Geochemistry of sediments in the Neogene Mizunami group around Tono uranium ore deposit, central Japan

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The Tono sandstone-type uranium deposit is located at Toki City, about 30 km northeast from Nagoya, central Japan. Although a great deal of effort has been made on the genesis, the processes and mechanism of the ore formation has not been clarified certain yet. As a course of our understanding of the genesis of the Tono uranium deposit, chemical analysis using a X-ray fluorescence analyzer was carried out for bulk sediments in the Neogene Mizunami group, especially in the Toki lignite-bearing formation in which the Tono uranium deposit is embedded. Here we report the analytical results, with discussion on the origin and enrichment processes of uranium and associated elements in the sediments.

Geology of the Tono area is composed of the Toki granite of Cretaceous to Palaeogene in age, the overlying Mizunami, and Seto Groups of Neogene. The Mizunami Group of Miocene is stratigraphically subdivided into three formations, i.e., Toki lignite-bearing, Akeyo and Oidawara Formations, in ascending order. The Toki lignite-bearing Formation consists mainly of granitic conglomerate, sandstone and tuff, and includes lignite. The constituents are clay minerals, feldspars, quartz, and zeolites, with subordinate amounts of calcite, pyrite, and gypsum. The Tono Uranium deposit is concordantly embedded in the lowermost Toki lignite-bearing Formation just above the granite basement. The ores are lenticular in form. It should be noted that high magnetic susceptibility was recognized in the borehole samples from the lower part of the Toki lignite-bearing Formation.

The sediments of the Mizunami Group are enriched in Al2O3, TiO2, t-Fe2O3, MgO and CaO, and depleted in SiO2 and K2O, as compared with the Toki granite. Samples from the Toki coal-bearing formation have a series of the chemical composition, whose end members are assumed to be granite and clays, lying in the range of SiO2=55-80 %, TiO2=0-4 %, Al2O3=10-15 %, t-Fe2O3=5-10 %,MgO=0-5 %, and CaO=0-7 %. Zr is enriched in Al2O3-poor uraniferous samples (U is higher than 15 ppm). V and Cu are enriched in Al2O3-rich uraniferous samples and barren samples (U is below 15 ppm) in the vicinity of the mineralized portions.

In order to know the origin of elements in sediments of the Mizunami Group, the relationship between each element and Al2O3 is examined, as is often used in geochemical systematics. As a result, these sediments can chemically well be explained to be essentially composed of the following four components, i.e., granitic, clayey, placer and hydrogenous components.

In the Al2O3-SiO2, -MgO and -K2O diagrams, the data of the Toki lignite-bearing formation show a trend indicating of the mixing of granitic and clayey components. In the Al2O3-Zr and -Th diagrams, addition of the placer component to these components is noteworthy especially in the samples of which the magnetic susceptibility values are high. The compositions of the placer component are not homogeneous probably due to the difference of those in the source area. In the Al2O3-U,-V and -Cu diagrams, the addition of the hydrogenous component to the above three components is conspicuous mainly in the samples taken in the vicinity of the uranium mineralizing area. The enrichment of the V and Cu is probably due to the reduction in association with the uranium mineralization.

Previous studies indicate that the Toki lignite-bearing formation is composed of a sequence of sediments of granitic conglomerate and clay-rich sandstone, filling in channels on granitic basement. Our results show that granitic conglomerates contain layers of the heavy minerals, and clay-rich sandstones have enrichment of uranium. Uranium and vanadium might have been deposited by the reduction in association with decomposition of organic matter in clay-rich sandstones. It seems that the layers of heavy minerals in granitic conglomerates are possible origin of uranium in the Tono uranium deposit, although the granite of the basement is also a possible.