

Solubility of Al₁₃ tridecamer sulfate : Preliminary study for the behavior of toxic Al₁₃ in soil environment

Yungoo Song*, Gyoo Ho Lee, Hi-Soo Moon, and Ji-won Moon
(Dept. of Earth System Sciences, Yonsei University)

Al₁₃ tridecameric polycation (AlO₄Al₁₂(OH)₂₄(H₂O)₁₂⁷⁺) is the major hydrolyzed species of aluminum under simulated natural conditions with 5-7 of pH range in the laboratory, and is known to be much more toxic to plants and aquatic organisms than mononuclear species, suggesting the importance of the study on the formation and transformation of Al₁₃ tridecamer in natural ecosystem. In spite of the previous studies supporting the possible existence of Al₁₃ tridecamer in natural conditions, it is not confirmed yet. Failure to detect the presence of Al₁₃ tridecamer is known to be partially attributed to the existence of sulfate, silicic acid, and tartaric acid in soil solution. For the existence of sulfate, Al₁₃ tridecameric polycation is ready to be precipitated as Al₁₃-sulfate crystal, which prevents from identifying the Al₁₃ tridecamer in soil solution. This study is primarily focused to measure the solubility of synthetic Al₁₃-sulfate in the laboratory condition. The experiment was performed as measurement of Al, SO₄²⁻, and pH in the pH-adjusted solutions (pH 4~5) after equilibrated with synthetic Al₁₃-sulfate for 7 days at 20±2°C. After thermodynamic modeling for the activities of Al³⁺, H⁺, and SO₄²⁻, the mean value of logK_{so(Al₁₃-sulfate)} at 25°C was calculated as 163.95, indicating that the Al₁₃-sulfate is relatively soluble, especially in acidic condition. The solubility characteristics of Al₁₃-sulfate would define the conditions of precipitation of Al-containing materials, such as allophanes, imogolite, and gibbsite, the behavior of toxic Al₁₃, and the maximum concentrations of Al released during acidic episodes from soils, such as Andisols.