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HOW EARTHQUAKES ARE MEASURED

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Photographs and films in news reports of earthquake damage show us in a vivid way how strong some earthquakes are. However, many earthquakes do not cause visible damage. Therefore, pictures are not the only means to describe the strength of an earthquake. In fact, most news accounts mention reports from scientists who refer to the severity of an earthquake by using measures of "magnitude" and "intensity." What do these terms mean?

The *magnitude* of an earthquake is computed from ground movement recorded at seismic stations by instruments called seismographs. Magnitude is the measure of the total seismic energy released by the earthquake. It was originally defined by Charles F. Richter, an American seismologist, to make it easier to compare the differences in amounts of energy released by earthquakes. Magnitude is not directly proportional to the amount of energy released. For example, an earthquake of magnitude 5 does not release only 25 percent more energy than an earthquake of magnitude 4. The earthquake of magnitude 5.5 that occurred in southern Illinois on November 9, 1968, released about 250 times the energy of the southern Illinois quake of magnitude 4.5 on April 3, 1974.

The *intensity* of an earthquake is a measurement of the effects of the shaking, as shown by the damage to property and by the earth deformation felt or observed by people in a particular part of the shaken area. Thus, for any earthquake there are many intensities (dependent upon the location of an observer in the earthquake area) but only one magnitude (measured by seismographs).

The most widely used intensity scale is the Modified Mercalli scale which was introduced in 1931. A Modified Mercalli scale of earthquake intensities and the approximately corresponding magnitudes on the Richter scale can be found in the table on the other side of this page. This table will help you to compare information between past earthquakes and future tremors about which you may read or hear in the news. Magnitudes and maximum intensities of some recent Illinois earthquakes are listed here. Maximum intensity is designated because an earthquake can produce several distinct shocks of different strengths.

	Magnitude	Maximum intensity
November 9, 1968	5.5	VII
September 15, 1972	4.63	VI
April 3, 1974	4.5	VI
June 5, 1974	4.0	V

The initial movements along a fault to relieve the buildup of stress may involve a relatively small area of the fault plane, but after a short interval of time a shift over a much larger area of the fault plane follows. Because tearing and displacement usually occur at great depths, shallower faults that can be seen at the earth's surface may or may not be affected. On the west coast, surface faults are highly active during earthquakes, but in Illinois, there is not yet evidence that recent earthquakes have caused shifts along the ancient fault lines intersecting the bedrock surface.

Sometimes the initial movements in the small area and the shifts in the much larger area of the fault plane occur almost at the same moment so that they cannot be distinguished. However, if the time interval between shocks is great enough to allow them to be distinguished, the first movements are called *foreshocks*. The shift of the rocks at the time of the principal break, or *main shock*, relieves the main stress in the rocks. Following the main shock, a series of adjustments in the rocks results in a sequence of *aftershocks* of gradually decreasing magnitude and frequency.

Instruments to measure magnitude had not yet been invented at the time of the New Madrid, Missouri sequence of earthquakes in 1811-1812, but from historical reports available on the effects and damage of that tremendous shaking, the total energy released in the New Madrid sequence is thought to be equivalent to at least magnitude 7.5 on the Richter scale. The first of the quakes, which took place on December 16, 1811, was estimated to have a maximum intensity of XI.

The so-called "New Madrid seismic region," which includes portions of extreme southern Illinois, southeast Missouri, western Tennessee and Kentucky, and northeastern Arkansas, has historically been an area of frequent earthquakes. In the southern Illinois area, the release of energy has occurred generally as numerous small shocks, most so small that they have caused little or no damage to man-made structures.

MODIFIED MERCALLI SCALE OF EARTHQUAKE INTENSITIES
WITH APPROXIMATELY CORRESPONDING MAGNITUDES*

Intensity		Description of characteristic effects	Richter scale magnitude approximately corresponding to highest intensity reached
I	Instrumental:	detected only by seismography	
II	Feeble:	noticed only by sensitive people	3.5 to 4.2
III	Slight:	like the vibrations due to a passing heavy truck; felt by people at rest, especially on upper floors	
IV	Moderate:	felt by people while walking; rocking of loose objects, including standing vehicles	4.3 to 4.8
V	Rather strong:	felt generally; most sleepers are wakened and bells ring	
VI	Strong:	trees sway and all suspended objects swing; damage by overturning and falling of loose objects	4.9 to 5.4
VII	Very strong:	general alarm; walls crack; plaster falls	5.5 to 6.1
VIII	Destructive:	car drivers seriously disturbed; masonry fissured; chimneys fall; poorly constructed buildings damaged	6.2 to 6.9
IX	Ruinous:	some houses collapse where ground begins to crack, and pipes break open	
X	Disastrous:	ground cracks badly; many buildings destroyed and railway lines bent; landslides on steep slopes	7.0 to 7.3
XI	Very disastrous:	few buildings remain standing; bridges destroyed; all services (railway, pipes and cables) out of action; great landslides and floods	7.4 to 8.1
XII	Catastrophic:	total destruction; objects thrown into air; ground rises and falls in waves	8.1+

* From Holmes, Arthur, 1965, Principles of Physical Geology: Ronald Press, N.Y., p. 901.