

Simulation of migration colloidal gold in surface waters of natural

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With the purpose of studying migration and accumulation nature of the colloidal metal forms in natural and anthropogenic environments the conditions for nanoscale metal forms, stabilized by low molecular and macromolecule organic ligands with the example of gold were defined. The kinetics and completeness of obtained particle concentrating with goethite (FeOOH) in circum neutral environments were studied. It is established, that gold particles stabilized with natural ligands of humus nature, interact with goethite most quickly, providing both efficient colloid transport of gold and its deposition on geochemical barriers.

Key words: nanoscale gold, preparation, sorption by goethite

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Nanoscale metal forms, including gold, are very common in natural systems and are an intermediate link in the mineralization processes. Depending on the conditions the superfine particles can either be dissipated by migrating as a fluid component (as dissolved compound forms, stabilized colloids or pseudocolloids), or concentrating on geochemical barriers up to ore deposits formation. The paper considers the possibility of nanoscale gold forms preparation, stabilized by natural organic substances, and their deposition kinetics in the circum neutral environments on goethite (FeOOH) – one of the main components of natural suspensions and bottom sediments.

As an example of nanoscale gold forms stabilized low molecular organic compounds, particles in the size range of 10–20 nm prepared during the H₂AuCl₄ reduction in the presence sodium citrate [Turkevich, 1953] were considered. Monodisperse gold nanoparticles stabilized citrate, have been obtained by the microwave hydrothermal synthesis and characterized by the plasmon resonance spectra, as well as the scanning electron microscopy (SEM). The effect of preparation conditions (pH, temperature, time, reagent ratios) on the size, shape and amount of produced particles. It is established, that the most stable monodisperse gold nanoparticles (10–20 nm) produced in the pH range of 5.0–6.0 at 100–130 °C. The maximum plasmon resonance wavelength and the intensity of absorption are practically identical and correspond to the wavelength of 522–524 nm. The study of the colloidal gold formation kinetics at pH of 5.5 and 100 °C showed that the particles take the final size and shape during the first minutes of synthesis with the molar ratio of reagents of 1:1.

Nanoscale gold forms, stabilized macromolecule organic substances of humus nature – fulvic acids (FA), allocated from the natural color of water by the method [Varshal, 1973] obtained and investigated the same way. FA concentration for the synthesis was 120 µg/ml. Fig. 1 shows the plasmon resonance spectra of colloidal gold, stabilized sodium citrate (curve 1) and FA (curve 2), as well as the electronic absorption spectrum of the dissolved gold (curve 3). Electronic microphotography of colloidal gold particles, stabilized FA and received in the chosen conditions, is shown in Fig. 2.

The behavior of nano-sized gold, stabilized organic matter of a different nature, at interaction with the suspended (sedimentary) matter, studied in the model sorption experiments with the use of synthetic amorphous iron oxyhydroxide as sorption phase. The kinetics of the gold particles sorption studied in the pH range of 5.0–7.0, which is typical for surface waters, in comparison with the kinetics of the dissolved inorganic forms sorption [Kubrakova, 2011]. Concentration of gold in the solutions over the residue was determined by ETAAS.

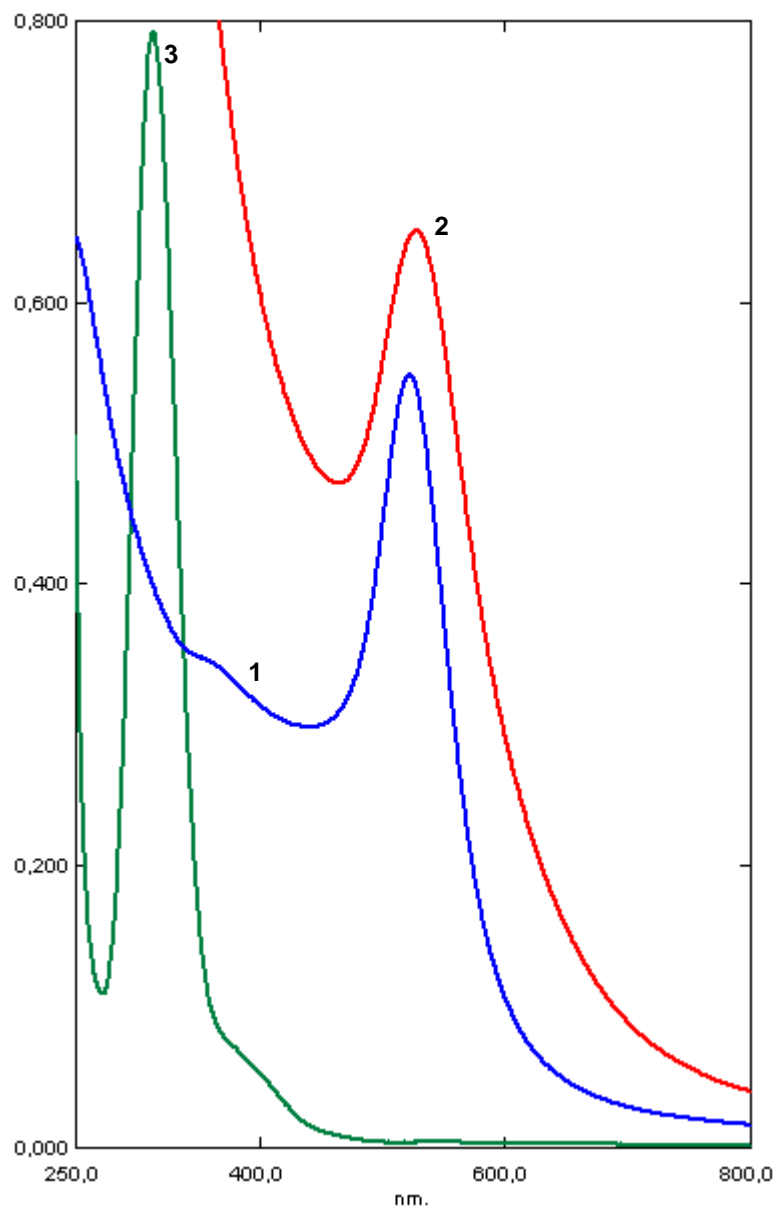


Fig. 1. Plasmon resonance spectra of colloidal and dissolved gold: particles, stabilized sodium citrate (1); particles, stabilized FA (2); hydrogen tetra-chloroaurate solution (3)

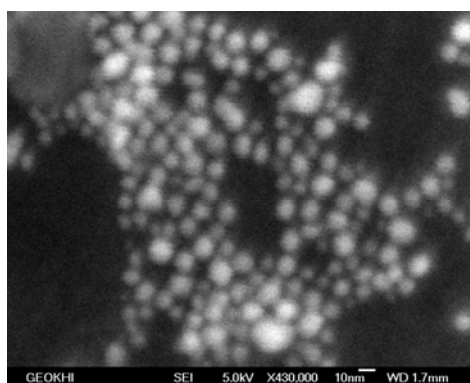


Fig. 2. SEM image of gold nanoparticles, stabilized FA (Jeol JSM 6700F, the scanning area 245x180 nm)

Fig. 3 shows the sorption of colloidal gold, stabilized FA (1), gold sols, stabilized citrate (2), and dissolved inorganic gold (III) forms (3) at pH6.0. It seems that at the interaction of nano-sized Au^0 , stabilized FA, with iron oxyhydroxide sorption equilibrium is achieved most quickly – in several

hours. This is caused, probably, the strength of covalent binding of polyfunctional natural ligand, stabilizing nanoscale metal particle, with the surface of the iron oxyhydroxide by the complexation mechanism. In the case of inorganic gold complex, as well as colloidal gold, stabilized low-molecular citrate ions, sorption equilibrium is established in several days.

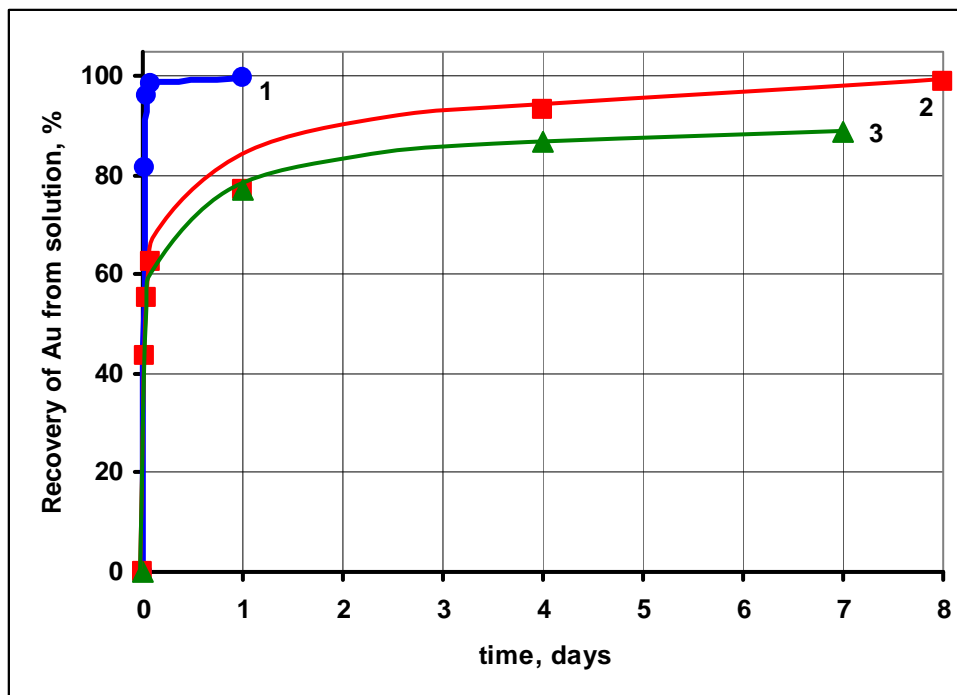


Fig. 3. Sorption of Au° , stabilized FA (1), Au° , stabilized sodium citrate (2) and inorganic Au(III) complex (3) by goethite as a function of time at pH6.0

Thus, goethite interacts with both the molecular and with nanoscale gold forms, providing their migration and accumulation in aquatic environments regardless of the metal form. At the same time, organic matter, especially humus nature, substantially (dozens of times) accelerates the interaction of gold with iron oxyhydroxide, providing both colloid transport of gold and its deposition on geochemical barriers. This fact allows to consider nanoparticles, stabilized humic substances, as the most active migration form of gold in natural waters.

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