

## Sand ripples in a washbowl

### 洗脸盆里的波纹沙地

#### How asymmetrical ripple marks form in sand

#### 不对称波纹是如何在沙地上形成的

Put a mug of water, or large glass of water, into the middle of a washbowl, as shown in the diagram opposite.

把一杯水放在一个盘子（洗脸盘）的中央，如图片所示。

Fill the bowl about half full with water. Add a few table-spoonfuls of washed sand as evenly as possible around the washbowl. It is best to use washed sand as otherwise the water will be cloudy and it will be difficult to see what is happening. Wash the sand by rinsing it in water several times and pouring off the cloudy water.

用水把盘子装到半满。均匀地把若干汤匙的沙子放到盘里。最好用洗干净的沙子，否则水会变得浑浊而无法看清水里发生的情况。用水冲洗沙子，然后倒掉浑水，反复多次就可以把沙子洗干净了。

Stir the water around and around the mug, or glass, fairly fast with a tablespoon until the sand grains move into a pattern on the floor of the washbowl. Remember to stir in one direction only and don't let the spoon touch the bottom.

用汤匙快速环绕杯子搅拌水，直到盘底下的沙粒形成纹理图案。记住保持向一个方向搅拌（顺时针或逆时针），而且不要让汤匙触碰到底部。

#### Ask the pupils:

##### 询问学生:

- Why do you think the sand forms these shapes?
- 你认为为什么沙子会形成那样形状的模式吗?
- How are the shapes linked to the speed of the water flow and its direction?
- 形状和水流的速度方向之间有什么联系?
- How could we use 'fossilised' ripple marks like these in an ancient sandstone to work out the speed and direction of the water when the sand was laid down?
- 我们怎么样可以利用古代沙岩上的波浪痕化石来推断出当沙子沉淀时水流的速度和方向?

#### The back up:

##### 备忘录

**Title:** Sand ripple marks in a washbowl.

**题目:** 洗手盆里的波纹沙地

**Subtitle:** How asymmetrical ripple marks form in sand.

**副标题:** 不对称波纹是如何在沙地上形成的

**Topic:** Ripple marks can indicate the direction of flow of the water. Direction of flow can then be worked out when 'fossil' ripple marks are studied.

**主题:** 波纹可以指示水流的方向。水流的方向可以通过研究波纹化石来得出。

**Age range of pupils:** 10 - 18 years.

**学生年龄范围:** 10-18岁

**Time needed to complete activity:** 30 minutes.

**活动所需时间:** 30分钟。

**Pupil learning outcomes:** Pupils can:-

**学生学习成果:** 学生可以

- explain why water flowing in one direction creates asymmetrical ripple marks in sand;
- 解释为什么水向一个方向流动会在沙上产生不对称的波纹;
- describe how, when the flow of the water reaches a certain velocity, sand grains are picked up by the water and start to move;
- 解释当水流达到一定速度时沙粒如何被水抬起然后开始移动;
- interpret 'fossil' ripple marks often seen in sandstones as being formed by a uni-directional flow of water, e.g. in a river or the sea;
- 把沙岩上的波纹化石解释为单一方向水流造成的结果, 例如河流和海洋里的波纹化石;
- explain the direction of flow, which created asymmetrical 'fossil' ripple marks.
- 解释造成不对称波纹化石的水流方向。

**Context:** The activity could form part of a lesson about looking at sedimentary rocks and their structures to find evidence for how the rocks formed.

**背景:** 在一些课上, 老师和学生观察沉积岩及其结构来寻找岩石形成过程线索。本项活动就可以作为这些课的一个部分。

- Why do you think the sand forms these shapes? The water is fast enough to form undulations, then to move sand grains up the shallow backs of ripple marks and deposit them on the steeper fronts - but not too fast to destroy the ripple marks and move all the sand to the middle.
- 你认为为什么沙子会形成那样形状的图案? 水流的速度足以形成波动, 把波纹较平缓的背部的沙粒移动到相当陡峭的前部——但水的速度又不足以破坏波纹而把所有沙子移到中间。
- How are the shapes linked to the speed of the water flow and its direction? They only form at certain speeds - too slow, and the water does not have enough energy to move most of the grains, too fast and the ripple marks are destroyed. They form with the shallow slope up-current and the steeper slope down-current.
- 波纹形状和水流的速度和方向之间有什么联系? 它们只会在一定的速度下形成——太慢的话, 水流没有足够的能量移动沙粒, 太快的话, 波纹会被破坏。它们在迎向水流的一面斜度较浅, 背向水流的一面斜度较陡。
- How could we use "fossilised" ripple marks like those in an ancient sandstone to work out the speed and direction of the water when the sand was laid down? The ancient ripple marks must have been formed by a current flow of similar speed and direction to those in the washbowl.
- 我们怎么样可以利用在古代沙岩上的波纹化石来得出当沙子沉淀时的水流速度和方向? 古代波纹一定是在类似的水流速度和方向下形成的。

**Notes:**

**注释:**

- Asymmetrical ripple marks form in water in many places - in rivers, on beaches (as water drains off) and in shallow seas (by tidal currents). They even form in deep seas.
- 不对称波纹在许多有水的地方形成——河流，沙滩（当水浪退去的时候）和浅海（潮水所为）。甚至会在深海里形成。
- Asymmetrical ripple marks can be formed by winds in sand dunes too – and give clues to the wind direction in ancient wind-deposited sandstones.
- 不对称波纹也可以由风作用在沙丘上造成——提供了关于古代风成沙岩的风向线索。

**Following up the activity:**

**后续活动:**

Try stirring the water even faster - - -

以更快的速度搅动水；

Try the next Earthlearningidea which is about how symmetrical ripple marks are formed.

尝试下一个Earthlearningidea活动，那是关于对称波纹如何形成的活动。

**Underlying principles:**

**背后的原理:**

- Many sedimentary rocks are formed of sediments like gravels, sand and mud which have been weathered and eroded from other rocks.
- 许多沉积岩是由从其它岩石上侵蚀下来的沉积物（比如砂砾，沙，和淤泥）形成的。
- These sediments were mostly laid down by rivers and the sea in the geological past.
- 这些沉积物大都会落在相应地质年代的河流和海洋里。
- These sedimentary rocks contain clues, such as sedimentary structures like asymmetrical ripple marks, about how they were formed.
- 这些沉积岩里藏有很多线索，比如说象不对称波纹这样的沉积结构就提供了它们是如何形成的线索。
- The sand that is carried up the shallow slope of the ripple mark is then 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.
- 在波纹较平缓一侧的沙子被带起翻越波纹的顶部，然后沉积在较陡峭的一侧。
- The ripple marks migrate downstream by sand being eroded from the upstream side and being deposited on the downstream side.
- 波纹向下游方向迁徙。上游一侧的沙子被侵蚀，然后沉积在下游一侧。
- Asymmetrical ripple marks form in the washbowl and it can be observed that gradually, they move in the direction of the flow of water. If the velocity of flow is increased by faster stirring, the structures are destroyed.
- 不对称波纹在盘子里形成。可以观察到它们向水流方向缓慢移动。如果水流速度随搅拌速度的增加而增加，波纹结构会被破坏。
- Medium sized sand grains of about 0.3mm in diameter are picked up by water flowing at about 0.25 ms<sup>-1</sup>.
- 中等大小的沙粒（直接大概0.3毫米）会被速度为大约0.25米每秒的水流带起。
- Most sedimentary rocks are formed from loose sediment which in the past was carried by currents of water. These currents transport vast quantities of previously weathered and eroded material from one place to another.

- 多数沉积岩是由过去被水流带走的松散沉积物形成的。这些水流把大量被侵蚀物质从一个地方搬运到另一个地方。

### Thinking skill development:

#### 思维技能发展:

- How does ripple mark shape indicate flow direction (pattern, construction).
- 波纹如何指示水流（气流）的方向（模式，构建）。
- Explanation of how the ripple marks form i.e. the reasoning behind the answers (metacognition).
- 解释波纹的形成。答案背后的推理（元认知）
- If 'fossil' asymmetric ripple marks are preserved in local rocks with the steeper slope dipping north, which way was the water flowing? (bridging).
- 如果保存在本地岩石的不对称波纹的陡面朝北，那水流是向哪个方向？（联系）

### Resource list:

#### 资源列表:

- circular washing-up bowl
- 圆形洗盘
- mug, or large drinking glass
- 水杯，或大玻璃杯
- washed sand
- 洗干净的沙子
- tablespoon.
- 汤匙

### Useful Links:

#### 有用链接:

<http://www.geology.pitt.edu/GeoSites/sedstructures.htm>

[http://www3.interscience.wiley.com:8100/legacy/college/levin/0470000201/chap\\_tutorial/ch03/chapter03-5sedstr.html](http://www3.interscience.wiley.com:8100/legacy/college/levin/0470000201/chap_tutorial/ch03/chapter03-5sedstr.html)

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