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Noble gas analyses of the ancient atmosphere trapped in amber and the comparison with a numerical simulation

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Noble gases are chemically inert and hold past information without the process regarding the chemical reactions. Their abundances and isotope ratios are sensitive to the external influences because noble gases are very volatile and rare. Noble gas could be a good tracer to examine the formation process of the Earth.
Noble gas isotopic ratios inside the mantle are studied by many researches, but those of the ancient atmosphere are not well known. As the historical fluctuation of the 3He/4He ratio in air is expected to be larger than that of the mantle, we believe that we can detect the time variation in more detail. This study tries to measure helium isotope ratio of the ancient atmosphere.
We need to measure the gas in the bubble contained in some material/mineral that was formed in the ancient atmosphere. As SiO2 minerals are known to be permeable for He, we suppose that they do not hold ancient air. Ambers and a copal (two million, 24~38 million, 40 million years ago) are used in this study as samples that hold ancient air. We obtained the gas out from bubbles by crushing about 10 g samples with large crusher, and measured helium isotopic ratios with the noble gas mass spectrometer VG5400 installed in Osaka University.
The 3He/4He ratios in bubbles were 2.8~16 times higher than that of present air. As 3He is not formed on the Earth but 4He is produced by the radioactive decay from U and Th, the 3H/4He ratio becomes smaller than that of the original value when gas was trapped in the bubble. Therefore, obtained results are thought to be lower limit values when the gases were trapped in bubbles. Our result indicates that the 3He/4He ratios of the past terrestrial air were significantly higher than that of the present atmosphere.
These results are thought to be very important constraints when we study the evolution of the terrestrial atmosphere. We carried out the computer simulation how the isotopic ratio of helium in air has changed since the formation of the Earth with degassing from the Earth, escaping to space, and 4He accession by radioactive decay. We compared the result of computer simulation with our obtained helium isotopic results from amber.