

Platinum group elements and Re in marine sediments across the K-T boundary: constraints on Re-PGE transport in the marine environment

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The nature of Re-PGE (PGE = Pt, Pd, Ir, Os, Ru) transport in the marine environment was investigated using marine sediments at and across the Cretaceous-Tertiary boundary (KTB) at two hemipelagic sites and two pelagic sites. A traverse across the KTB in a south Pacific pelagic clay core found elevated levels of Re, Pt, Ir, Os and Ru, each of which is symmetrically distributed over ~1.8 m across the KTB. The Re-PGE abundance patterns are fractionated from chondritic relative abundances: Ru, Pt, Pd, and Re contents are slightly subchondritic relative to Ir, and Os is depleted by ~95%. A similar depletion in Os (~90%) was found in a sample of a pelagic KTB in the north Pacific, but this site is enriched in Ru, Pt, Pd, and Re relative to Ir. The two hemipelagic KTB clays have near-chondritic abundance patterns. The ~1.8 m wide Re-PGE peak in the pelagic south Pacific section cannot be reconciled with the fallout of a single impactor, thus post-depositional redistribution has occurred. The elemental profiles appear to fit diffusion profiles, but bioturbation may have also played a role. If diffusion occurred over ~65 Ma, the effective D 's are $\sim 10^{-13}$ cm²/s, smaller than that of soluble cations in pore waters ($\sim 10^{-6}$ cm²/s). The coupling of Re and the PGEs during redistribution indicates that post-depositional processes could not have caused significant elemental fractionations. Fractionation of Os from Ir during the KTB interval thus occurred during aqueous transport in the marine environment. Distinctly subchondritic Os/Ir ratios throughout the Cenozoic in the south Pacific core further indicate that fractionation of Os from Ir in the marine environment is a general process through geologic time because most of the inputs of Os and Ir into the ocean have Os/Ir ratios >1. Mass balance calculations show that Os and Re burial fluxes in pelagic sediments account for only a small fraction of the Os (<10%) and Re (<0.1%) riverine inputs into the ocean, but pelagic sediments roughly balance the riverine Ir input. If the missing Os and Re are assumed to reside in anoxic sediments in oceanic margins, the calculated burial fluxes in such sediments are similar to observed values. If Os is indeed preferentially sequestered in anoxic marine environments, it follows that the Os/Ir ratio of the ocean may be sensitive to changes in the rates of anoxic sediment deposition.

Geochemistry of the porewater in the soils near mine tailing disposal site

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Closure of mining activities leaves tailings in the site, subsequently releasing the metals, often with acidic drainage. Potential leaching of metals from the residual tailing and consequent contamination of soil and groundwater are of our primary concern. Metals released from the source area migrate through the soils and then finally sink as pollutants. Understanding of soil solution chemistry is instrumental in comprehensive understanding the migration of pollutants in relation to abandoned mine.

Methods

We collected soil samples near mine tailing disposal sites in Dukum Ag-Au mine in the southwest of Korea, using hand auger drill. Soil porewaters were extracted by centrifugation and then analysed using ICP-AES.

Results and Discussion

Metal concentrations including Cd, Cu, Ni, Pb and Zn generally decrease with distance from the source area and pH of porewater increase with distance from the source area, from 3.53 to 7.23 (Table). Concentrations of the metals in the porewater generally increase as pH lowers. Maximum values of Cd, Ni, Pb and Zn substantially exceed domestic standard for drinking water, implying input of metals from the mine area. Sequential extraction of the soil revealed exchangeable forms are predominant in the samples near the source whereas residual or reducible forms are higher in the soil samples in the distant. Elemental concentrations in the mine tailing porewater are a function of geochemical equilibrium, in association with various solubility controlling solid phases. However, pH-dependency and the speciation of soil sample support that sorption/desorption processes can be important in controlling bioavailability and mobility of the metals in the soil solution, as well as equilibrium

Soils	pH	Mn	Fe	Cd	Ni	Pb	Zn
P1u	4.51	13.1	6.0	0.0	0.0	0.1	0.9
P1l	5.98	100.0	0.8	0.0	0.1	0.2	4.3
P3u	4.27	20.2	11.9	0.0	0.0	0.2	3.2
p3m	4.44	202.0	43.6	0.1	0.3	2.3	104.0
P3l	4.77	281.0	0.3	0.4	0.4	1.4	121.0
p9m	3.53	29.8	0.4	0.2	2.6	5.2	19.2
P9l	4.26	32.2	12.3	0.0	3.1	2.8	16.4
p12u	5.94	9.3	0.1	0.0	0.0	0.0	0.5

Table. Chemical composition of some selected porewaters (unit: mg/l, expect for pH)

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