Nate Monnig
Surface Water Hydro

Benoît Mandelbrot*

Benoît Mandelbrot was born in Poland in 1924. His Lithuanian-Jewish family fled to France when Benoît was 11, anticipating political turmoil. He was introduced to mathematics by two of his uncles. He studied in Paris and California after WWII, receiving his Ph.D. in Mathematical Sciences from Paris University in 1952. [Wikipedia]

Throughout his years as an academic Mandelbrot has published papers in a variety of fields in addition to mathematics, including hydrology, fluid dynamics, economics, and information theory. Mandelbrot coined the term *fractal* in 1975, to describe structures that are self-similar at all scales—one of the major focuses of his research. In 1982, Mandelbrot published *The Fractal Geometry of Nature*, introducing his computer generated self-similar images to the mainstream of mathematics. He is also known for his study of “heavy tailed” (Lévy) distributions. Lévy distributions have heavier tails than the typically used Gaussian distribution. Additionally, a Lévy distribution has a poorly defined mean and a diverging variance. Likely owing at least somewhat to his time studying under Paul Lévy in Paris, Mandelbrot believed that Lévy distributions had great potential to model many naturally occurring phenomena. [Wikipedia]

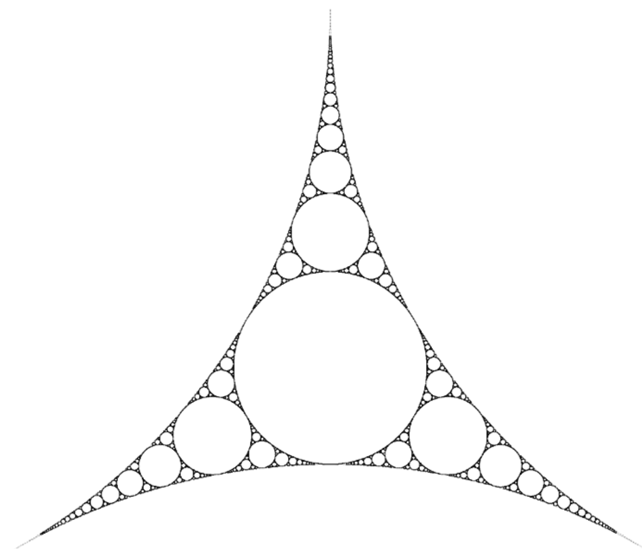
Mandelbrot is known in hydrology for introducing fractional Brownian motion (fBm) and fractional Gaussian motion (fGn) to hydrologic applications. FBm and fGn are types of correlated random noise that exhibit self-similar characteristics. In one of his landmark papers [*Mandelbrot*, 1968], Benoît endeavored to explain the “Joseph effect”, the tendency towards persistent periods of unusually high or low precipitation, by application of a fractal model. This and several other early papers by Mandelbrot opened the door for a great deal of ongoing research into the application of fBm and fGn models to hydrologic systems.

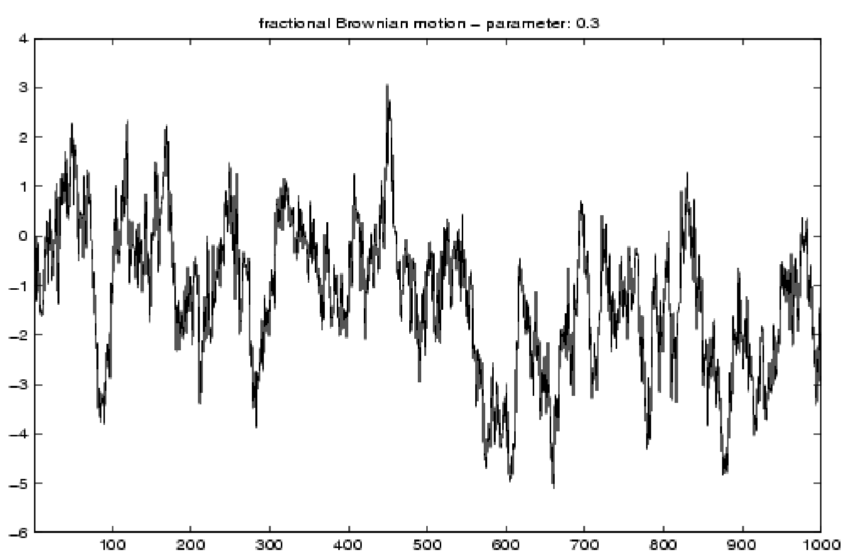
*although the assignment was to write a one-page paper on a dead hydrologist, my hydrologist is indeed still alive, but he is pretty old and very well might die soon enough.

References

Mandelbrot, B.B., and J.R. Wallis, (1968), Noah, Joseph, and Operational Hydrology, *Water Resour. Res.*, 4(5), 909-918.

Wikipedia contributors. Benoît Mandelbrot [Internet]. Wikipedia, The Free Encyclopedia; 2006 Aug 12, 18:40 UTC [cited 2006 Aug 28]. Available from: http://en.wikipedia.org/w/index.php?title=Beno%C3%AEt_Mandelbrot&oldid=69250412.





Clockwise from top left: Benoît, computer generated fractal, fBm.

Scott D. Formolo
GEGN 598A, fall 2006

Henry Darcy: Pioneer in Hydrogeologic Sciences

Henry Darcy (1803-1858) was born in Dijon, France. His father died when he was 14. His mother borrowed enough money to pay for his early education. In 1821, his higher-education journey started at the Polytechnic School in Paris and later led him to the School of Bridges and Roads (Brown, 2002, p.4). Darcy graduated in 1826 with a degree in Civil Engineering and was assigned by the Corps to the Department of Jura, and was soon transferred to his hometown of Dijon (Brown 2002, p.4). In 1828, he married Henriette Carey and remained with her for the remainder of his life (http://biosystems.okstate.edu/darcy).

From 1834 to 1848, Darcy's professional career advanced as he carried out a number of significant projects (Brown, 2002, p.6). His first major professional success was his design of the municipal water supply for the city of Dijon (Biswas, 1970, p.288). In 1838, after several futile attempts were made, under Darcy's initiative, to provide the city with fresh waters using wells, Darcy successfully designed a purely gravity-driven aqueduct system that carried water to city reservoirs from a spring over 12 km away (Brown, 2002, p. 4-5). During this time, he also supervised the construction of the longest existing tunnel at the time. This project provided Darcy the unique opportunity of direct observations of geology and seepage processes (Brown, 2002, p.6).

In 1848, Darcy became Chief Director for Water and Pavements in Paris. The position provided him much desired research opportunities. He focused immensely on his research of flow and friction losses in pipes (Brown, 2002, p.7). Darcy's research was profound in that it greatly improved friction estimates of fluids passing through pipes (Brown, 2002, p.7-8). In 1855 and 1856 he conducted column experiments that established what has become known as Darcy's law, today, a fundamental law in hydrogeology. This law was designed to describe fluid flow through sands. Today it is used to measure the behavior of water in a variety of hydrogeological situations. Notably, in 1856, he and his colleague published four papers about various forms of an improved Pitot tube design, which ultimately lead to more accurate measurements of water velocities (Brown, 2002, p.10).

Darcy's achievements are a result of a lifetime of education, professional practice, research, and civil servitude. In fact, he was a humble 'servant' to the people of France. He provided them with clean water and sewage systems. His early contributions to the field of hydrogeology were essential building blocks of the science. Darcy started as a bright student, blossomed into a profound engineer, and is one of the most celebrated hydrogeologists of all time.

References:

Books and Articles

Biswas, A.K. (1970). History of hydrology. New York, New York: American Elsevier Publishing Co.

Brown, G.O. (2002). Henry Darcy and the making of a law. Water Resources Research, 38(7).

Internet

Glenn Brown, 2005, Henry Darcy and His Law (August 27, 2006). [http://biosystems.okstate.edu/darcy/]

Martin Briggs
GE 598

Edgar Buckingham: Physicist and Hydrologist

One of the great things about hydrology as a discipline is that it incorporates important parts from several distinct scientific fields. Edgar Buckingham was a trained physicist who made some very important contributions to our understanding of how water moves through soils. Edgar was born on the 8th of July, 1867 in the city of Philadelphia. His scholastic interests took him up to Cambridge Massachusetts, where he graduated with a B.S. in Physics in 1887. He then traveled abroad, attending both the University of Strasbourg and the University of Leipzig. This was no small feat in the late 1800’s and stands as a testament to Edgar’s adventurous spirit. This spirit was exemplified again in 1918 when Buckingham returned to Europe and served as associate scientific attaché to the US embassy in Rome. Buckingham graduated with a PhD from Leipzig in 1893, after studying under famed German chemist and Nobel Prize winner Wilhelm Ostwald.

After some relatively brief teaching spells at Byrn Mawr College and the University of Wisconsin, Buckingham signed on with the USDA Bureau of Soils (BOS) where he worked from 1902 to 1906 as a soil physicist. After conducting some early and significant work with soul aeration he concentrated his efforts into the investigation of soil water. It is because of this subsequent work with hydrological principles that Buckingham is remembered by many today.

Buckingham was the first to define several important principles such as capillary potential (matric potential), unsaturated hydraulic conductivity (K) and the definition of transient water content as a function of time and space. He also described specific water capacity and unsaturated flow, the latter of which he defined in an equation. His equation was an adaptation of Darcy’s law, which Buckingham apparently paid little homage to at the time and is now known as the Buckingham-Darcy Equation. When it could be assumed that unsaturated flow is both isomotic and isothermal, Buckingham combined his concepts of capillary conductivity(K) with soil water matric potential head $h(\theta)$ and modified several of the variables in Darcy’s Law to create:

$$q=K(\theta)\left[\left(\frac{\delta h(\theta)}{\delta z}\right)-1\right] \qquad (2.)$$

This equation describes one-dimensional, unsteady, vertical flow where z is the soil depth (measured positive downward) and θ is the volumetric soil water content.

In 1907, Buckingham described these principles along with the concept of self-mulching soil behaviors during arid conditions in the well known Bulletin 38 USDA Bureau of Soils: Studies on the Movement of Soil Moisture. Interestingly Buckingham seems to have had strained relations with the BOS officials, who rejected his two page conclusion to the Bulletin. He left the BOS for the National Bureau of Standards (NBS) that year, and worked there until the mandatory retirement age of 70. Edgar Buckingham died three years later on April 29th, 1940 in Washington D.C.. As a brilliant physicist with a keen interest in hydrologic principles in soils, Buckingham made several important contributions to the scientific community that still provide the basis for research happening today.

Bibliography

1. "Edgar Buckingham". Wikipedia: the free encyclopedia. Last revised : 4/29/06 by online contribution. http://en.wikipedia.org/wiki/Edgar_Buckingham

2. Maidment, David R., ed. Handbook of Hydrology. USA : McGraw-Hill Inc., 1993.

3. Nimmo, John R.; Landa, Edward R. "The Soil Physics Contributions of Edgar Buckingham". Soil Science Society of America Journal 69:328-342(2005) http://soil.scijournals.org/cgi/content/abstract/69/2/328

Ralph L. Parshall

Prepared by Aurora Bouchier
GEGN 598A – Surface Water Hydrology Homework Assignment #1

A Colorado native, Ralph Leroy Parshall was born in Golden on July 2nd, 1881. Aside from a couple summers spent doing graduate work, Mr. Parshall lived and worked in Colorado. In 1906 Ralph and Florence May Stuver were married. Together they had two sons, Maxwell and Deane. Mr. Parshall died on December 29th, 1959 at the age of 78, in Fort Collins, CO.[1]

In 1899 Parshall entered Colorado Agricultural College (CAC), now known as Colorado State University, in Fort Collins.[2] Parshall graduated from CAC with a Bachelor of Science in Civil and Irrigational Engineering in 1904. He then worked as an instructor of physics and civil engineering at CAC from 1904 though 1909. During the summers of 1906 and 1907, Parshall conducted graduate work at the University of Chicago. From 1909 through 1913 Parshall worked at CAC as an assistant professor. Then in 1913 Parshall took a job as an assistant engineer and director of irrigation investigation with the Division of Irrigation, Soil Conservation Service of the United States Department of Agriculture.[1] At that time, the 'Irrigation Investigation Office' was located with CAC's hydraulics lab.[2] In 1918 Parshall served as director and retired in 1948 with the title of Senior Engineer. Even after his retirement, Parshall conducted field work, served as a consultant, and occasionally gave lectures at the college.[1]

While working for the USDA Parshall observed issues in measuring irrigation flow. Though Parshall is most widely known for the Parshall flume, he worked on numerous projects including various irrigation recording instruments and meters, sand traps of various sorts including a vortex tube and riffle deflector. Parshall was even involved with investigating snow measurement methods relating to water content in the snow pack to irrigation supply.[1] There is some uncertainty as to whether the Parshall flume was patented. Although Parshall certainly did design and develop the flume which bares his name, it appears that he never patented it. In his Guest View write-up for the Arizona Water Resources, Sol Resnick recollects that Parshall "did not patent it, although it could have made him very rich."[3] In 1921 Parshall did file a patent for a Venturi Flume Water Stage Recording Instrument. In 1922 that patent was granted.[2] Parshall continued to develop his flume, and by 1953 had developed depth/flow relationships for flumes with throat widths from 3" to 50'.[4]

During his lifetime Mr. Parshall received numerous honors. Included are a Life Member of the American Society of Civil Engineers, a Life Member of the Colorado State of Engineers, a lifetime achievement award from the Alumni Association of the Colorado Agricultural College, a special citation and medal from the USDA upon his retirement, and a gold medal from the Colorado Engineering Council.[1]

An interesting side note: the town of Parshall, located between Hot Sulphur Springs and Kremmling, has a web page claiming that the town is named after this particular Ralph Parshall[5], although all subsequent information about Mr. Parshall does not mesh with other information found on Ralph Leroy Parshall.

References Cited:

1) http://lib.colostate.edu/archives/findingaids/water/wrlp.html
2) http://lib.colostate.edu/archives/water/parshall/
3)http://cals.arizona.edu/AZWATER/awr/novdec03/guestview.html
4) http://www.flowmeterdirectory.com/flowmeter_artc/parshall.html
5) http://www.rkymtnhi.com/Visitors/Towns/Parshall/

Ralph Parshall, taking Flume measurements

http://lib.colostate.edu/archives/water/parshall/flume.html

Scott Ikard

C. V. Theis

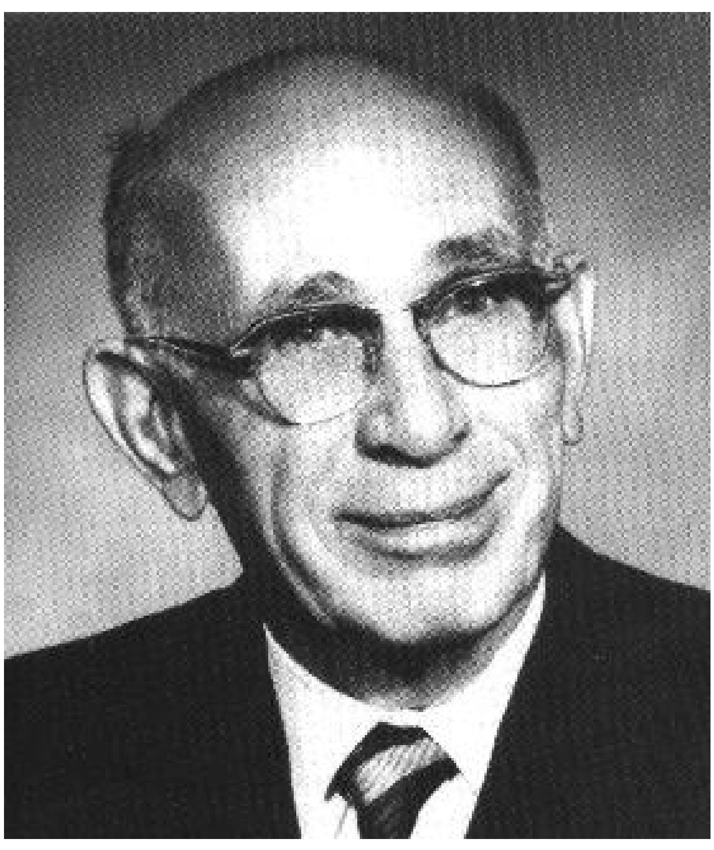
Charles Vernon Theis (referred to as C. V.) was the second son of Edwin David and Ida Holbrook, born March 27, 1900 in Newport, Kentucky. Throughout his childhood years he was shuffled between Oklahoma and his hometown of Newport, changing schools on several occasions. Despite inherent difficulties associated with such moves his academic progress did not suffer, but ironically excelled. Theis, being somewhat of a child prodigy was very adept in mathematics. He accelerated through elementary and high school graduating at the age of 16, two years younger than his peers.

Theis worked after high school, only staying long enough to save enough money to enroll in college. He enrolled as a civil engineering major at the University of Cincinnati, OH. Hindrances such as world war and the flu epidemic would soon delay him from his studies but would not keep him long. He received his undergraduate degree in civil engineering in 1922 and would later complete a Ph.D., graduating in 1929. However, this did not mark the end of Theis' academic development, but rather its conception. His professional growth would be largely based around research and understanding of concepts which were at the time foreign to him. He would eventually hold positions with the U.S. Army Corps of Engineers, the U. S. military, the Atomic Energy Commission and the USGS Division of Groundwater Resources (formerly known as Division of Groundwater), as well as others, advancing in title from a Junior Geologist to the District Geologist of the USGS' Groundwater Division in New Mexico. In 1952 Theis made what may arguably be his most prominent contribution to the scientific and engineering communities when he published "The Relation between Lowering of the Piezometric Surface and the Rate and Duration of Discharge of a Well Using Groundwater Storage." Included in this publication was the equation that now bears his name, shown in figure one.

$$s = \frac{Q}{4\pi T} \int_{\frac{r^2 S}{4Tt}}^{\infty} \frac{e^{-u}}{u} du$$

Figure 1. The Theis equation (sometimes referred to as the Non-equilibrium equation), published in his August 1952 paper.

C. V. Theis was not limited to his equation. His research earned him a variety of distinctions including honorary membership in professional societies and the acceptance of the Robert E. Horton Medal in 1984, given by the American Geophysical Union. Although he died shortly afterwards his contributions to hydrology are highly studied and still built upon today by future scientists and engineers. His picture is shown below.



References

1) USGS Water Resources Division, Groundwater Branch, Washington, D.C. Theis, C.V., "The Relation between the Lowering of the Piezometric Surface and the Rate and Duration of Discharge of a Well Using Groundwater Storage" Ground Water Notes No. 5, August 1952

2) White, Robert R. and Clebsch, Alfred. C.V. Theis; The Man and his Contributions to Hydrogeology. www.olemiss.edu/sciencenet/saltnet/theisbio.html

3) Http://elibrary.unm.edu/aonm/Nmu/

4) USGS Water Resources Division, Groundwater Branch, Washington, D.C. Theis, C.V. The Source of Water Derived from Wells. Essential Factors Controlling the Response of an Aquifer to Development. Ground Water Notes No. 34, December 1957.