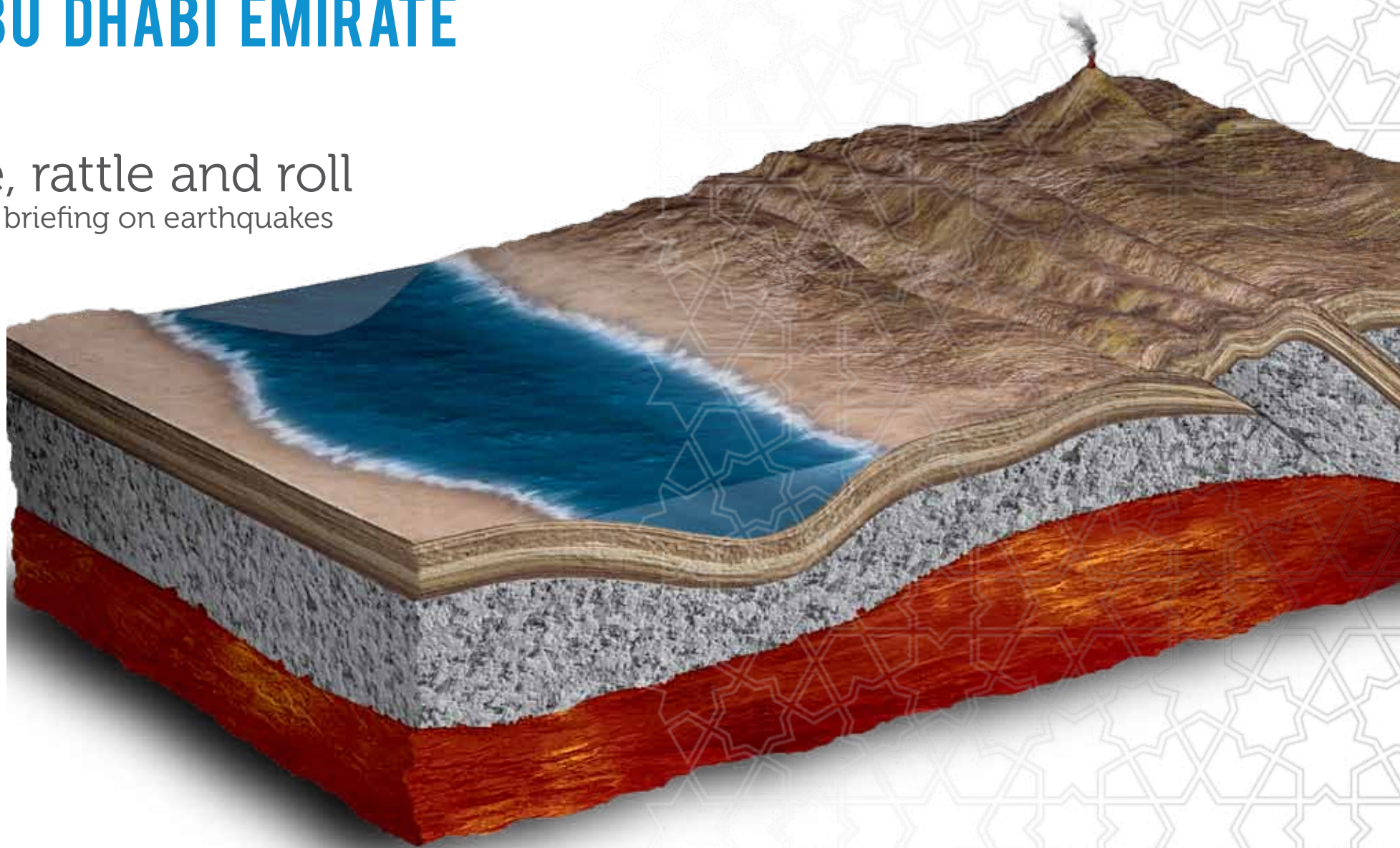


# ENVIRONMENTAL ATLAS OF ABU DHABI EMIRATE

Shake, rattle and roll  
A teacher briefing on earthquakes





This teacher briefing is for teachers and other educators to give young people an understanding of earthquakes.



An earthquake shattering a road

## Earthquakes are the Earth's natural means of releasing stress.

An earthquake is the sudden release of strain energy in the Earth's crust resulting in waves of shaking that radiate outwards from the earthquake source<sup>(1)</sup>. When stresses in the crust exceed the strength of the rock, it breaks along lines of weakness.

As the Earth's plates move past each other, friction between them results in the build up of pressure. As the plates continue to move and the pressure builds up, eventually the pressure is great enough to overcome friction and the plate jolts forward releasing the pent up energy in the form of seismic waves.

Occurrences of earthquakes are unevenly distributed over the Earth, with the majority occurring at the boundaries of the major crustal plates<sup>(2)</sup>.

Sometimes an earthquake has foreshocks. These are smaller earthquakes that happen in the same place as the larger earthquake that follows.

Scientists can't tell that an earthquake is a foreshock until the larger one happens. The largest, main earthquake is called the mainshock. These always have aftershocks that follow. These are smaller earthquakes that occur afterwards in the same place as the mainshock.

Depending on the size of the mainshock, aftershocks can continue for weeks, months and even years after the mainshock<sup>(3)</sup>.

Earthquakes can have a range of strengths with the strongest having severe consequences for the areas where they are centered, nearby areas, and even some far away in the case of earthquake-generated tsunamis. The effects of an earthquake can be devastating.

## Types of Earthquake

There are many different types of earthquakes: tectonic, volcanic, and explosion<sup>(4)</sup>. The type of earthquake depends on the region where it occurs and the geological make-up of that region. The most common are tectonic earthquakes<sup>(5)</sup>. These occur when rocks in the earth's crust break due to geological forces created by movement of tectonic plates. Another type, volcanic earthquakes, occur in conjunction with volcanic activity.<sup>(6)</sup>

Whilst earthquakes are caused mostly by rupture of geological faults, they are also caused by other events such as volcanic activity, landslides and mine blasts.<sup>(7)</sup>

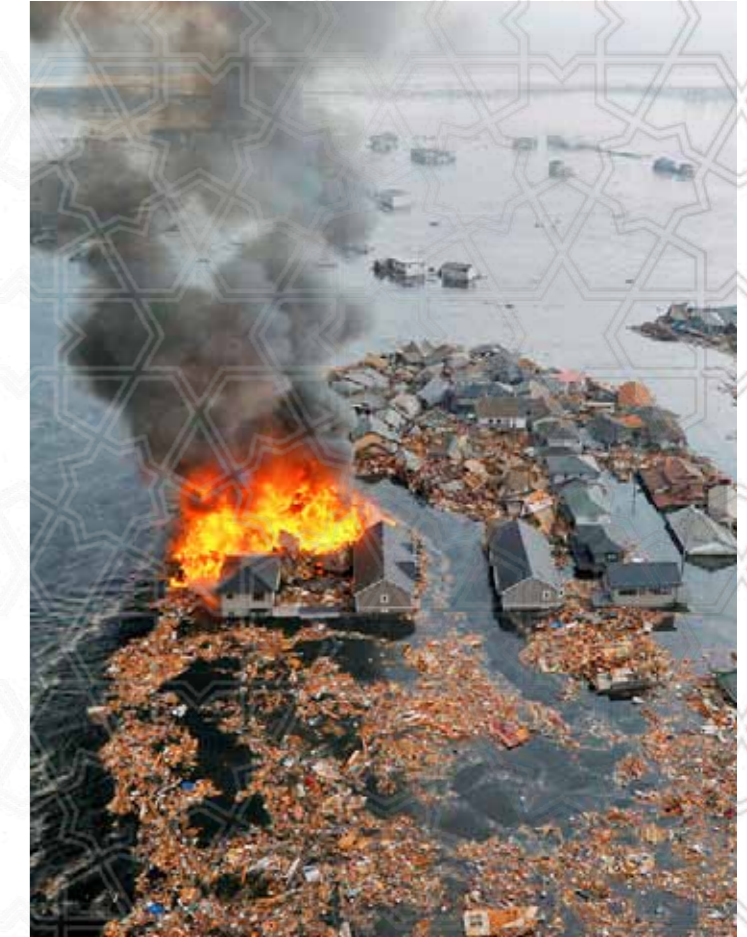
## The causes of Earthquakes

Most earthquakes occur at fault zones, where tectonic plates, the giant rock slabs that make up the Earth's upper layer, collide or slide against each other<sup>(8)</sup>. These impacts are usually gradual and unnoticeable on the surface; however, immense stress

can build up between plates. When this stress is released quickly, it sends massive vibrations, called seismic waves<sup>(9)</sup>, often hundreds of miles through the rock and up to the surface. Other earthquakes can occur far from faults zones when plates are stretched or squeezed<sup>(10)</sup>.

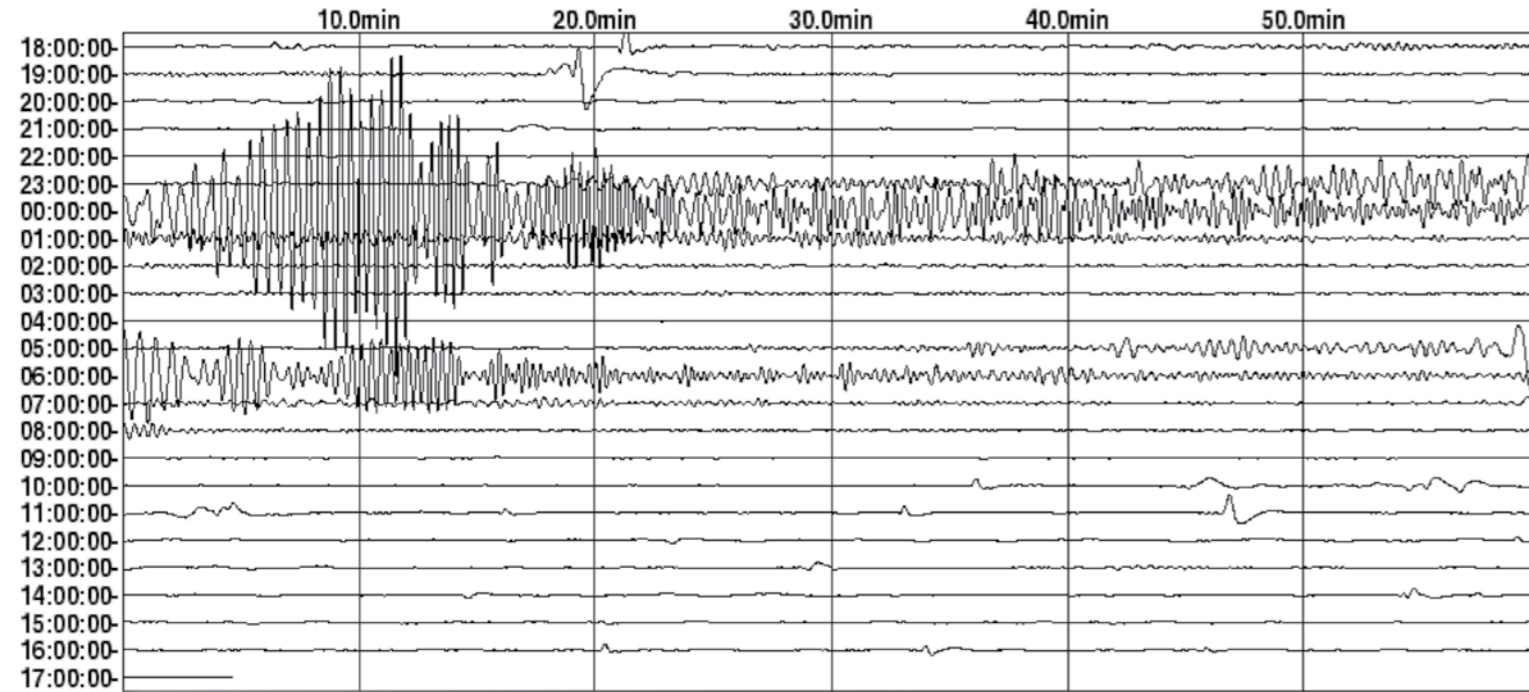
The surface where they slip is called the fault or fault plane<sup>(11)</sup>. The location below the earth's surface where the earthquake starts is called the hypocenter<sup>(12)</sup>, and the location directly above it on the surface of the earth is called the epicenter<sup>(3)</sup>. The point inside the crust where the pressure is released is called the focus.<sup>(13)</sup>

Earthquake energy is released in seismic waves<sup>(14)</sup>. These waves spread out from the focus. The waves are felt most strongly at the epicentre, becoming less strong as they travel further away. The most severe damage caused by an earthquake will happen close to the epicentre<sup>(15)</sup>.



Earthquakes can destroy settlements





A seismogram

**Measuring earthquakes**

Earthquakes vary in size. Those that do the most damage are extremely large, but some are so small they are almost undetectable.

To measure earthquakes, geologists use seismographs<sup>(16)</sup> to record the surface and body waves. Inside a seismograph designed to measure horizontal motion, a

weight is freely suspended. As waves from earthquakes reach the seismograph the mass stays in relatively the same place, while the ground and the support move around it. This movement is recorded on magnetic tape by a pen attached to the mass. In a seismograph designed to measure vertical motion, the mass is connected to a spring,

so as the ground and support move up and down, the pen on the mass measures the vertical motion. The metal tape which the motion is recorded on is marked with lines that correspond to one minute intervals. When motion is recorded a seismogram<sup>(17)</sup> is created, which tells about the waves, how big they were and how long they lasted.

Using the information from the seismogram, the epicenter and focus of the earthquake can be determined. The focus is the point on the fault at which the first movement or break occurred. The epicenter is the point on the surface directly above the focus. Once several seismograph stations have determined their distance from the epicenter, the actual epicenter can be located, using triangulation, on a map<sup>(18)</sup>.

The strength of an earthquake is measured using the Richter scale. The Richter scale is numbered 0-10<sup>(19)</sup>.

Earthquakes measuring just 1 or 2 on the scale are very common and can happen everyday in many places. These earthquakes are so small that people cannot feel them, they can only be picked up by a seismometer. Earthquakes measuring around 7 or 8 on the Richter scale can have a devastating effect<sup>(20)</sup>.

**Effects of earthquakes**

Earthquakes can destroy settlements and kill many people<sup>(21)</sup>. Aftershocks can cause even more damage to an area. We can divide the effects of an earthquake into those known as the primary effects and

those known as the secondary effects<sup>(22)</sup>. Primary effects of an earthquake are those resulting directly from the earthquake itself. These include; buildings collapsing; roads cracking; bridges giving way; shattering of glass and injuries / deaths resulting from these. Secondary effects are those that result from the primary effects.

For example ground shaking may result in the cracking of gas and water pipes (primary effects) this can result in severe fires due to explosion from escaping gas and difficulties in putting out fires due to lack of water from burst mains (secondary effects). Other secondary effects include, homelessness, business going bankrupt and closing etc.

Constructive effects of earthquakes also include the formation of lakes and hot springs, the lifting of the water table, the exposure to deep minerals and formation of new minerals and the creation of new coastal plains that are very fertile<sup>(23)</sup>.

**Impact of earthquakes**

A number of factors can contribute to the impact of an earthquake:

- > The distance from the epicentre - the effects of an earthquake are more severe at its centre.
- > The higher on the Richter scale, the more severe the earthquake is.
- > The level of development - the more developed the nation, the more likely to have the resources and technology for monitoring, prediction and response.
- > The population density - the more densely populated an area, the more likely there are to be deaths and casualties.
- > The time of day influences whether people are in their homes, at work or travelling.
- > The time of year and climate will influence survival rates

**Predicting earthquakes**

Scientists have tried many different ways of predicting earthquakes, but none have been successful. On any particular fault, scientists know there will be another earthquake sometime in the future, but they have no way of telling when it will happen<sup>(24)</sup>.



# ENVIRONMENTAL ATLAS OF ABU DHABI EMIRATE

## Earthquakes in the Region

Movement of the Arabian Plate in relation to the surrounding tectonic plates generates pressure and heat, exerting immense force on the sub-surface rocks of the region.

Under such persistent and enormous stresses, sub-surface rocks may respond by breaking or 'faulting.' Once faults have developed, these zones of weakness may become earthquake zones. Earthquake epicentres occur mostly to the north in the Arabian Gulf and Iran.

The ongoing compression of the Zagros Range causes frequent but relatively weak earthquakes in the region. Occasional large movements along vertical linear faults, such as the north-south trending Nayband Fault in south-east Iran, are usually accompanied by powerful and devastating earthquakes that can sometimes be felt across the Gulf. A south-west branch of this fault lies beneath Dibba in the north-east Emirates but probably does not extend into Abu Dhabi.



Seismic events and tectonic plate boundaries

The following definitions are provided for the educator's reference. Young people should have the opportunity to explore definitions through individual activities. Some definitions may have been deliberately simplified for a young audience.

### Aftershock

An aftershock is a smaller earthquake that occurs after a previous large earthquake, in the same area of the main shock.

### Epicenter

The epicenter is the point on the Earth's surface that is directly above the hypocenter or focus, the point where an earthquake or underground explosion originates.

### Hypocenter

An earthquake's hypocenter is the position where the strain energy stored in the rock is first released, marking the point where the fault begins to rupture. This occurs at the focal depth below the epicenter.

### Landslides

A landslide or landslip is a geological phenomenon which includes a wide range of ground movement, such as rockfalls, deep failure of slopes and shallow debris flows, which can occur in offshore, coastal and onshore environments.

### Richter scale

The expression Richter magnitude scale refers to a number of ways to assign a single number to quantify the energy contained in an earthquake.

### Rupture

A breaking apart or the state of being broken apart.

### Seismic waves

Seismic waves are waves of energy that travel through the earth, and are a result of an earthquake,

### Seismograph

A seismograph, or seismometer, is an instrument used to detect and record earthquakes.

### Tsunami

A very large ocean wave caused by an underwater earthquake or volcanic eruption.

### Triangulation

The location of an unknown point, as in navigation, by the formation of a triangle having the unknown point and two known points as the vertices.

## References

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