Gold and silver deposition from aqueous solution on alumina and silica gels

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In order to elucidate the chemical relationship between electrum and aluminium minerals in quartz veins of low-sulfidation epithermal gold-silver deposits, it is important to examine the role of aluminum for the enrichment of Au(I) and Ag(I) ions. As a model experiment in this study, adsorption behavior of $[Au(S_2O_3)_2]^{3-}$ and $[Ag(S_2O_3)_2]^{3-}$ complexes on the surface of alumina and silica gels was investigated as a function of the change in the ratio of Ag/Au. Results showed that the amount of Au(I) and Ag(I) complexes adsorbed on alumina gel decreased with increasing pH from 4 to 9. Based on the zeta potential of the alumina gel, its isoelectric point was around pH 8-9. This shows that the surface charge of the alumina was positive below that pH. These results suggest that the adsorption of Au(I) and Ag(I) complexes on the alumina was mainly controlled by the electrostatic interaction. The ratio of Ag/Au in the solution is not always reflected in the adsorbed substances, because much Ag(I) complexes can be adsorbed on alumina than on Au(I) complexes. On the other hand, minimum adsorption of Au(I) and Ag(I) complexes took place on the surface of the silica. In addition, to clarify the chemical state of Au and Ag adsorbed on alumina, spectroscopic analytical methods were applied. According to the spectra of XANES and XPS of Au 4f region, the chemical state of gold adsorbed on alumina was changed from Au(I) to Au(0), native gold. This indicates that the adsorbed Au(I) complex was spontaneously reduced to Au(0) on the surface of alumina by the disproportionation, and then the reduction of gold occurred even in the presence of silver. The XPS spectrum of Ag 3d region for gold-silver coexisting system adsorbed on alumina was divided into two doublets having 6 eV of spin orbital splitting. One doublet completely corresponds to Ag(0), metallic silver. The other component shifted to about 1 eV in the direction of lower binding energy, suggesting the existence of alloy with gold (electrum). These data suggest that both Au(I) and Ag(I) thiosulfate are reduced to elemental gold and silver state on the surface of alumina. Therefore, these results show that aluminum plays a more important role for the enrichment and reduction of gold rather than silica (quartz) during the formation of low-sulfidation epithermal gold deposits.