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Evidence of fast neutron operating in Oklo

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The fission processes for thermal neutron induced 235U and 239Pu fission and for fast neutron induced 238U fission produce fragments with a wide range of mass (72<A<162; A=mass number), and neutrons. As the results of fission events, many elements in the Oklo reactor zones (hereafter, RZs) and the related samples show the variations in the isotopic compositions caused by a combination of reactions of nuclear fission, neutron capture and radioactive decay. Isotopic measurements by mass spectrometry provide useful information of geochemical behavior of fissiogenic radioisotopes and nuclear characteristics of the reactors. Since the discovery of the first RZ in 1972, many isotopic studies have been performed to understand the mechanism of the operation as fission reactors and to trace the migration behaviors of fissiogenic isotopes produced in the Oklo RZs [1-2]. In this talk, I will show some typical examples of the isotopic data, and explain the interpretation how and why the fission reactions occurred in the Oklo RZs. In particular, one of the Oklo RZs, RZ 13, is several specific features in the view point of nucleonic characteristics. As representative parameters to characterize the operating conditions of RZs, neutron fluence as the time integration of a neutron flux generated in RZ, duration of RZ operation, restitution factor of 235U from decay of 239Pu produced by neutron capture of 238U, and the proportion of fission events due to 235U, 238U and 239Pu, are listed in Table 1.
By comparison of the data between RZ13 and other RZs, fission contribution of 238U for RZ13 is found to be significantly higher than those of other RZs. Considering that 238U reacts with fast neutron rather than thermal neutron, RZ13 might have located at less moisture area, and had reacted with fast neutrons. Furthermore, the lower restitution factor of RZ13 may also support the fast neutron operating in RZ13 because of the preference of fission reactions of 238U instead of neutron capture reaction caused by the generation of fast neutrons.

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