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$^{234}\text{U}/^{238}\text{U}$ disequilibrium as a measure of weathering rates in soils and sediments

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U-series disequilibrium in natural waters and secondary mineral phases is ubiquitous in systems where meteoric fluid is in contact with solid phases. This property can be used to extract information about weathering rates of bulk solids in aquifers and marine sediments. The primary complication in any U-series application is the effect of α -recoil processes in the sediment. Decays that occur proximal to the surface of the mineral grain will cause the ^{234}Th to be ejected to the pore water where it decays rapidly to ^{234}U , resulting in significant depletion in ^{234}U of up to 20-30% for fine-grained solids. Concurrently, the dissolution of minerals supplies U to the pore waters at the isotopic value of the bulk solid, thus the weathering rate is a balance between the preferential release of ^{234}U to the pore fluid and weathering of minerals in the system. The process of α -recoil to meteoric fluid provides the timescale for determining weathering rates, if it can be adequately parameterized. This process has been quantified previously in laboratory experiments, but estimates from natural systems remain scarce due primarily to the heterogeneity of natural systems. The use of selective leach procedures to remove the depleted surface layers of weathering grains provides a measure of the ^{234}U depletion, and the isotopic composition of the weathering material, when the bulk sediment value may be at secular equilibrium of 1.0 and the pore water significantly enriched in ^{234}U .

The complex system is best quantified through a multi-component reactive transport formulation. The multi-component reactive transport model of U-series isotopes is applicable to both marine sediments and terrestrial soils and provides an in-situ measure of weathering rates. The model uses a reactive transport formulation to couple fluid flow and water-rock interaction based on the isotopic composition of the solids and the fluid. The derived rates can also be verified independently based on the geochemistry of the pore waters and sediments. Estimates of weathering rates from soils and sediments based on this method are in good agreement with other estimates of weathering in natural systems, and confirm both the observed decrease in weathering rates over time, and the discrepancy between natural and laboratory-derived weathering rates.

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Mineralogical and geochemical characteristics of the Tirebolu (Giresun) bentonite deposits, NE Turkey

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The Eastern Pontides (NE Turkey) as an island arc complex are represented by volcanic products of different age and type. Alteration products of these volcanics, mainly Upper Cretaceous aged dacite-ryholite and trachyte-trachyandesite are very common and widespread in the region. There are a lot of clay occurrences in the region but there have not been enough studies about their geology, mineralogy and especially genesis, except a few recent detailed work [1-2].

Tirebolu bentonite outcrops are composed of alteration products of Upper Cretaceous aged pyroclastic rocks. These pyroclastics are dacite and trachyte-trachyandesite in composition. They consist plagioclase (oligoclase-andesine), sanidine, quartz and rarely biotite. According to field observation and mineralogical (XRD, DTA, SEM) data obtained from the Tirebolu bentonites, volcanogenic components are plagioclase, biotite and glass shards. The main alteration product of the volcanic units is smectite, as well as mordenite and kaolinite in places, associating with opal-CT, quartz, feldspar and traces of illite. Whole-rock bentonite samples have low Sr, Ba, Ti, P and high K, Rb, Th contents similar to parent volcanic rocks. They also show very similar REE patterns with Eu anomalies indication plagioclase fractionation of precursor material of clays.

Field observations and preliminary mineralogical and chemical determinations indicate that bentonites are formed authigenically due to the physicochemical environmental condition developed by the decomposition of volcanic glass and feldspar by meteoric water in subtropical climatic condition in addition to the activities of the Black Sea water which is possibly moved into the units by capillary pressure. Furthermore, the O- and H-isotopic compositions of montmorillonites show narrow ranges from +25 and +28 and -114 and -131‰, respectively. The O- and H-isotopic variations refer that smectites derived from pyroclastics at low temperatures by mixing of seawater and meteoric water in a shallow marine environment.

References

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