SIMIT

Earthquake Lessons

A simple journey into our planet and what makes it shake

Italia-Malta Programme - Cohesion Policy 2007-2013

A sea of opportunities for the future

This project and post are part-financed by the European Union
European Regional Delvelopment Fund (ERDF)
Co-financing rate: 85% EU Funds; 15% National Funds

Investing in your future

Earthquake Lessons. A simple journey into our planet and what makes it shake
D’Amico S.*, Galea P.*, SIMIT Working Group**
* Department of Geosciences, University of Malta, Malta
** Agius M.R., Bonello M., Borg R., Farrugia D., Lombardo G., Panzera F., Torpiano A.

Published by
Mistral Service sas
Via U. Bonino, 3,
98100 Messina (Italy)

First published: November, 2015
Assembled in Italy

A free online copy of this book is available at www.mistralservice.it/books

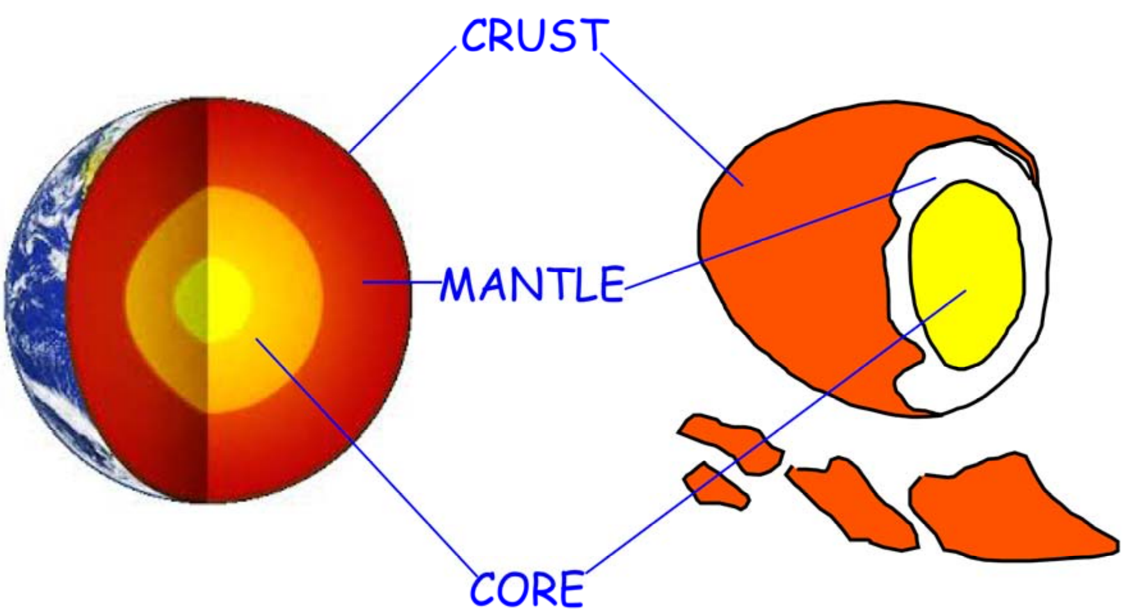
Earthquake Lessons. A simple journey into our planet and what makes it shake
D’Amico S., Galea P., SIMIT Working Group
ISBN:978-88-98161-18-8

Table of contents

INTERNAL STRUCTURE OF THE OUR PLANET: EARTH AS AN EGG	5
HOW ARE EARTHQUAKES GENERATED?	6
HYPOCENTRE AND EPICENTRE	6
EARTHQUAKE MAGNITUDE AND INTENSITY	8
CHAIN OF DISASTERS	10
SEISMIC HAZARD AND RISK	12
SHAKING HOUSES	13
GOLDEN RULES	14
IF AN EARTHQUAKE STRIKES… IS ANYONE THINKING ABOUT US?	17
USEFUL WEBSITES	18

INTERNAL STRUCTURE OF OUR PLANET: EARTH AS AN EGG

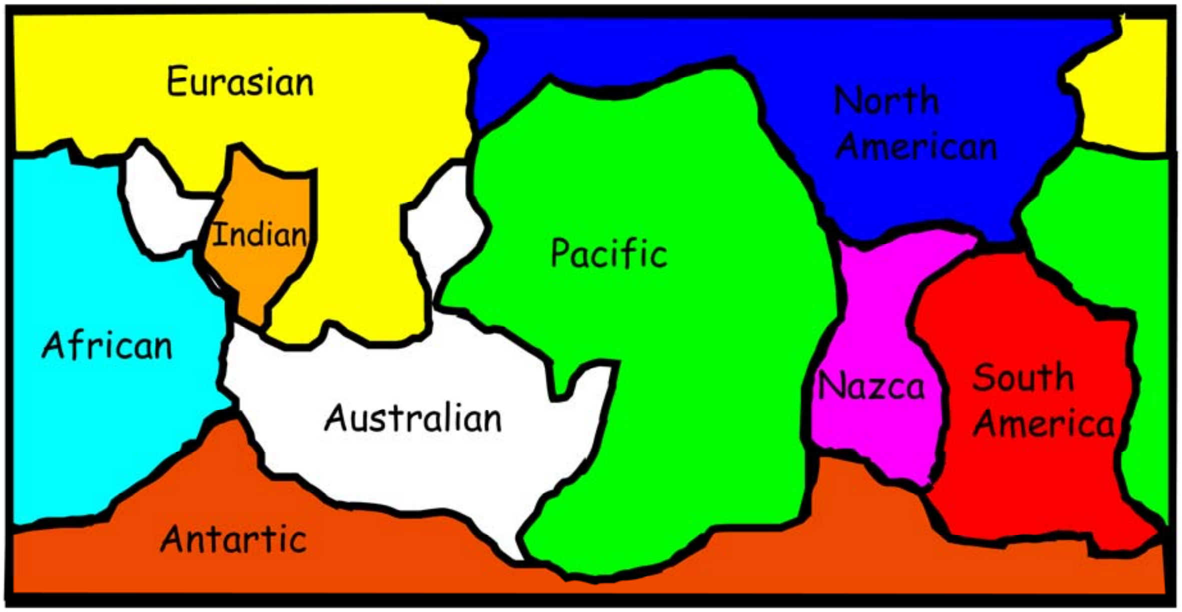
The Earth is constantly moving under our feet. The proportions of the internal layers are similar to the proportions of shell, white, yolk in an egg. The crust that forms continent and ocean floor is broken into several pieces, called tectonic plates, floating across the surface of the planet. The crust under the oceans is 5 to 10 km thick while continental crust is typically 30 to 50 km thick. Below the Earth's crust we encounter the mantle which extends to a depth of approximately 2900 km. Parts of the Earth's mantle are made up of semi-melted rocks. Scientists believe that the Earth's core is mostly made up of iron. There is evidence that the inner core is solid while the outer core is in a liquid state. It is very hot, from 4400 to 5000+ ^{o}C.



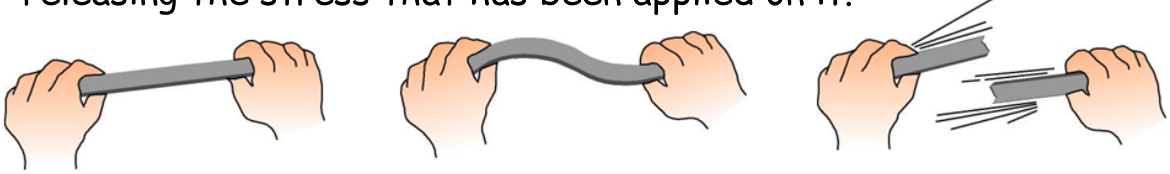
Heat from the core causes convection currents in the mantle. These currents slowly move the crust around, pushing and pulling the tectonic plates over the Earth's surface. There are about 20 major plates making up the surface of the Earth that move continuously past each other at a few mm or cm per year. At the boundaries between plates, the crust may be absorbed into the mantle, folded up into mountains or new crust may be formed. Earthquakes and volcanoes are primarily found at plate boundaries.

HOW ARE EARTHQUAKES GENERATED?

Earthquakes are the Earth's natural means of releasing stress in the crust. They are the shaking, rolling or sudden shock of the Earth's surface and cannot be predicted.

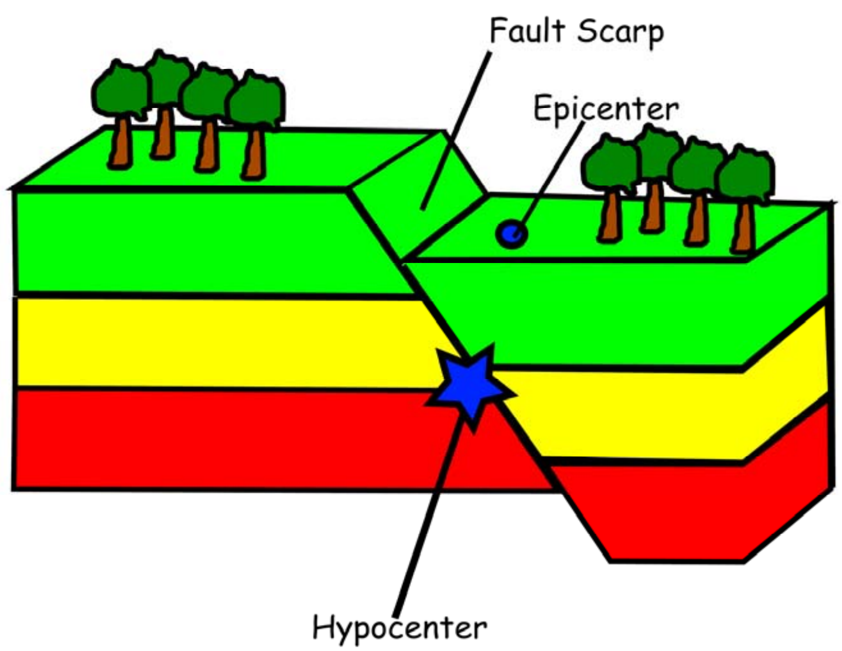


As the plates push, pull and slide past each other, their edges experience large forces. When these forces become too large, the crust deforms and finally breaks.. When the break occurs, the stress is released and energy moves through the Earth in the form of seismic waves, which we feel and call earthquakes. This process can be easily visualized if we imagine holding a pencil horizontally and applying a force to the ends. After enough force is applied, the pencil starts to bend and ultimately breaks, releasing the stress that has been applied on it.



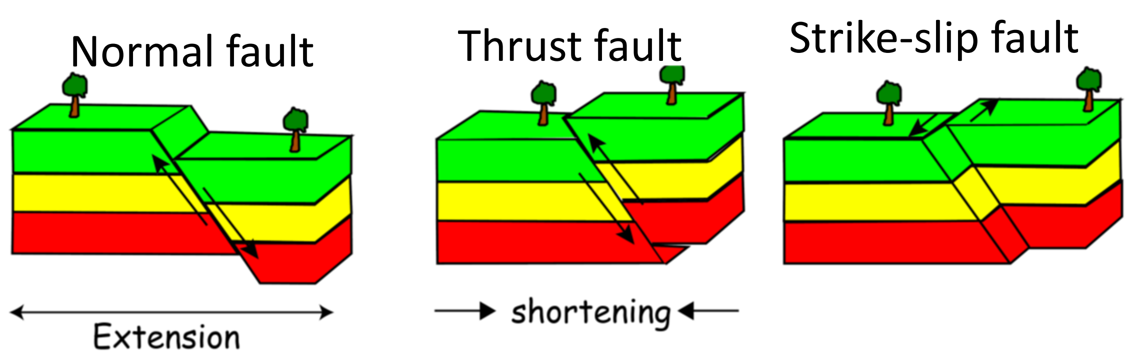
HYPOCENTRE & EPICENTRE

Earthquakes happen as a result of sudden movements along faults deep underground. The location where they start is called hypocentre, that is the point where the rocks start to fracture. The epicentre is the point on the Earth's crust just above the hypocenter. The worst damage occurs on the ground surface where strong shaking reaches populated urban areas. Sometimes the fault causes movement to occur also at the ground surface, creating a step-like fault scarp..



Earthquake Faults Move Up, Down, and Sideways

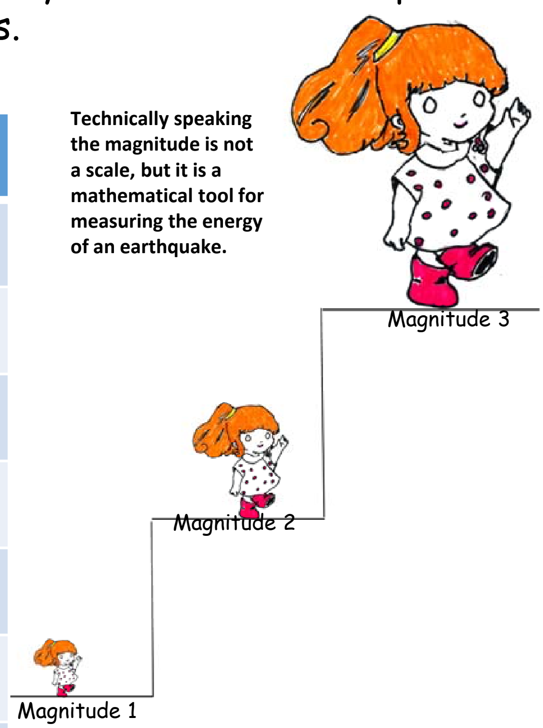
Normal faults develop in areas where land is pulling apart or stretching. A thrust (or reverse) fault develops in areas where land masses are pushing together. With a strike-slip fault the two blocks slide sideways.



EARTHQUAKE MAGNITUDE AND INTENSITY

Magnitude and Intensity measure different characteristics of earthquakes. Magnitude is a quantitative measure of the size of an earthquake; it measures the amount of energy released at the source of the earthquake and it is determined mathematically from seismograms. Seismograms are the records of ground motion measured by seismometers placed at different distances from the epicentre. Earthquake magnitude is given by a single value, for example 6.5. Intensity measures the strength of shaking produced by the earthquake at a certain location (see next page) on a scale from I to XII, and it is determined by evaluating the effects on people, man-made structures, and/or the natural environment. The intensity varies over the area affected by the earthquake, with high intensities near the epicenter and lower values further away. The table below gives a rough comparison between earthquake effects that are typically observed in the epicentral area against earthquake magnitudes.

Magnitude	Earthquake effects
0-2	Not Felt by people
2-3	Felt by few people
3-4	Ceiling lights swing
4-5	Walls crack
5-6	Furniture moves
6-7	Few buildings collapse
7-8	Many building are destroyed
>8	Total destruction



The magnitude calculates the energy released during each seismic event. The figure shows that, for example a magnitude 3 event is 30 times larger than a magnitude 2 event.


Imperceptible
I

Very Slight
II

Slight
III

Moderate
IV

Rather Strong
V

Strong
VI

Very Strong
VII

Destructive
VIII

Higly Destructive
IX

Ruinous
X

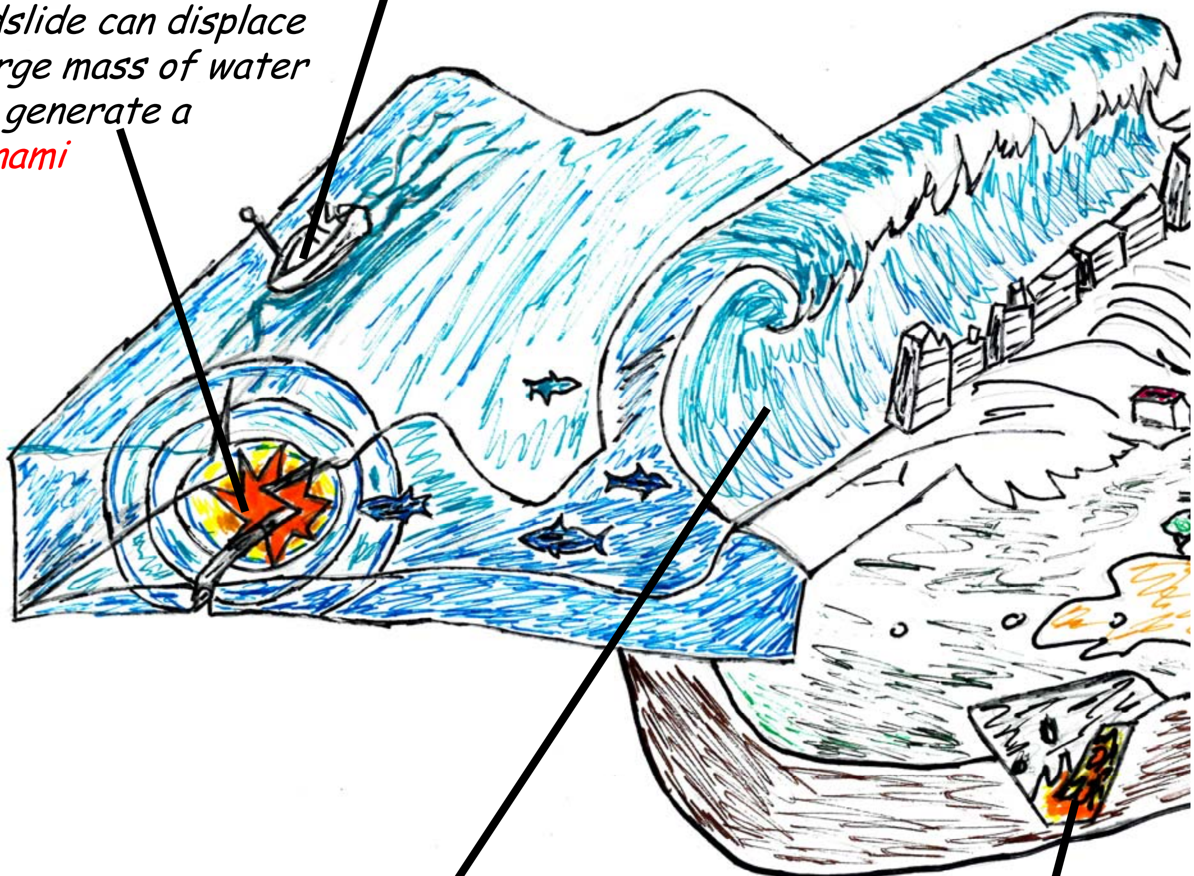
Catastrophic
XI

Totally Catastrophic
XII

Chain

A large earthquake occurring at the ocean floor or an underwater landslide can displace a large mass of water and generate a tsunami

An observer at sea will not feel the tsunami wave



At open sea waves travel very fast (up to 800km/h) and they have a low amplitude. When they approach the shoreline their amplitude increases mainly because the sea becomes shallower.

Pipelines can break and gas, liquid and other potential pollutants maybe to be spilt into the environment

# of Disasters

In urban centres houses and critical facilities can collapse, interrupting also telephone and power lines. This can cause several devastating fires in the first hours after the earthquake

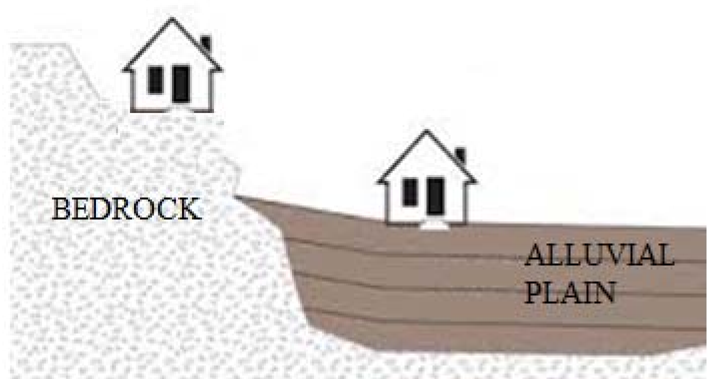
Railways can be damaged and deformed by the ground shaking and trains can derail

A large earthquake can trigger several seismo-induced disasters. For example, tsunami, fire, landslides, flooding due to the breaking of dams. Such hazards can increase the impact of the event on the area and create additional problems such as interruption of communication systems and spillage of chemicals and pollutants into the environment.

SEISMIC HAZARD AND RISK

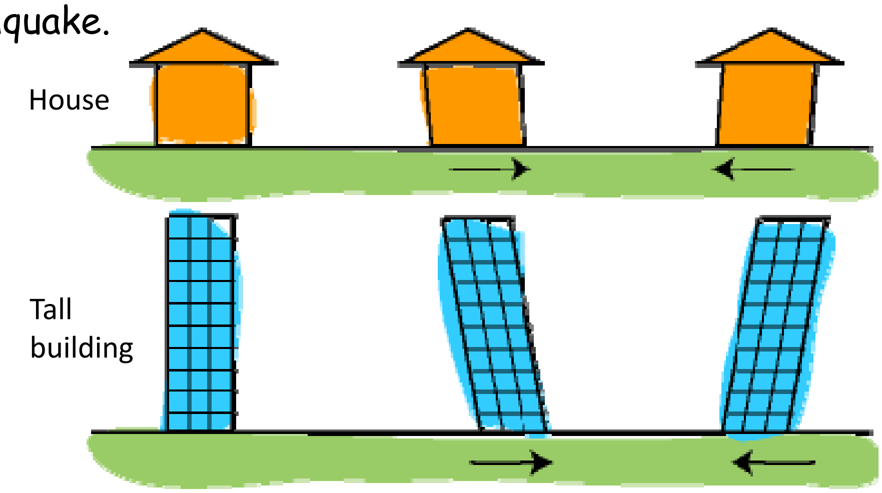
Seismic hazard is the probability that an earthquake will occur in a given geographic area. Seismic risk refers to the risk of damage from earthquakes to the built environment. The latter can be considered as the combination of hazard, vulnerability and exposed value in a certain area.

The risk at a certain area depends also on the so- called site effects. It can happen that strong ground shaking and building damage occur even if the site is located many kilometres away from the earthquake, while other locations at similar distances may experience very little to no shaking at all. This behavior is due to the fact that the local geology (for example, sediments such as ancient river deposits or clay) can contribute to amplify the ground shaking. The wave energy is transferred to the soft sediments, causing a significant amplification of wave energy, which can result in greater shaking of the ground. In these areas, the seismic energy is felt more readily and can increase the risk of damage to buildings and other structures.



SHAKING HOUSES

Several recent earthquakes, even having moderate magnitude, have shown that millions of people live in houses that cannot withstand ground shaking. Is it possible to build an earthquake-proof building? There are several engineering techniques that can be used to create a very sound structure, which will endure a modest or even strong earthquake. However, during a very strong event, even the best engineered building may suffer severe damage. In general, old houses were built in order to withstand vertical weights. This is not enough during an earthquake because structures will shake and oscillate in a horizontal plane, too. If a house has not been designed to resist such shaking, it can collapse (trapping people inside). Engineers design buildings to withstand as much sideways motion as possible, in order to minimize damage to the structure and give the occupants time to get out safely. Some buildings are more vulnerable and more prone to collapse during an earthquake, because of their shape or method of construction. In areas prone to earthquakes new houses should be built according to anti-seismic regulations. These rules define how the building should be constructed, the material to be used, how to build foundations and how to connect non-structural elements, such as chimneys, correctly. In this way, engineers can plan and build anti-seismic houses that can be damaged, but that will not collapse. For old houses it is possible to retrofit them. Strategic buildings, such as hospitals, schools, fire stations, power plants etc. should be designed with the highest standards because they need to keep functioning after an earthquake.



GOLDEN RULES

If you are at home, and you feel a tremor do not leave it during the earthquake. Wait until it is over.

During shaking get under a table. This will protect you from falling objects.

You can also find a shelter under a doorway or a supporting wall.

Another quite secure place is the corner between two master walls.

Do not use stairs during an earthquake

Do not use the elevator during an earthquake

If you are outside move away from houses since tiles, chimneys could fall

Stay away from trees, street lamps and electric poles

Do not stay under or on a bridge

When the tremor is over leave the house calmly and make sure you wear shoes

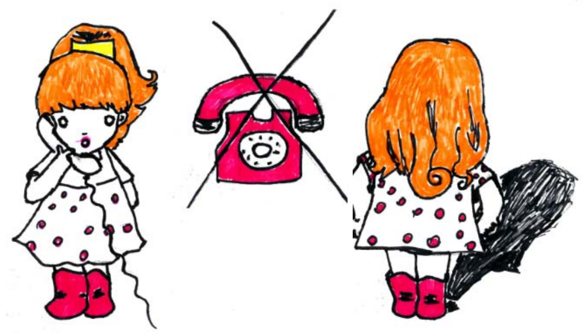
For safety reasons, make sure that gas and electricity are switched off before you leave the house

In helping others make sure you do not move any badly injured person.

When the tremor is over go to an open area

Always follow the instructions given by the emergency personnel.

Try not to use vehicles and telephone in order not to jam lines and rescue operations.

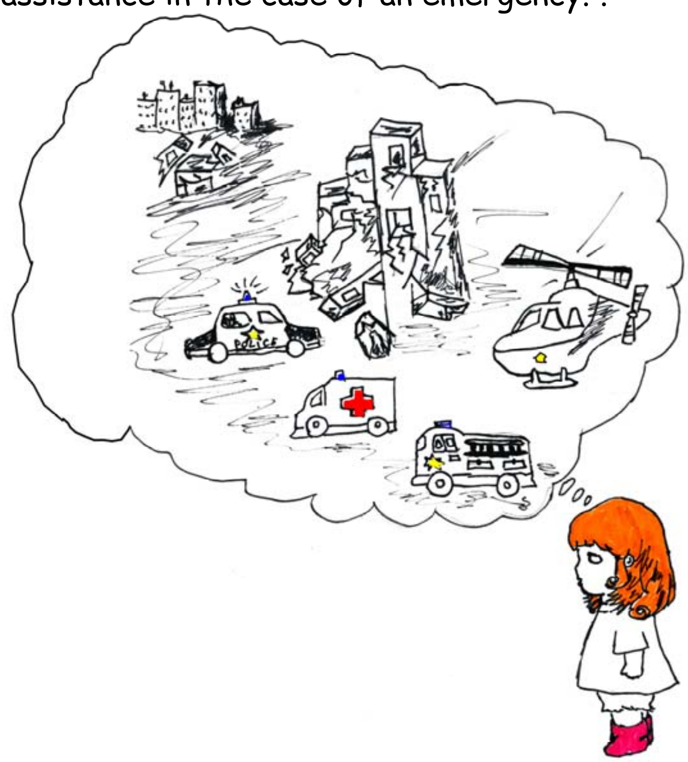


If you live near the sea and you experience an earthquake or tremor do not go near beaches dams or industrial plants

IF AN EARTHQUAKE STRIKES... IS ANYONE THINKING ABOUT US?

When an earthquake occurs, it is important to know that there is a "Civil Protection Department" having the function of helping and protecting people in need. The Civil Protection system provides emergency services such as the Fire Department and Urban Search and Rescue, but also contributes to disaster prevention, mitigation and preparation. Together with the Armed Forces, the Police, the Emergency Health Services and Voluntary Service organisations, this system ensures that the citizens of our country will get the necessary protection and assistance in the case of an emergency. .

After a severe earthquake, locating and saving people trapped under rubble is probably the most difficult task of all. Rescuers have to detect a human's movements, breathing or even their heartbeat, distinguish the movement of a person or of an animal, locate people hidden behind meters of solid concrete or buried beneath meters of rubble. If a person has lost consciousness, it is even more difficult to detect him or her.



There are several ways to detect/save people under rubble, such as dogs that can sense people stuck under rubble; flexible poles equipped with a video or thermal camera pushed through gaps in the rubble; using microphones pushed into small spaces in order to detect even the weakest heartbeat of a survivor; and a special device called FINDER (Finding Individuals for Disaster and Emergency Response), which uses microwave-radar technology to detect heartbeats.

Useful websites:

Seismic Monitoring and Research Group, University of Malta
http://seismic.research.um.edu.mt/

Civil Protection Department, Malta
http://homeaffairs.gov.mt/en/MHAS-Departments/CPD

Civil Protection Department, Sicily
http://www.regione.sicilia.it/presidenza/protezionecivile/

Civil Protection Department, Italy
http://www.protezionecivile.gov.it/

Istituto Nazionale di Geofisica e Vulcanologia, Italy
www.ingv.it

European-Mediterranean Seismological Centre
www.emsc-csem.org

United State Geological Survey, USA
www.usgs.gov

Part of the SIMIT project:
Integrated civil protection system for the Italo-Maltese cross-border area

Italia-Malta Programme – Cohesion Policy 2007-2013
A sea of opportunities for the future Tender part-financed by the European Union European Regional Development Fund (ERDF) Co-financing rate: 85% EU Funds; 15% National Funds. Investing in your future.

ISBN:978-88-98161-18-8