Chemical composition of early terrestrial atmosphere: late-stage accretion generates a reduced atmosphere

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We estimated the chemical composition of the early terrestrial atmosphere about 4 billion years ago, when the accretion of planetesimals are almost completed. The surface environment of the Earth about 4 billion years ago is one of the most important problems in considering the origin of life. In particular, the redox state of the early terrestrial atmosphere is closely related to the prebiotic synthesis of biologically important organic compounds. However, the composition of the atmosphere around that time is uncertain owing to the scarcity of the geologic record. Here we evaluated the chemical composition of the atmosphere generated by the accretion of CI chondrite, which is probably similar to an oxidized material supposed to be accreted at a late-stage of Earth formation. Our calculation demonstrates that the early terrestrial atmosphere would contain a significant amount of reduced species, such as H2, CO, and CH4. Although CI chondrite is thought to be one of the most oxidized material among all the primitive materials in the solar system, it contains a significant fraction of reduced components. Since the accretion of CI chondrite generates a reduced atmosphere, we conclude that the early atmospheres of Earth is likely a reduced one.