (1946), Chow (1952), Hantush and Jacob (1955), Hantush (1956, 1960), Boulton (1963), Prickett (1965), and Lohman (1972). The book provided an excellent overview of the motivation and theoretical framework for transient flow and a systematic introduction to various methods for analyzing aquifer tests. The book had a lasting influence on a whole generation of Chinese hydrogeologists beginning in the mid-1970s after the end of the Cultural Revolution. The author of this note can still remember how one day in the fall of 1979 he came across this book in the library of Chengdu College of Geology in Sichuan Province and was mesmerized by the discussion of many elegant theories and solutions that he had never seen before. Some of his colleagues from those days had very similar experiences.

It is noteworthy that the choice of the original papers in the collection of the translated works compiled by Zhang has remarkable overlap with *Benchmark Papers in Physical Hydrogeology* (Freeze and Back 1983). One noticeable difference is the absence of Darcy's (1856) work in the translated paper collection. Zhang could not find the original source when he was working on the first translation. So, in 1991, when he was visiting France, he made a special effort to stop by the National Library in Paris and make a copy of the original papers by Darcy (1856) and Dupuit (1863). Translated versions of both papers would later be included in the second edition of Zhang's volume, which was published in 1992. This book continues to be a valuable reference today.

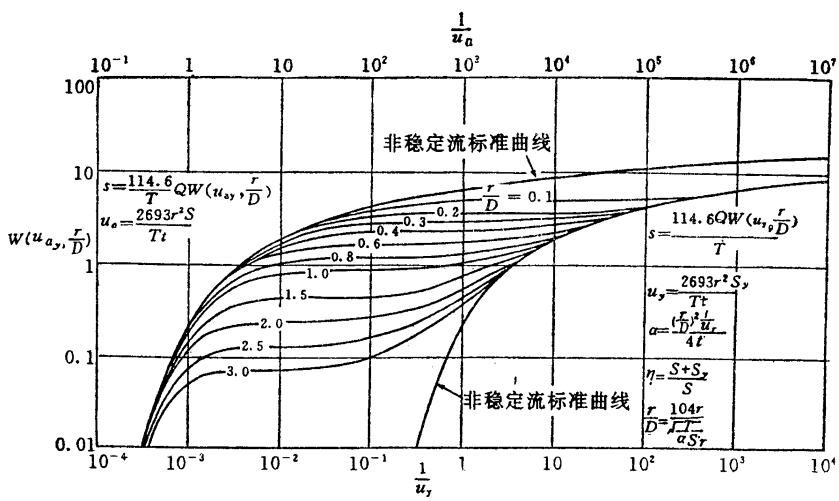

Figure 2. A portion of a page from the translation of Prickett (1965) in the book by Zhang showing Boulton's (1963) type curves for transient analysis of pumping in an unconfined aquifer.

Power of Serendipity in Scientific Contributions

Zhang would later move on to become a leading hydrogeologist in China and assume numerous leadership positions along the way, including the Chief Geologist and Vice Minister of Geology and Mineral Resources. Currently, Zhang is president of the International Union of Geological Sciences, the first Chinese to lead such an influential international organization. But his greatest scientific contribution to Chinese hydrogeology may well be the introduction of transient flow theory to China more than 30 years ago through the publication of the translated volume. Sometimes Zhang wonders how his career would have turned out if he had not, by a pure random chance, run into that old English book on a Beijing street nearly 40 years ago.

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