Measuring EQs

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It is a base-10 logarithmic scale obtained by calculating the logarithm of the combined horizontal amplitude (shaking amplitude) of the largest displacement from zero on a particular type of seismometer (Wood–Anderson torsion). For example, an earthquake that measures 5.0 on the Richter scale has a shaking amplitude 10 times larger than one that measures 4.0.

A log scale, formally known as a logarithmic scale, measures exponential values rather than unit values as a linear scale does. This is useful when values change more rapidly than is convenient to represent on a linear scale. Many physical phenomena are most easily measured with a logarithmic scale.
A regular graph has numbers spaced at even intervals, while a log scale graph has numbers spaced at uneven intervals. The reason for this is that while a regular graph uses regular counting numbers like 1,2,3,4, and 5, a logarithmic graph uses powers of 10, such as 10, 100, 1000 and 10,000. To add to the confusion, scientific notation is often used on log scale graphs, so instead of 100 you might see 10^2. Reading a log scale graph is no more challenging than reading a regular X Y axis graph.
While a line in a regular numbered graph means a linear relationship, in a logarithmic graph it normally means an exponential relationship.

If we want to plot something that changes with time and the time period is relatively short, we often use a linear scale.

While this kind of scaling is intuitive and easy to recreate by hand, linear scaling should not be used on charts with large vertical ranges. **A move from 10 to 20 is much better than a move from 90 to 100, but on a linear scale they both appear the same.**
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These charts are
useful for comparing relative (percentage) changes, rather than absolute amounts of change, for a
set of values. On a logarithmic scale, equal distances represent equal ratios. For example, the
distance from 1 to 2 is the same as that from 2 to 4, 4 to 8, 8 to 16, etc. - at each interval, a ratio
of 1 to 2.
On a logarithmic scale chart, the vertical spacing between two points corresponds to the percentage change between those numbers. Thus, on a log scale chart, the vertical distance between 10 and 20 (a 100% increase) is the same as the vertical distance between 50 and 100. Because these charts show percentage relationships, logarithmic scaling is also called

"percentage" scaling. It is also called "semi-log" scaling because only one of the axes (the vertical one) is scaled logarithmically. Semi-log scales can be useful for long-term charts to gauge the percentage movements over a long period of time. Large movements are put into perspective

The line chart at the left below presents data plotted on standard arithmetic scales. It is useful for reading the absolute amount by which each value changes; however, it does not show relative change. It simply shows that one data series (Data A) increased by a greater amount than the other (Data B). The example on the right below presents the same two data sets plotted on a logarithmic line chart using a logarithmic scale on the y axis. This chart is useful for comparing the rates at which each value changes. Absolute values can be read from the scale at the side of the chart, but not compared visually. This chart shows that Data B increased at a greater rate than Data A and reveals that the rate of increase became progressively larger in Data B and progressively smaller in Data A. Much more information about the differences between these two data series is obtained from the logarithmic line chart.
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The Richter magnitudes are based on a logarithmic scale (base 10). What this means is that for each whole number you go up on the Richter scale, the amplitude of the ground motion recorded by a seismograph goes up ten times. Using this scale, a magnitude 5 earthquake would result in ten times the level of ground shaking as a magnitude 4 earthquake (and 32 times as much energy would be released). To give you an idea how these numbers can add up, think of it in terms of the energy released by explosives: a magnitude 1 seismic wave releases as much energy as blowing up 6 ounces of TNT. A magnitude 8 earthquake releases as much energy as detonating 6 million tons of TNT. Pretty impressive, huh? Fortunately, most of the earthquakes that occur each year are magnitude 2.5 or less, too small to be felt by most people.

USGS The standard body-wave magnitude formula is

$mb = \log10(A/T) + Q(D,h)$,

where A is the amplitude of ground motion (in microns); T is the corresponding period (in seconds); and Q(D,h) is a correction factor that is a function of distance, D (degrees), between epicenter and station and focal depth, h (in kilometers), of the earthquake.

USGS Magnitude is related to the amount of seismic energy released at the hypocenter of the earthquake. It is based on the amplitude of the earthquake waves recorded on instruments which have a common calibration. The magnitude of an earthquake is thus represented by a single, instrumentally determined value.

MS Earthquakes
per year
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8.5 - 8.9 0.3
8.0 - 8.4 1.1
7.5 - 7.9 3.1
7.0 - 7.4 15
6.5 - 6.9 56
6.0 - 6.4 210