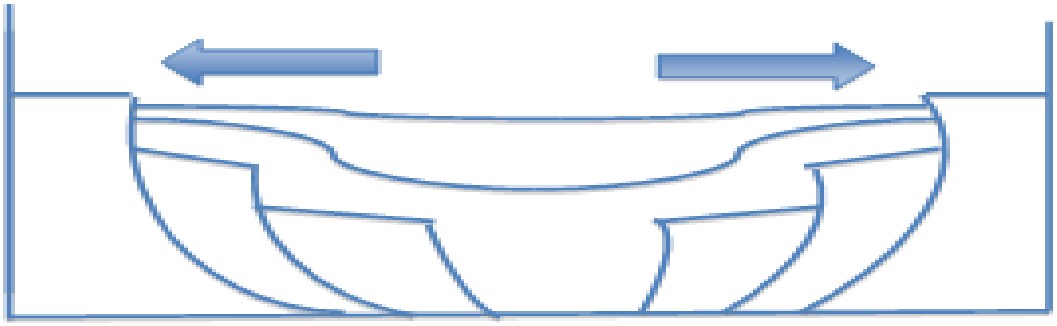
## Recognising Metamorphic Rocks - Teacher Notes

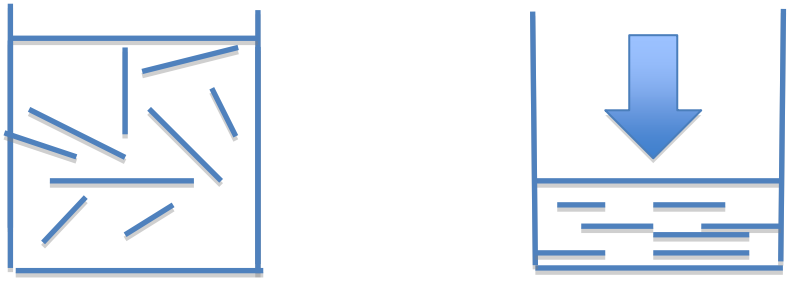
Metamorphism can refer to partial melting of rock due to pressure, temperature or a combination of both. (Latin. meta = change, morpho = body)

**Regional Metamorphism**

Tectonic movements cause some parts of the Earth's crust to thin and sag to form basins and other parts to rise as mountains. During ancient geological times Australia, India, Africa, New Zealand and Antarctica were welded together to form the super-continent of Gondwanaland. About 184 million years ago the super- continent began to break up and the present continental plates started to move apart. Continental crust between the separating plates was stretched thin and split by a series of faults. The stretched crust then sagged to create a marine sedimentary basin presently filled by the Indian Ocean.



Lower layers of sediment were compressed and dewatered by pressure from overlying deposits. (A student activity demonstrating pressure dewatering sediments is given in our WASP 7 materials in the "Oil" section). Clasts will compact and also align at right angles to the direction of pressure.



This is particularly true of mud and silt. Their platy alumina-silicates align well under pressure. The sediments compress and compact to form slate and then with further increase in temperature and pressure, schist.

*Progression from mudstone on left, to slate in centre to schist on right*

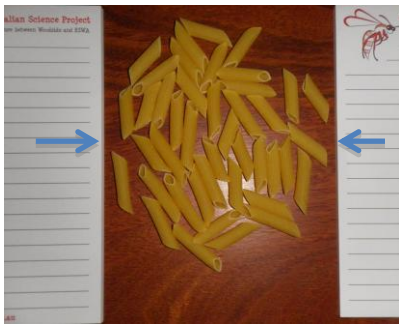
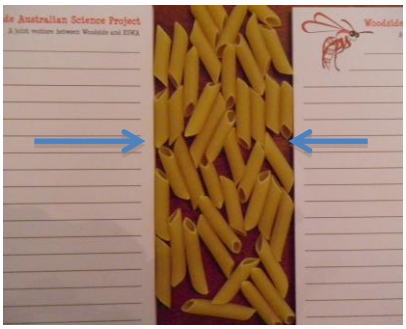
## Recognising Metamorphic Rocks - Teacher Notes

**Teacher demonstration - Platy materials aligning under pressure**

Materials

- 2 rulers or thick books
- Handful of dried long pasta pieces

Pieces of dried spaghetti or elongate noodles are dropped on the desk to form a random pattern. Hold the parallel rulers vertically like walls on either side and slowly compress the pile. The pasta pieces align like mica does in metamorphic rock.


We can see the effect of pressure when we compact a fluffy snowball in our hands. The highly compressed centre of the ball recrystallises to form ice.

Temperature also increases with depth, roughly 25$^{o}$C for every kilometre. Minerals melt and reform to take on a different crystalline form that is more stable under the new conditions of higher temperature and pressure.

| Depth | Rock |
|---|---|
| Surface | Mud |
| 5 km | Shale |
| 10 km | Slate (different micas form) |
| 15 km | Schist (garnet appears) |
| 20 km | Gneiss (staurolite appears) |

**Contact metamorphism**

An intrusion of hot magma, perhaps granite or a dolerite dyke, alters the surrounding country rock. In this case heat, not pressure, is the major agent of metamorphism. Changes grade away from the contact to create an aureole of metamorphism.

Since some components of the original rock will be affected before others, partial melting of the rock occurs. This also contributes to lines of weakness or schistosity.

## Recognising Metamorphic Rocks - Teacher Notes

**Teacher demonstration** **Metamorphism examples**

When fossil rich limestone is subjected to increased temperature and pressure it metamorphoses into marble. Often traces of bedding and fossil shapes remain.

Materials

- Toasted sandwich maker
- Bread
- Grated cheese
- Tomato slices

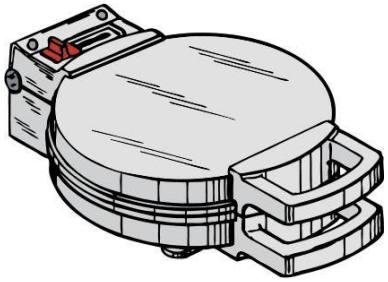
1. Assemble two sandwiches. One is the control against which change is to be measured and the other is the experimental sandwich.
2. After the sandwich has been compressed and heated cut cross sections of both then compare and contrast.

**Bread** - **No physical change but graded chemical change.** The bread will be most affected by heat on its outer surface, where it is brown sugars have caramelised in response to heat. The slice will have maintained its shape but be thinner/compressed. If you compare the taste of the bread with and without toasting, toasted bread is sweeter as some of the carbohydrates in flour have broken down to form sugars.

**Cheese - Major physical change and chemical change.** The grated cheese component has decreased in volume. The protein chains have shrunk. The cheese is no longer discrete grated particles but has melted into one plastic band.

**Tomato - Slight physical and chemical changes** The tomato has become slightly liquid and tastes sweeter than the original slightly acid raw tomato. Its shape is still recognisable

***Extension:*** Students may wish to make toasted sandwiches with fossil shapes cut from cheese slices and observe changes. Slices of apple or pieces of ham may be added.



| **Original rock** | **Metamorphosed rock** |
|---|---|
| Mudstone | slate > schist |
| Sandstone | quartzite |
| Limestone | marble |
| Granite | gneiss |