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硅酸盐矿物溶解动力学及其对滑坡研究的意义

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摘要 硅酸盐是地壳岩石最主要的造岩矿物，表生条件下硅酸盐矿物的溶解是普遍的。实验室条件下，硅酸盐矿物存在非线性溶解现象，稳定态溶解速率一般为10－12～10－8 mol/(m2·s)，而组分析出一般都是非理想配比的。体溶解速率与比表面积不存在简单的比例关系，但当单晶典型尺寸大于矿物表面上相临缺陷的间距时，体溶解速率则与比表面积呈正比。酸性条件下的溶解速率与H+ 活度正相关。源于可溶有机质的有机配位体能够络合溶液及固－液界面上的金属离子，可显著提高溶解速率。温度对溶解速率的影响受控于阿雷尼乌斯方程。鉴于硅酸盐矿物溶解规模的影响因素与滑坡灾害的发生条件基本一致，在滑坡灾害的区域性评价中，可以考虑纳入流域地表水化学组分浓度这一地球化学指标。植被可以提高斜坡岩土体的酸度、有机质丰度及地下水径流量，在促进硅酸盐矿物溶解及深层滑坡孕育方面的作用是显著的。

关键词 工程地质；硅酸盐矿物；溶解动力学；非线性溶解；优先溶解；力学效应；滑坡

分类号

KINETICS OF SILICATE MINERAL DISSOLUTION AND ITS IMPLICATIONS FOR LANDSLIDE STUDIES

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Abstract

Silicates are the most important forming-rock minerals of earth crust rock and in exogenous environments，and the dissolution of silicate minerals is universal. In most laboratory experiments，there is an initial period during which nonlinear dissolution behavior is observed and steady-state dissolution rates range from 10－12 to 10－8 mol/(m2·s). Dissolution is nonstoichiometric in most experiments. Bulk dissolution rates are not directly proportional to the surface areas of the minerals studied，but when grains are large

compared with the distance among adjacent defects, they will vary linearly with the specific surface areas. Under acidic conditions, dissolution rates are positively proportional to the concentration of hydrogen ion. Organic ligands deriving from organic soluble matter can complex metal ions in solutions and at solid-solution interface, and promote dissolution of silicate minerals. The effect of temperature on dissolution rates follows the Arrhenius equation. In view of the coincidence between the promoting factors of silicate dissolution and landslide occurrence, concentrations of chemical components in watershed surface water may be taken into account in regional evaluation of landslide hazard. Plants can raise the acidity of groundwater and content of organic mater in soil and groundwater runoff rate. The effect of plants on silicate mineral dissolution and landslide preparation is conspicuous. The nonlinear dissolution on slope rockmass scale and the multi-scale preferential dissolution of rock mass are necessary to investigate thoroughly. The concrete problems include identifying and dividing the lasting time of different dissolution states in natural slope water-rock systems, identifying multi-scale damage model of rockmass and transporting mechanism of fluid and chemical components in slope rockmass, and mechanical effect of multi-scale preferential dissolution and so on.

Key words engineering geology; silicate minerals; dissolution kinetics; nonlinear dissolution; preferential dissolution; mechanical effect; landslide

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