Global emissions of carbon ions from the total lunar surface

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It had been believed that carbon and other volatile elements are depleted in the Moon for the decades, because of early analyses of the Apollo samples. The notion of a volatile-depleted Moon is one of the greatest premises behind the hypothesis that a giant impact occurred between the nascent Earth and a Mars-sized body, which generated high-temperature events. Recently, advanced analyses have determined volatile elements, such as water and carbon, in volcanic lunar glasses. Analyses of meteorites and returned samples are the most precise methods currently available for determining the chemical composition of the parent bodies and investigating their geologic origins and histories, even though it is acknowledged that a small number of samples are potentially biased. The existence of indigenous water in lunar materials has been supported not only by analyses of Apollo samples but also by conducting wide-area observations using neutron spectrometers and neutral mass spectrometers on lunar orbiters. In the case of carbon, however, no such observations have been conducted around the Moon to date because both the neutron interactive properties and brightness in the ultraviolet range are insufficient for spaceborne instruments.
Here, we present observations by the lunar orbiter KAGUYA of carbon ions emitted from the Moon. These emissions were distributed over almost the total lunar surface, but amounts differed with respect to lunar geographical areas. The estimated emission fluxes to space were ~5.0×10^{4} cm^{-2} s^{-1}, which is greater than possible ongoing supplies from the solar wind and micrometeoroids. Our estimates demonstrate that indigenous carbon exists over the entire Moon, supporting the hypothesis of a carbon-containing Moon, where the carbon was embedded at its formation and/or was transported billions of years ago.

Keywords: Moon, Volatile elements, KAGUYA, Mass analyses, Carbon

