Role of sulfate reduction in organic matter degradation and molybdenum accumulation: Theoretical framework and application to Cenomanian-Turonian organic matter burial event

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A new methodology for assessment of the controls on organic matter (OM) burial in ancient strata uses authigenic molybdenum accumulation as a geochemical tracer to assess rates of OM remineralization under anaerobic conditions. Sensitivity experiments with a geochemical box model for OM degradation highlight the dependence of authigenic molybdenum accumulation on OM production and export, bulk sedimentation rate, OM dilution, and the location of the upper interface of the sulfate reduction zone (SRZ). Box model results are integrated with geochemical burial fluxes (based on an orbital time scale), and new primary production estimates, to evaluate controls on OM burial and molybdenum accumulation during and following Oceanic Anoxic Event II (OAE II) in the Cretaceous Western Interior Sea. The study shows that: (1) OM accumulation in the study interval is controlled by OM export rate to the SRZ, (2) location of the SRZ upper boundary is the first-order control on OM export into the sulfate reduction zone, and (3) changes in SRZ location and molybdenum accumulation rates are attributable to the balance between hydrogen sulfide production via sulfate reduction, and hydrogen sulfide depletion through reactive iron delivery and pyrite formation. These results suggest that the strong correlation between source rock development and intervals of transgression in the geologic record is a biogeochemical consequence of decrease in siliclastic flux: (1) concentration of labile OM drives higher rates of sulfide production, and (2) reduction of the reactive iron flux permits sulfide levels to escalate, thus enhancing the preservational state. As the burial flux data from the study interval demonstrate, the increased rate of export of labile OM into a shallower SRZ results in elevated organic carbon accumulation rates, even under lower rates of primary production.

Environmental studies of geochemical behaviors of artificially produced uranium isotopes

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In natural environment, ^{234}U is present approximately in radioactive equilibrium with ^{238}U. Anthropogenic uranium contains ultra-trace quantity of ^{236}U produced by capture of ^{235}U in nuclear artifact processes. Therefore, ^{236}U can be used as a finger print for the presence of uranium in the environment that originates from a nuclear reactor.

Method

Uranium was chemically separated from the soils affected due to Chernobyl nuclear power plant accident, JCO criticality accident and Hiroshima atom bomb and its isotopic composition was measured using a VG (Micromass) thermal ionization mass spectrometer equipped with a WARP energy filter.

Results and Discussion

Some of our results are shown in table below. We have recognized two effects in case of JCO samples. One of them is mixing of "slightly ^{234}U-depleted in soil" and the enriched solution. In a clay sample, ^{234}U is depleted to some extent due to loss by recoil effect.

Sample Name	$^{234}U/^{238}U$	$^{235}U/^{238}U$	$^{236}U/^{238}U$
JLK-1	0.0000549	0.0072548	ND
Chernobyl	0.0000901	0.0081942	$3.25x10^{-4}$
JCO A	0.0000555	0.0075432	$2.20x10^{-6}$
JCO B	0.0002589	0.0325078	$2.12x10^{-5}$
Hiroshima	0.0000552	0.0072745	$7.56x10^{-8}$

Another effect is remarkable enhancement of ^{236}U. Needless to say, $^{236}U/^{238}U$ indicates neutron burst, ^{235}U (n,γ) ^{236}U due to the nuclear accident. Depth profile studies reveals the migration behavior of isotopic composition in soil.

References

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