SIMULATION OF THE WEATHERING CRUST FORMING

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Weathering processes at the Earth's surface occur at low temperature, therefore they are characterized by incompleteness of chemical reactions. For simulation of these processes the numerical methodic described in [*Zolotov, Mironenko, 2007*] and realized in the GEOCHEQ code [*Mironenko et al., 2008*] can be applied.

Numerical modeling of the weathering crust forming is implemented by imitation of the many waves passage of aqueous solution with constant composition through the same volume of rock. The chemical composition of washing solution corresponds to rainwater. The percolation duration of one water wave can be estimated by accounting of the substratum hydrodynamic properties. The water-rock ratio – by proportion of the bulk atmospheric precipitation and the weathering rock weight. Thus, the general continuance of a weathering process (t) can be shown as $t = n \cdot \sum_{\tau} \Delta t_{\tau}$, where n – the quantity of solution waves, $\sum_{\tau} \Delta t_{\tau}$ – the duration of the one solution wave percolation. If $n \to \infty$, and $\sum_{\tau} \Delta t_{\tau} \to 0$, the aqueous solution will be strongly unequilibrated to bulk volume of rock as well as the substratum will be dissolved effectively.

Molar amount of each chemical element for τ-th equilibrium is calculated from the chemical composition of aqueous solution at the previous time step and the molar amount of minerals dissolved during the current time step. Molar amount $\Delta x_{i\tau}$ of mineral i-th, dissolved by solution on the step τ is calculated as $\Delta x_{i\tau} = S_{i\tau} \cdot r_{i\tau} \cdot \Delta t_{\tau}$, where $S_{i\tau}$ – the current surface area of i-th mineral, $r_{i\tau}$ – the current dissolution rate of i-th mineral, Δt_{τ} – the time step duration. The initial surface area of i-th mineral can be estimated by the use of the specific surface area (S_{SSA}): $S_{i\tau} = \mu_i \cdot S_{SSA}$, where μ_i – the mole fraction of i-th mineral in the bulk rock volume. The rates of mineral dissolution ($r_{i\tau}$) are calculated by the formula combined the Laidler equation of pH-dependence, the Arrhenius equation of temperature-dependence and Lasaga equation describing the decrease of the mineral dissolution rate at near-equilibrium conditions [*Zolotov, Mironenko, 2007*]. On the each step primary minerals as well as secondary phases formed on the previous steps can be dissolved on condition that they are unequilibrium to the current aqueous solution composition.

Application of this approach for simulation of the basalt komatiite weathering [*Novoselov, Silantyev, 2010*] has been shown that the final weathering crust consisted from amorphous silica (96.4 vol.%) and illite (3.3 vol.%) was formed as result of the water solution washing of substratum during 2000 model years.