DP Biology – A1.1 (HL extension)

Where water came from

- Which features of water make life possible?
- What does living in water make easier and harder for organisms?

HL statements A1.1.7–8. Textbook pp. 11–13.
Image: the Earth from Apollo 17. NASA, public domain.



Objectives for each class

Class	Statements	By the end of the class, you can...
1	A1.1.7–8	Evaluate the asteroid hypothesis for the origin of Earth's water, explain why Earth kept it, and explain why the search for life beyond Earth starts with water

A wet planet that formed dry

A1.1.7



Earth from Apollo 17. NASA, public domain.

- The Earth formed about 4.5 billion years ago, too hot near the Sun for water vapour to condense
- Further from the Sun, water could freeze into ice on rocky bodies
- So most of Earth's water probably came from **outside the planet** (extraplanetary)
- Water has been present for most of Earth's history, giving life billions of years to evolve

Question

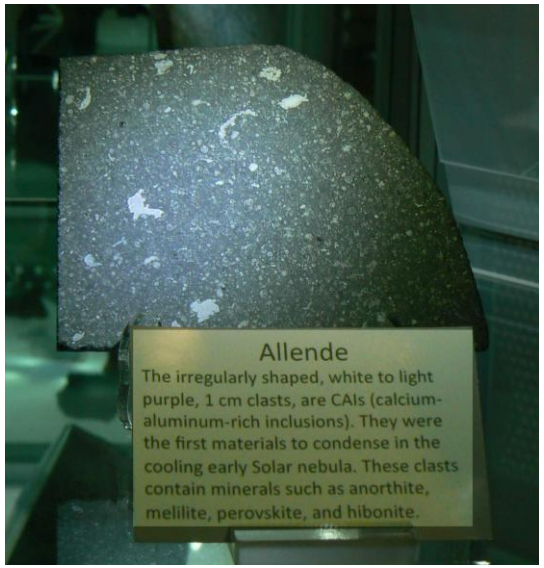
If the young Earth was too hot to hold water, how did it end up with oceans covering 70% of its surface?

The asteroid hypothesis

A1.1.7



The asteroid Vesta. NASA/JPL, public domain.



Allende, a carbonaceous chondrite. Milo44, CC BY-SA 3.0.

Evidence	Detail
Water in meteorites	Some carbonaceous chondrites are up to about a fifth water, held in minerals
Isotope ratio	The deuterium-to-hydrogen ratio in these meteorites matches seawater
Organic molecules	They also carry amino acids

Deuterium

Deuterium is hydrogen with one neutron. Water from different parts of the solar system has different proportions of deuterium. Comets have more deuterium than seawater, so they are thought to have supplied little of it; certain asteroids match closely. Other hypotheses exist (comets, water from inside the Earth), but the syllabus limits us to asteroids.

Why Earth kept its water

A1.1.7

Factor	Effect
Gravity	Earth is massive enough to hold water vapour and an atmosphere
Temperature	Cool enough for water vapour to condense into liquid oceans
Atmosphere	Keeps surface pressure high enough for liquid water to exist

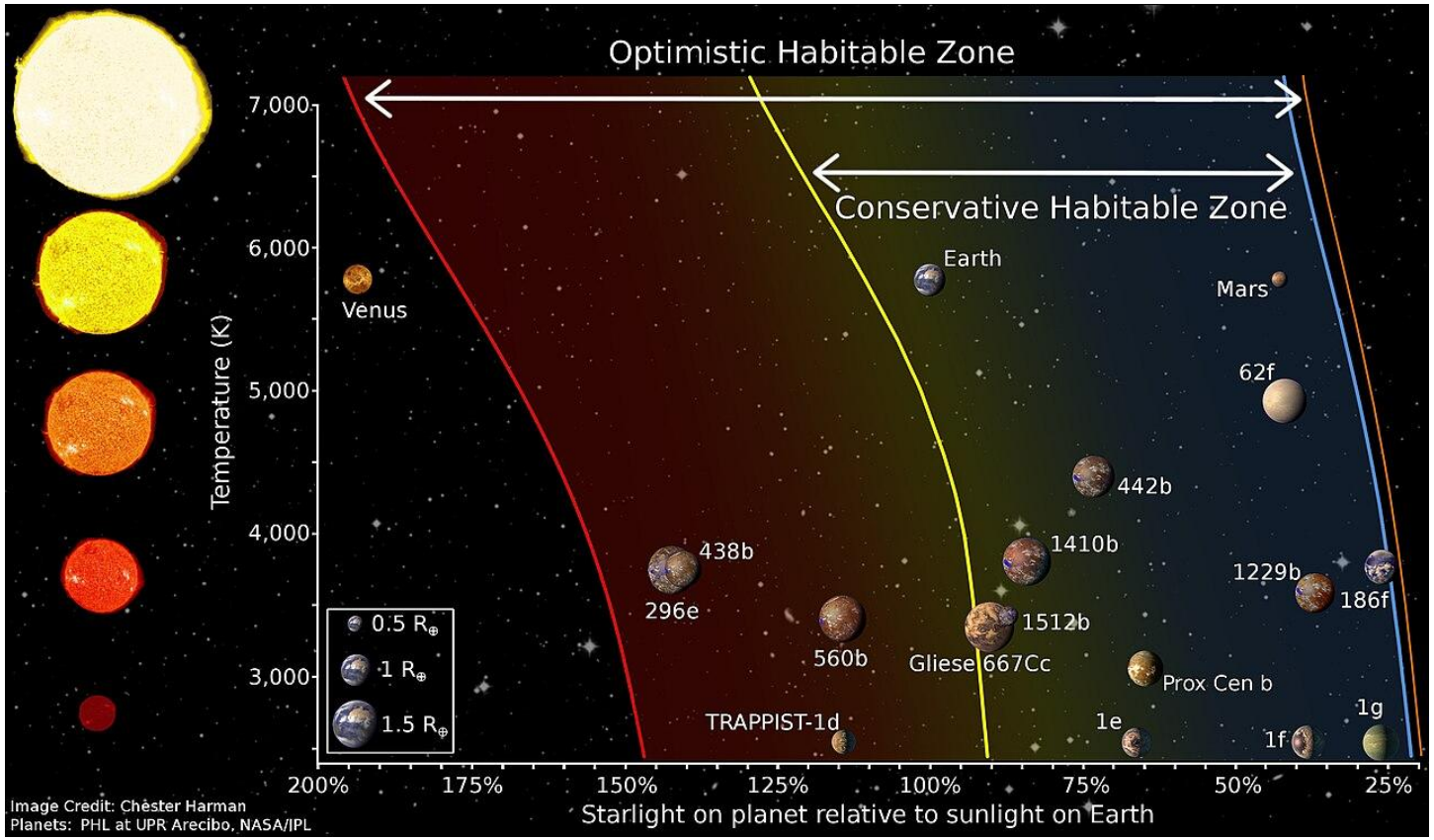


Mars. Public domain.

Compare

Mars once had liquid water. It is smaller, with weaker gravity, and lost most of its atmosphere, so its water is now frozen or underground. Venus is too hot for liquid water.

The Goldilocks zone



Habitable zones around stars of different temperatures. Chester Harman, CC BY-SA 4.0.

Not too hot, not too cold

The habitable (Goldilocks) zone is the range of distances from a star where a planet's surface could hold liquid water. Cooler stars have zones closer in; hotter stars have zones further out.

Life as we know it needs liquid water as a solvent, so searching for water narrows the search for life.

How astronomers look for water

A1.1.8

- **Transit spectroscopy**: as a planet passes in front of its star, starlight passes through its atmosphere
- Molecules such as water absorb particular wavelengths, leaving a signature in the spectrum
- Kepler-186f is an Earth-sized planet in its star's habitable zone
- Probes and rovers have found ice and signs of ancient rivers on Mars

Discuss

Why might a planet in the habitable zone still have no life? Think about size, atmosphere, magnetic field, and the time needed for life to arise.

Check that you can explain

1. Why the early Earth could not condense water
2. Evidence that asteroids delivered Earth's water
3. Why gravity and temperature let Earth keep it
4. What the Goldilocks zone is
5. How scientists detect water on distant planets
6. Why water is the first thing to look for when searching for life

Exit activity: 5 minutes

On your own and without notes. Hand this in as you leave.

1. Give one piece of evidence that asteroids brought water to Earth.
2. State two reasons Earth has kept its water.
3. Explain why the search for life beyond Earth focuses on water.

Image credits

The Earth seen from Apollo 17.jpg – NASA/Apollo 17 crew; taken by either Harrison Schmitt or Ron – Public domain

Vesta in natural color (cropped).jpg – NASA / JPL / MPS / DLR / IDA / Björn Jónsson – Public domain

Allende meteorite slice ASU.jpg – Milo44 – CC BY-SA 3.0

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Diagram of different habitable zone regions by Chester Harman.jpg – Chester Harman – CC BY-SA 4.0

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