Riches in the river

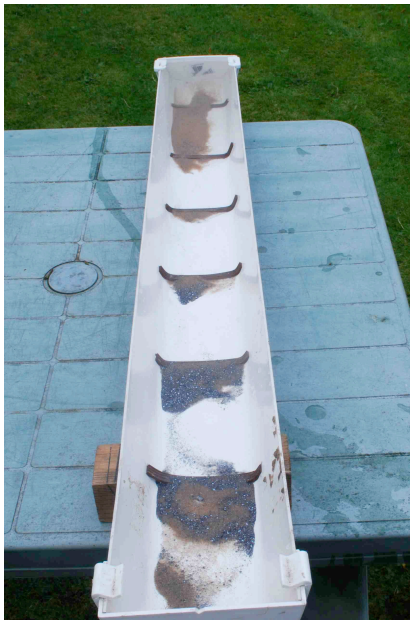
Investigating how valuable ores may become concentrated on river beds

Show pupils a cup of sand with glistening metallic particles in it. Pretend that the glistening particles are gold. How could we separate the 'gold' from the sand? Remind them of some of the properties of gold, including the fact that it is very much more dense than sand.

When the pupils have made their suggestions, show them a length of gutter with thin baffles (low barriers) glued across it, a block of wood and a bucket of water. Ask them how this equipment could be used to separate the 'gold' from the sand. Follow the pupils' suggestions in a demonstration. Then, if they have not thought of it for themselves, show how it may be done. Rest one end of the gutter on the wood block and let the other end drain into a bucket. Add about 50ml of the sand/'gold' mixture to the top of the gutter and then very gently trickle water down over it, from a jug. The less dense sand washes over the baffles and comes to rest in the lower end of the gutter, but most of the dense 'gold' remains trapped behind the top two or three baffles.

This process happens in real rivers, where gold and ores of other dense metals settle out behind obstructions on the river bed.

The gutter set up on a wooden block ready for action



View from the top end of the gutter showing how the dense ore is trapped behind the top three baffles, whilst the sand is washed to the bottom

The second demonstration models a bend in a river, but here it is a continuous bend! Pour about 10cm depth of water into a round flat-bottomed bowl. Place a round object in the middle of the bowl, to represent the inner bank of a meander. Sprinkle about 75ml of the sand/'gold' mixture evenly onto the base of the bowl and jiggle the bowl slightly to even out the layer.

Using a dessert spoon or similar object, gently stir the top 2 cm or so of the water round and round, for a few minutes until the sand moves along the bed to form shapes. (Do **not** stir the sand itself). The 'gold' settles out behind the newly formed ripple marks, whilst the sand keeps sweeping over the crest of each ripple mark. Where the current is fastest, on the outside of the bend, the sand may be swept clear, leaving behind the dense 'gold'.

The 'continuous river bend' model set up with an even layer of sand and dense ore

Ripple marks formed in the sand, with the dense ore trapped behind each ripple
(*All photographs by Peter Kennett)*

Ores which become concentrated in moving water, as in these two activities, are referred to as **placer deposits.**

The back up

Title: Riches in the river

Subtitle: Investigating how valuable ores may become concentrated on river beds

Topic: Investigating the importance of differences in density of sand and a valuable ore, to see how the ores may become concentrated by the action of moving water.

Age range of pupils: 10 – 18 years

Time needed to complete activity: About 10 minutes for each activity

Pupil learning outcomes: Pupils can:
- explain how moving water can separate particles of different density;
- predict where best to look for gold and dense ores on a river bed;
- explain how density differences can be used to separate valuable ores from less dense waste in a commercial situation.

Context: The activity could be used in a lesson on sedimentary processes, or to show the economic value of density differences in a physics lesson. Some pupils may live in countries where the commercial extraction of placer deposits is an important contributor to the national economy.
If you have water from the tap available, the water can be run down the gutter from a pipe, instead of using a jug.

Following up the activity:
Try the Earthlearningidea activity, 'Sand ripples in a washbowl' to investigate more fully the ways in which sand behaves in moving water.
Ask pupils to devise other ways of separating ores from sand.
Carry out a web search for the techniques used by mineral extraction companies to separate the ore from the waste. This will include the process known as froth flotation.

Underlying principles:
- Loose particles in moving water are either carried in suspension, or are dragged along the bottom as bed-load.
- As the sand particles move downstream ripple marks develop in the sand.
- The sand that is dragged up the shallow slope of the ripple mark is carried over the top and is deposited by eddies travelling up the front (steep) slope of the ripple mark, depositing sand on this steeper slope.
- Dense ores settle in the trough areas of the ripple marks, which are protected from the main water current.
- Density differences have long been used to separate valuable ores from the lower density waste material. The process featured above is called 'buddling'. 'Jigging' is a process whereby a container of ore and waste is jigged up and down in water, which pulses though the open mesh base of the container.
- Modern separation of ores from waste is mostly done by froth flotation, which depends more on the chemical properties of the materials than their densities.

Thinking skill development:
Pupils observe the patterns forming in the ores and the sand in both activities (construction). They reason why the ore remains behind (metacognition) and apply their findings to the commercial world (bridging).

Resource list:
- gutter with baffles (low barriers about 0.5 cm high) glued across the gutter at 10cm intervals. (Self-adhesive draught excluder is easy to use)
- washed medium-grained sand
- particles of dense metals or metal ores, e.g. crushed pyrite or galena, brass turnings, iron filings, etc. The photographs show galena particles produced by crushing galena between two hammers, sieving through a kitchen sieve to remove the larger fragments and washing in water to remove the grey dust.
- jug
- bucket
- water
- small block to raise one end of the gutter
- round flat-bottomed bowl.
- round object placed in the middle of the bowl,
- dessert spoon

Useful links:
http://www.ectonhillfsa.org.uk/Geology_pdf_files/GW7_SS1_What_makes_an_Ore_Deposit_worth_Mining.pdf

Source: Adapted by Peter Kennett of the Earthlearningidea team from the Earthlearningidea activity 'Sand ripples in a washbowl' and from 'Earth Science Experiments for A Level', Mike Tuke, Earth Science Teachers' Association, on CD Rom.