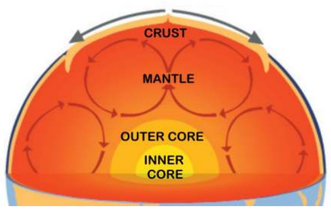
http://earthquake.usgs.gov/

# Earthquakes

Compiled by U. Schreiber

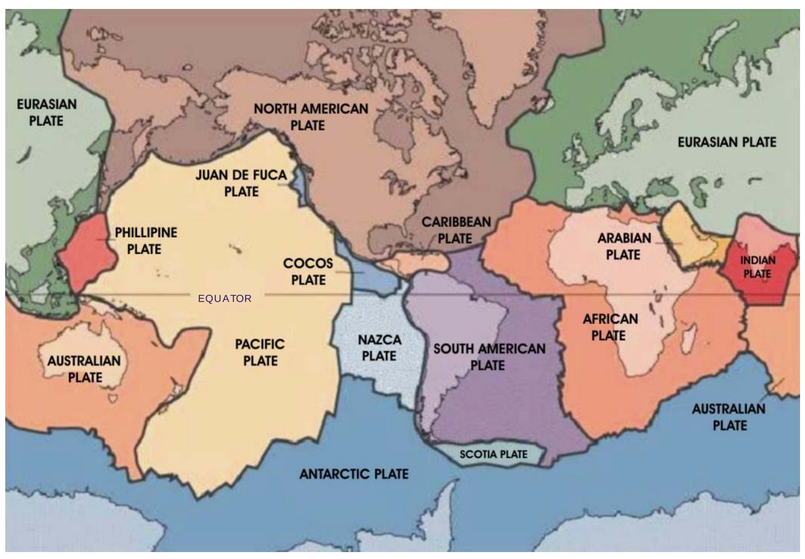
**Earthquakes are natural phenomena, which have fascinated as well as terrified Man throughout recorded history as well as before. In ancient to medieval times a variety of godheads, who wished to express their displeasure with and discipline humankind, were held responsible for the inexplicable and usually highly destructive tremors of the ground, making them yet more awe-inspiring to a superstitious populace. But although science - in tandem with modern technology - over the last hundred years has made some headway towards predicting earthquakes and mitigating their devastating effects to life and property, they still have no means of preventing them, so that nearly another half a million deaths have been added to the overall toll of victims since the beginning of the new century alone.**



Simplified sketch of the Earth's structure

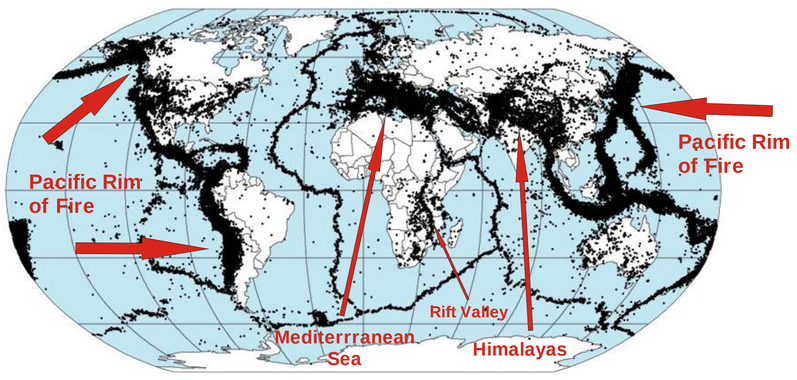
## WHAT CAUSES AN EARTHQUAKE?

An earthquake is the result of the sudden release of built-up stresses within the Earth's crust, which is recorded with a *seismograph*. Earthquakes of *magnitude* 3 or lower are mostly imperceptible, while quakes of *magnitude* 7 and above cause serious damage over large areas. Earthquakes are either naturally occurring or artificially induced. While the first - more common - type are caused by movement along *plate boundaries* or *intraplate* faults, volcanic activity and major landslides, the second are an effect of human activities, such as the collapse of underground mining structures, blasting or nuclear experiments. Their effects are of a rather more localized nature, but still may be felt hundreds of kilometres away from their source. When a large earthquake epicentre is located offshore, the seabed may suffer enough displacement to cause a tsunami.

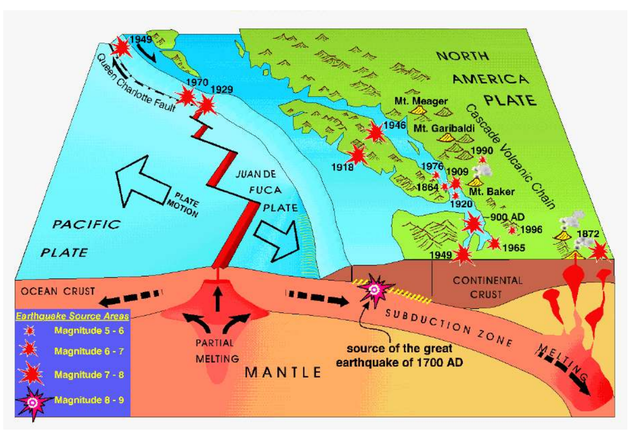


"Mosaic" of lithospheric (crustal) plates sliding on the molten material of the Earth's upper mantle at a speed of a few inches each year

**Earthquake epicentres, 1963 - 1998 (358 214 events)**



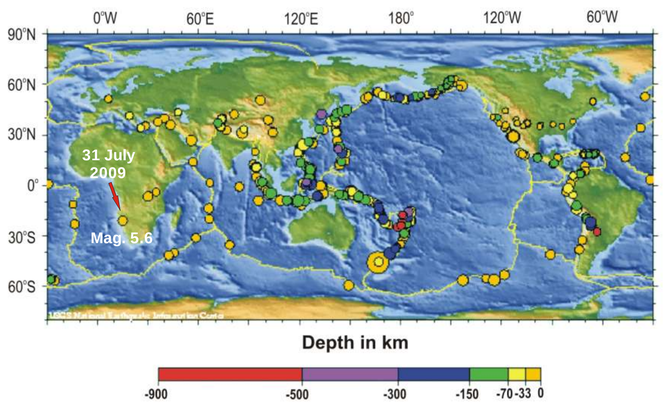

What happens when one of the up to 50 miles thick crustal plates is subducted under the neighbouring one, is illustrated in this example from Northwestern America (right). As the movement generally is not smooth, stresses are built up within the subduction zone, which are eventually released in a major earthquake (for example the 1700 subduction earthquake). Lesser seismic events occur along faults away from the actual subduction zone, but related to it. Great subduction zone earthquakes release up to 100 times more energy than these smaller ones, but fortunately happen only once every 500 to 600 years, on average. Furthermore earthquakes also occur where two plates are pushed apart by upwelling molten rock from the Earth's interior (mid-ocean ridge).

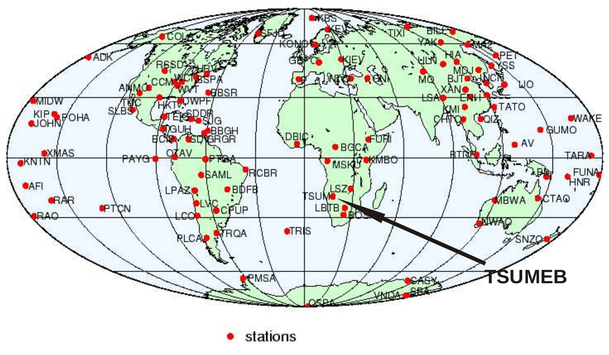


Block diagram of Juan de Fuca Plate being subducted under the North American Plate, with locations of earthquake epicentres

## SIZE AND FREQUENCY OF EARTHQUAKES

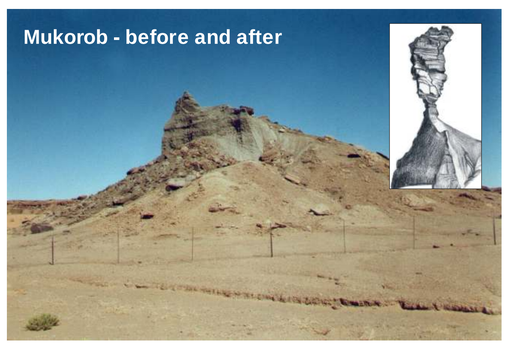
Minor earthquakes occur nearly constantly around the world, and can happen almost anywhere; larger earthquakes occur less frequently, as the greater amount of energy released needs a longer time to build up, and are generally related to plate boundaries. The USGS estimates that, since 1900, there have been an average of 18 major earthquakes (magnitude 7.0-7.9) and one great earthquake (magnitude ≥ 8.0 ) per year. The map below (left) shows the epicentres of earthquakes having occurred between mid-July and mid-August 2009 worldwide (http://neic.usgs.gov/neis/qed/).



Dsitribution of seismological recording stations worldwide

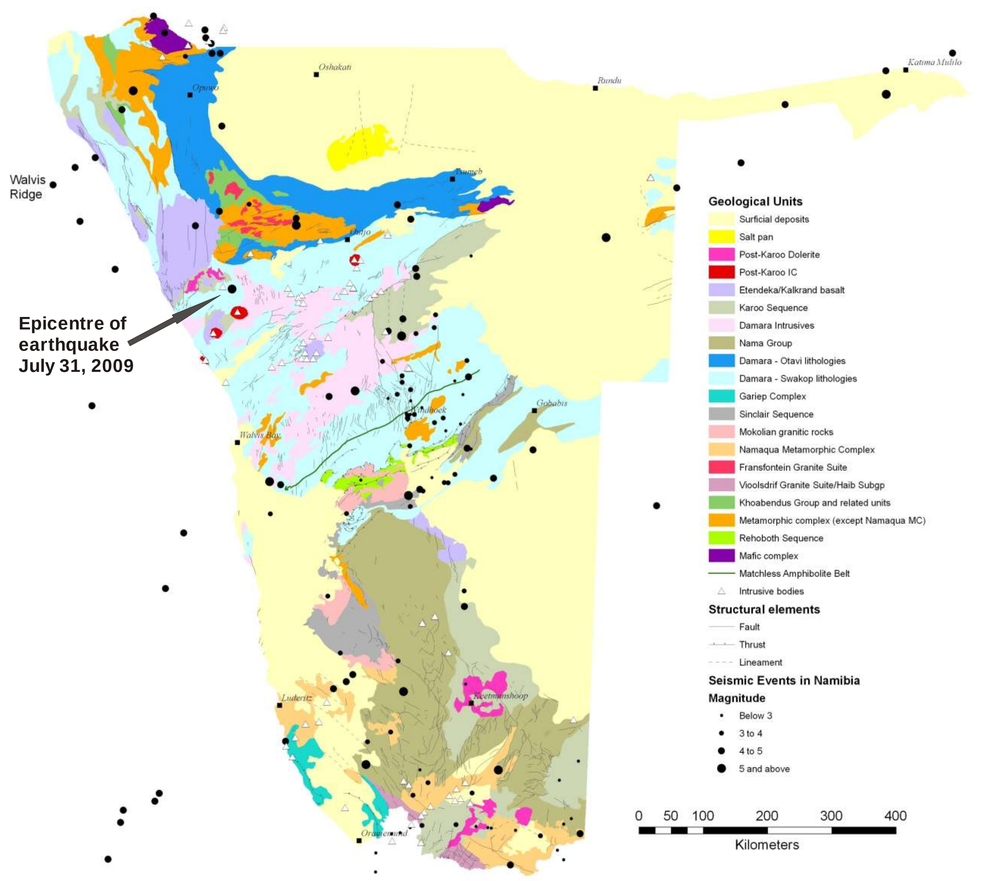


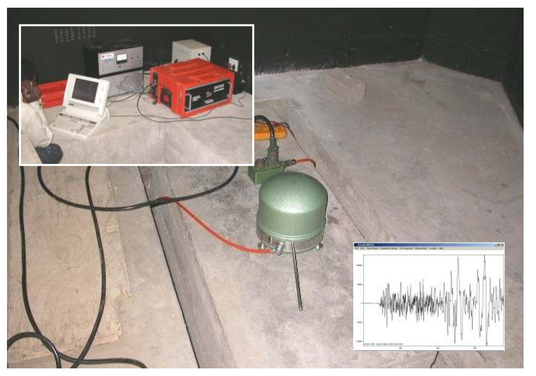



## SEISMIC ACTIVITY IN NAMIBIA

Although earthquakes are not common in Namibia - or on the southern African subcontinent in general- they do occur with a frequency of one to two events per year - many of them however are so weak that they remain unnoticed, and are only detected with the aid of sophisticated instrumentation. Some 160 ground tremors between magnitude 1.0 and 5.6 have been recorded in the last hundred years, occurring all over the country but favouring certain zones of structural weakness in the Earth's crust, such as the Waterberg Thrust, the Windhoek Graben or the Kuboos-Bremen Line of intrusives crossing the border to South Africa. The map below shows a correlation between present day earthquakes and the distribution of ancient granitic bodies, indicating the rejuvenation of these zones of crustal weakness.

The latest seismic event in Namibia happened on the morning of July 31, 2009, ca. 90 km southwest of Khorixas, and was felt as far away as Walvis Bay and Windhoek. With a magnitude of 5.6, it was among the strongest tremors ever recorded in Namibia, although no damage was reported. The material damage done





Recording equipment at Tsumeb and seismogram

by earthquakes naturally is more severe in densely populated areas, such as the American west coast, Japan, or Turkey (see photographs), whereas the most famous case of earthquake damage in Namibia, is the final destruction of Mukorob "The Finger of God", which was toppled over by the repercussions of a magnitude 6.8 earthquake in Armenia/Turkey, in 1988.

Looking at earthquake statistics over the last few hundred years (http://earthquake.usgs.gov/regional/states/events), it would appear that there has been a significant increase in the number of seismic events worldwide. This however is actually just an effect of the vastly improved instrumentation for measuring ground tremors and a much denser network of recording stations around the world. From about 350 in 1931 it has mushroomed to many thousands in 2008, one of them being situated at Tsumeb. As a result, many more earthquakes are reported today than in the past.