Create a Cavern – Teacher Notes

What created these interesting flat topped "hills" in Kalgoorlie?
These are ***spoil heaps*** left over from mining. Once the ore and mullock (non-economic country rock) is removed it is processed and the ore refined. The leavings are piled up as spoil.

Does the volume of the rock piles represent the amount of empty space mined out below?
The spoil heaps only represent the non-economic leavings of mining. The resource is removed and refined. However, there is no direct relationship between volume they take up above ground + resource and volume removed below. Above ground there are more voids left between rocks as they are piled up

Pit props in a stope in Hannan's Gold Mine, Kalgoorlie.

Removing rock to form a cavity causes stress to the walls of adits, drives, shafts and stopes. Broken wall and roof rock is usually supported by pit props, weld mesh, concrete and bolts to guard against collapse. The roof of the open stope created by gold mining at Hannan's Mine near Kalgoorlie is supported by pit props. The old props had to be replaced by fresh new ones when the mine was re-opened for tourists.

Rock and even unconsolidated soil and sand can support small cavities without collapsing.

<u>Aim</u> **To find if wet sand can maintain a cavity without collapsing.**

Students are asked to do a trial run before designing a proper experiment to see if the proximity of an earthquake will affect the ability of sand/soil to maintain a cavern.

Materials per group

- A large beaker (over 1000mL) bucket or container (See below for alternatives)
- Clean damp sand or soil
- 3 balloons
- A long skewer

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Method

1. Inflate the balloons and tie them off. They should have different diameters but be small enough to fit easily inside your container with at least 3cm of sand piled on top.
2. Place a little sand on the bottom of the container, place the balloon on top and fill with sand until the balloon is covered with at least 3cm sand.
3. Tamp down the sand firmly.
4. Insert the skewer to deflate the balloon.
5. Observe and report what happens

This activity can alternatively be carried out in the school's sandpit, long jump or high jump pits or in the garden. Students will need trowels.

Results vary depending on the materials used. This activity is flawed as a scientific experiment as variables are not controlled. Students will be asked to design an improved version controlling variables and repeating any measurements.

Usually, the balloon deflates without the cavity collapsing.
Why did the sand not collapse when the balloon was punctured?
This is due in part to the small amount of pressure caused by overlying sand, partly to the adhesive nature of water and partly due to the curved shape left by the balloon.

Miners and architects learned from Nature that burrows with rounded roofs remained stronger longer than those with flat roofs and that arched roofs permitted wider cavities below. The compressional pressure is diverted from the roof to the walls. The deeper the mine the greater this pressure from overburden becomes.

A gold prospector's adit driven into greenstones near Yalgoo. Note escaping resident micro-bats .

Add more sand/soil until the cavern lid collapses.

Scientists often run a trial version of an experiment before they collect data.
Why would they do this?
To ensure equipment selected will work and they can collect data that is both precise (repeatable) and accurate (of a suitable scale).

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The following activities can be done as extension or homework as they require minimal equipment.

Extension
Redesign this experiment to make it a "fair test".

What is your hypothesis? _____

What is the dependent variable? _____

What is the independent variable _____

Which variables have been controlled? _____

_____

How did you ensure your measurements were accurate? _____

_____

How did you ensure your measurements were precise? _____

_____

What data did you collect? _____

_____

What conclusions can you draw from the data? _____

_____

Extension - Pressure increases with depth.

Method

- Take an empty cool drink container and make three holes in a vertical line down its side.
- Fill a measuring jug or another empty bottle with water and go outside onto a grassed area.
- With the holes on the side of the bottle pointing away from your body, rapidly fill the bottle with water.
- Observe the waterspouts.

How can you tell that pressure increases with depth in this experiment?
Water near the top dribbles out whereas the water from the lower hole spouts out almost horizontal

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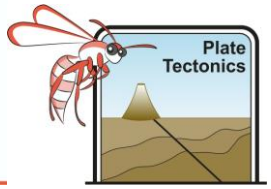

Why do the waterspouts have different shapes?
The lower spout is pressurised by a higher column of water above it.

Is there any other data you could measure that would support the hypothesis that the lowest spout was under greatest pressure?
Measure the distance the spouts cover on a horizontal plane. Put your fingers in the waterspouts and feel (relative measurement) which felt strongest.

If you can access Youtube I can highly recommend watching National Geographic: Megastructures- Tau Tona – City Of Gold! (47m) to find all the pressure miners work under in one of the deepest mines in the world. http://www.youtube.com/watch?v=7MIrUZzFl2s

Interesting fact
The pascal (Pa) is named after the French philosopher and scientist Blaise Pascal. It is a measurement of force per unit area. One Pa is the pressure one newton exerts on one square meter. Standard atmospheric pressure at the surface of the earth is 101325 Pa.
A megapascal MPa is 1,000,000Pa.
Pressure at the foot of a 3km mine can be 80Mpa (9x greater than at surface)
Pressure at the foot of a 4km mine can be 110MPa (108.6x greater than at surface)

Pumping water from underground
In California pumping underground water for domestic supplies and a decrease in rainfall has produced a lowering of the water table. The competency of the reservoir rock has decreased and many small earthquakes have been measured locally.