

Take a 'Chance' on the volcano erupting How hazardous is the volcano?

Earth Learning Idea has already published 'Party time for volcanoes! – How much force does it take to set off a party popper?'

This activity provides a major extension of that original idea, and both should be downloaded for reference.

Set up two or three 'party popper volcanoes' as described in 'Party time for volcanoes'. Provide students with a pack of 'Chance' cards, cut from the sheets below. They can either share a pack, or have a pack each. Explain that each card gives one type of evidence which might indicate whether the volcano was more or less likely to erupt. Each card will tell the students to add one or more masses, or sometimes even to remove a mass.

Explain that each volcano has a major town nearby. (Teachers may wish to invent a name for each town). Students should also be provided with an 'Emergency' card stating "Evacuate" and "Return to homes". They can choose whether to play these cards at any point in the game.

Now, ask the students to take turns to take a 'Chance' card from the pack and to carry out what it says on the card. Masses should be added gently, in order to obtain a valid comparison between each 'volcano'.

Usually, the total mass required to 'erupt' each party popper varies widely between the three of them – an analogy for the difficulty that scientists

have in trying to predict volcanic eruptions precisely.

Students should avoid putting their heads directly above the party poppers.



"Wow, mine's blown up already!" The 'Chance' cards in use during a teacher education session (Photo: Peter Kennett)

The back up

Title: Take a 'Chance' on the volcano erupting

Subtitle: How hazardous is the volcano?

Topic: Measuring the force required to burst a party popper as an analogy for the prediction of volcanic eruptions. A series of possible events in the build up of a volcanic eruption is given on 'Chance' cards. These are selected at random and the instructions given on the card are followed until the party popper 'erupts'. (N.B. See footnote re the use of the terms 'force' and 'mass')

Age range of pupils: 8 – 80 years

Time needed to complete activity: 10 minutes, with a few minutes preparation time, mostly in tying a string loop to each party popper.

Pupil learning outcomes: Pupils can:

- measure the increasing force required to 'erupt' a party popper;
- debate why there may be major differences in the force required;
- appreciate the wide range of activity on and below the Earth's surface which precedes a volcanic eruption;

- understand why it is almost impossible to predict a volcanic eruption (although we can **forecast** the statistical likelihood of a dramatic Earth event, it is usually impossible to correctly **predict** the time and place).

Context: Through this activity, students will discover many of the factors which are associated with the build up to a volcanic eruption. These include seismic activity, changes in gas emissions, swelling of the volcano's surface, and minor eruptions of tephra (solid particles of congealed lava, in the form of ash or larger fragments).

Following up the activity: Use the web to find real-time data of active volcanoes, e.g. <http://volcanoes.usgs.gov/activity/methods/index.php>

Underlying principles:

- In many volcanoes, gas pressures build up underneath the surface, until the pressure exceeds the force exerted by the overlying rock and an eruption takes place.

- Any of the following (represented on the 'Chance' cards) may indicate that an eruption is imminent:
 - The ratios of the gases emitted from the volcano. An increase in the sulphur dioxide/carbon dioxide ratio is particularly significant;
 - Increases in the emission of steam and other gases at fumaroles (minor vents on the volcano's surface);
 - Shallow seismic swarms (groups of small earthquake shocks), indicating very near surface movement of magma and gases;
 - Harmonic seismic tremors (shocks produced by magma movement), indicating magma rising from a magma reservoir below the volcano.
 - Minor eruption of tephra (ash, bombs), showing that some of the rising material has found its way to the surface and that more may follow shortly;
 - Minor rock falls near the summit or swelling of the flanks of the volcano, measured by tilt meters or GPS systems (satellite-based positioning systems).
 - Changes in the local magnetic field strength or of the Earth's gravitational field may indicate rising magma. Several volcanologists were killed and injured by a small eruption of tephra whilst testing the use of micro-gravity changes to predict eruptions near the summit of Galeras volcano in Columbia in 1993. They thought the gravity meter was defective, when in fact the readings had gone off the scale, as rising magma rose into the near-surface structure of the volcano.
- The 'Chance' cards also make provision for times when ominous signs diminish, such as the swelling of the volcano subsiding, or when no data are gathered. (In the case of Galeras, a TV programme stated that the resident seismologist was on holiday, so the seismic records were not examined until after the fatal eruption).

- Prediction of eruptions remains very difficult and it is seldom possible to give precise timings of anticipated events, to allow the evacuation of populations to safety.

Thinking skill development:

- Prediction of the outcome of adding the masses involves construction;
- Explaining why students' predictions were not always fulfilled involves cognitive conflict;
- Metacognition is involved as the group discusses the outcomes;
- Linking the model to the real world requires skills in bridging.

Resource list:

- at least three party poppers, with the strings tied into firm loops
- three clamp stands, clamps and bosses
- six 100g mass hangers
- 100g masses (up to 90 may be needed if all the party poppers are stubborn!)
- one or more sets of 'Chance' cards prepared by printing the sheets below onto card and cutting them up.

Useful links:

<http://volcanoes.usgs.gov/activity/methods/index.php> : <http://geology.com/volcanoes/galeras/> : <http://sese.asu.edu/teacher-resources> - look for 'Issue 2 Eruptions of the Icelandic volcano Eyjafjallajokull'.

Source: From an original activity and game devised by David Turner, of the Earth Science Education Unit.

See www.earthlearningidea.com 'Party time for volcanoes! How much force does it take to set off a party popper 'volcano'?'

N.B. We have recommended using 100g masses in this activity. To convert the mass in grams into the approximate force in Newtons, divide the mass by 100.

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Volcano Alert

Increased
Fumerole Activity



Add 1 mass

Volcano Alert

Minor Tephra Eruption



Add 2 masses

Volcano Alert

Steam Venting



Add 1 mass

Volcano Alert

Summit Elevation +1m



Add 1 mass

Volcano Alert

Shallow Seismic Swarm



Add 1 mass

Volcano Alert

Carbon Dioxide
Emission Increase



Add 1 mass

Volcano Alert

Sulphur Dioxide
Emission Increase



Add 2 masses

Volcano Alert

Harmonic Tremors



Add 2 masses

Volcano Alert

Minor Magnetic
Field Changes



Add 1 mass

Volcano Alert

Tilt Meter Increases



Add 1 mass

Volcano Alert

Long Period
Earthquakes



Add 1 mass

Volcano Alert

Decreased
Sulphur Dioxide
Emissions



Remove 1 mass

Volcano Alert

Zero Activity



You Choose

Volcano Alert

Decreased Seismic Activity



Remove 1 mass

Volcano Alert

Hot Spring
Temperature Increase



Add 1 mass

Volcano Alert

Increased Gravity Anomaly



Add 1 mass

Volcano Alert
EVACUATE



Volcano Alert
RETURN TO HOMES



Volcano Alert
**Decreased
Slope Angle**



Remove 1 mass

Volcano Alert
**Minor Rock Falls
Near Summit**



Add 1 mass

Volcano Alert
Major Steam Venting



Add 1 mass

Volcano Alert
Minor Seismic Events



Add 1 mass

Volcano Alert
No Data



You Choose

Volcano Alert
**Increased
Fumarole Activity**



Add 1 mass