^{244}Pu FISSIOGENIC Xe IN MANTLE. Ozima, M. S. Azuma, S. Zashu and H. Hiyagon, Geophysical Institute, University of Tokyo, Tokyo 113, JAPAN

Mantle-derived materials such as MORBs and mantle xenoliths often show excesses in ^{129}Xe and in $^{131-136}Xe$ relative to the atmospheric Xe. The excess in ^{129}Xe has been reasonably attributed to extinct nuclide ^{129}I. Although the excess in $^{131-136}Xe$ must be due either to ^{238}U spontaneous fission or to ^{244}Pu spontaneous fission, it has not been possible to resolve their origin because of experimental difficulties. While cosmic elemental abundance ($^{244}Pu/^{238}U = 0.006$, $4.6Ga$ ago[1]), if applied to the Earth, favours ^{244}Pu, U-content in the mantle appears to be enough to account for the fissiogenic $^{131-136}Xe$ in mantle-derived materials[2]. The problem of whether the excess in $^{131-136}Xe$ is due to ^{238}U-fission or to ^{244}Pu-fission is still open to future investigation. Since the problem bears far-reaching implications for the evolution of the Earth especially the atmospheric degassing chronology, we reexamined the problem in the light of all the published Xe isotopic data on MORBs and diamonds, and of our newly obtained data on diamonds. We conclude that the excess $^{131-136}Xe$ in MORBs and diamonds, and therefore in the mantle is most reasonably attributed to ^{244}Pu-fission for the following reasons.

(i) Both MORBs and diamonds lie on the same correlation line in a $^{136}Xe/^{130}Xe-^{129}Xe/^{130}Xe$ plot (Fig.1). Such a linear correlation was first reported for MORBs by Staudacher and Allègre[3]. Allègre et al.[4] interpreted the linear trend as a mixing line between air type Xe and mantle Xe which has excess ^{129}Xe and $^{131-136}Xe$. They suggested that the excess ^{129}Xe is due to the decay of ^{129}I and that in $^{131-136}Xe$ to ^{238}U-fission. A striking feature in Fig.1 is that both the modern MORBs and the ancient diamonds lie on the same mixing line, indicating the same mantle Xe for the both samples. Although the exact age of the diamonds are not known, they are much older than the MORBs, some of them being early Precambrian. Since ^{238}U-fissiogenic Xe has been still evolving ($T_{1/2} = 4.41Ga$), it is difficult to see why samples formed at entirely different ages should lie on the same mixing line, or why mantle Xe has remained unevolved for more than 1 Ga, if the excess $^{131-136}Xe$ were due to ^{238}U-fission. However, if the excess ^{129}Xe and $^{131-136}Xe$ were derived from $^{129}I(T_{1/2} = 17Ma)$ and $^{244}Pu(T_{1/2} = 82Ma)$, Xe isotopic ratio would have practically ceased to evolve soon after the formation of the Earth ($\leq 100Ma$) to give rise to the same mantle Xe thereafter, or the same mixing line for both modern MORBs and ancient diamonds.

(ii) No correlation was observed between the excess ^{136}Xe and ^{238}U-derived ^{4}He.

(iii) Xe isotopic compositions obtained on two diamonds which have the best experimental quality lie closer to a mixing line between the atmospheric Xe and ^{244}Pu-fissiogenic Xe than to a mixing line between the atmospheric Xe and ^{238}U-fissiogenic Xe in a $^{136}Xe/^{132}Xe - ^{134}Xe/^{132}Xe$ correlation plot.

References. [1] Hudson, G. B. et al. (1988) Proc. 19th Lunar Planet. Sci. Conf., 546-555. [2] Fisher, D. (1985) J. G. R., 90, 1801-1807. [3] Staudacher, Th. and C. J. Allègre (1982) Earth Planet. Sci. Lett., 60, 389-406. [4] Allègre, C. J. et al. (1986/7) Earth Planet. Sci. Lett., 81, 127-150.

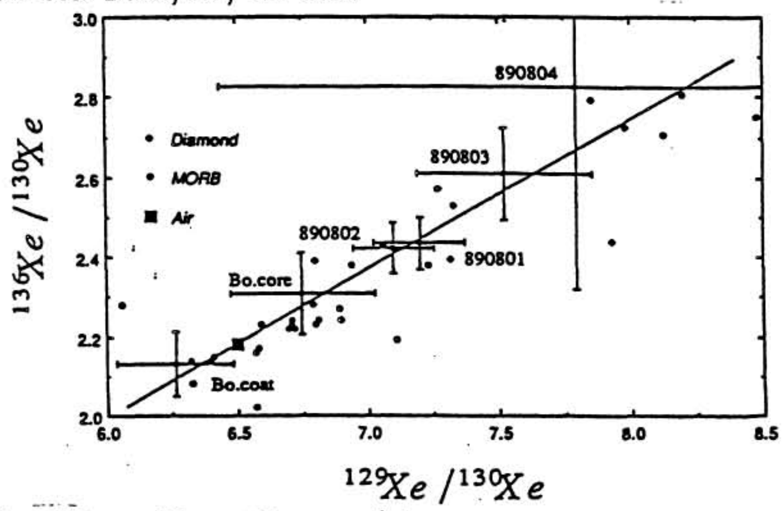

Figure 1. $^{136}Xe/^{130}Xe - ^{129}Xe/^{130}Xe$ three isotope plot. Note that diamond data lie on the correlation line defined for MORB by Staudacher(1987). Error bars are 1 σ and shown only for newly obtained data (this work). MORB(•): Staudacher and Allegre,1982, Ozima and Zashu,1983, Staudacher et Allegre, 1986, Allegre et al.,1986/7, Marty,1989. Diamond(◇) : Ozima and Zashu,1988, Ozima et al.(this work).