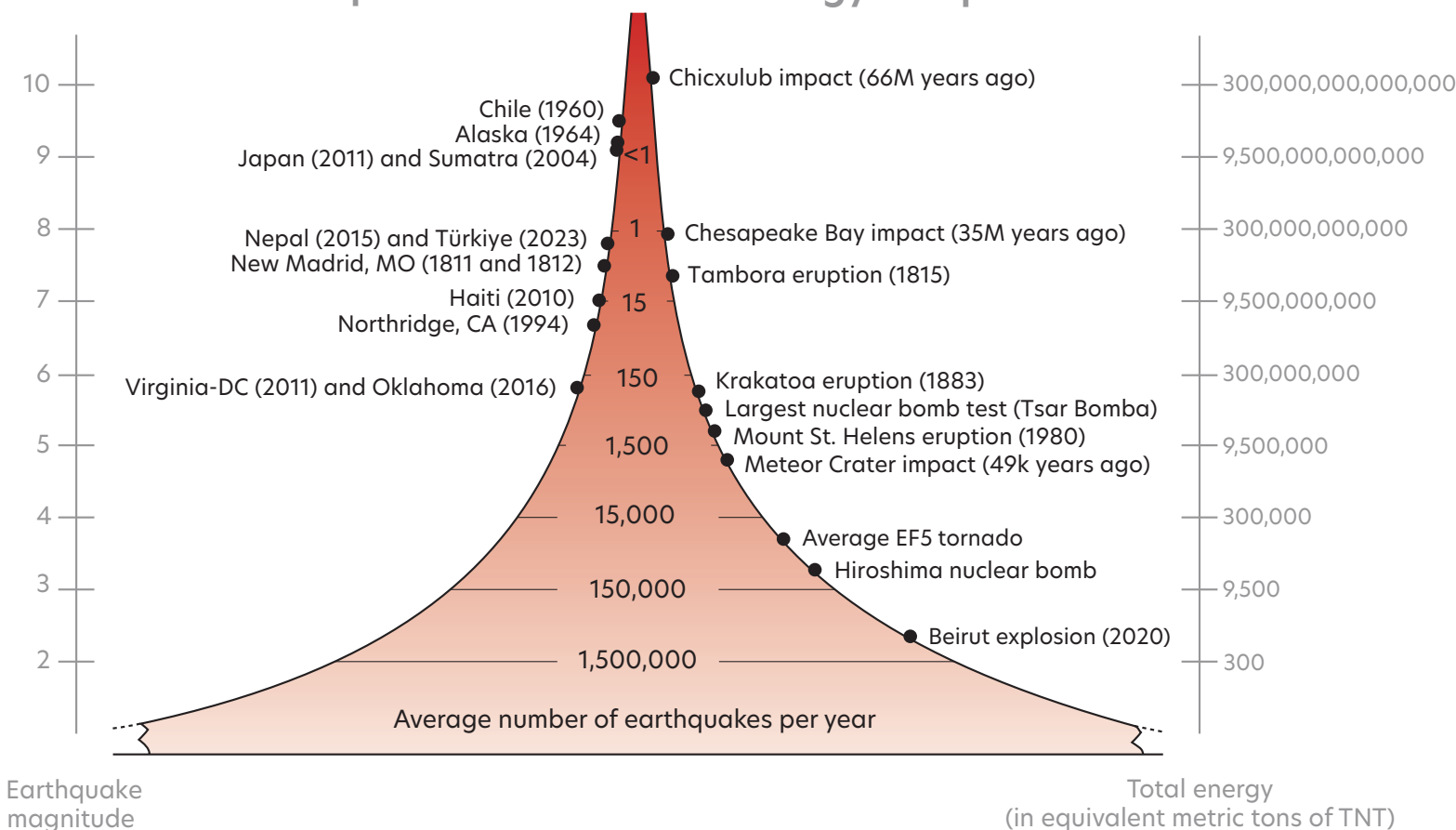


How often do earthquakes occur?

Earthquakes

Energy Comparisons



The total energy of the earthquake includes the seismic waves that radiate from the epicenter and cause shaking, as well as energy dissipated as heat due to friction along moving faults and energy producing new cracks in the rock. The relative percentages of these processes vary, but the total energy equates to an earthquake's magnitude.

Earthquake frequency

Although major earthquakes of magnitude 7 or higher make news because they occur infrequently—and can cause great damage and harm—smaller earthquakes are quite common. In an average year, for example, we can expect around 15,000 magnitude 4 earthquakes around the world. These are long-term averages, however, and a given year may see more or fewer earthquakes of a specific magnitude. For example, 9 earthquakes of magnitude 7.0 or higher occurred in 2020, while 2021 saw 19 such events.

By chance, several major earthquakes may even occur in different locations around the world within a short period of time, but this does not imply they are causally related. Seismologists can study sets of earthquakes for evidence that one altered stress on the fault or triggered another, but coincidences are more common than connections.

Has earthquake activity been increasing?

There has been an increase in the number of earthquakes that can be detected and located because the number of seismic stations has dramatically increased over the last century. But that doesn't mean the number of earthquakes has increased. The number of magnitude 7 or higher earthquakes—which are easier to detect—has remained consistent since records began.

Understanding earthquake magnitude

For a magnitude difference of 1, earthquake frequency changes by a factor of 10—that is, magnitude 6.0 earthquakes are 10 times more common than magnitude 7.0 earthquakes. The total energy of an earthquake is also logarithmic. For a magnitude difference of 1, energy changes by a factor of about 32. This means that a magnitude 7.0 earthquake is far stronger than a magnitude 6.0 earthquake—and even magnitude 6.0 and 6.5 earthquakes are significantly different.

Earthquake magnitude is generally reported using the moment magnitude scale, which differs from the older Richter scale that you may have heard of because of its use in everyday language. The Richter scale was created in the 1930s to measure California earthquakes based on a specific type of seismometer that was in use at the time. In the 1970s, seismologists developed the moment magnitude scale to more accurately represent earthquakes anywhere in the world and using any kind of seismic data.

The two magnitude scales are actually quite similar for smaller earthquakes, but the Richter scale becomes inaccurate for earthquakes above magnitude 6, while the moment magnitude scale continues to work well for even the largest earthquakes.

The moment magnitude scale is based on estimating the seismic moment, which is the total force that moved the fault during the earthquake. The larger the area of the fault that slips, and the farther it slips, the larger the seismic moment. This value is directly related to the amount of energy released as seismic waves, which produce the shaking we experience.

Compare moment magnitudes of 6.0, 6.5, and 7.0—represented here by the area of each circle

6.0

6.5

7.0

What does total energy mean?

The total energy of an earthquake shown on the right axis of the main figure includes more than just the seismic waves that radiate away from the epicenter. Two other processes actually account for the bulk of the energy: the formation of new fractures in the rock, and heat produced by friction.

When a fault slips during an earthquake, the rock on opposing sides of the fault grinds together. This friction turns into heat, just as the brakes of a car get hot after use. At the same time, fault slip can also damage the rock near the fault, breaking open new cracks—this action requires energy.

The figure focuses on total energy rather than just radiated seismic waves because total energy is similar for earthquakes of the same magnitude. The proportion of the total energy that is released as seismic waves can vary significantly between earthquakes, making it difficult to calculate an accurate energy comparison.

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