Distribution of the correction factors of interferences during the irradiation of ^{40}Ar-^{39}Ar dating samples in HFETR

LI Junjie*, LIU Hanbin, ZHANG Jia, JIN Guishan,

ZHANG Jianfeng, HAN Juan, SHI Xiao

Beijing Research Institute of Uranium Geology, No.10, Anwaixiaoguan East, Chaoyang District, Beijing, China (*Correspondence: lijunjie@briug.cn)

Samples irradiated by fast neutrons in the reactor is the basis of the ^{40}Ar-^{39}Ar dating. The energy distribution of neutrons covers a wide range, which is from 1ev to 17Mev.Such wide range makes several interferential nuclear reactions occur except the target nuclear reaction $^{39}K(n, p)^{39}Ar$. For most terrestrial samples, the main interferential nuclear reactions are $^{40}K(n, p)\ ^{40}Ar$、$^{40}Ca(n, n\alpha)\ ^{36}Ar$ and $^{42}Ca(n, \alpha)\ ^{39}Ar$,which require $(^{40}Ar/^{39}Ar)_K$、$(^{36}Ar/^{37}Ar)_{Ca}$ and $(^{39}Ar/^{37}Ar)_{Ca}$ correction factors to be precise measured respectively through the irradiation of K_2SO_4 and CaF_2.

It is reported that the correction factors $^{40}K\ (n, p)\ ^{40}Ar$ during irradiation process is variable while the correction factors $^{40}Ca(n, n\alpha)\ ^{36}Ar$ and $^{42}Ca(n, \alpha)\ ^{39}Ar$ are both relatively uniform. Through the irradiation of CaF_2 and K_2SO_4 in the outer channel of HFETR, the difference of the correction factor $(^{40}Ar/^{39}Ar)_K$ also exists along the axial direction of the channel, and the effect of the Cd shielding for this interference is strikingly different, which indicates the neutron energy distribution is the main reason for the different $(^{40}Ar/^{39}Ar)_K$ factors. There is little difference between the correction factor $(^{36}Ar/^{37}Ar)_{Ca}$ at different position, maybe the relative high energy barrier of reaction $^{40}Ca(n, n\alpha)\ ^{36}Ar$ (up to 7Mev) could account for this phenomenon .The proportion of the neutron flux with energy higher than 7Mev is very small in the channel, which means the effect of the difference of the neutron energy distribution on the incidence of the nuclear reaction $^{40}Ca(n, n\alpha)\ ^{36}Ar$ is not obvious. However, the correction factor $(^{39}Ar/^{37}Ar)_{Ca}$ is different along the axial direction of the channel, this phenomenon is different from the former research results. The correction factor $(^{39}Ar/^{37}Ar)_{Ca}$ at the bottom of the irradiation quartz tube is 30% higher than that at the top of the tube. Therefore, the correction factor $(^{39}Ar/^{37}Ar)_{Ca}$ should be carefully measured at different position of the channel, which is especially important for poor potassium samples and extremely old age samples.

[1] Brereton (1970), EPSL 8(6),427-433. [2] Turner (1971), EPSL 10(2),227-234.