

Logarithmic Scales

by Sophia Tutorial



WHAT'S COVERED

Logarithmic scales are used to adjust the axes on a plot to make it easier to interpret. This tutorial will discuss:

1. Logarithmic Scales
2. Moore's Law

1. Logarithmic Scales

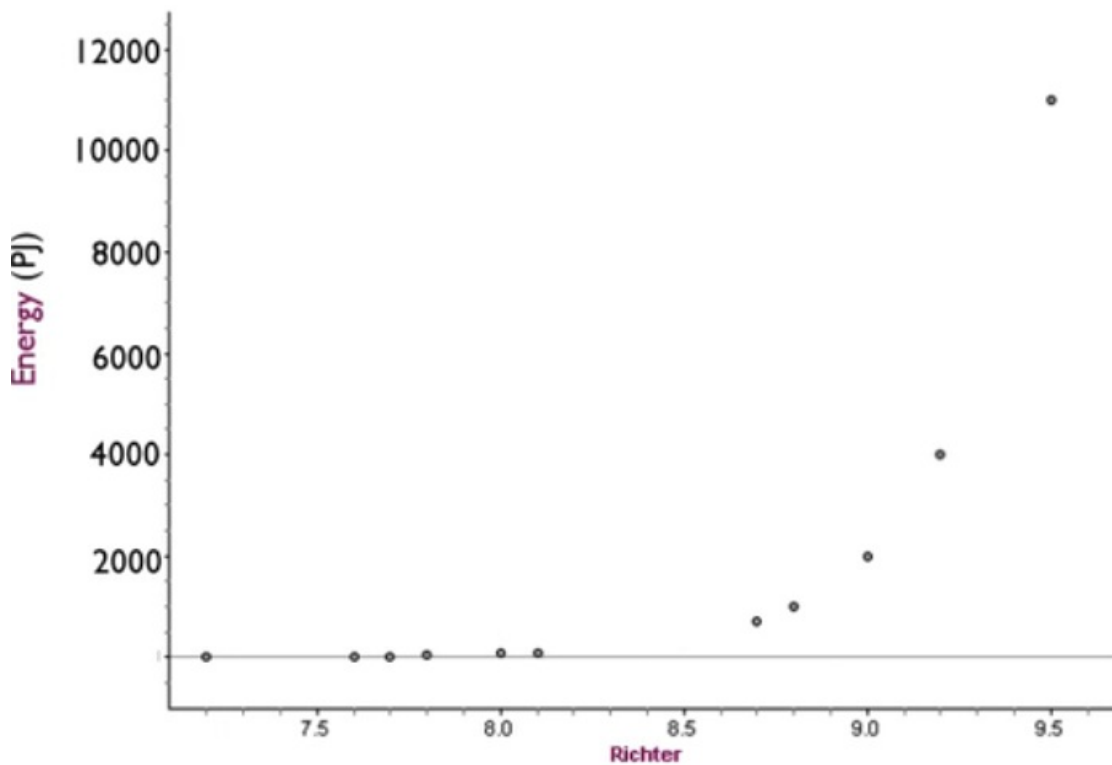
The best way to explain logarithmic scales is to show you how it works. Here's a list of earthquakes based on where and when they occurred.

Location	Country	Year	Energy (in PJ)	Richter
Lisbon	Portugal	1755	2000	9
San Francisco	USA	1906	63	8
Hawke's Bay	New Zealand	1931	32	7.8
Valdivia	Chile	1960	11,000	9.5
Anchorage	USA	1964	4,000	9.2
Tangshan	China	1976	32	7.8
Vrancea	Romania	1977	4	7.2
Mexico City	Mexico	1985	89	8.1
Jiji	Taiwan	1999	16	7.6
Indian Ocean	Indonesia	2004	4,000	9.2
Sumatra	Indonesia	2005	710	8.7
Sichuan	China	2008	63	8
Sumatra	Indonesia	2010	22	7.7
Pelluhue	Chile	2010	1,000	8.8
Tohoku	Japan	2011	2,000	9

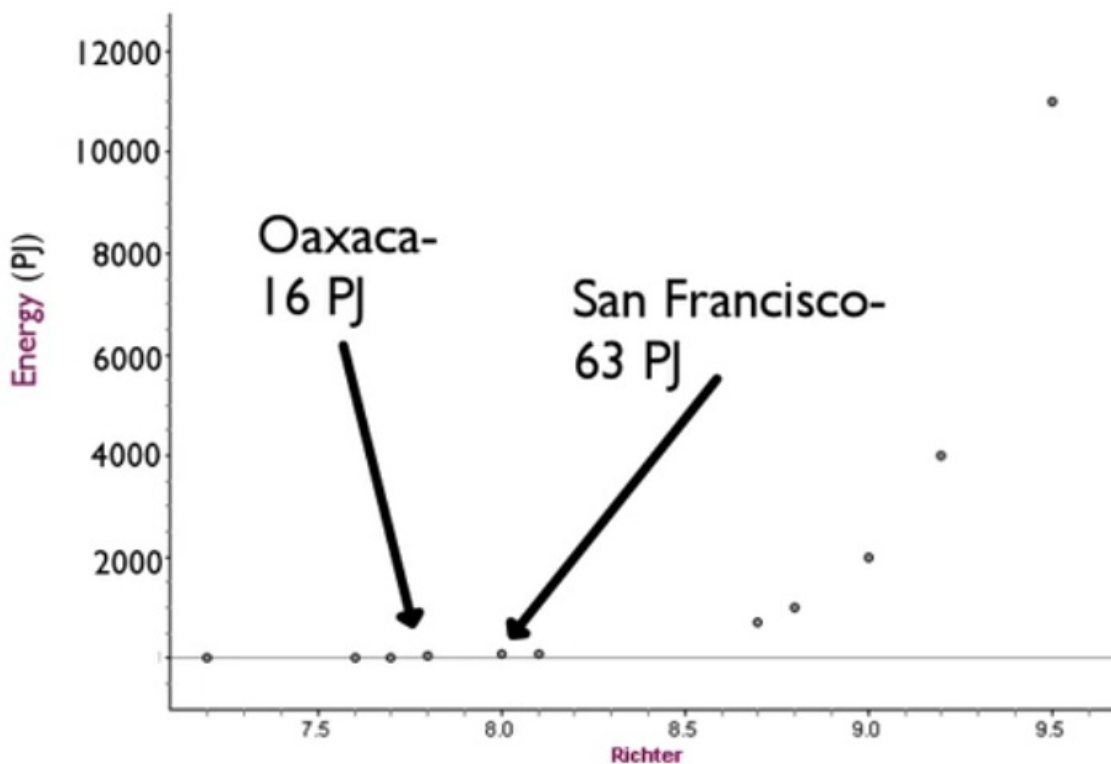
Oaxaca	Mexico	2012	16	7.6
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More importantly, the focus on this table is the energy released in petajoules, which is millions of millions of joules and their values on the Richter scale. You can see that in 2004, Christmas Day, a tsunami struck Indonesia. You can also see the famous San Francisco earthquake of 1906.

Look at the data on a scatter plot. The data actually follows a curve. As the Richter value goes up, so does the energy released from the earthquake. But it's a curve, it's not a straight line.



Here is the problem: Oaxaca earthquake released 16 petajoules of energy, which is a lot. However, the San Francisco earthquake released almost four times as much energy, yet it looks very similar to the Oaxaca earthquake on this particular scale.



It's difficult to interpret the differences even though the difference is large. But it's hard to tell because the values differ by such a large order of magnitude.

To see those differences, it's to use a logarithmic scale instead of beneficial, instead of a standard scale. A standard scale uses equal increments.



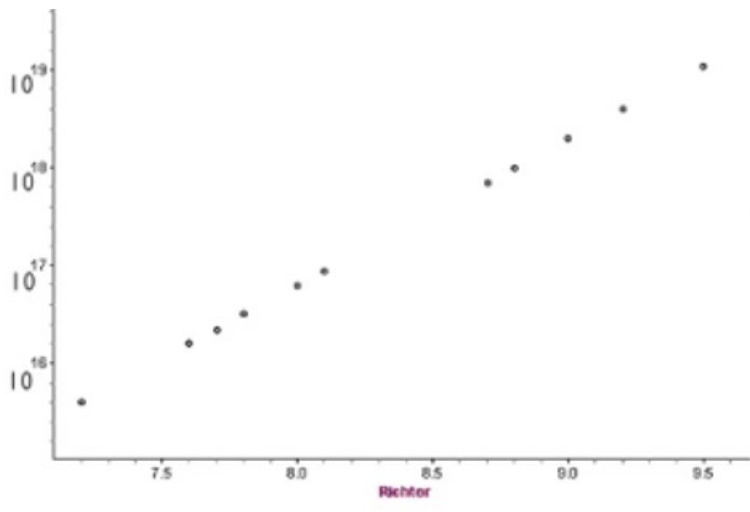
TERM TO KNOW

Logarithmic Scale

A scale that uses equal measurements to represent equal ratios (usually multiplying by 10) rather than equal intervals.

A logarithmic scale will use equal ratios, so each distance represents 1,000, no matter how many increments used. So it might be 10, and then times 10 again, and times 10 again, etc. So you get to 10,000. As opposed to 10 being way way, way down here near the x-axis, it's actually up here. So you can see those differences more clearly.

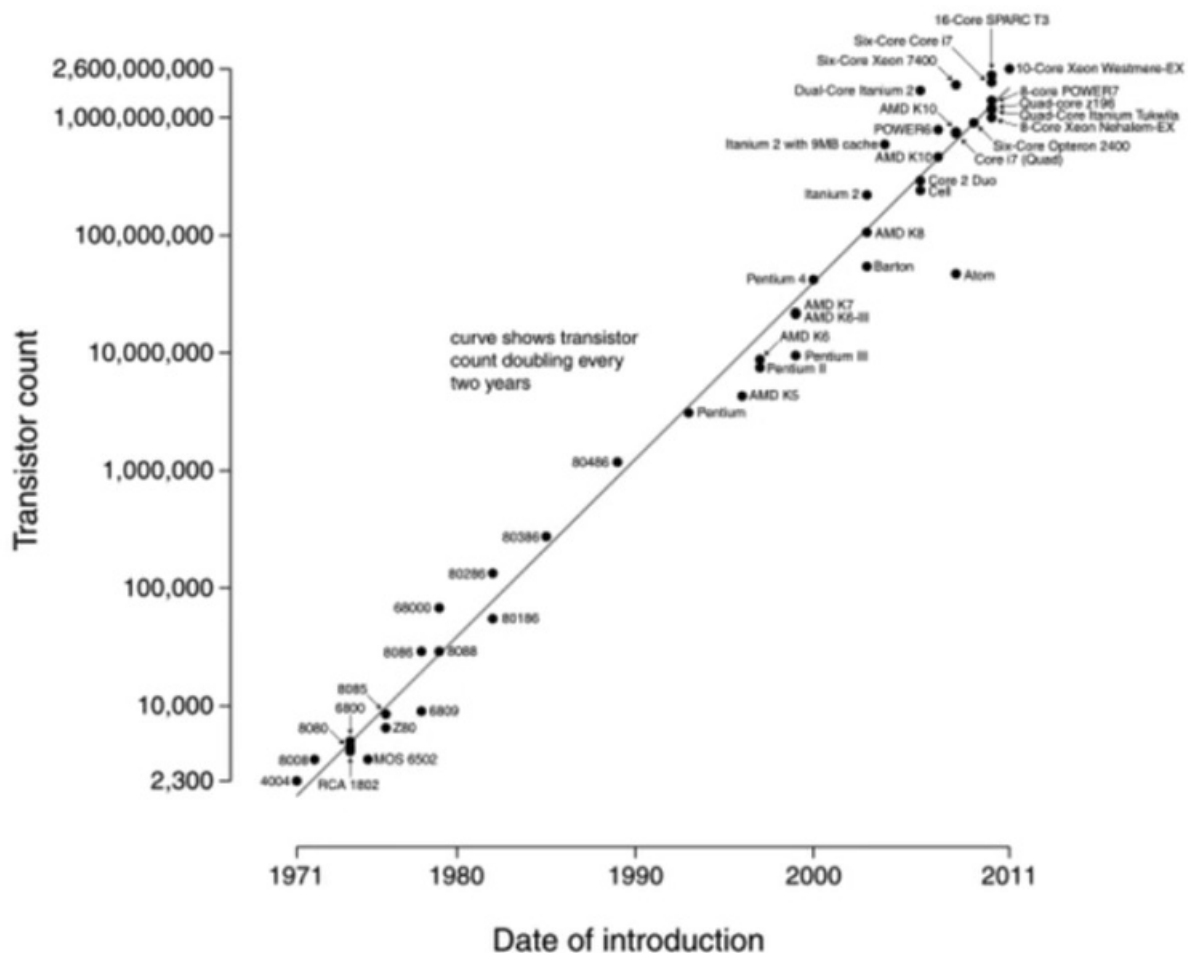
Compare the standard scale for earthquake data vs. a logarithmic scale. This is energy in 10 to the 16th power, 10 to the 17th power, etc. Data that appear exponentially curved on a standard scale will often end up appearing linear on a logarithmic scale. This is an important piece to consider.



2. Moore's Law

One big example of a logarithmic scale being useful is something called Moore's Law. This law focused on a trend involving components on microprocessors on a circuit. Gordon Moore said that the number of components in circuits has doubled every year since the invention of the circuit, and the trend would continue for at least 10 years. So, why does this matter?

Well, if you look at what actually ended up happening, it actually continued much, much further into the future than he had predicted. It does appear that between every one and two years, typically around every year, the number of microprocessor transistors had in fact doubled. This is viewed on a logarithmic scale and it looks linear. Doubling every year is actually an exponential growth curve.





TERMS TO KNOW

Logarithmic Scale

A scale that uses equal measurements to represent equal ratios (usually multiplying by 10) rather than equal intervals.

Moore's Law

A trend in technology for the number of components on microprocessors to double every year. It was first posited by Gordon E. Moore in 1965, and has more or less continued to the present day.