

# Charles Richter, His Scales, and More Scales

**Richter's Scale: Measure of an Earthquake, Measure of a Man.** By Susan Hough, Princeton University Press, Princeton, New Jersey, 2007, 336 pages, \$27.95.

Scales (sometimes called indexes) are widely popular these days. On a scale of 0 to 10, how much do you like sweet potatoes? On a scale of 0 to 10, what would you say is the level of democracy in Country C? The McLaughlin panel (PBS) is frequently asked questions of the following type: On a scale of 0 to 10—0 meaning absolutely stupid, 10 meaning absolutely brilliant—how would you rate Policy P?

## BOOK REVIEW

By Philip J. Davis

Numbers provide a cachet of objectivity to matters that are essentially subjective, and they allow for mathematical manipulation and comparisons among disparate categories. Thus, given an “index of happiness” (and there are such things), one might conclude from the numbers that the levels of happiness in certain groups correlate well with their appreciation of sweet potatoes.

Probably the most newsworthy scientific scale these days is the Richter scale, which measures the magnitude of earthquakes. Thinking of the vast numbers of lives lost, of the property reduced to rubble, one easily realizes why the media give prominence to this single, objective number. Seismologists themselves now refer simply to the “magnitude” of an earthquake, for which there are a number of different scales, or, when pressed, to the Gutenberg–Richter scale rather than the historic Richter scale. Newspapers, though, often cling to the old designation; thus, recent reports of “an earthquake in West Sumatra that flattened hundreds of buildings and killed more than 50 people” pointed out that it “measured 6.3 on the Richter scale.”

Who was Richter, what sort of a person was he, and how did he come to devise his scale? And, finally, what's the scale for? Susan Hough, a “grandstudent” of Richter and now a seismologist at the Pasadena Office of the U.S. Geological Survey, answers these questions in a well-written, engaging, and detailed book intended for a general readership.

Although Hough makes a celebration of Richter's work a central feature of her book, it contains much more. The reader will find a history of the Seismological Laboratory at Caltech and of progress made over the years, along with profiles of the numerous people who have worked there, particularly Beno Gutenberg. The book underlines the fact that the pursuit of science is a communal enterprise.

The reader will also find descriptions of notable earthquakes of the past, the pre-Richter history of intensity classifications, an elementary tutorial on seismological facts and theory. Balancing “the measure of an earthquake [with] the measure of a man,” Hough has added substantial stories about Richter's wife, Lillian, and older sister, Margaret Rose, along with an introduction to Asperger's syndrome, to which she firmly attributes Richter's personal eccentricities and his idiosyncrasies. All this is fleshed out with lots of gossip.

Charles Francis Richter (1900–1985) was born in Hamilton, Ohio. Mother: Lillian A., née Richter; presumptive father: Frederick W. Kinsinger. Moving to California early on with his maternal grandfather, mother, and older sister, he would say later that he was raised by two women: his mother and his older sister. He went to Stanford, then to the California Institute of Technology, where he got a PhD in theoretical physics in 1928. In the same year he married Lillian Brand, a divorcée with a son; their long and often stormy marriage endured for more than forty years, although with much “apartness.” They had no children together. Hough describes Richter as “a man whose relationship with women was complicated from the day of his birth.”

Richter's Nachlass, now in the Caltech archives, consists of dozens of boxes of stuff, much of it significant, much of it the sort of thing that can only make one wonder why on earth he saved it. Also available are media interviews with Richter, and oral histories from people he worked with; I suspect that in the presence of such a wealth of material, Hough was hard put to restrain herself in assembling her manuscript.

Earthquakes can occur anywhere on earth—there were quakes in Massachusetts in 1727 and 1755, and I remember one that shook my dorm around 1942. Because of the substantial frequency of earthquakes in California, several seismographic institutes were established there. In 1921, the Carnegie Institution provided for one in southern California that would ultimately be located at Caltech. The general prominence of Caltech goes back essentially to the early '20s. Bent on making the institution a scientific powerhouse, president Robert Millikan, a Nobel laureate renowned for his oil-drop experiment, loaded it with stars. An early appointment was Charles Richter. Though his PhD research had been in the evolving field of quantum physics, the prospect of employment pulled him into seismology and into the group at Caltech. Richter remained there from 1927 until his retirement, in 1970. He became a seismographic star of the first magnitude, and the blending of his rays with those of his colleague Beno Gutenberg (1889–1960; PhD: Göttingen, 1911) rapidly brought the Caltech group into world renown.

As regards geophysics and seismology, Millikan had set his sights on Gutenberg, then of Frankfurt University, a geophysicist and one of the brainiest seismologists of his day. Offered a substantial salary, and alert to the German political turmoil of the '20s or to the prospect of another war, Gutenberg accepted the position, arriving in Pasadena with his wife and two small children in 1930. Gutenberg had already produced four books on geophysics, of which the latest was the 1929 *Lehrbuch der Geophysik*, which he edited. It was in Pasadena that he met up with Richter, who was to become his collaborator and his co-author.

Gutenberg's presence was absolutely critical to Richter's subsequent career. The two differed both emotionally and scientifically: Gutenberg had broad interests in global seismology and the structure of the deep earth, while Richter was narrowly focused on local California earthquakes.



Gutenberg was the theoretical partner; Richter, less theoretically inclined, nonetheless had an uncanny feeling for what went on seismically in California. Yet with this pairing—in which to some extent Gutenberg functioned as a substitute for the father Richter never had, in which Gutenberg was a powerhouse of organization while Richter’s scientific oeuvre lay buried in a scattering of uncompleted thoughts and activities—these two men were able to pull together a collaboration that was productive and redounded to the fame of both. Thanks to Hough’s investigative energies and writing skill, this remarkable story is now part of the chronicles of scientific collaboration.

The Richter scale, devised in the early ’30s to describe and quantize “earthquake size,” was simply a measure of the maximum deflection picked up on seismometers of a certain kind. The scale doesn’t measure energy released or some other such physical quantity. An earthquake is an extremely complicated geophysical affair, one that, if the human effects are factored in, cannot be summed up with one number. Hence, a variety of post-Richter scales have been constructed, of which the most frequently used is the “moment magnitude,”  $M_w$ , devised in 1979 by Hanks and Kanamori.

Susan Hough has written a nontechnical biography, and because I wanted to display at least one equation\*, I wrote to Seth Stein, a friend and a seismologist at Northwestern University, who provided me with the following information:

“Magnitude  $M$  is based on the concept that the recorded amplitude reflects the earthquake size once it has been corrected for the decrease with distance due to geometrical spreading and attenuation:

$$M = \log_{10} (A/T) + F(h, \Delta) + C,$$

where  $A$  is the amplitude of the signal,  $T$  is its dominant period,  $F$  is a correction for the variation of amplitude with the earthquake’s depth  $h$  and distance  $\Delta$  from the seismometer, and  $C$  is a regional scale factor.”

I suppose that the public associates events reported in terms of Richter or other scales or “magnitudes” simply with the extent of property and human damage. This, of course, depends on where the quake occurs. Once again, Seth Stein pinpointed for me the uses to which the numbers are put:

“Magnitudes are used to characterize the size of earthquakes. This matters in terms of assessing how much the ground moved, which in turn relates to how often such an earthquake will happen.

“Over time the slip in earthquakes can’t exceed the plate motion. Magnitudes predict the amount of shaking, as in the alternative hazard maps for New Madrid [devastating quakes occurred in New Madrid, Missouri, in 1811–12] depending on how large a future earthquake might be. The different magnitudes are used to assess energy release as a function of period, which reflects the stress drop and rupture velocity. This is important both for studying the physics of earthquake sources and for understanding the damage they do.

“Analysis of seismograms from the December 26, 2004, Sumatra earthquake that generated the devastating tsunami shows that it was much bigger than previously thought and explains in part why the tsunami was so destructive.

“Measurements of seismic energy at vibration periods much longer than previously studied show that the earthquake was approximately three times larger than previously reported. Its revised moment magnitude,  $M_w = 9.3$  instead of the previously reported 9.0, makes it the second largest recorded since the invention of the seismometer about 100 years ago. The rupture occurred by slip along the 1200-km long fault delineated by aftershocks, making the rupture zone much larger than previously thought from analysis of shorter-period waves. The amplitudes of the earth’s split normal modes show the larger fault area, because they are better fit by a source at 7N, in the center of the rupture zone, than by one at the epicenter at 3N.”

How did Beno Gutenberg regard his younger colleague? Hough says nothing about this—perhaps Gutenberg himself was silent on the question. But she does report a remark of Hertha Gutenberg, Beno’s wife. Hertha regarded “her husband’s quirky young protégé as childish.” And this assessment brings me to the next topic.

Hough has included a substantial chapter on the Asperger (personality) syndrome (1944; Hans Asperger, Austrian pediatrician, 1906–1980) and considers Richter’s behavior to be consistent with its various manifestations. Asperger’s syndrome is a psychiatric condition, a type of autism, often characterized by poor social interactions, repetitive behavior patterns, and numerous eccentricities. The talent displayed by people with this syndrome can be considerable, verging on the genius. Having had one student with Asperger’s and having known a number of brilliant mathematicians whom I would put in this category, I found this chapter eyebrow-raising.

Following the lead of *The Oasis Guide to Asperger Syndrome*, by Patricia R. Bashe and Barbara L. Kirby (Oasis = Online Asperger Syndrome Information and Support), Hough lists a dozen diagnostic traits and behaviors associated with Asperger’s syndrome, ranging from difficulty with social relationships and social use of language to extreme preoccupation with special interests to tic disorders. By my reading, Hough’s assessment is that Richter strongly manifested nine of 12 traits associated with Asperger’s, and possibly three others as well. Do we have here the makings of an Asperger scale? In fact, a number of Asperger scales are available commercially, some including as many as fifty traits. Luckily, though, conference-type badges identifying people as “Certified Level 18 Asperger” have not come into use.

Some might view a few of Richter’s behavior patterns as mere eccentricities. He and his wife were devoted nudists, for example. He often went to work wearing two ties. He wrote lots of introspective, soul-baring poetry. He was a “world-class Trekkie” (*Star Trek*), and, Hough writes,

“among his papers at the CIT Archives one finds long rows of archival boxes filled with his collection of magazines: *Amazing Stories*, *Other Worlds*, and many more spanning nearly three decades.”

Susan Hough’s book is very much in the tradition of biographies of highly creative people who have substantial mental problems. I’m reminded of *A Beautiful Mind* and *The Man Who Loved Only Numbers: The Story of Paul Erdős*, the hero of the latter having as certifiable a case of Asperger’s syndrome as one might find. And yet . . .

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\*The books of Richter, and of Gutenberg and Richter, display practically no mathematics. But because seismology deals with wave propagation in solids and liquids, it has a deeply mathematical side that has been greatly developed since the appearance of the digital computer. See, for example, *Seismological Algorithms* (D.J. Doornbos, ed., Academic Press, 1988).

In May 1970, Richter was honored at a retirement party. It was a painful occasion for him—he hated the ceremony and said so out loud. He left behind a draft of a very moving retirement speech dated May 22, 1970, which included the following:

“I need not tell you that right now there are all the necessary means to create a decent world. The chief obstacles are ignorance, greed, militarism, nationalism; and the violence stems either from a psychotic impulse to destruction or from a feeling of inferiority and a desire for revenge.”

Considering world history since 1970, I should say that, Asperger’s or no, nudism or no, poetry writing or no, Richter was dead right about the convulsions of our times. I read somewhere that a touch of Asperger’s is probably good for creativity. To which we may add: A touch of it may be good for sanity as well.

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