# Earth’s Mantle and Evolution of Life



## Why in News

According to a study published in the journal ‘Nature Communications’, an evolution of the Mantle of the Earth could have not only controlled evolution of the atmosphere, but also evolution of life.

## Key Points

- **Role of Earth’s Mantle:**
  - According to the study, although there were amounts of oxygen before the **Great Oxidation Event (GOE)**, it could not concentrate in the atmosphere.
  - This was because of the reaction of oxygen with the large amount of gases ejected by Volcanoes. The oxygen produced by the early life-forms combined with things like hydrogen ( for example), and was removed from the atmosphere.
    - When volcanoes are active, they send large amounts of gases into the atmosphere. The nature of these gases depends on the nature of the materials in the Earth’s mantle.
  - As volcanic activity continued, it produced less material that would readily combine with oxygen. Earth’s mantle was becoming more and more oxidized.
  - With time, the oxygen produced by life-forms could accumulate in the atmosphere. This started the **Great Oxidation Event,** paving the way for complex life.

- **Great Oxidation Event:**
    - The atmosphere of the early Earth lacked oxygen. This began to change during what is known as the Great Oxidation Event (GOE).
    - It refers to a **series of chemical changes** that geologists and geochemists have observed in rocks that are between **2.5 and 2.3 billion years old.**
    - These changes were the result of **oxygen given off by ancient cyanobacteria (blue-green algae).** Communities of this bacteria lived in shallow seawater and were preserved in rocks as structures called **stromatolites.**
        Stromatolite means **'layered rock'.** It is a rocky structure created by the activity of colonies of single-celled bacteria, mostly cyanobacteria.
    - Oxygen first accumulated in Earth's atmosphere at this time and has been present ever since.
- **Boom of Cyanobacteria and Carbonates:**
    - Prior to the GOE, an increase in tectonic activity produced **new volcanoes** which pumped **big amounts of carbon dioxide** in the air which led to the warming of the climate, increased rainfall, and leading to more minerals washed into the ocean.
    - These phenomena led to the **boom of cyanobacteria and carbonates.** The increase in photosynthesis is attributed to the rise in the population of cyanobacteria and in turn, the carbon present in the atmosphere was buried underground.

**Earth's Mantle**

- The mantle is the mostly-solid bulk of Earth's interior. It lies between Earth's dense, super-heated core and its thin outer layer, the crust.
- It is about 2,900 kilometers thick and makes up 84% of Earth's total volume.
- The upper portion of the mantle is called the **asthenosphere.** The word astheno means weak. It is considered to be extending upto 400 km. It is the **main source of magma that finds its way to the surface during volcanic eruptions.**
- The **crust and the uppermost part of the mantle are called lithosphere.** Its thickness ranges from 10-200 km.
- The lower mantle extends beyond the asthenosphere. It is in solid state.

**Cyanobacteria**

- Cyanobacteria are aquatic and photosynthetic, that is, they live in the water, and can manufacture their own food. Because they are bacteria, they are quite small and usually unicellular, though they often grow in colonies large enough to see.
- They have the distinction of being the **oldest known fossils,** more than 3.5 billion years old.

- They are important providers of **nitrogen fertilizer** in the cultivation of rice and beans.
- The oxygen atmosphere that we depend on was generated by numerous cyanobacteria during the Archaean and Proterozoic Eras (4.6 billion to 541 million years ago).

## Way Forward

- The study indicates that one cannot exclude the mantle of the planet when considering the evolution of the surface and life of the planet.
- It not only affects understanding of earth and the emergence of complex life here, but also that of exoplanets, and their potential to support life.