

Size effect in the adsorption of gold nanoparticles on pyrite surfaces

YUHONG FU, ZONGHUA QIN, SHANSHAN LI, JINKAI XIAO, YI XIAO AND QUAN WAN*

Institute of Geochemistry, Chinese Academy of Sciences, Guiyang, Guizhou, 550002, P.R. China, wanquan@vip.gyig.ac.cn (* presenting author)

Size effect is essential to perhaps all aspects of nanogeoscience. The metal adsorption by minerals is thought to be one important ore-depositing mechanism. Gold nanoparticles (<100 nm) have been ubiquitously found in the Carlin-type deposits, although how they were formed remains elusive. We hypothesize that nanosized gold may be involved in the pathway of ore transportation and enrichment, and therefore have carried out experimental study on adsorption of gold nanoparticles on pyrite surfaces.

Batches of gold nanoparticles in the size range of 10~80 nm were synthesized using the classic Frens method [1]. The monodisperse size of gold particles were controlled through changing the molar ratio of chloroauric acid to sodium citrate. Natural pyrite mineral powders with particle size of tens of microns were obtained through grinding/sieving, and were cleaned with deionized water. Aqueous nano-gold sols (10 ml) of varying gold particle size were mixed (with adequate stirring) at calculated proportions with pyrite powders of varying particle size for 20 hours. Transmission electron microscopy (TEM) was used to characterize the size of the gold nanoparticles as well as their distribution on pyrite surface. Atomic absorption spectroscopy (AAS) was used to monitor the gold concentration in the liquid phase.

We have found that pyrite can strongly adsorb gold nanoparticles. In some cases where sufficient amount of pyrite was present (e.g., 10% of gold coverage on pyrite surface), gold (original concentration ~50 µg/ml) was completely adsorbed from the gold sol to pyrite surface (i.e., zero gold absorbance on AAS after adsorption). This is consistent with the fact that pyrite exists as a major gold-bearing mineral in many gold deposits. Smaller pyrite particle (200~400 mesh) showed higher ability to adsorb gold nanoparticles than larger pyrite particles (100~160 mesh), i.e., more gold (mg) was adsorbed on unit mass of pyrite (g) of smaller particle size. This seems to readily explain the observation that higher concentration of gold was normally found on pyrite of smaller size, however does not necessarily support that gold travelled in either nanoparticle or ionic/complex state. Our data also indicate that more quantity (mg) of gold was adsorbed on pyrite when the size of the gold nanoparticle was larger. While appearing counter-intuitive, this along with other aforementioned results supports a simplified adsorption mechanism that gold nanospheres pack and cover the pyrite surface. Our ongoing work aims to elucidate the detailed thermodynamics and kinetics of gold nanoparticle adsorption on pyrite. It is also worth noting that nanoparticle adsorption by minerals has wider implication beyond the field of ore deposit.

[1] Frens (1973) *Nature-Physical Science* **241**(105), 20-22.

Mineralogy of lacustrine sediment from Darhad basin records the past lake level changes of the paleo-lake.

MADOKA FUCHIZAKI^{1*}, TAKAAKI YABE¹, HITOMI ABE¹, KEISUKE FUKUSHI², NORIKO HASEBE² AND KENJI KASHIWAYA²

¹Division of Earth and Environmental Sciences, Graduate School of Natural Science and Technology, Kanazawa University, Ishikawa, Japan

(*madoka14@stu.kanazawa-u.ac.jp)

²Institute of Nature and Environmental Technology, Kanazawa University, Ishikawa, Japan

Darhad basin in northern Mongolia is located in the continent where is sensitive to the climate change. It has been reported that several hydrologic events with climate changes occurred in this area. Ice dam lake had been formed in Darhad basin by Pleistocene glaciers. There had been several flooded events during warm periods. Darhad basin has many inflows and one outflow (Shishhid Gol river). Limestone is present in southeastern rim of basin. Granitic rocks are distributed in northern part. There are basalt flows near the valley of the Shishhid Gol[1].

164 m of long drilling core (DDP10-3 core) were obtained from Hodon site (51°20'11.20" N , 99°30'04.40" E) in Darhad basin at April 2010. The core was cut into 3 cm. Top 100 m of the sediments were analyzed by X-ray diffraction in order to identify the constituent minerals. Selected samples were observed by scanning electron microscope. Water of several rivers were collected at August 2011. The water quality (pH, electric conductivities, ORP and alkalinities) were measured on site. The concentrations of chloride and sulfate were measured by high-performance liquid chromatography. Those of major cationic species were measured by inductively coupled plasma atomic emission spectroscopy.

The mineralogical analyses showed that there are the intervals of presence of carbonate minerals and absence of the minerals. In the Some samples during the carbonates absence intervals, the formations of gypsum were observed. The water chemistry of the river samples showed that there are large variations of alkalinities among the inflows. The two inflows came from the southeast carbonate area on the basin have high Ca²⁺ and HCO₃⁻. The pH of the rivers ranges from 7.39 to 8.86. The inflow came from northwest has lowest pH and dissolved solid.

The lake must be contacted with southeast limestone area if the lake level was high. The high Ca²⁺ and HCO₃⁻ of inflows from southeast area were evidence that clastic carbonates were entered in paleo-lake from this region. Therefore, the intervals of presence of carbonate minerals indicate the high lake level of the paleo-lake. In contrast, carbonates must be absent if lake got away from the limestone area. The formation of gypsum found in the carbonates absence intervals indicate the concentration of dissolved solid must be very high because the mineral possesses high solubility. Therefore, the intervals of absence carbonate indicate the periods of low lake level due to the evaporation.

[1] Gillespie.A.R et al. (2008) *Quaternary Research* **69**, 169-187