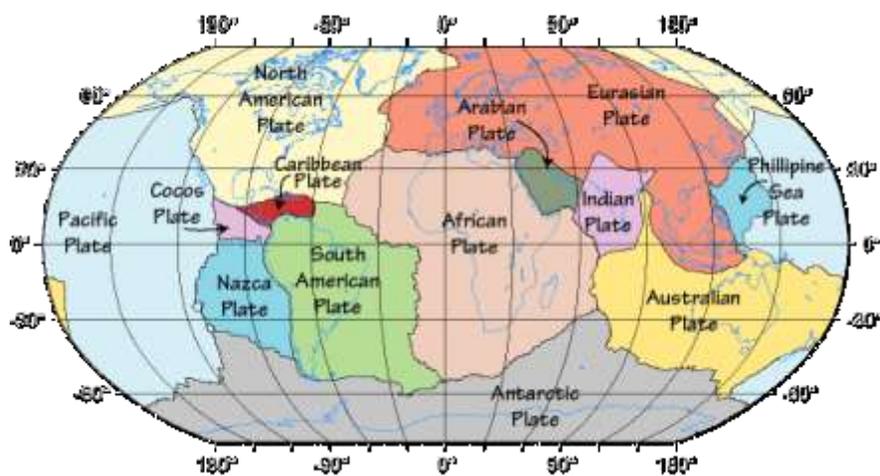


# Rock, Mineral and Aggregate

SRI ATMAJA P. ROSYIDI, PH.D.  
ASSOCIATE PROFESSOR



## Major Tectonic Plates



## How the continents are moving

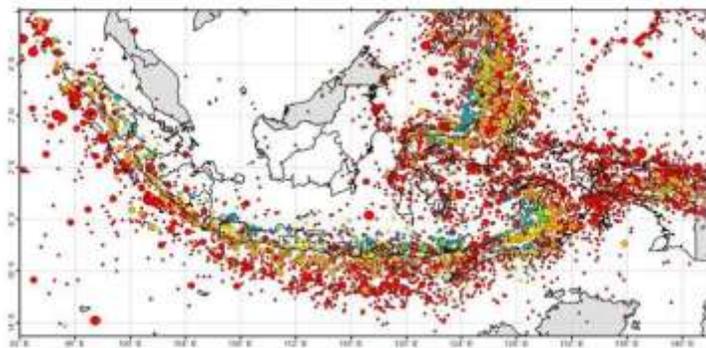


### How The Continents are moving

Dr. Iain Stewart

#### Seismicity of Indonesia

Indonesia is one of the most seismically active countries in the world, it is situated in South-east Asia tectonic regime.

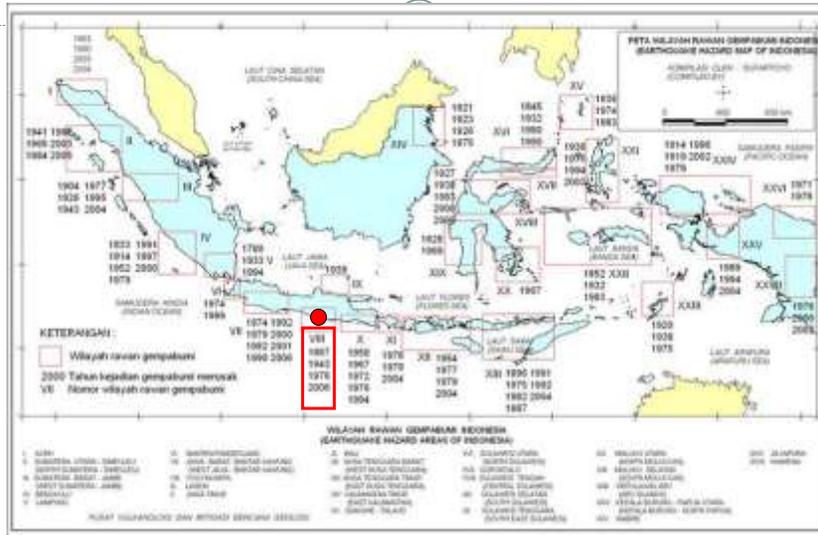


Main shocks only

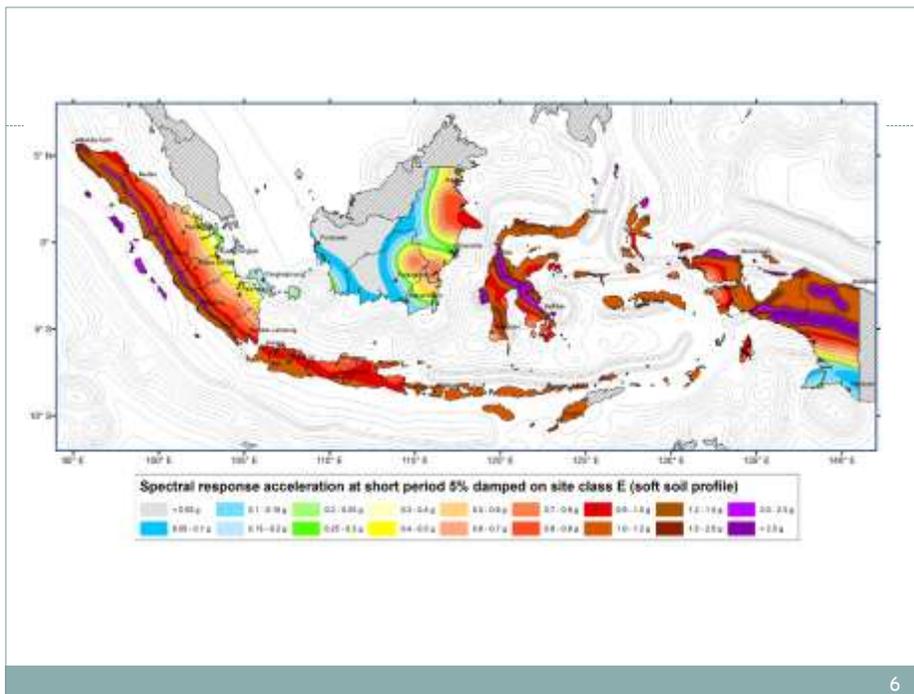


Irsyamet al., 2010

# Earthquake Hazards Map in Indonesia



5



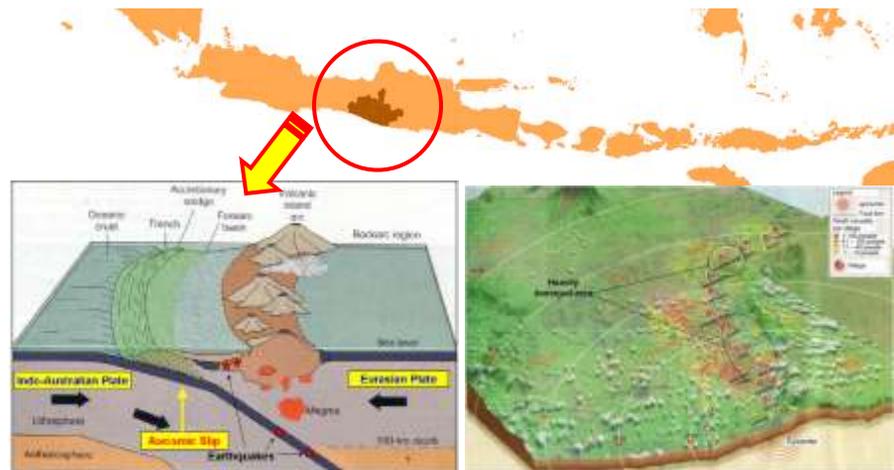
6

## Damages and Losses

Country	Disaster event	Date	Number killed	Damage & losses (US\$ million)	Damage & losses (US\$ million, 2006 constant prices)
Turkey	Earthquake	Aug.17, 1999	17,127	8,500	10,281
Indonesia (Aceh)	Tsunami	Dec. 26, 2004	163,708	4,450	4,747
Honduras	Hurricane Mitch	Oct.25–Nov.8,1998	14,600	3,800	4,698
Indonesia (Yogya-Central Java)	Earthquake	May 27, 2006	5,716	3,134	3,134
India (Gujarat)	Earthquake	Jan. 26, 2001	20,005	2,600	2,958
Pakistan	Earthquake	Oct. 8, 2005	73,338	2,851	2,942
Thailand	Tsunami	Dec.26, 2004	8,345	2,198	2,345
Sri Lanka	Tsunami	Dec.26, 2004	35,399	1,454	1,551
India	Tsunami	Dec. 26, 2004	16,389	1,224	1,306

Sources: Asia Disaster Preparedness Center, Thailand; ECLAC, EM-DAT, World Bank

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- A magnitude 6.3 Mw which lasted for 52 seconds struck Central Java and Yogyakarta, at 5:54 am (Local Time) on 27 May 2006.
- The location of the earthquake according to the United States Geological Survey (USGS) is 20 km SSE of Yogyakarta City at 7.962°S – 110.458°E.

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## Damages in Observed Area

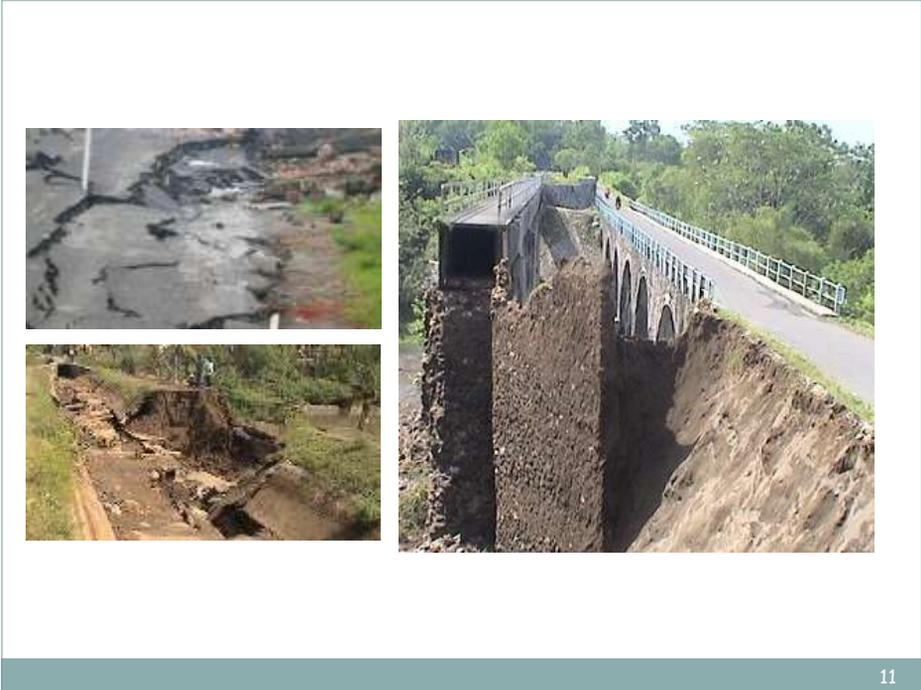


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9



10



وَتَرَى الْجِبَالَ تَحْسَبُهَا جَامِدَةً وَهِيَ تَمُرُّ مَرَّ السَّحَابِ صُنِعَ اللَّهُ الَّذِي أَنْقَنَ  
 كُلَّ شَيْءٍ إِنَّهُ خَبِيرٌ بِمَا تَفْعَلُونَ ﴿٨٨﴾

"Dan kamu lihat gunung-gunung itu, kamu sangka dia tetap di tempatnya, padahal ia berjalan sebagai jalannya awan. (Begitulah) perbuatan Allah yang membuat dengan kokoh tiap-tiap sesuatu. Sesungguhnya Allah Maha Mengetahui apa yang kamu kerjakan." (QS. An-Naml, 27 : 88)

أَفَلَا يَتَذَكَّرُونَ الْقُرْآنَ وَلَوْ كَانَ مِنْ عِنْدِ غَيْرِ اللَّهِ لَوَجَدُوا فِيهِ اخْتِلَافًا  
 كَثِيرًا ﴿٨٢﴾

"Maka apakah mereka tidak memperhatikan Al Quran? Kalau kiranya Al Quran itu bukan dari sisi Allah, tentulah mereka mendapat pertentangan yang banyak di dalamnya"(Surat an-Nisa: 82)

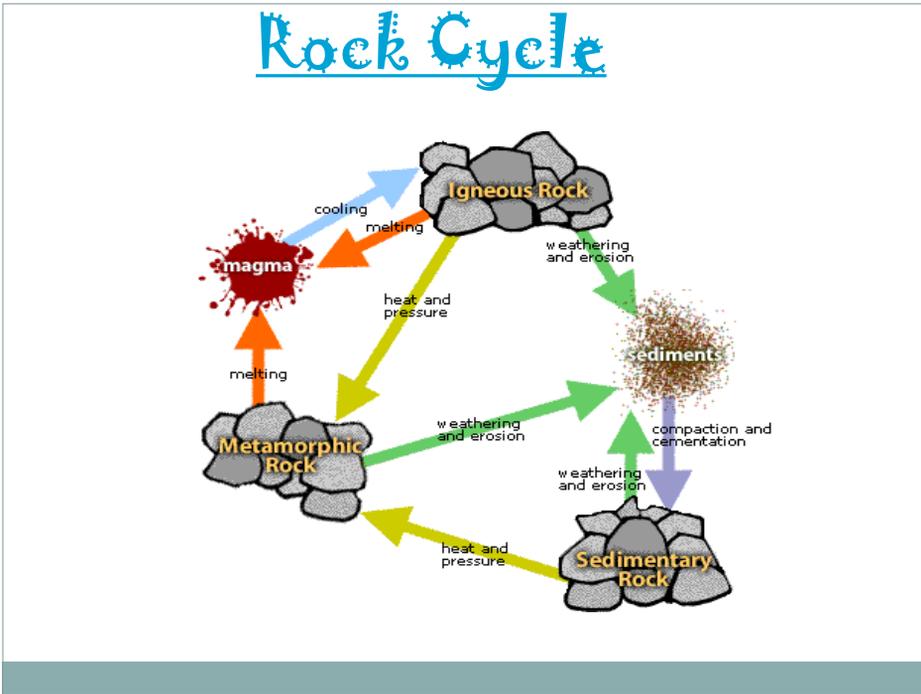
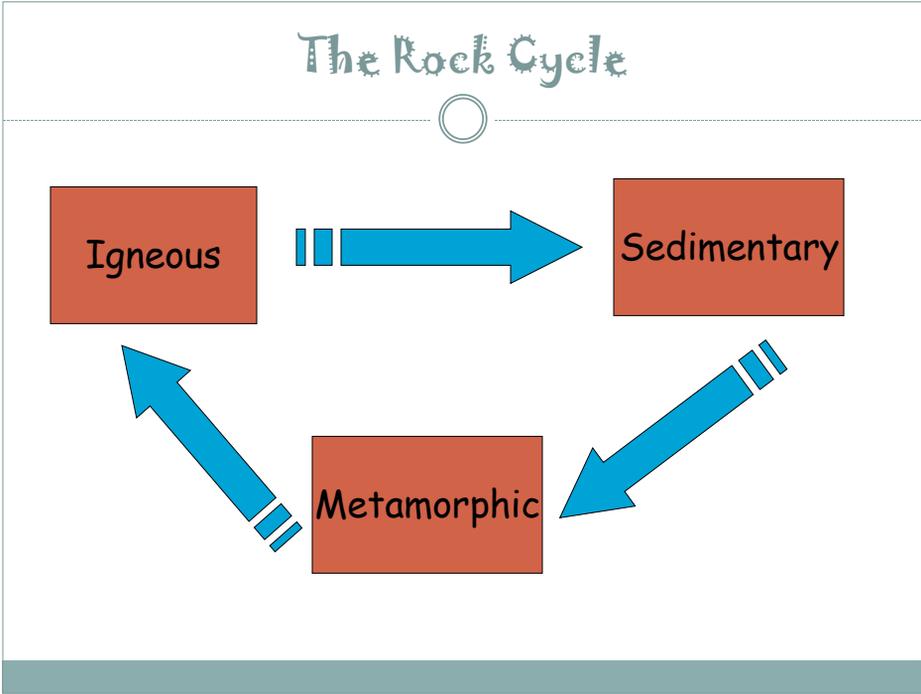
## Rock Cycle

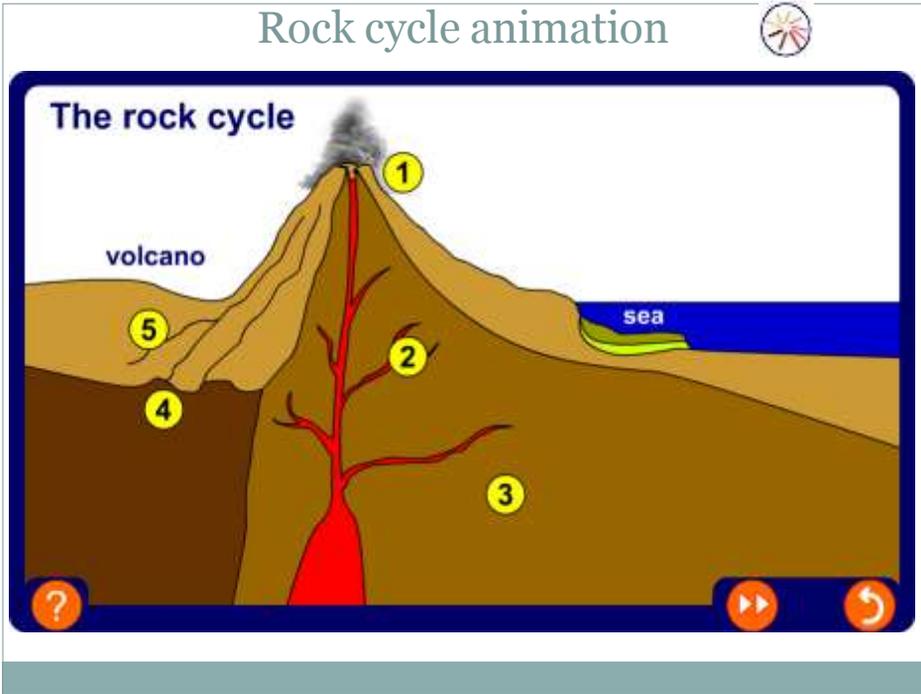
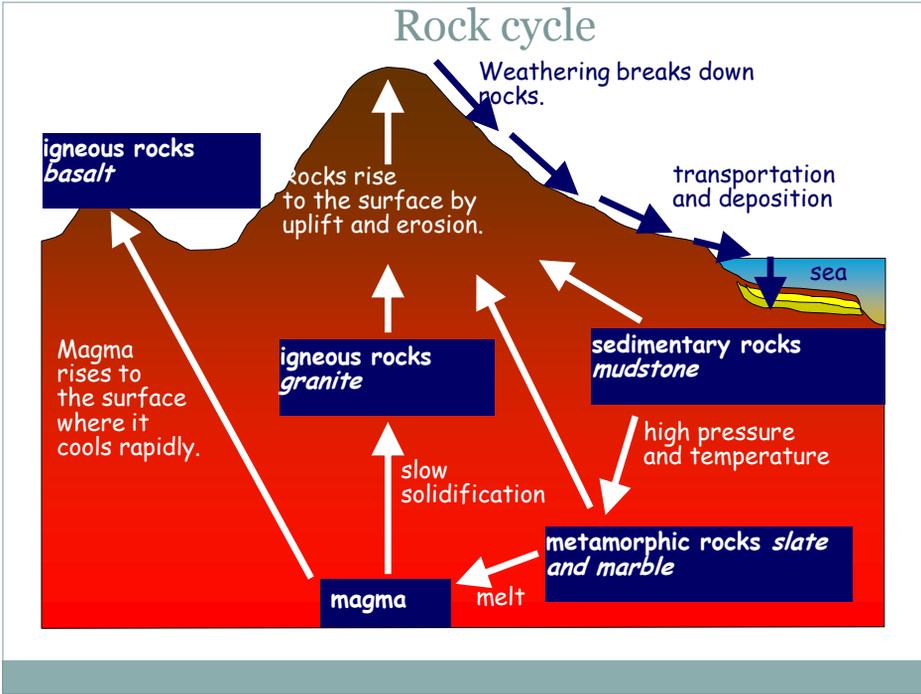


## Types of Rocks



- **Igneous rock** is formed from molten rock that has cooled and hardened.
- **Sedimentary rock** is formed from material that has settled into layers and hardened.
- **Metamorphic rock** is a rock that has changed by heat and pressure.





## Examples of sedimentary rocks

**limestone**



**chalk**



**sandstone**



**sandstone**



## How can you describe sandstone?

**Sandstone is ...**



...an orangy-coloured rock which looks like lots of sand grains stuck together. It is quite soft.

## How can you describe limestone?

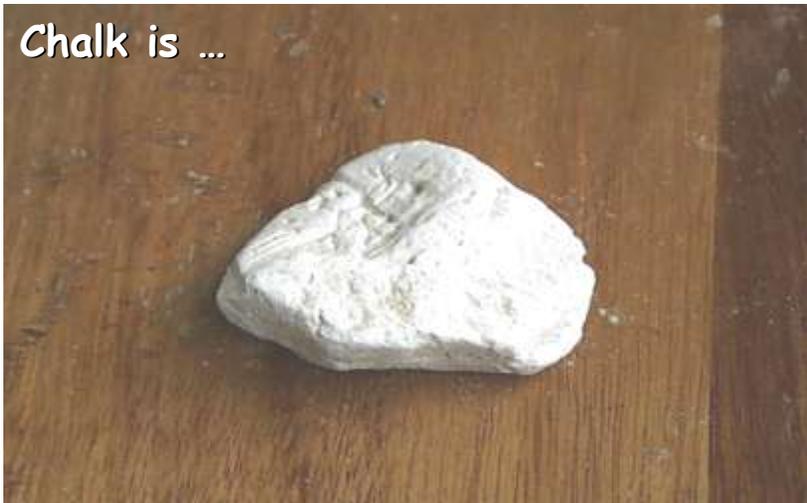
**Limestone is ...**



...a grey/white rock which is mostly made from crushed sea shells. Limestone often contains fossils.

## How can you describe chalk?

**Chalk is ...**



...a white or grey powdery rock with very fine grains. Chalk often contains fossils.

## Properties of sedimentary rocks

What are the properties of sedimentary rocks?

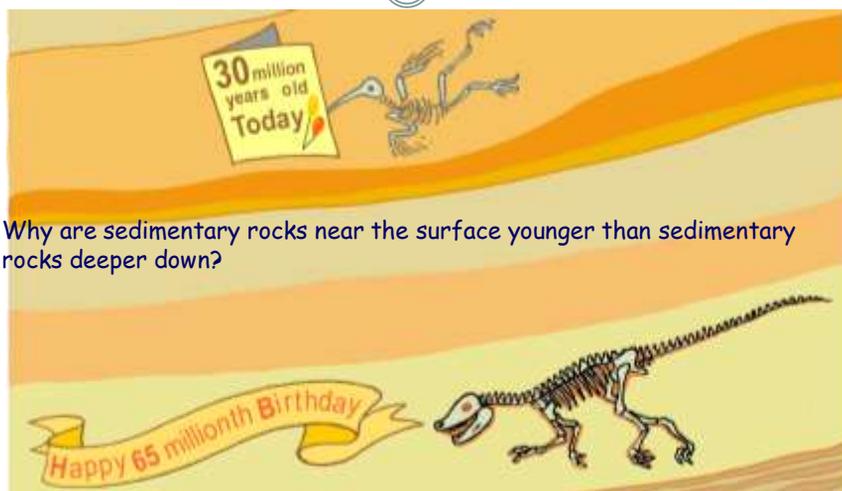
- Sedimentary rocks often have **layers** showing the deposition of sediment at different time periods.
- Sedimentary rocks consist of lots of **small grains**. These grains may be weakly held together so the rocks are often porous and may be soft and crumbly.
- Sedimentary rocks often have **fossils** trapped within them.



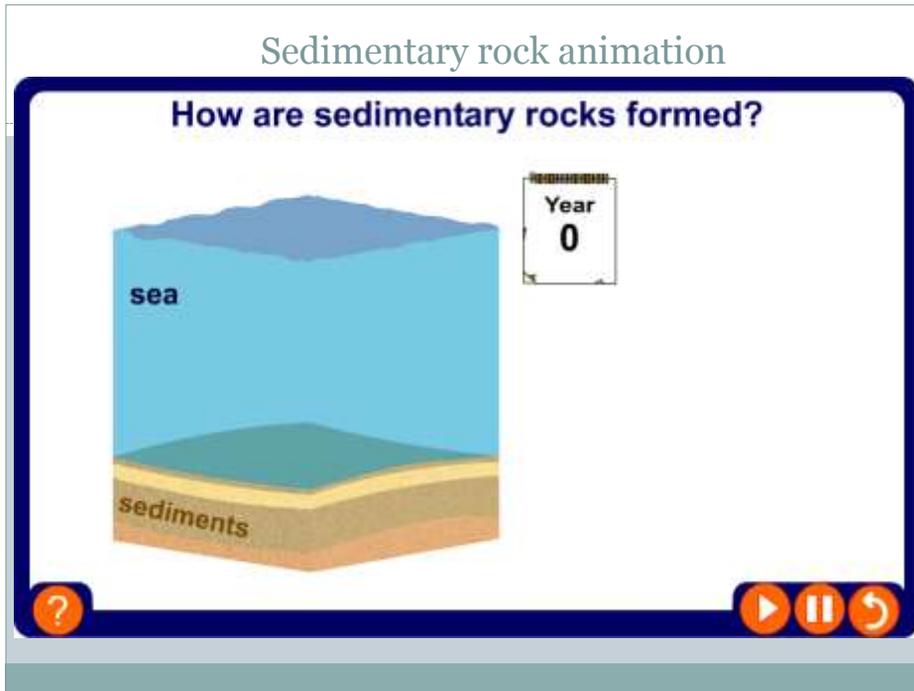
Sedimentary rocks consist of layers of lots of small particles and are often porous.



## Comparing ages of sedimentary rocks

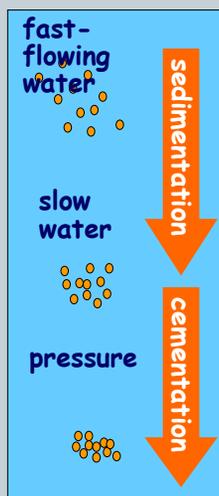


Why are sedimentary rocks near the surface younger than sedimentary rocks deeper down?



## Formation by cementation of sediment

- Some sedimentary rocks are formed by the cementation of sediment.



- Weathering creates small rock fragments which are transported to the sea where they are deposited (sink) and form a sediment.
- At this stage, dead creatures may become trapped within the sediment and give rise to fossils.
- Over millions of years, the pressure of layers above and the effects of salts cement the sediment together. This is how sedimentary rocks like sandstone, mudstone and limestone are formed.

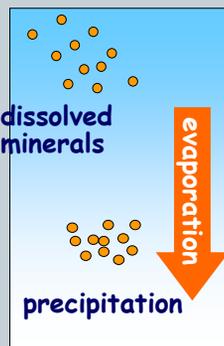
## Pancake Rocks in New Zealand

- These limestone rocks at Punakaiki in New Zealand are known as the Pancake Rocks. How were they formed?



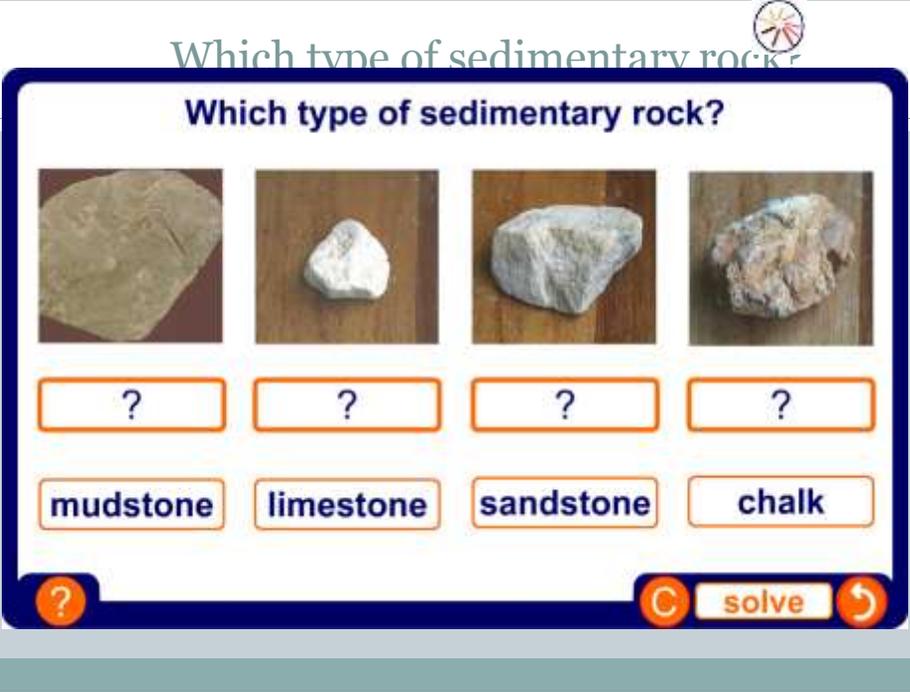
## Formation by precipitation of minerals

- Sedimentary rocks can also be formed from minerals which are left behind when water evaporates.



- Certain minerals are dissolved in seas and lakes.
- Over millions of years these seas or lakes dry up.
- As the water disappears, the dissolved minerals precipitate.
- Chalk and limestone, common in the UK, can be formed in this way.

Which type of sedimentary rock?



Which type of sedimentary rock?

			
?	?	?	?
mudstone	limestone	sandstone	chalk

?

solve

Examples of metamorphic rock

marble



slate



## What is marble?

**Marble is ...**



...a hard smooth rock made from sedimentary limestone or chalk in conditions of strong heat and low pressure.

## What is slate?

**Slate is**

...



...a grey rock with fine grains made from sedimentary shale in conditions of low temperature and low pressure. Slate can be split into thin sheets.

## Properties of metamorphic rocks

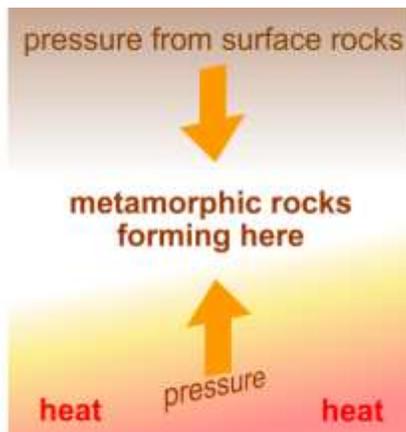
How are the properties of metamorphic rocks different from sedimentary rocks?

- Metamorphic rocks often have layer structures of **crystals** caused by the effect of heat and pressure.
- Metamorphic rocks are usually **denser and harder** than sedimentary rocks.
- Metamorphic rocks sometimes show **distortions** caused by the movements that led to their formation. This may give rise to **wavy or zig-zag patterns** within the rock.

Metamorphic rocks contain regular layers of crystals that sometimes have a wavy or zig-zag arrangement.



## Formation of metamorphic rocks



- Metamorphic rocks are formed by the effect of extreme pressures and temperatures deep within the Earth.
- These conditions change the structure of existing rocks so that new rocks are formed.

Which type of metamorphic rock?



**Which type of metamorphic rock?**

Dark grey rock used for roofing since it easily splits into thin layers.	<b>mica</b>
Smooth and hard white rock widely used in building and sculpturing.	<b>marble</b>
Transparent sheets used as an insulator in some electrical devices.	<b>slate</b>

**? solve ↻**

Examples of igneous rocks

**granite**



**pumice**



**basalt**



## What is granite?

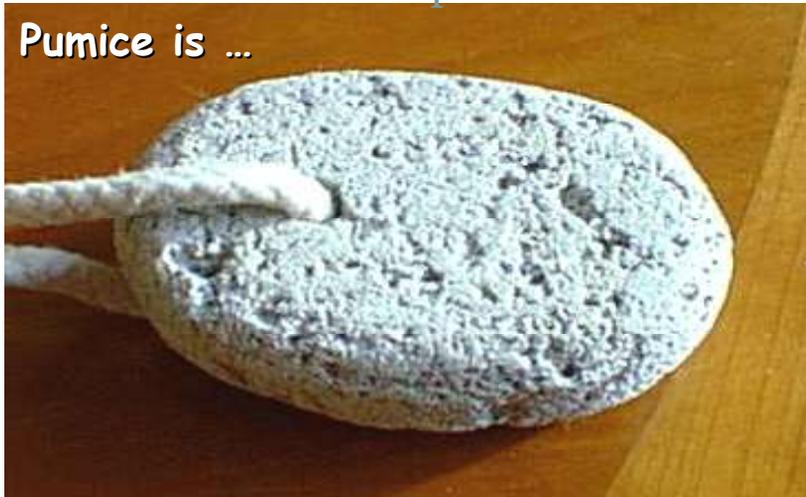
**Granite is...**



...a hard grey rock consisting of large crystals that are randomly arranged.

## What is pumice?

**Pumice is ...**



...a pale grey rock made up of very small crystals and is porous and extremely light.

## What is basalt?

**Basalt is ...**



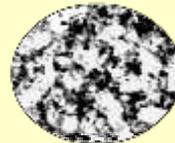
...a dark glassy rock which has very fine crystals and often forms as columns of rock.

## Properties of igneous rocks

**What are the properties of igneous rocks?**

- Igneous rocks contain **interlocking crystals** which are held together very strongly and make the rock hard.
- The crystals in igneous rocks have a disorderly arrangement.
- The size of the crystals depends on how quickly the igneous rock solidifies.
- Igneous rocks never contain fossils.

**Igneous rocks consist of randomly arranged interlocking crystals.**

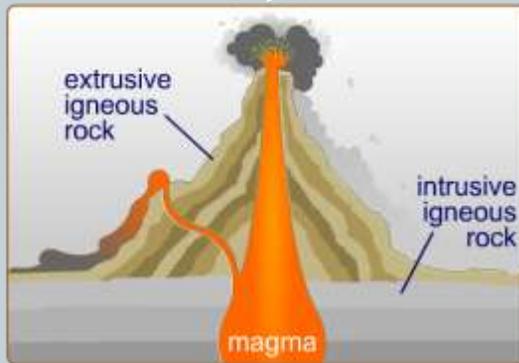


## Formation of igneous rocks

### How are igneous rocks formed?

Deep in the ground is molten rock called **magma**. Sometimes, magma bursts through the surface causing volcanic eruptions.

Igneous rocks are formed when **magma cools and solidifies**.



- When magma cools above the surface, **extrusive igneous rocks** are formed.
- When magma cools below the surface, **intrusive igneous rocks** are formed.

## Size of crystals in igneous rocks

### How is the size of crystals in igneous rocks determined by the rate at which magma cools and solidifies?

- Magma above the Earth's surface **cools quickly**. Only **small crystals** are formed as the magma solidifies.

This is how **extrusive igneous rocks** like pumice and basalt are formed.



- Magma below the Earth's surface **cools slowly**. There is time for **large crystals** to grow as the magma solidifies.

This is how **intrusive igneous rocks** like granite are formed.



## Which type of rock am I?



Which type of rock am I?			
Description	igneous	sedimentary	metamorphic
I am formed by heat and pressure.			
I contain many fossils.			
I contain some really big crystals.			
I do not contain any fossils.			
I contain many small grains "cemented" together.			
I have regular layers which are sometimes wavy.			

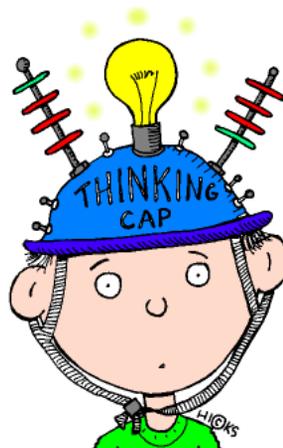




## What is the difference between rocks and minerals?



- A mineral is a nonliving solid found in nature.
- But, aren't rocks nonliving and found in nature too??
- Then what is the difference between a rock and a mineral?



## Rocks and Minerals

- Rocks are made up of one or more minerals!!!
- The reason why some rocks have more than one color, is because they contain more than one mineral.
- Also, some rocks are made of other things, such as sand and pebbles, in addition to minerals.

## How do we know the strength of rocks and minerals?

- The Mohs Hardness Scale was designed for us to use as a scale to determine the strength of rocks and minerals.



# Mohs Hardness Scale

