

**Experiment title:**

XAS study of gold-bearing minerals and organic compounds

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17 MAR. 1999**Names and affiliations of applicants (* indicates experimentalists):****PETIT Pierre-Emmanuel*^{\$}, GREFFIE Catherine*, FREYSSINET Philippe**
BRGM
3, av Claude Guillemin
BP 6009
45060 Orléans Cedex 2, France

\$ Now at ESRF, experiments division, EXAFS group

Report:

We prepared last year samples of well characterized peat doped in gold with AuCl_4^- and $\text{Au}(\text{CN})_2^-$ solutions, which are the most probable inorganic Au^{III} and Au^{I} complexes in soil pore solutions. Au L_{III} -edge EXAFS and XANES spectra were recorded in the fluorescence mode at RT on these samples, as well as on reference chloride and cyanide solutions, in order to characterize the speciation of adsorbed gold (i.e., its oxidation state, and the nature of associated complexes). Since the possibilities of photoreduction of complexed gold are well-known (e.g., Albert et al. 1992; Farges et al. 1993), we decided to look carefully at this possibility by using the quickscan mode (40 s acquisition time), and then stacking the spectra.

1. Reference samples

We used chloride and cyanide solutions with 1000 ppm Au. The XANES spectra (fig. 1) show that it is really easy to distinguish oxidized Au from its metallic state. Chloride solutions evidenced photoreduction to Au^0 , where the first effects may be seen on the spectra in approx. 30 minutes. Photoreduction was not observed in cyanide solutions. The EXAFS spectra collected were modeled by using the FEFF6 program (Zabinsky et al. 1995). Both complexes show strong multiple-scattering effects due to the alignment of the scattering atoms (the so-called colinear and focussing effects).

2. Chloride peat samples

We collected the XANES spectra of samples with Au concentration ranging from 1200 to 8000 ppm. The spectra obtained are the same as that of Au^0 (fig. 1), which would indicate that gold chlorides are reduced into metallic gold at the contact of peat. We think that an occurrence of photo-reduction (due to either UV or X-ray light) is unlikely since (i) the adsorption experiments from chloride solutions onto peat were conducted in the darkness, and (ii) the first spectrum obtained in quickscan mode shows that gold is fully reduced. However, we can not completely rule out this possibility. The reduction of AuX_4^- solution ($\text{X}=\text{Cl}, \text{Br}$ or I) on activated carbon has been showed by several authors (e.g., Teirlinck and Petersen 1996).

3. Cyanide peat samples

We collected XANES spectra of samples with Au concentrations ranging from 110 to 400 ppm. Most of the spectra does not show a XANES of metallic gold (fig. 1), but rather exhibit a XANES close to that of the cyanide solution. However, we have a spatial heterogeneity of the samples, with several spectra showing a mixture of Au^0 and Au^{I} XANES. All these spectra show that a large part of cyanide complexes is not reduced by peat, but is rather adsorbed.

We also collected EXAFS spectra of a sample with 310 ppm Au. The FT-modulus of the stacked spectrum shows a clear difference with that of the cyanide solution (fig. 2), particularly in the first shell. This suggests that it may be due to other atoms (C, N, O or S) lying at a distance higher than the C-atoms of the cyanide group. The interaction of $\text{Au}(\text{CN})_2^-$ complexes with peat may follow several possibilities : (i) a simple electrostatic interaction or (ii) a reaction involving a chemical modification of peat. Further data processing is clearly required to better understand the interaction process.

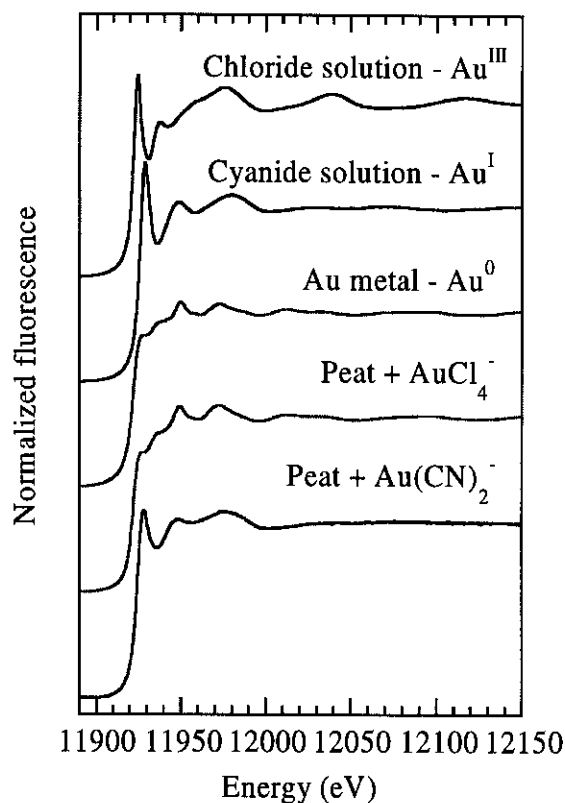


Fig. 1: Selected Au-L_{III} XANES fluorescence spectra of reference samples, as well as samples of peat enriched in gold.

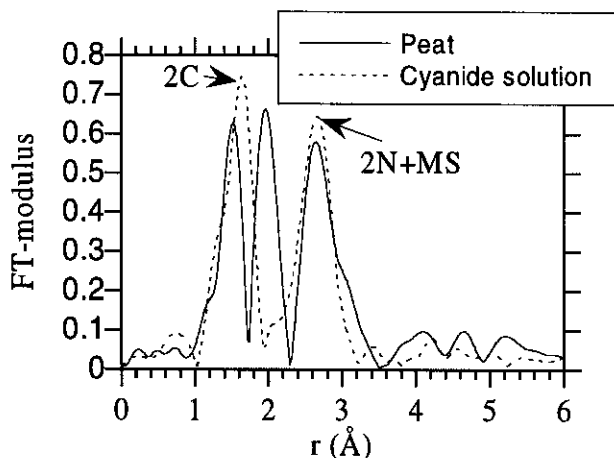


Fig. 2: FT-moduli of EXAFS spectra of peat prepared from cyanide solution (310 ppm Au) and of the reference cyanide solution. The distances are uncorrected from phase shifts. The first peak of the FT-modulus of the cyanide solution appears to have been splitted in two peaks (which exhibit a strong interference effect).

References

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