

# Carbon circulation; Why the Earth has become a habitable planet and maintained over 4.0Ga?

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The total amount of limestone reserved in the crust corresponds to 100 atm of CO<sub>2</sub>. Besides limestone, there are various carbon reservoirs such as animals including microbes, plants, fungi, fossil fuels (petroleum, coal, natural gas), organic matter (kerogen) trapped in the sedimentary rocks through the earth history. The total amount of them corresponds to 300 atm of CO<sub>2</sub>. Therefore, many researchers think 300 atm of CO<sub>2</sub> had been given to the earth when it formed. However, it is pointed out that *p*CO<sub>2</sub> has to be less than 5 atm not to evolve into blazing planet like Venus. So, how can the earth be habitable planet with 300 atm CO<sub>2</sub>?

The key is the formation process of the Earth. ABEL model is newly proposed two step formation model of the earth, explaining the earth was born as a dry planet without ocean and atmosphere at 4.53Ga, and followed by secondary accretion of atmospheric and oceanic components between 4.37-4.20Ga. Gradual accretion of water components finally formed primitive ocean to initiate plate tectonics. As a result, carbon which is fixed to the crust as carbonate minerals was carried into deep mantle through plate subduction. Due to this process, *p*CO<sub>2</sub> did not accumulate over 5 atm in atmosphere, and the earth did not evolve like Venus.

Transported carbon into deep mantle return to the surface environment through volcanism as the form of volcanic gas. However, such returned gas is recycled to form organic matters through photosynthesis by autotrophic organisms. Due to the process to bury organic matters as sediments, carbon does not accumulate in atmosphere to play as greenhouse gas. Such a process has continued since Hadean and it did not stop until now. That is why the earth could be a habitable planet. Living organisms spend carbon constantly and fix it in the sediment, which enable earth to be habitable.

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