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DETERMINATION OF NICKEL AND COBALT IN COPPER ORES AND CONCENTRATES BY ATOMIC ABSORPTION SPECTROMETRY

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A method for nickel and cobalt determination in copper ore and concentrate by atomic absorption spectrometry is presented. Investigations of the matrix interferences showed that copper, iron, calcium, magnesium, aluminum and lead do not influence nickel and cobalt absorbance. The method was checked by the standard addition method, and by comparing of the results obtained and by spectrographic analysis.

Key words: determination; nickel; cobalt; copper; atomic absorption

INTRODUCTION

It is very important to follow the presence of nickel and cobalt in copper ore and concentrate because in copper production, they pass into a metal phase, and this contaminates the obtained copper. The nickel and copper determination in geological materials is performed by various methods, but atomic absorption spectrometry (AAS) is one of the most frequently applied. In addition, different technique of AAS is used: flame (Endo et al., 1969; L. Beccaluva and Venturelli, 1971; Warren and Carter, 1974; Ayranci, 1977; Clark and Viets, 1981, Castillo et al.,

1988; Baros, 1989), or electrothermal AAS (Schweizer, 1975; Schroen et al., 1983; Kuroda et al., 1986).

In this work a method for direct nickel and cobalt determination in copper concentrate by flame AAS is presented. Investigations of the matrix interferences showed that copper, iron, aluminum, calcium and magnesium do not influence nickel and cobalt absorbance. The method was checked by the standard addition method, by comparing the results obtained by spectrographic analysis and by analyses of referent standard samples.

EXPERIMENTAL

Instrumentation

A Perkin-Elmer M 5000 atomic absorption spectrophotometer was applied. A bismuth hollow cathode lamp was used as a source, while a deuterium lamp was used as a background corrector. The instrumental parameters are given in Table 1.

Table 1

Instrumental parameters for bismuth determination by AAS

Parameter	Nickel	Cobalt
Wavelength, nm	232.0	340.7
Slit width, nm	0.2	0.2
Lamp current, mA	25	30
Gas mixture	Air-acetylene	Air-acetylene

Procedure

5 g of copper concentrate were taken into a beaker of 400 cm³ and 45 cm³ concentrated HCl and 15 cm³ concentrated HNO₃ were added. This solution was heated 30–40 minutes on a hot-plate. Then, 25 cm³

distilled water was added and the solution was heated for another 15 minutes. The solution was cooled and filtered off. The filtrate was collected in a volumetric flask of 100 cm³, and filled with distilled water; from this solution the determination of nickel and cobalt by AAS was performed.

RESULTS AND DISCUSSION

In the application of AAS it is necessary to cheque the possible interferences on the determination of the investigated element, especially when the sample is of a complex composition and the determined elements have very low concentration.

To avoid these interferences in the nickel and cobalt determination by flame AAS in different geological samples a matrix modification (Endo et al., 1969; Komarek et al., 1992; Nakamura et al., 1992), or extraction of nickel and cobalt (Langmyhr et al., 1974; Tarasevich et al., 1975; Hannaker and Hughes, 1977; Sanzalone et al., 1979; Clark and Viets, 1981; Guskin-skii et al., 1982; Donaldson, 1989) were applied.

It was necessary to see the eventual influence of the elements of higher concentration in copper concentrates (copper, iron, calcium, magnesium, aluminium and lead) on the nickel and cobalt determination. For this purpose, a series of solutions with a constant concentrations of nickel and cobalt (10 mg·cm⁻³), and different concentration of the potential interferent elements, were prepared. The investigations show that the presence of calcium, magnesium, aluminum and lead (from 50 to 250 g·cm⁻³, corresponding to 0.1 to 0.5 % in the solid sample) and copper and iron (up to 16 mg·cm⁻³, corresponding to the concentration up to 32 %) do not interfere the absorption of nickel and cobalt. Because of that, it is possible to determine nickel and cobalt in copper ore and concentrate by the proposed procedure by flame atomic absorption spectrometry.

This procedure was chequed by the standard addition method and by comparing the results of nickel (Table 2) and cobalt (Table 3) concentration obtained by the proposed procedure were compared with the values obtained by the spectrographic method. From the results given in Tables 2 and 3 one can notice that the recovery values are very satisfactory (98.5–102.6 %).

The method was chequed by the comparison of the values for nickel and cobalt by the proposed procedure and by the spectrographic method, too. The results given in Table 4 show that nickel and cobalt values are similar to those obtained by the spectrographic method.

Table 2

Results of the determination of nickel in copper ore and concentrate samples by standard addition method (given in %)

Sample No	w _{Ni} (added)	w _{Ni} (calculated)	w _{Ni} (found)	Recovery (%)
<i>Copper ore</i>				
1'	—	—	0.0016	—
2'	0.0005	0.0021	0.0021	100.0
3'	0.0010	0.0026	0.0025	96.2
4'	0.0015	0.0031	0.0031	100.0
5'	0.002	0.0036	0.0035	98.6
6'	0.0025	0.0041	0.0042	102.4
<i>Copper concentrate</i>				
1'	—	—	0.0038	—
2'	0.001	0.0048	0.0048	100.0
3'	0.002	0.0058	0.0056	98.5
4'	0.003	0.0068	0.0068	100.7
5'	0.004	0.0078	0.0079	101.3
6'	0.005	0.0088	0.0087	98.9

Table 3

Results OF the determination of cobalt in copper ore and concentrate samples by the standard addition method (given in %)

Sample No	w _{Co} (added)	w _{Co} (calculated)	w _{Co} (found)	Recovery (%)
<i>Copper ore</i>				
1'	—	—	0.0014	—
2'	0.0005	0.0019	0.00195	102.6
3'	0.0010	0.0024	0.00245	102.1
4'	0.0015	0.0029	0.00292	100.7
5'	0.002	0.0034	0.00338	99.4
6'	0.0025	0.0039	0.00385	98.5
<i>Copper concentrate</i>				
1'	—	—	0.0034	—
2'	0.001	0.0044	0.00438	99.5
3'	0.002	0.0054	0.00536	99.3
4'	0.003	0.0064	0.00636	99.4
5'	0.004	0.0074	0.00738	99.7
6'	0.005	0.0084	0.00838	99.8

It was also found that the values obtained of nickel and cobalt concentration in one ore and in one concentrate referent standard sample are very similar to the certified values (Table 5).

Table
Resu
ore a
and b

Sample
Cu ore 1
Cu ore 2
Cu concen

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Baros, J. S.
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flam
Beccaluva, L.
deter
sorpt
Donaldson, E.
muth
atom
extrac
Endo, Y., Hara
Pb an
Bunsel
Castillo, J. R., M
compo
12.

Clark, J. R., Vie
determi
Anal. C
Hannaker, E. P.,
geologic
atomic a

Table 4

Results of nickel and cobalt determination in copper ore and concentrate samples by the proposed method and by laser spectrographic (LS) and spectrographic methods

Sample	NICKEL (%)		COBALT (%)		
	Proposed method	LS	Proposed method	Spectrographic method	LS
Cu ore 1	0.0016	0.002	0.0013	0.0015	0.001
Cu ore 2	0.0016	0.002	0.0013	0.001	0.001
Cu concentrate	0.0038	0.005	0.0056	0.003	0.006

Table 5

Determination of nickel and cobalt by the proposed method in referent standard copper ore and concentrate

Referent standard sample	NICKEL (%)		COBALT (%)	
	Certified value	Proposed method	Certified value	Proposed method
SU-1a (Ore)	1.233	1.228	0.0041 ± 0.001	0.0043
NR-3 (Concentrate)	0.04 ± 0.002	0.0037	0.0074 ± 0.002	0.0073

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