

# Spectrophotometry of Au(III)-halide Complexes

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Understanding the mobility of gold in near-surface, low T environments will aid the development of effective exploration strategies, particularly as many new low-temperature deposits are typically low-grade and contain 1-3 g/tonne total gold. This presents challenges for successful exploration and hydrometallurgical processing, especially in playa environments and where saline groundwater is used in mineral processing. Knowledge of the speciation behaviour and reaction chemistry of gold in brines is therefore potentially of twofold economic significance, leading to advances in both finding and recovering the resource. Despite the perception of gold as a highly resistate element, it is mobile under a range of weathering environments and has been directly observed to exist in three natural oxidation states; Au(0), Au(I) and Au(III). All of these states are mobile so knowledge of the speciation behaviour of gold in a given environment is a prerequisite for understanding its mobility. The present study describes a UV-Visible spectrophotometric study designed to identify the aqueous species and measure the formation constants of Au(III)-halide complexes to quantify chloride/bromide ligand competition in oxidised Au-H<sub>2</sub>O-halide environments. Under near-surface conditions, the [AuCl<sub>4</sub>]<sup>-</sup> complex undergoes ligand substitution with Br<sup>-</sup> according to the series [AuCl<sub>(4-n)</sub>Br<sub>n</sub>]<sup>-</sup> where  $n = 0 - 4$ . Initial modelling suggests formation constants (Log  $\beta_n$  for Au<sup>3+</sup> + 4L<sup>-</sup> = [AuL<sub>4</sub>]<sup>-</sup>; L = Cl<sup>-</sup> or Br<sup>-</sup>) for the series are 25.3, 27.5, 29.5, 31.0 and 32.2 respectively. Good agreement is noted between these results and the electrochemical study of Chateau et al (1966) for the two end-member complexes [AuCl<sub>4</sub>]<sup>-</sup> and [AuBr<sub>4</sub>]<sup>-</sup>. The intermediate complexes ( $n = 1, 2, 3$ ), identified here for the first time, are predicted to predominate in solution even at low [Br]/[Cl] ratio, suggesting that inclusion of the whole series of complexes in gold speciation models may result in a more accurate description of the solutions involved in gold-mobility in the oxidised weathering zone and provide a deeper understanding of ligand competition in saline ore-processing systems.

## References

[1] Chateau H., Gadet M., Pouradier J., (1966) *J. Chim. Phys* **63**, 269-271.