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素過程に基づいた化学風化モデリングによる風化速度の推定
Estimation of chemical weathering rates using a process-based chemical weathering model

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Chemical weathering of silicate minerals has been recognized as one of the most important processes in the long-term geochemical cycles in the Earth system. However, field-based studies on different spatial-scale watersheds have shown that the chemical weathering rates are different according to the scale of observations. Long-term mineral dissolution experiments and compilation of chemical weathering rates estimated for different weathering durations suggested that the chemical weathering rates decline significantly with time. The discrepancy may be explained as a sum effect of several phenomena such as increase in surface roughness with time and difference in reaction affinities between natural and experimental conditions.

We are developing a process-based chemical weathering model to study behaviors of the geochemical cycle system in response to changes in modern- and paleo-environment. This model consists of soil physics (heat, moisture, and gas transport) modules, chemical reaction (mineral dissolution/precipitation and aqueous speciation) modules, and a simplified soil biological activity module. We consider difference and variation in hydraulic parameters depending on soil texture and moisture content. The model has been applied to several different small (< 10 km^2) watersheds to verify the model to reproduce major ion concentrations of modern streams. We introduced a free parameter which represents a ratio of field-scale weathering rate to mineralogical dissolution rate to fit the observational data. Sensitivity analyses show that riverine ionic concentrations of base cations are well reproduced from the model by tuning this parameter alone. This parameter may represent erosional effect which, in turn, controls age of the weathering environment. That is, the time dependency of silicate weathering can explain the difference in this parameter. The obtained parameter is also comparable with the ratio of the effective surface area to the BET surface area estimated in previous studies. Methods of determination of the effective surface area from environmental parameters such as an erosion rate and lithology will be discussed.

キーワード: 化学風化, 反応表面積, 数値モデル
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