

Adsorption mechanisms of gold nanoparticles on synthetic pyrite and As-bearing pyrite under anoxic condition

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Gold nanoparticles (AuNPs) have been extensively found in hydrothermal ore deposits and Earth surface environments. Elucidating the adsorption behaviors of AuNPs on the surface of sulfide minerals is pivotal to understand the fundamental step in relative geochemical processes in the hydrothermal ore deposits and environmental behavior in the Earth surface environments. However, experimental studies focused on the adsorption of AuNPs on the surface of sulfide minerals especially on pyrite and arsenian pyrite (As-bearing pyrite) are scarce, and very limited information about the interaction mechanisms between the AuNPs and sulfide minerals surface is available.

In this study, adsorption of negatively charged AuNPs on synthetic pyrite and As-bearing pyrite were comparatively investigated under an anaerobic condition. No AuNPs could be adsorbed on pure pyrite surface under all experimental conditions due to the high surface negative charge density of pure pyrite increases the electrostatic repulsion between AuNPs and pyrite. Although both As-bearing pyrite and AuNPs were negatively charged and were thereby expected to electrostatically repel each other, AuNPs could be preferentially adsorbed on As-bearing pyrite surface probably due to the formation of strongly negative charge-assisted hydrogen bonds between acidic oxyl groups on the surface of As-bearing pyrite and carboxyl groups on citrate capping agents of AuNPs. The incorporation of As into the structure of pyrite facilitated the adsorption of negatively charged AuNPs. The adsorption rate of AuNPs increased with the decrease of solution pH and increase of ligand concentration as well as ionic strength. The combined effect of van der Waals attraction, negative charge-assisted hydrogen bonds, and electrostatic repulsion forces, determines the adsorption behavior of AuNPs on As-bearing pyrite surface.