

The Earth's early atmosphere

4.9.1.2 · Chemistry of the atmosphere · revision notes

One theory of how the Earth's first atmosphere and the oceans formed, what the early atmosphere contained, and why scientists cannot be certain about it. Expect recall and 'describe' questions, and questions where you use data you are given to interpret evidence and evaluate theories.

Key facts

- Age of the Earth: about 4.6 billion years
- First billion years: intense volcanic activity released the gases
- Early atmosphere: mainly carbon dioxide, little or no oxygen (like Mars and Venus today)
- Also nitrogen (built up gradually), and maybe small proportions of methane and ammonia
- Oceans: water vapour from volcanoes condensed
- Carbon dioxide dissolved in the oceans → carbonates precipitated → sediments
- Evidence is limited because of the time scale of 4.6 billion years

Notes

How the early atmosphere formed (one theory)

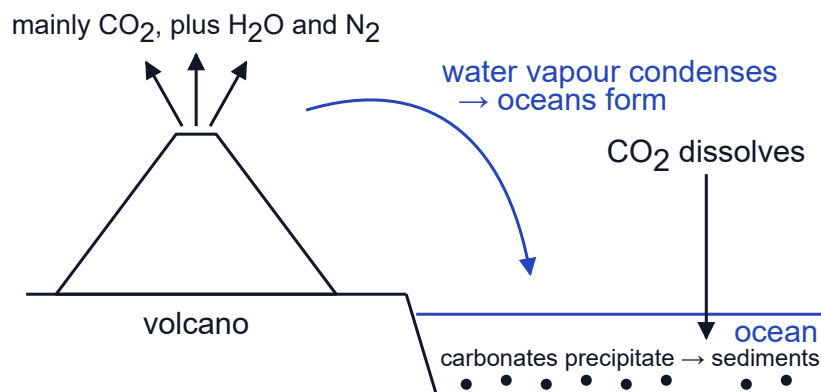
- The Earth is about **4.6 billion years** old.
- One theory suggests that during the **first billion years** of the Earth's existence there was **intense volcanic activity**. The volcanoes released the gases that formed the early atmosphere.
- Volcanoes also released **water vapour**, which **condensed** to form the **oceans**.
- You only need to know this one theory, but you may be given information about others and asked to compare them.

What the early atmosphere contained

- At the start of this period the atmosphere may have been like the atmospheres of **Mars and Venus** today: **mainly carbon dioxide**, with **little or no oxygen**.
- Volcanoes also produced **nitrogen**, which gradually built up in the atmosphere.
- There may also have been small proportions of **methane**, CH_4 , and **ammonia**, NH_3 .

The first fall in carbon dioxide

- When the oceans formed, carbon dioxide **dissolved** in the water.
- Carbonates** were then **precipitated** (formed as insoluble solids) and settled to produce **sediments**.



Volcanic gases formed the early atmosphere; the oceans then took up some carbon dioxide.

- This reduced the amount of carbon dioxide in the atmosphere.

Why scientists are not certain

- Theories about the early atmosphere have changed and developed over time as new evidence has been found.
- Evidence is **limited** because of the huge time scale of **4.6 billion years**: no one was there to measure the atmosphere, and very little rock from that time survives unchanged.
- Scientists rely on indirect evidence, such as the chemicals in very old rocks, the gases that volcanoes release today, and comparisons with other planets.

How to answer each type of question

Recall and describe: the early atmosphere and the oceans

1 to 3 marks

Grade 4

- Main gas: carbon dioxide. Where it came from: volcanoes.
- For the oceans, give the source (water vapour from volcanoes) and the process (it condensed).

Example. (a) Name the main gas in the Earth's early atmosphere.
(b) Describe how the oceans formed.

Model answer. (a) Carbon dioxide (1)
(b) Volcanoes released water vapour (1), which condensed to form the oceans (1)

Don't lose marks

- ✗ Saying the early atmosphere was mainly oxygen or nitrogen. It was mainly carbon dioxide with little or no oxygen.
- ✗ Saying the oceans formed from 'rain' without saying that water vapour from volcanoes condensed.

- ✗ Saying carbon dioxide 'turned into' the oceans. It dissolved in the oceans, and carbonates were precipitated as sediments.
- ✗ Giving vague reasons for uncertainty such as 'they don't know'. Say why: the time scale, no direct measurements, little evidence survives.
- ✗ Getting the order wrong: volcanoes and carbon dioxide came first, and oxygen appeared only much later, after algae evolved.

More tips

Memory tricks

- Story in one line: volcanoes → gases (mainly CO₂) → water vapour condenses → oceans → CO₂ dissolves → carbonate sediments.
- Early Earth's air was like Mars and Venus today: mostly CO₂, almost no O₂.
- Early gases: 'Cows Never Make Any Waves': Carbon dioxide (most), Nitrogen, Methane, Ammonia, Water vapour.
- Why uncertain? Think TIME: 4.6 billion years ago, no one there to measure, rocks since changed.

Exam technique

- When you are given data about Mars and Venus, or about volcanic gases, quote the numbers in your answer.
- 'Evaluate' means give evidence for and against, then a conclusion.
- Use the key words examiners look for: volcanic activity, condensed, dissolved, precipitated, sediments.
- Only one theory is on the specification, so answer using it unless the question gives you information about another.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3

Say where the early atmosphere came from

Intense volcanic activity during the Earth's first billion years released the gases that formed it.

Grade 4

Name the main gas in the early atmosphere

It was mainly carbon dioxide with little or no oxygen, like the atmospheres of Mars and Venus today.

Grade 4

Describe how the oceans formed

Water vapour released by volcanoes condensed to form the oceans.

Grade 5

Name other gases in the early atmosphere

Nitrogen from volcanoes gradually built up, and there may have been small proportions of methane and ammonia.

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