

Magnitude

Magnitude is the physical size of an earthquake. In *figure 1*, notice the magnitude scale in correspondence to the earthquake's energy equivalence.

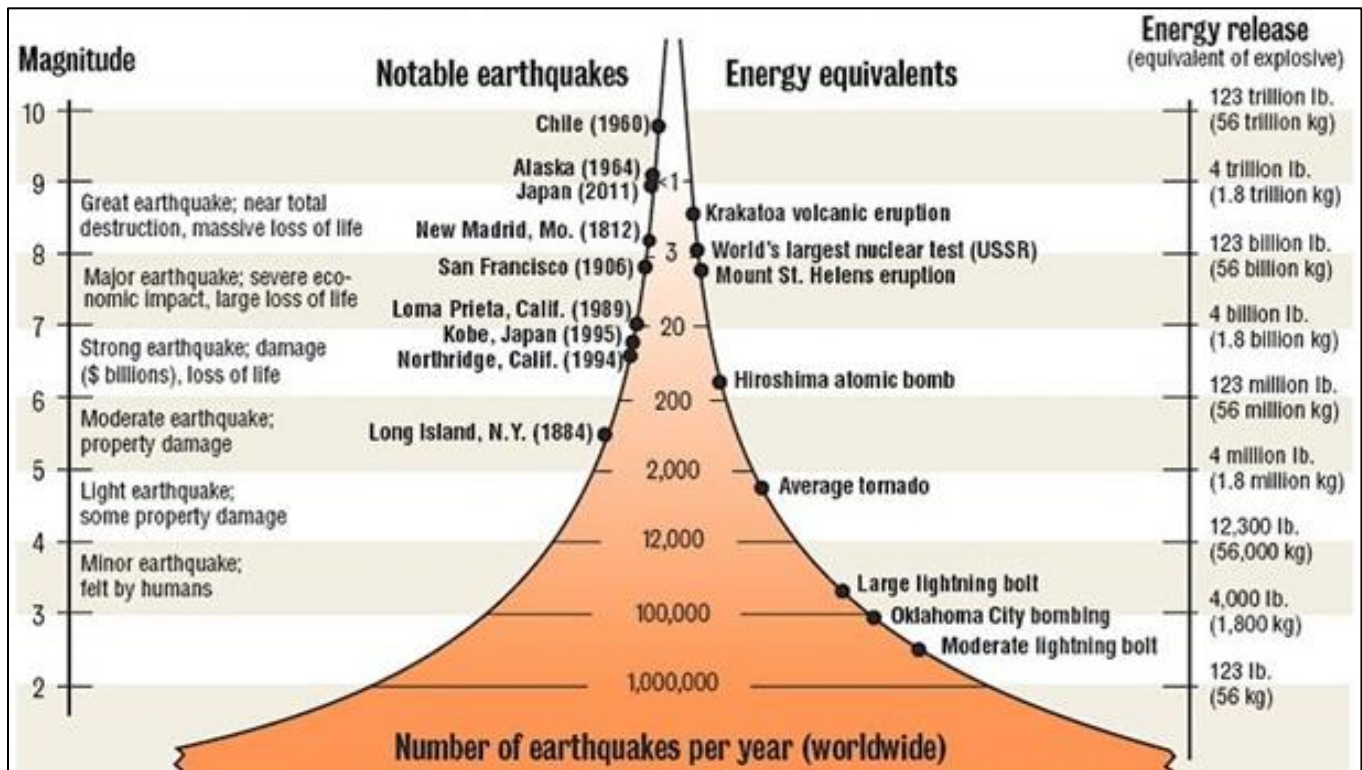


Figure 1: Seismic wave energy in earthquakes and energy equivalents. (Figure adapted from (Incorporated Research Institutes for Seismology, IRIS))

Both seismic moment and moment magnitude (M_w) can be calculated using GeoGateway's moment magnitude calculator. As shown in *figure 2*, **seismic moment** equates to the product of the shear modulus, rupture area, and slip length, and **moment magnitude** equates to the product of two-thirds the log base of seismic moment, subtracted by 10.73.

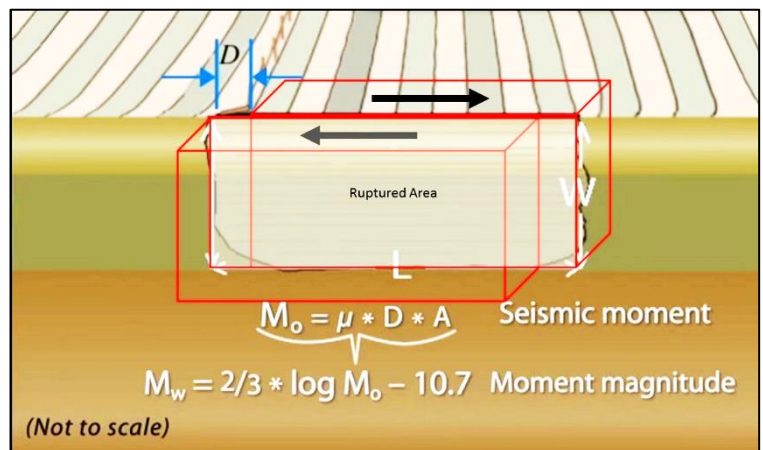


Figure 2: Represents the seismic moment and moment magnitude equations. (Figure adapted from (Vista Heights Middle School))

The shear modulus (μ) is

3.2×10^{11} dynes/cm² in the crust

7.5×10^{11} dynes/cm² in the mantle

The area (km²) as shown in *figure 2* can be found by using the length (L) and width (W). The slip (meters) is the average displacement (D) of the rupture.

Step 1: To begin calculations,
click on the "Magnitude" tab

Step 2: Once the tab is open, input the
fault length that ruptured in kilometers

Step 3: Input the fault width that ruptured, in
units of kilometers

Step 4: Input the distance the fault moved (slip),
in units of meters

Step 5: Input the shear modulus in units of $\frac{10^{11} \text{ dyne}}{\text{cm}^2}$

Step 6: Click on Calculate

The diagram illustrates the process of calculating seismic moment and moment magnitude for the 2011 Tohoku-Oki earthquake using the GeoGateway Magnitude calculator. The process is divided into six steps:

- Step 1:** Selecting the **Magnitude** tool from the top navigation menu.
- Step 2:** Entering the **Length** (249 km) in the first input field.
- Step 3:** Entering the **Width** (120 km) in the second input field.
- Step 4:** Entering the **Slip** (23 m) in the third input field.
- Step 5:** Entering the **Shear Modulus** (3 10^{11} dyne/cm²) in the fourth input field.
- Step 6:** Clicking the **Calculate** button.

The results displayed at the bottom of the calculator are:

- Seismic Moment:** 2.1×10^{29}
- Moment Magnitude:** 8.8

Figure 3: Calculating seismic moment and moment magnitude of 2011 Tohoku-Oki earthquake.

GeoGateway has set the moment magnitude 9.0 Tohoku-Oki earthquake as default. The results indicate a seismic moment of 2.1×10^{29} dyne*cm and a moment magnitude of 8.8.