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Does E-chondrite relate to the chemical state of the Earth?

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The chemical state of the Earth has been estimated based on chemical and isotope analyses of terrestrial materials which compose the crust and the mantle, taking the physical and geological information on physical properties account. However, to understand the chemical state of the early Earth and the whole Earth fromthe view of material science, itis required to use materilas which could represent them even as approximated ones. As geochemical approaches to pursue this purpose, CI-chondrite has been generally used, because it maintains most abundant volatile elements among meteorite groups and show similar chemical compositions of the Sun which have been estimated by spectroscopy.

However,it does not always guarantee that CI-chondrite directly represents the chemical state of the Earth when it was formed. Hence, some different models have been proposed so far based on the other meteorite groups. Here, noting the importance of similarities with the Earth in oxygen isotopes, the significance of E-chondrite group is reexamined to estimate the chemical state of early and deep Earth.

Three oxygen isotopes of terrestrial and exterrestrial materilas have been extensively studied since 1970's, initiated by R.N.Clayton's group and followed by some other groups. Trough such studies, it has been revealed that in the (Delta)17O/16O-(Delta)18O/16O diagram data of terrestrial materials lie on an isotope mass fractionation line (TFL)and the other exterrestrial materials are mostly off the line and each group forms a different isotope mass fractionation line. Among exterrestrial materials, only lunar samples and E-chondrite group lie on the TFL. Even Martian meteorites do not lie on the TFL. Such results indicate that the Moon and E-chondrite group might have been possibly formed in the similar chemical state to that of the Earth. This is compatible with the observation that stable isotopes such as C and N of the Earth are more similar to those of E-chondrite rather than C-chondrite groups.

In the (Fe+FeS)/Si-FeO/Si diagram, it has been clearly demonstrated that E-chondrites represent quite reduced conditions, while C-condrites show much oxidized conditions. In the same diagram, mantle xenoliths are plotted in a rather reduced region. It has been suggested thatthe surface condition of the early Earth might have been in a relatively reduced condition. The Redox state of E-chondrites and the Moon might reflect it.

Furthermore, the estimated chemical state of the lower mantle would highly depend on the model of the reference material. If we assume C-chondrite as a starting materila to form the the Earth, the Redox state of the lower mantle would be estimated to be less reduced condition. However, if E-chondrite is assumed to have been related to the early Earth, the inferred state of the lower mantle would be in a rather reduced state. It might be compatible with the observation that kimberlite magma, which might have been originated in the lower mantle, show a rather reduced condition which is different from those of the other volcanic rocks.

It should be noted, however, that the chemical composition of the E-chondrite does not always represent that of the whole Earth, just as in the same manner that the Moon does not have the same composition of the Earth.

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