What catastrophic natural processes affected your region in the geological past?

Use the evidence in your local region to interpret dramatic geological events

Although many geological processes are very slow, some take place so quickly that they would certainly be noticed or felt if there had been people living at that time. They might even have produced catastrophic damage, and there may be evidence of such past events in the region where you live.

The photographs show evidence of past "catastrophic events" recorded in the rocks within 25 miles (40km) of the home of the author in Sheffield, UK. Study the photographs, answer the questions, and try to imagine yourself in that situation at that time - would you have been able to survive?

The sea bed

Brachiopod fossils on a limestone bedding plane, Ricklow Quarry, Peak District, UK (penknife is 9cm long)

Brachiopods are shell fish with two shells, most of which live in shallow, warm sea water today. The ones in the photograph have all been turned upside down. What sudden event must have happened about 340 million years ago? Would you have been able to survive if you had been there?

A lava flow

Pupils examining an exposure of basalt lava, with columnar jointing, Cavedale, Peak District, UK.

The pupils are examining an ancient lava flow. The columnar jointing shows that it was erupted onto land and not under water. However, the pupils are standing on the top of a bed of limestone, and limestone beds start again above the head of the boy in the brown shirt. Explain what happened here, in several stages, starting with the limestone beneath their feet. How might you have survived if you had been here when the lava erupted?

Faulting

Students visiting an opencast coal mine, near Sheffield

The students are standing on a coal seam. The same coal seam can be seen on the left at a higher level, where the red digger is excavating it. The difference in level is caused by an ancient fault, which happened when all the rocks were buried well below ground level.

If you had been living on the surface at the time, what might you have felt when the faulting took place? Would it all have happened at once? Would you have been in any danger?

Folding

Intense folding at Apes Tor, Manifold Valley, Peak District, UK.

These beds of limestone and other rocks were deposited on a flat seabed. The folds were then created deep below the ground. Would you have felt anything if you had been living on the surface above when the folding took place?

Would it all have happened at once? Would you have been in any danger?

Suggest the directions of the forces which created the folds. Look very carefully and see if you can spot a place where the forces were too great for folding and the rocks were suddenly shattered by faulting.

For pupils to decide

The limestone beds in the photograph alongside were once horizontal and have been tilted into a vertical position. With your finger, trace the three very thin beds from the bottom to the top of the photo and decide what has happened to them.

Steeply inclined beds, Ecton Mine, Manifold Valley, Peak District, UK (width of rock face is about 1.5m.)

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The back up

Title: What catastrophic natural processes affected your region in the geological past?

Subtitle: Use the evidence in your local region to interpret dramatic geological events.

Topic: Interpreting photographic evidence of catastrophic events in the geological past – how could this thinking be applied to your area?

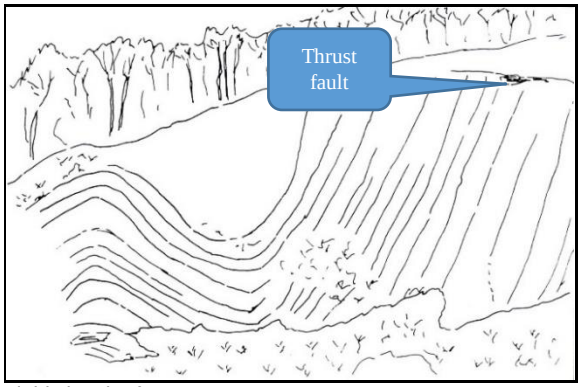
Age range of pupils: 11 – 18 years

Time needed to complete activity: 20 minutes

Pupil learning outcomes: Pupils can:
- interpret geological evidence from photographs;
- imagine themselves to be back in the past when dramatic events were happening;
- estimate their chances of survival during rapid upheavals of the Earth.

Context: Several photographs are used to stimulate discussion about possible rapid geological processes in the past which might have had "catastrophic" outcomes if there had been humans on the Earth at those times.

- **The sea bed**
  Large brachiopods, such as the ones in the photograph, live with their larger convex shell resting in the soft surface sediment, with the convex side pointing down. The fact that these fossils are all convex-up shows that a major storm disturbed the shallow water. A human entering such water whilst the storm was raging would be unlikely to survive.
- **A lava flow**
  The main stages in the story are: deposition of soft limey sediment under the sea; compaction and cementation to turn the limey sand to hard limestone; fall in sea level (or rise in sea bed) to expose the limestone at the Earth's surface; eruption of a mobile basalt lava flow; cooling and crystallisation of the lava, forming columns; rise in sea level (or sinking of land area); further deposition of limey sediment, turning to limestone; uplift of all the rocks and erosion to form the present landscape. The eruption would have been largely non-explosive and could be safely watched from a distance.
- **Faulting**
  A fault of this scale would almost certainly have been accompanied by earthquakes, which would have been felt on the surface above and further afield. Earthquakes seldom occur as just one shock, but are preceded by smaller shocks and often followed by aftershocks. The fault probably took several stages before it reached its full displacement of about 3m in this view. If you had been there at the time you would undoubtedly have been shaken, but most deaths and injuries are caused by collapsing buildings, not by the ground cracking.
- **Folding**
  Folds are produced by the gradual plastic deformation of rocks, under intense lateral pressure, e.g. at plate margins, so you probably would not feel anything at surface level, even though the level might have been imperceptibly rising. However, rocks do give way when their plastic limits are reached, so the folding would be accompanied by faulting, resulting in earthquakes, so any dangers to a human would be as for faulting (described above). The forces which produced the folds in the picture would have acted from right to left/ left to right. In the top right hand corner, fracture of the rocks has resulted in a small thrust fault, shown in the photograph and field sketch below.



Field sketch of Apes Tor


The thrust at Apes Tor. The ruler is on the thrust plane

For students to decide
The three thin beds have been displaced by a thrust fault for about 45cm to the left as they are traced up the rock face in the mine. This would have been accompanied by an earthquake at the time.

Following up the activity: Use this example to encourage students to search for evidence of past "catastrophic" events in their own home region.

Underlying principles:
- Most geological processes take place very slowly, but some are rapid enough to have caused a catastrophe at the time, in human terms.
- Catastrophic events may be repeated at the same site, e.g. earthquakes caused by faults.
- Most catastrophic events take place at former active plate margins, but others may occur in less active areas, such as tsunamis on a coast distant from the earthquake, landslides etc.

Thinking skill development: Building up the realisation that events can happen very quickly in the geological past is a construction skill. Cognitive conflict may arise when some apparently rapid events are found to take place in stages. Bridging skills are required to relate spectacular Earth events of the present day to those of the past in the pupil's home region.

Resource list:
- paper copies of these sheets, or the facility to project the images onto a screen

Useful links: Search the Earthlearningidea website for related activities, e.g.
https://www.earthlearningidea.com/PDF/Earthquake_thro_window.pdf
https://www.earthlearningidea.com/PDF/Eruption_thru_window.pdf

Source: Written by Peter Kennett of the Earthlearningidea Team. All pictures by Peter Kennett