

2.1 EARTHQUAKES & VOLCANOES

Plate movement & Boundaries

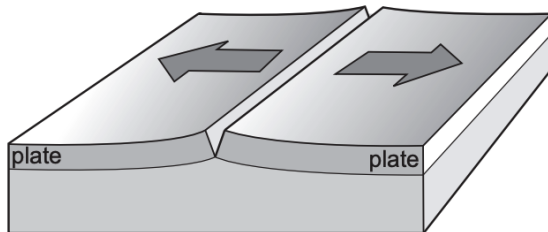
Tectonic plate: Large part/piece/section of the earth's crust or surface. // The way in which the Earth's surface is broken or fractured into pieces.

Plate boundary: Edge of tectonic plates/where plates meet/where plates move apart/where plates move together/margin of tectonic plates.

Why plate movement occurs

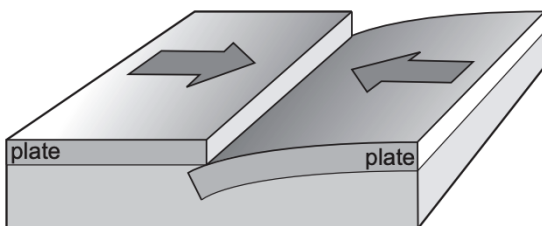
- Heating of magma
- Convection currents (solid crust floats on semi-molten magma)
- Magma rises up through mantle

1. Constructive / divergent plate boundary



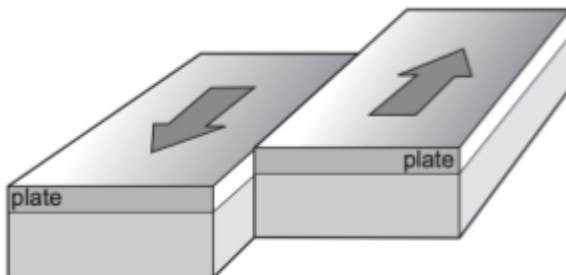
Plates move away from each other

2. Destructive / convergent plate boundary



Plates move towards each other

3. Conservative plate boundary



Plates move against each other

Volcanoes

Volcano: Opening in the earth's crust through which hot molten magma (lava), molten rock and ash erupts onto land.

Magma: liquid molten rock inside the earth's interior.

Lava: magma that flows out onto the earth's surface.

Causes of volcanoes

- They occur on/close to plate boundaries/lines of weakness/where plates meet
- They occur due to relative movement of these plates (caused by convection currents)
- Destructive margin or constructive margin processes (eg. subduction) occur
- Pressure builds up
- Creation of magma
- Release of magma

Location of volcanoes

- Most volcanoes are found at plate boundaries
- There are some volcanoes located at isolated hotspots (eg. volcanoes in Hawaii)

Hotspot: areas of weakness in the middle of a plate

Why volcanoes erupt on constructive plate boundaries.

- Plates move apart
- Due to convection currents
- Gap created between plates
- Magma is forced upwards/ rises/ fills the gap
- Due to pressure

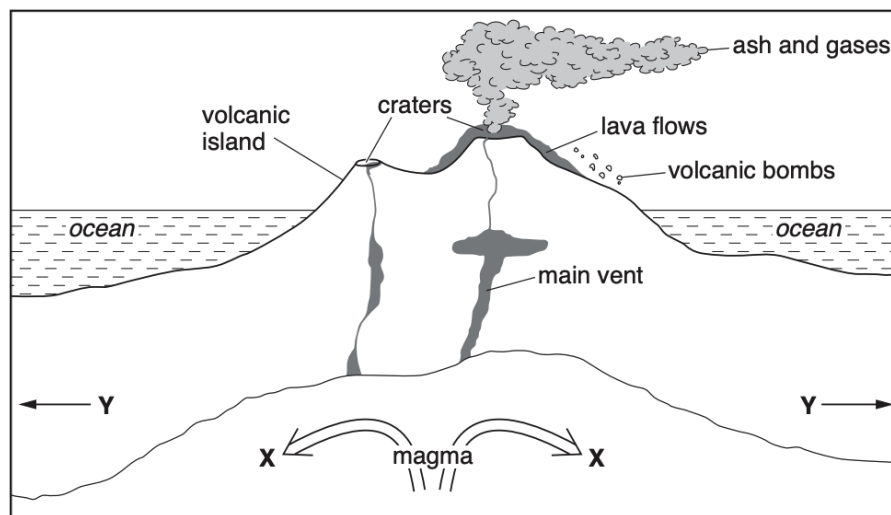
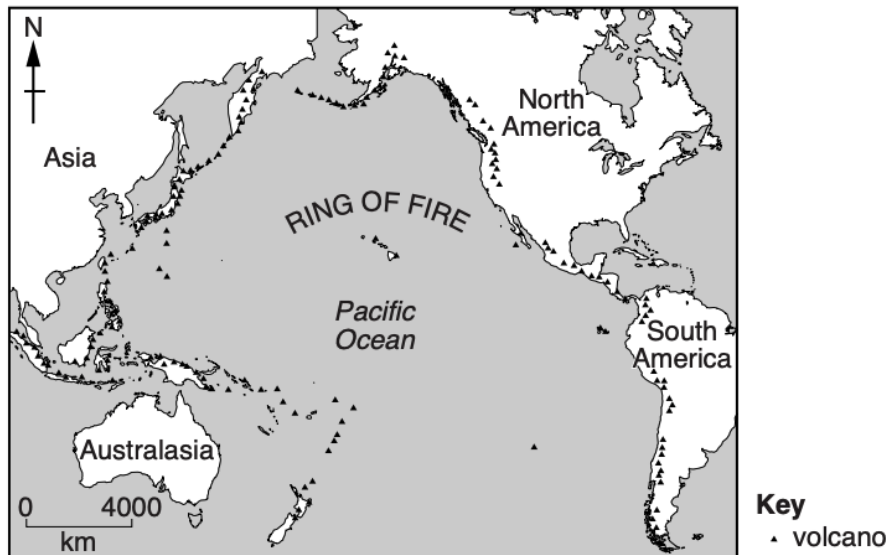
Why volcanoes erupt on destructive plate boundaries.

- Plates converge due to convection currents
- Subduction (one plate sinks under the other): Heavier/denser oceanic plate moves under lighter continental plate
- Heat/friction builds up
- Melting/destruction of plate material/crust; plate turns into magma/ magma created
- Buildup of magma / Buildup of pressure
- Magma is forced upwards through cracks/lines of weakness

Global distribution of volcanoes

- In circle/ ring
- Around Pacific Ocean; in the Pacific Ring of Fire
- Linear/ in lines/ in long, narrow belts

- Clustered
- On/near plate boundaries/where plates meet
- On destructive margins/where plates move toward each other; Pacific Ring of Fire
- On constructive margins/where plates move apart; Eg. mid Atlantic Ridge
- In isolated hotspots/few in the middle of plates; Eg. Hawaii



X: convection currents

Y: direction of plate movement

Opportunities provided by volcanoes

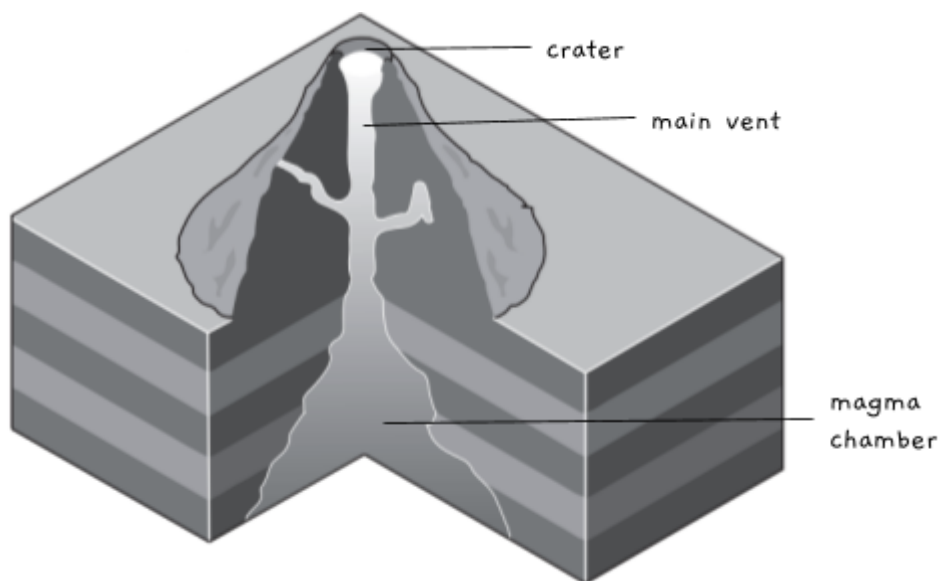
- Employment in the tourism industry; Eg. tourist guides, selling souvenirs, etc.
- Scenic beauty
- Hot springs
- Mining / quarrying; Eg. pumice, sulphur deposits, etc.

- Fertile soils/ High yield of crops/ good for farming
- Geothermal power/ Renewable energy supplies/ Hot water & Hot springs
- For science/research/to study volcanoes

Other reasons why people continue to live near volcanoes

- They have lived there all their lives / emotional ties / religious ties
- Friends and family live in the area
- Have jobs / education in the area
- Cannot afford to leave/ too expensive to move
- Population pressure / there isn't enough land to live on
- Confidence in prediction
- Willing to take the risk/ unaware of the risks
- Have faith in precautions
- They don't happen very often

Structure of a volcano



Magma chamber: reservoir of magma located deep inside the volcano.

Vent: the channel that allows magma within the volcano to reach the surface.

Crater: depression at top of volcano, following a volcanic eruption (may contain lake).

Features of a volcano (from an image)

- Top has been removed
- Crater
- Conical
- Steep sides
- Bare rock/ little vegetation/ ash covered

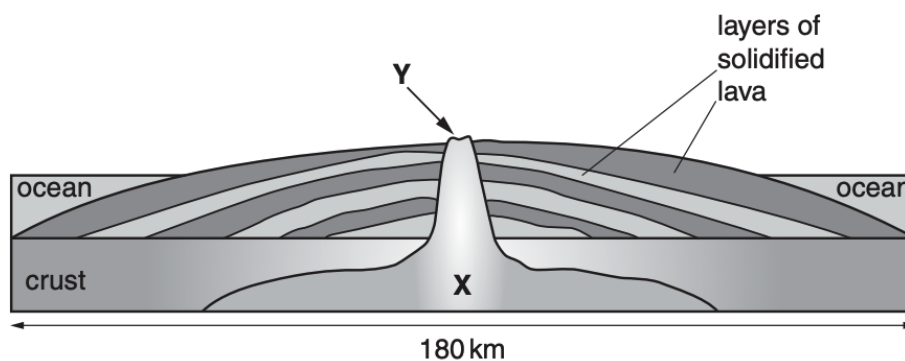
Describe a crater (from an image)

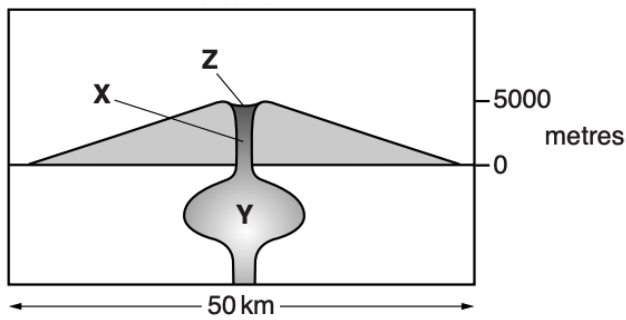
- Bare rock/ rocky
- Steep slopes
- Bowl shape
- Colour (eg. grey)
- Mud/water/hot spring
- Ash
- Yellow sulphur deposits
- Smoke/ gas

Types of volcanoes

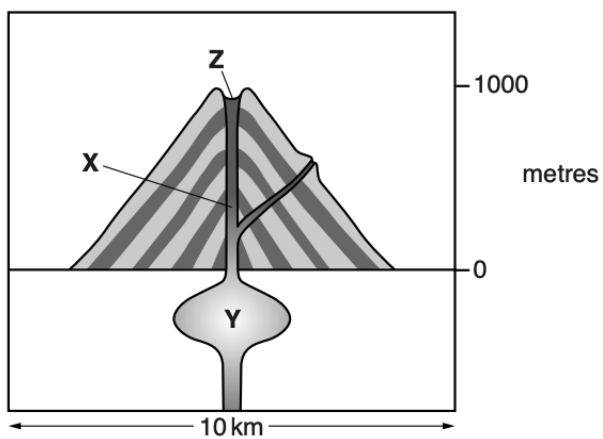
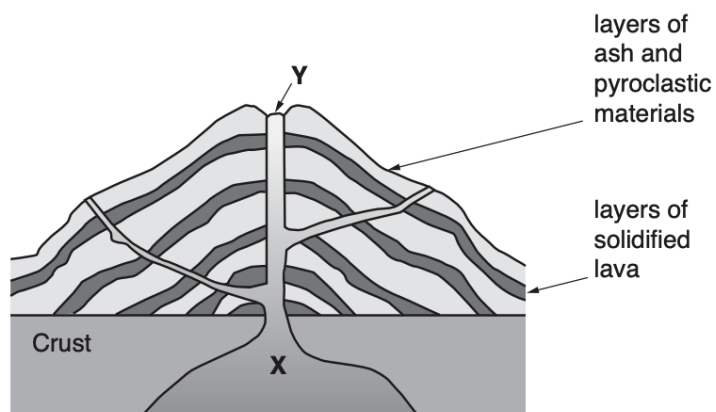
Shield volcano	Strato-volcano (composite)
Formed on constructive (divergent) plate boundaries and hotspots	Formed on convergent plate boundaries
Does not have alternate layers of ash and lava; just made of lava	Has alternate layers of ash and lava; more ash
Fluid/thin/runny/less viscous lava	Sticky/thick/more viscous lava
Low height to width ratio; lower	Greater height to width ratio; taller
Has a wider base	Has a narrower base
Has gentle slopes/ flatter	Has steeper slopes
Unlikely to have parasitic cones	Secondary/parasitic cones or side vents
Gentle/less explosive or violent eruptions	Destructive/explosive/violent eruptions
Frequent eruptions	Periodic eruptions

Shield volcano





Strato-volcano (composite volcano)



Signs of a volcanic eruption

- Release of gases (detected using chemical sensors)
- Increase in temperature (eg. of lakes & rivers)
- Earthquakes
- Animal behaviour
- Tiltmeter & seismic interferometry

Direct hazards caused by volcanoes

- **Lava**
- **Ash**: cause respiratory issues, disruption to visibility & travel large distance in wind.
- **Volcanic bombs**: large hot pieces of rock/boulders ejected at great heights.
- **Poisonous fumes (gases)**: sulphur dioxide (causes acid rain) & water vapour.
- **Mudflow/ Lahars**: consists of mud, water vapour & debris that travel several km.
- **Pyroclastic flow**: super hot flows of ash and pumice (volcanic rock) moving at high speeds, away from the vent.
- **Nuée ardente**: an incandescent (glowing) cloud of gas, ash, and lava fragments ejected from a volcano, typically as part of a pyroclastic flow.
- **Cinders**: small rocks and coarse volcanic materials.

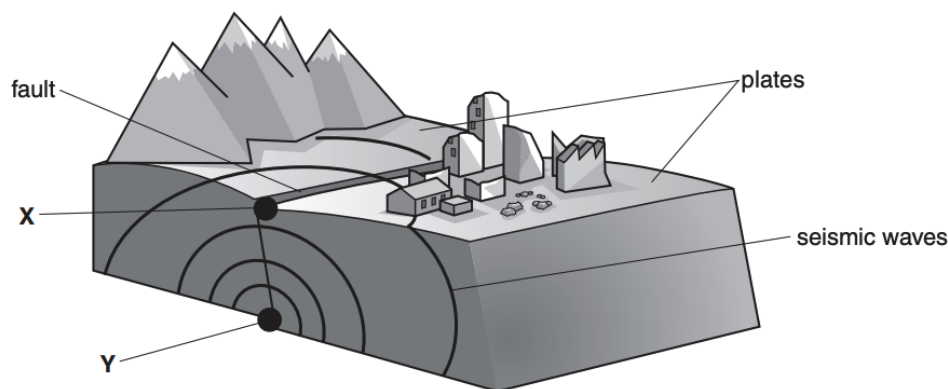
Earthquakes

Earthquake: Shaking of the ground caused by plate movement.

Focus: Point beneath earth's surface, below the epicentre, where the plates shift/the earthquake originates/rocks are fractured; NOTE: shallow focus is more deadly, as it is closer to the ground surface.

Epicentre: Point on the surface directly above the focus; where the earthquake occurs.

Seismic waves: A wave/vibration which travels within the earth/through the rocks.



X = epicentre

Y = focus

Causes of earthquakes

- They occur on/close to plate boundaries/lines of weakness/where plates meet
- They occur due to relative movement of these plates (Plates slide past each other/converge/diverge)
- Friction occurs/the plates stick to each other/plates lock into each other
- Pressure builds up/tension builds up
- Pressure/energy is released // jolting/plates jerk apart/sudden fracture
- Vibrations transmitted to surface/creates seismic waves/creates shock waves

Location of earthquakes

- Deep-focus earthquakes are associated with subduction zones; Convergent boundaries.
- Shallow-focus earthquakes are located along constructive & conservative boundaries.

Global distribution of earthquake-prone areas

- Clustered
- Linear/In lines
- On/near plate boundaries/where plates meet
- A few in middle of plates/hotspots
- Around Pacific Ring of Fire
- More in northern hemisphere/North of equator

Why global distribution of earthquakes is uneven

- The earth's crust is divided into a series of plates/there are plate boundaries
- Plate boundaries are lines of weakness/tectonic activity occurs at plate boundaries
- Plates move relative to each other
- Plates get stuck/friction
- Pressure build up
- Pressure release/plates jerk apart
- Vibrations cause seismic waves

Why people continue to live in earthquake prone areas

- They have lived there all their lives / emotional ties / religious ties
- Friends and family live in the area
- Have jobs / education in the area
- Cannot afford to leave/ too expensive to move
- Population pressure / there isn't enough land to live on
- Confidence in prediction
- Willing to take the risk/ unaware of the risks
- Have faith in precautions, eg. in earthquake resistant buildings
- They don't happen very often

Impacts of earthquakes & volcanoes

Why more people have been affected by natural hazards in recent years

- Rapid increase in population (especially in developing countries)
- Increased levels of urbanisation, so more shanty towns which are often located in hazardous locations
- Changing land use in rural areas- causing flash floods, soil erosion & landslides
- Increased number of people living in poverty- lack resources to cope with hazards

- Changes in natural environment, causing increasing frequency & intensity of storms, floods & droughts

Why earthquakes & volcanoes cause more damage in LEDCs than in MEDCs

- MEDCs invest more money in methods of protection & monitoring.
- MEDCs instigate evacuation procedures more effectively // LEDCs are not likely to have planned evacuation procedures/routes.
- MEDCs educate people to protect themselves from impacts, by having drills, etc. // LEDCs are not likely to have education about earthquakes & volcanic eruptions/drills.
- MEDCs provide better healthcare/hospitals/doctors/ambulances // LEDCs have poorer levels of medical care.
- MEDCs provide quicker/more efficient rescue services/helicopters // LEDCs have poorly prepared rescue teams/lack equipment/have to wait for international aid.
- MEDCs have better road networks // LEDCs have poor quality roads for rescue.
- MEDCs build stronger buildings, built using earthquake-proofing // LEDCs have poorer quality of buildings/infrastructure, not built using earthquake-proofing // building regulations not enforced in LEDCs
- LEDCs lack finance to rebuild/recover
- LEDCs are unable to cope with after effects – e.g. lack of food, water etc.

Impacts of Volcanic Eruptions On the economy

- Closure/damage to workplaces: businesses/factories/shops
- People become too ill to work
- Disruption to roads/railways, which prevents movement of raw materials/products
- Disruption of flights, so people are stranded
- Airlines lose money
- Reduced tourism
- Ash covers crops, reducing yields
- Cost of medical care/rescuing people
- Cost of rebuilding infrastructure/buildings

Why volcanic eruptions don't cause many deaths (although many people live nearby)

- Signs of eruption: swelling of volcano, radon gas increases, smoke comes from the volcano before it erupts
- Eruptions can be predicted/forecasted/people can be warned
- People have time to evacuate/ evacuation routes planned/ evacuation centres built
- People have education about what to do to stay safe/ drills
- Precautions: e.g. wear gas masks
- Lava moves slowly/ doesn't flow in all directions/ affects only a limited area
- Strategies: divert lava by digging channels, slow down lava by spraying water on it

- Eruptions are often ash clouds that mainly erupt high in the sky, so less likely to cause deaths at ground level
- Properties can be protected from ash

Impacts of Earthquakes

- Death from falling buildings/crushing
- Damage to/need to repair homes/buildings/people are homeless
- Damage to possessions/cars
- Damage to/need to repair school, hospital etc.
- Damage to/need to repair roads/railways/communications/bridges
- Businesses/factories/shops damaged
- Fires
- Loss of water/electricity/gas supply
- loss of production/less economic activity/loss of jobs;
- Diseases
- Could cause a tsunami which would cause flooding

Why earthquakes have high financial cost

- Destruction to buildings/settlements // need to rebuild homes
- Damage to possessions/cars/property
- Closure/damage to workplaces: businesses/factories/shops
- Loss of production from industry/people lose their jobs
- Disruption to /need to repair roads/railways/bridges
- Harbour/airport destroyed or damaged: cannot export or import goods
- Damage/loss of water/electricity/gas supplies
- Damage to schools/hospitals
- Cost of medical care
- Cost of providing emergency food/shelter/water
- Cost of clean-up operation (e.g. removing rubble)

Why earthquakes of same magnitude may have different impacts

- Variation in ability to monitor/study faultline movements
- Variation in depth of focus: shallow depth of focus is more destructive
- Variation in education/awareness about earthquakes/evacuation plans/first aid kits
- Variation in access to area/roads for rescue services
- Variation in quality of buildings: poorer quality in LEDCs
- Variation in emergency services: better emergency & healthcare services in MEDCs
- Variation in population density: more impact if population density is higher
- Time of day: if people are at work/school, there is less likely to be deaths
- Variation in availability of international aid

- Variation in access to food & water
- Impacts will depend on physical characteristics of location: impact will be worse if settlements are built on former lake beds/ sediment/ on a steep slope
- There may be more impacts if an earthquake causes a tsunami

Why distribution of areas where large number of deaths caused by earthquake is uneven

- Dependent on proximity to a plate boundary: less deaths away from plate boundaries
- Depends on type of movement taking place at the plate boundary: Whether boundary is destructive/conservative/constructive impacts numbers
- Differences in magnitude/intensity/Richter Scale measure
- Differences in depth of focus
- Aftershocks
- On land or at sea/whether they will cause tsunamis
- Monitoring/warning/evacuation planning/creating safe areas
- Earthquake planning/education about what to do in an earthquake/ evacuation routes
- Some areas are more densely populated
- Quality of rescue services/healthcare
- Some countries can invest in earthquake proofing for buildings

Methods to reduce impact of volcanic eruptions

- Monitoring the volcano // Prediction of eruption/warning system
- Create an exclusion zone around volcano/hazard zoning
- Restrict tourist access to volcano/ restrict flights
- Evacuation of people from area/evacuation routes/evacuation centres
- Spray water on lava to slow it down
- Dig diversion channels for lava/ build barriers or embankments to block path of lava
- Educate residents on actions to take if the volcano erupts/emergency drills
- Train emergency services/medical staff
- Wear masks to protect from ash
- Store emergency provisions/ food/water kits or storage/first aid kits/emergency bag
- International aid/ short term aid: blankets/food/water/tents
- Buildings that are volcano proof: Strengthen roofs/houses
- Avoid building strategic/public buildings (hospitals, power stations) on plate boundaries/fault lines

Methods to reduce impact of earthquakes

- Monitoring
- Evacuation of people from area/evacuation routes/evacuation centres
- Leave areas of empty land to use during an evacuation

- Educate people about what to do in an earthquake/emergency drills/National earthquake day
- Train emergency services/medical staff
- Store emergency provisions/ food/water kits or storage/first aid kits/emergency bag
- International aid/ short term aid: blankets/food/water/tents
- Buildings that are earthquake-proof
- Avoid building strategic/public buildings (hospitals, power stations) on plate boundaries/fault lines

Earthquake-proofing

- Do not build high rise buildings
- Build pyramid-shaped buildings
- Build deep/stronger/flexible foundations
- Reinforce: use concrete/bricks for walls & roofs, use metal beams (steel/aluminium), use diagonal bracing
- Use flexible building materials
- Use fire resistant materials
- Use shatterproof glass
- Use automatic window shutters
- Use automatic cutoff for gas pipes/ electricity cables
- Use dampers/shock absorbers in base of buildings
- Install computer controlled weights/ counter balances on roof