Formation process of micro-metallic aggregates in the Oklo natural reactor

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The Oklo uranium deposit, Gabon, known as natural fission reactors is an unique natural analgoue, because large-scale fission reactions occurred 1.97 Ga ago [1]. This site provides us practical information on long-term behaviors of actinides and fission products in the natural environment. It is reported that fissiogenic Mo, Tc, Ru, and Pd tend to form fine metallic particles in spent nuclear fuels [2]. Interestingly, numerous micro-metallic aggregates, consisting of Ru, Rh, Te, Pb, U, As and S, have been also found in the Oklo reactor zones (RZs) 10 and 13 [3]. In this study, isotopic analyses of the metallic aggregates newly found in RZ 13 were performed by a sensitive high resolution ion micro-probe (SHRIMP) to understand their formation process.

Besides Ru, Rh, Pd, Te, Pb, U, As, S, Bi and Sb as major elements from EPMA analysis, the SHRIMP analysis indicated that the aggregates also contain Zr and Mo as minor elements which cannot be detected from EPMA observation. Successively, *in situ* isotopic analyses of Zr, Mo, Ru, Pb and U in the aggregates were performed.

The Zr and Mo isotopic ratios can be simply explained by mixing of reactor (fissiogenic) and non-reactor (non-fissiogenic) components. On the other hand, large variation of $^{99}Ru/^{101}Ru$ ratios (0.3235-1.725) cannot be explained only by two-component mixing, suggesting the occurrence of chemical fractionation between Tc and Ru during the reactor criticality. The $^{235}U/^{238}U$ ratios also show a large variation from 0.00478 to 0.01466. ^{235}U-depletion (<0.00725) have been commonly obeserved in RZs because of consumption by fission, while ^{235}U-enrichment (>0.00725) have been rarely shown. The ^{235}U-enrichment is interpreted as additional incorporation of ^{235}U decayed from ^{239}Pu produced by neutron-captured ^{238}U, indicating the occurrence of chemical fractionation between U and Pu and their heterogeneous redistribution in RZ 13 during the reactor criticality. The data from the Pb isotopic composition and chemical compositions suggest that fissiogenic Zr, Mo, Ru, Tc, Rh, Pd, and Te were incorporated into PbS which originally existed in the RZ uraninite, and formed metallic aggregates as a core of PbS.

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Analysis of aerosol-cloud interaction and its relationship to atmospheric stability in Northeast Asia

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Although the various studies on the aerosol indirect effect have been carried out all over the world[1][2], relatively few focuses have been put on the Northeast Asian region, which has suffered from a lot of anthropogenic air pollution and various kinds of aerosol compositions. Therefore, this study is to first understand the current state of aerosol and cloud optical properties derived from ground and satellite-based remote sensings available since 2001 to 2008 mainly in Northeast Asia, and further its association with the atmospheric environment (e.g. stability).

There seem to be no annual increasing/decreasing trends of monthly-average aerosol optical depth (AOD) from MODIS in the downstream region of China, which is also confirmed by the aerosol robotic network (AERONET). In general, 8-year average AOD showed the strong horizontal gradient from China to Korea, without relevant systematic association with the effective radius and optical depth of the liquid-phase cloud, which might be attributable to the masking synoptic meteorological variations and probably the coarse horizontal grid (1°×1°). Specific comparisons of monthly-average AOD and the effective radius demonstrated the significant negative correlation only in summer and especially over the Yellow Sea, where the relative variability of cloud (cloud optical depth) appears to be suppressed largely by the static stability determined by NCEP reanalysis data and furthermore aerosol loadings tend to be significantly variable relative to other regions and other seasons. This implies the possible facilitation of aerosol-cloud interactions in the specific region and period with the favorable atmospheric environement [3] such as the relatively low variability in cloud macroscopic property mostly controlled by atmospheric stability in the long-term climatologic perspective, even admitting the coarse spatial resolution and long-term temporal average data.

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