

EXPERIMENTAL MODELING OF GOLD SORPTION ON ORGANIC MATTER

AT 20-500°C, 1 Kbar

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Over the past decades has been increasing interest in C-bearing rocks enriched with noble metals. An ability of carbonaceous matter (CM) to accumulate the noble metals was connected usually with the chemical sorption of metals onto CM [1, 2]. However, a metamorphic effect on its sorption activity is discussed hitherto. Experimental study of Au sorption on bitumens at 200-300°C and $P_{\text{tot}} = 1$ kb marked an increase in sorption capacity with rising temperature [1]. To the contrary, G.M.Varshal with co-authors [2] using empirical data had concluded that the sorption capacity of coals in relation to the noble metals decreases with increasing degree of their metamorphism. Besides, an effect of Cl presence in a metamorphic fluid on the sorption ability of CM in relation to Au is also problematic [3].

Thus, goal of the paper was experimental study of the Au sorption on CM in water and 1mNaCl solution at 20-500°C and 1 kb. Asphaltenes (As) and asphaltenic

acids (Ac) composing about 80% of fractionated coals were chosen as modeling CM. Hydrothermal experiments were conducted in externally heated Ti or Ni autoclaves. Solution and 50 mg of the dry As (or Ac) were placed in Au ampoules, which also served as a source of Au for dissolution. In the system, the reaction $C + 2H_2O = CH_4(g) + O_2(g)$ is the principal redox-controlling one [4], that is why inorganic solid buffers were not used in the runs. After each run, CM precipitated on the filters was fractionated at 50°C with an alcohol-benzene (1:2) mixture for 12-20 hours. Thus, organic soluble fraction (SF) and solid residue (R) were derived. The Au content in both fractions was analyzed by AAS with about 20% accuracy, and IR-spectroscopy of starting As and Ac and run products (SF and R) was performed. The X-ray analysis of R was used to control the beginning of CM graphitization, fixed at $T = 500^\circ\text{C}$. Experimental results are shown in the table 1.

Table 1
Au content (mole per 1 kg of dry matter) in the soluble fraction (SF) and solid residue (R)

t°C	CM	log C_{Au} in SF		log C_{Au} in R		τ , hrs	Ls
		H ₂ O	1mNaCl	H ₂ O	1mNaCl		
20	Ac	-5.37	-	-	-	816	6
20	As	-5.58	-	-	-	816	2
200	Ac	-4.30	-4.69	-3.78	-4.55	624	33
300	Ac	-3.84	-3.29	-2.34	-3.04	336	45
400	Ac	-4.23	-4.60	-2.29	-2.67	240	74
400	As	-4.25	-	-2.44	-	240	55
500	Ac	-3.89	-	-1.72	-	168	92
500	Ac	-3.79	-	-1.82	-	24	90

CM - carbonaceous matter; Ls – weight loss of CM (%); τ - run duration.

It turns out, that abundance of SF and R in the run products varies depending on both T and runs duration. As a rule, with an increase in either of these variables the R/SF ratio grows, indicating the enhanced degree of aromatic condensation. The measured Au contents (C_{Au}) show that most of gold was sorbed on R in direct dependence from T ($\geq 200^\circ\text{C}$), while C_{Au} in the SF does not depend on T. It may be connected with different character of gold complexation in the fractions. In the SF, where aliphatic CM is predominant, the complexation of Au with CO and COOH functional groups is typical. In the R, with prevailing aromatic CM content, the more stable Au-C connections are leading. It is followed by the increase in sorption capacity of R up to $n \cdot 10^{-2}$ mole Au per kg of dry CM at 400-500°C. It is known that thermal destruction of hydrocarbons results in the formation of activated free radicals favorable for the reactions of metal addition [5]. The high sorption capacity of the CM in relation to Au, revealed in the study at $T > 400^\circ\text{C}$, is accompanied by its destruction, dissolution and gas exsolution that tends to decrease total organic

mass. Thus, the Au sorption on activated CM may be an effective mechanism of gold accumulation in the C-bearing rocks even at their metamorphic alteration.

1. Nekrasov I.Ya. and Efimova N.F. (1991) // Dokl. Rossiiskoi Akad. nauk. V.318.N 3.P. 724-726 (in Russian).
2. Varshall G.M., Velyukhanova T.K., Korochantsev A.V. et al. (1996) // Geochem. Intern. V.33. P.139-146
3. Mironov A.G., Al'mukhamedov A.I., Heletii V.F. et al. (1989) Experimental study of gold geochemistry by method of radioisotopic indicators. Nauka. Novosibirsk, 281p (in Russian).
4. Plyusnina L.P. and Kuz'mina T.V. (1999) // Geokhimia. N 5. P.505-514 (in Russian).
5. Sykes P. (1986) A guidebook to mechanism of organic chemistry. Longman. London, 446 p.