

Supporting Information

Alkaline Soil Disintegration and Organic Nanocolloidal- dissolved U Release under IPCC-scenario Elevated CO₂ with Global Environmental Risk Implication

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SI-Text-1. Sampling sites and sample collection.

The two types of alkaline soils we collected belong to the representative alkaline soils in China. Among them, the loessial soil is widely distributed in the Loess Plateau region of China, where soil erosion is more serious. The saline soil is more widely distributed and has many types, and the area of saline soil is expanding at a rate of 2.0×10^3 ha per year.¹ These two soils were aged with U in addition to the original background U content, with an ageing cycle of 22 months. The aged and naturally dried soils were ground and passed through a 30 mesh sieve and dried at 105°C for 8 h to constant weight. The dried soil samples were mixed with deionized water at a ratio of 1:25 (w/w) and shaken for 30 min to test the pH and salinity of the soil. In addition, 0.1 g of soil sample was taken on a heating plate and digested with HNO₃-HClO₄-HF (4:4:1, v/v) at 180-220°C until clarified, fixed and filtered through 0.22 µm filter membrane², and the total U content was determined by inductively coupled plasma mass spectrometry (ICP-MS) (Plasma Quant MS Elite, Analytik Jena AG. Germany) to determine the total U content. The total iron content in the soil was determined by Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES) (iCAP 7000, Thermo Fisher Scientific, USA) after digestion with HNO₃-HF-HClO₄ (4:4:1). The content of free iron oxides (Fe_d) in soil was extracted using the sodium dithionite-citrate-bicarbonate method (DCB extraction method).³ The amorphous iron oxides (Fe_o) were determined via the acid ammonium oxalate extraction method.⁴ The extracted solutions were digested and analyzed by ICP-OES.

SI-Text-2 Physical fractionation of aggregates and colloidal particles

The agglomerate fraction on each sieve was completely transferred to a glass dish and the last fraction of the inclusion solution was collected together, all sieved fractions were dried at 40°C for 48 h to constant weight and then weighed to calculate the percentage of each fraction. Four agglomerate sizes were included: >2 mm, 0.5-2 mm, 0.25-0.5 mm, 0.053-0.25 mm and <0.053 mm.⁵ Mean weight diameter (MWD) was calculated by the following formula.

$$MWD = \sum_{i=1}^n x_i * w_i$$

where w_i denotes the percentage of dry weight of soil aggregates to total dry weight in that size range, n denotes the number of sieves, and x_i denotes the average diameter of sieves aggregated at each size.

The leachate was first filtered through a 1 μm membrane and the filtrate was collected as particles smaller than 1 μm in the filtrate. Second, a portion of the sample was filtered through a 0.1 μm membrane after homogenization of the filtrate. Finally, a sample was centrifuged for 40 min at 14,000 rpm through a 3 kDa tangential filtration tube (Millipore, UFC5003BK, USA) to obtain the dissolved particles at < 3 kDa under the dissolved phase. Among them, considering the possible error caused by the retention of the filter membrane, it was ensured that an average of 5 mL of filtrate was replaced by a membrane with a diameter of 47 mm in order to minimize the error, but of course, there is a certain adsorption of colloidal particles by the filter membrane, which will make the results small.

SI-Text-3 Physicochemical analysis

All samples were analyzed in time-resolved analytical mode on an Agilent 7900 ICP-MS instrument (Agilent Technologies, Santa Clara, CA), where the sample was introduced into the ICP-MS instrument using a standard peristaltic pump and tubing, and analyzed using the Nano application module of the Syngistix software. Among them, the nanoparticle standard sample was consisted of Au NPs, with a residence time of 50 μs , a total analysis time of 100 s, and a sample flow rate of 199 $\mu\text{L}/\text{min}$. Prepare a standard sample of 50 nm Au NPs with a particle concentration of 1×10^5 to determine the transport efficiency (TE) to quantify the particle number concentrations. Calibration curve concentrations of 1, 2, 5, and 10 $\mu\text{g}/\text{L}$ dissolved U standards were subsequently analyzed. Monitor acid and water rinsing between samples to ensure no carryover.

References

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