

Formation and Transformation of Toxic Al_{13} Tridecameric Polycation in the Natural System

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Al_{13} tridecameric polycation 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. In spite of the previous studies supporting the possible existence of Al_{13} tridecamer in natural conditions, the formation and transformation of it is not confirmed yet. Failure to detect the presence of Al_{13} tridecamer is known to be partially attributed to the existence of sulfate, silicic acid, and tartaric acid in soil solution, which inhibit the formation of Al_{13} tridecamer. This study is primarily focused to identify the Al_{13} tridecamer in the solutions, which are reacted with B-horizon soils of some Andisols containing the large amounts of allophane, imogolite, and gibbsite, and aged from 2 days to 3 months. Chemical analysis shows that the solution contains the substantial amounts of $\text{Al}(\text{total})$, $\text{Si}(\text{total})$, and SO_4^{2-} . Liquid ^{27}Al -NMR spectroscopy and FT-IR measurements are carried out systematically for the solutions with different aging time. The

present results suggest that in spite of the substantial amounts of Si(total) and SO_4^{2-} , the Al_{13} tridecamer form as metastable species in the initial stage of aging, and transform to proto-imogolite and trihydroxide (gibbsite) with the increase of aging time. Further detail study for the soil solutions directly collected from a soil profile should be expected to show distinctly the formation and transformation of Al_{13} tridecamer and its controlling factors in the terrestrial environments.