

Vanadium adsorption onto goethite and its speciation simulation

SHIJUN NI, RUI WANG, LICHUN ZHONG, YI HUANG,
CHUNYU WANG, NINGMEI WANG

College of Earth Science, Chengdu University of Technology,
Chengdu 610059, China. nsj@cdut.edu.cn

Vanadium is a trace element can be beneficial or essential in biological system, but certainly harmful to humans and some living organisms. The nanoscale goethite is an excellent adsorption material and may affect the migration, distribution and transformation of various harmful heavy metals. This study accomplished the experiments and simulation of vanadium adsorption on goethite. The adsorption characteristics have been revealed through SEM, EDS, XRD, etc. In addition, the mechanism of vanadium adsorption on goethite by comparing the adsorption experiments and computer simulation was studied.

According to the results, the initial adsorption process was instantaneous followed by a slow step, and the adsorption capacity has not changed significantly. At pH 4, both the adsorption capacity and removal rate reached the highest. With the increase of pH, the removal rate gradually decreased, and then tended to be stable in the range of pH 8 to 10 and finally dropped rapidly. The ionic strength of solution hasn't influenced the adsorption of vanadium on goethite. Freundlich model fit well the adsorption on goethite at all temperature and pH range with correlation coefficient above 0.998. Using modified Tessier two-step sequential extraction for goethite at three different initial vanadium concentrations, most of vanadium was leached from the HCl extraction step, which indicated strong sorption mechanism. The forms of vanadium on goethite after adsorption were simulated by PHREEQC. It's found that the main form of vanadium in solution is $H_2VO_4^-$, followed by HVO_4^{2-} and $H_3V_2O_7^-$. There existed different adsorption mechanisms of vanadium adsorption in various pH. At low pH, the surfaces of goethite mainly combined with VO_2^+ to form $Goe_{-s_2O_2V(OH)_2}$, while at high pH, they tended to combine with HVO_4^{2-} to form $Goe_{-s_2O_2VO(OH)}$.

References

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