SPECTROPHOTOMETRIC DETERMINATION OF IONS OF VARIOUS ELEMENTS

A SURVEY

K. ERŐSS-KISS

Department of General and Analytical Chemistry,
Technical University, H-1521 Budapest

Received September 28, 1986
Presented by Prof. Dr. E. Pungor

Abstract

The special branch of analytical chemistry, spectroscopy is dealing with phenomena (emission, fluorescence, absorption, reflexion) accompanying the interaction between material and electromagnetic radiation. Spectroscopy is suitable for the determination of the structure and composition of materials. In the present comprehensive paper the application of molecular absorption spectra recorded in the ultraviolet (UV) and visible (VIS) spectral range for the quantitative analysis of inorganic ions is surveyed. The study has been prepared in tabulated form on the basis of books listed in [1–7]. The books and spectrum atlas presented in Ref. [7] and [8] are of use in the qualitative and quantitative analysis of organic compounds. Several fundamental books of UV-VIS spectroscopy (spectrophotometry) can be found in references entitled books [1–25]. In references under heading "Atlas of Spectral Data" [1–12] the important catalogues are presented.

Literature sources to the tables

1. J. G. GRASSELLI, W. R. RITCHEY: Atlas of Spectral Data and Physical Constants for Organic Compounds, 2nd edition, Cleveland, CRC Press, 1975.
2. G. KORTÜM: Kolorimetrie — Photometrie und Spektroskopie, 3. Aufl. Berlin, Springer, 1955.
3. E. UPOR, M. MOHAI, GY. NOVÁK: Photometric Trace Analytical Methods, Műszaki Könyvkiadó, Budapest, 1978 (in Hungarian).
4. Jn. LURIE: Handbook of Analytical Chemistry, Moscow, MIR Publishers, 1975.
5. K. BURGER: Organic Reagents in the Analysis of Metals, Műszaki Könyvkiadó, Budapest, 1969 (in Hungarian).
6. Z. MARCZENKO: Spectrophotometric determination of trace elements, CRC Critical Reviews in Analytical Chemistry, pp. 195–260. 1981.
7. S. GÖRÖG: Ultraviolet and visible spectrophotometry, Chemistry for Pharmacists by Gy. Szász, Medicina, Budapest, 1983, pp. 68–121.

8. UV- und IR-Spektren wichtiger pharmazeutischer Wirkstoffe, Herausgeber: Hans Werner Dibbern, Ed. Cantor D-1760, Aulendorf, Frankfurt am Main, 1983.

Books

1. BABKO, A. K., PILIPENKO, A. T.: Photometric Analysis of Non-metals, Izd. Khimia, 1964, Moscow (in Russian).
2. BABKO, A. K., PILIPENKO, A. T.: Colorimetric Analysis, Akadémiai Kiadó, Budapest, 1953 (in Hungarian).
3. BEAVEN, H. H., JOHNSON, E. A., WILLIS, H. A., MILLER, R. G.: Molecular Spectroscopy, London, Heywood and Co. Ltd, 1961.
4. BLUM, J. A.: Extractive Photometric Analytical Methods with Use of Basic Dyes, Izd. Nauka, Moscow, 1970 (in Russian).
5. BOLTZ, D. F.: Colorimetric Determination of Non-metals, New York, Interscience, 1958.
6. BURGESS, C., KNOWLES, A.: Techniques in Visible and Ultraviolet Spectrometry, Standards in Absorption Spectrometry, London and New York, Chapman and Hall, 1981.
7. CHARLOT, G.: Colorimetric Determination of Elements, Elsevier, Amsterdam, 1964.
8. CHARLOT, G.: Dosages Absorptiometriques des Elements Minéraux, Masson, Paris, 1978.
9. CSÁNYI, L., FARSANG, GY., SZAKÁCS, O.: Instrumental Analysis, Tankönyvkiadó, Budapest, 1969 (in Hungarian).
10. JAFFE, H. H., ORCHIM, M.: Theory and Application of Ultraviolet Spectroscopy, J. Wiley and Sons, New York, 1962.
11. KAKAC, B., VEJDELEK, Z. I.: Handbuch der Kolorimetrie, VEB, G. Fischer, Jena, 1966.
12. KOCH, O. G., KOCH-DEDIC, G. A.: Handbuch der Spurenanalyse, Springer Verl., Berlin, 1974.
13. KOREMAN, I. M.: Photometric Analysis, Khimia, Moscow, 1970.
14. LOTHIAN, G. F.: Absorption Spectrophotometry, Hilger-Watts, London, 1958.
15. MARCZENKO, Z.: Spectrophotometric Determination of Elements, Harwood-Wiley, Chichester, 1976.
16. MELLON, M. G.: Analytical Absorption Spectroscopy, Wiley, New York, 1950.
17. MILLER, U. N.: Techniques in Visible and Ultraviolet Spectrometry, Standards in Fluorescence Spectrometry, Chapman and Hall, London and New York, 1981.
18. MURREL, J. N.: Elektrospektren organischer Molekule, Bibliographisches Institut, Mannheim, 1967.

19. MURREL, J. N.: The Theory of the Electronic Spectra of Organic Molecules, Methuen and Co., London, John Wiley and Sons, Inc., New York, 1963.
20. RAO, C. N. R.: Ultra-violet and Visible Spectroscopy, Chemical Application (3. Ed.), Butterworths and Co. Ltd., London, Boston, 1975.
21. SANDELL, E. B.: Colorimetric Determination of Traces of Metals, Interscience, New York, 1959.
22. SCHWARZ, J. C. (comp.): Physical methods in organic chemistry. BLADOK, P., EGLINTON, G.: Ultraviolet, Visible and Infrared Spectroscopy, Műszaki Könyvkiadó, Budapest, 1968 (in Hungarian).
23. SCOTT, A. I.: Interpretation of the Ultraviolet Spectra of Natural Products, Oxford, London, Edinburgh, Pergamon Press, New York, Paris, Frankfurt, 1964.
24. SUZUKI, U.: Electronic Absorption Spectroscopy of Organic Molecules, An Application of Molecular Orbital Theory, Academic Press, New York, 1967.
25. SZABÓ, A., LIPTÁK, J.: Magy Kém. L. *30*, 10, p. 534, 1975.

Atlas of Spectral Data

1. Catalog of Ultraviolet Absorption Spectrograms, American Petroleum Institute, Project 44, Carnegie Inst. of Technology, Pittsburgh, Pa, USA.
2. FRIEDEL, R. A., ORCHIN, M.: Ultraviolet Spectra of Aromatic Compounds, J. Wiley and Sons, Inc. New York, 1981. revised ed.
3. GRASSELLI, J. G., RITCHEY, W. R.: Atlas of Spectral Data and Physical Constants for Organic Compounds, 2nd Edition, CRC Press, Cleveland, 1975.
4. HERSHENSON, H. M.: Ultraviolet Absorption Spectra, Index for 1930–1954, 1955–1959, 1960–1963, Academic Press, New York, 1956, 1961, 1966.
5. HIRAYAMA, H.: Handbook of Ultraviolet and Visible Absorption Spectra of Organic Compounds, Plenum Press, New York, Washington, London, 1967.
6. LÁNG, L.: Absorption Spectra in the Ultraviolet and Visible Region, Academic Press, New York, 1961 and Akadémiai Kiadó, Budapest, from 1961 annually.
7. Organic Electronic Spectral Data, Vol. I–XV, Interscience, New York, 1960–1979.
8. Ultraviolet Spectral Data, Manufacturing Chemists Association Research Project, Carnegie Institute of Technology, Pittsburgh, Pa, USA.
9. UV-Atlas organischer Verbindungen (DMS), Weinheim, Verlag Chemie and Butterworths, London, 1966.
10. UV-Atlas of Organic Compounds, (ED. Ferkampus-Timmons), Butterworths, London 1966–71.

Spectrophotometric determination of the ions of elements (1–7)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Al	Chromoazurol S, pH 6	545	4.9	1, 2, 8, 11	in uranium ores [3]
	Chromoazurol + CTA, pH 5.8		13.1	12–17	
	9-/5-bromohydroxy-phenyl fluorone, pH 3–4		7.5	18	in plant materials [4]
	Aluminon, pH 5.3	530	2.4	1, 2	in minerals [5]
	Eriochromecyanine R, pH 5.8–6.0	535	4.0	1, 2, 6	in quarz sand [6]
	Oxine, pH 8	395	4.8	1–5, 7–10	
	Arsenazo I, aqueous solution	600	1.3		
	Morin, 95% ethanol	415	1.8		
	Stilbazo, pH 5.4	500	1.95		

Literature

1. Tichonov, V. N.: Zh. Anal. Khim., *21*, 829 (1966)
2. Tichonov, V. N.: Analytical chemistry of aluminum, Moscow, Nauka, 1971 (in Russ.)
3. Upor, E.: Kém. Közl., *34*, 45 (1970)
4. Paul, J.: Microchim. Acta, *6*, 1075 (1966)
5. Lyubomilova, G. V., Miller, A. D.: New methods in the research and determination of rare metals and rocks, Nauka, Moscow, 1970 (in Russ.)
6. Takács J.: Bányászati Kut. Közl. *18*, 103 (1974)
7. Sandell, E. B.: Colorimetric Determination of Traces of Metals, 3rd ed., Interscience, New York, 1959.
8. Marczenko, Z.: Spectrophotometric Determination of Elements, Harwood-Wiley, Chichester, 1976.
9. Koch O. G., Koch-Dedic, G. A.: Handbuch der Spurenanalyse, 2nd ed., Springer, Berlin, 1974.
10. Charlot, G.: Dosages Absorptiométriques des Elements Mineraux, 3rd ed., Masson, Paris, 1978.
11. Martynov, A. P., Novak, V. P., Reznik, B. E.: Zh. Anal. Khim. *33*, 51, (1978)
12. Tichonov, V. N., Ekaterina, L. A.: Zh. Anal. Khim., *30*, 1507, (1975)
13. Tichonov, V. N., Karpeeva, L. A.: Zh. Anal. Khim., *33*, 2267, (1978)
14. Röbisch, G.: Chem. Anal. (Warsaw), 21, 1061, (1976)
15. Savvin, S. B., Chernova, R. K., Kudryartseva, L. M.: Zh. Anal. Khim., *33*, 2127, (1978)
16. Chernova, R. K.: Zh. Anal. Khim., *32*, 1477, (1977)
17. Chernova, R. K.: Sukhova, L. K., Amelin, V. G.: Zh. Anal. Khim. *33*, 1934, (1978)
18. Biryuk, E. A., Ravitskaya, R. V.: Zh. Anal. Khim. *27*, 459 (1972)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Ag	Dithizone, 0.5 N H_2SO_4, CCl_4	462	3.1	1–7	— in rocks [1, 2]
	Michler-thioketone, pH 3, H_2O-ethanol		9.4	8	— separation [16]
	Diethyldithiocarbamate, pH 2.6–5, CCl_4	340	0.54		— reagents [17]
	p-Dimethylamino-benzylidene-rhodanine and derivatives	395	2.3	1–7 9–10	
	1,10-phenanthroline + bromopyrogallol red		5	11	
	+ eosine		10	12	
	Methylene blue (CN^-), 1,2-dichloroethane		9.9	13–15	

Literature

1. Marczenko, Z.: Photometric determination of elements, Izd. Mir, Moscow, 1971 (in Russian)
2. Bloo, H.: Econ. Geol. *61*, 189 (1966)
3. see Al 7–10
7. Iwantshev, G.: Das Dithizon und seine Anwendung in der Mikro- und Spurenanalyse, 2nd ed. Chemie, Weinheim, 1972.
8. Cheng, K. L.: Microchim. Acta, 820, 1967.
9. Gureva, R. F., Trutneva, L. M., Savvin, S. B.: Zh. Anal. Khim. *33*, 632 (1978)
10. Savvin, S. B., Gureva, R. F., Trutneva, L. M.: Zh. Anal. Khim. *34*, 1493 (1979)
11. Dagnall, R. M., West, T. S.: Talanta, *11*, 1533 (1964)
12. Tananaiko, M. M., Gorenshtein, L. I.: Ukr. Khim. Zh. *40*, 275 (1974)
13. Likussar, W., Raber, H.: Anal. Chim. Acta *50*, 173 (1970)
14. Shestidesyatnaya, N. L., Kotelanskaya, L. I., Chuchulina, I. A.: Zh. Anal. Khim. *30*, 1303 (1975)
15. Koh, T., Katoch, M.: Anal. Chim. Acta *109*, 107 (1959)
16. Liscina, D. B., Shcherbov, D. P.: Investigations on chemical and physico-chemical methods in the analysis of minerals, Alma Ata, 1973 (in Russ.)
17. Stolyanov, K. P.: Instrumental and chemical methods of analysis Izd. Leningrad Univ. 1973, 47 (in Russian)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
As	Ammonium molybdate + hydrazine sulphate, pH 13	840	2.5	13–17	— extraction [1]
	Sodium molybdate 1 : 3 HCl, butanol	370	0.51		— reduction [2] in rocks [4, 5, 7]
	Sodium molybdate + sodium vanadate, 1 N HCl	400	0.25		— in tin [8]
	Diethyl dithiocarbamate, pH 3–6, CCl_4	340 or 525	0.36	6, 7, 14, 16, 18–21	— in air [9] — in Al [10]
	Crystal violet		31.0	3,22	— in fruits [11]
	Dithiol		20.0	23	— in urine [12]

Literature

1. Babko, A. K., Pilipenko, A. T.: Photometric analysis. Determination of non-metals. Izd. Khimiya, Moscow, (1974) (in Russian)
2. Satterle, H. S., Biodgett, G.: Ind. Eng. Chem. Anal. Ed. *16*, 400 (1944).
3. Babko, A. K., Ivaskovich, E. M.: Zh. Anal. Khim. *27*, 120 (1972)
4. Lisiczina, D. N., Shcherbov, D. P., Talatunova, N. A.: Investigations on chemical and physico-chemical methods in the analysis of minerals, Alma-Ata, *38*, (1973) (in Russian)
5. Duval, L.: Chim. Anal. *51*, 415 (1969)
6. Vasah, V., Sedivecz, V.: Chem. List. *46*, 341 (1952)
7. Bode, H., Hackmann, K.: Z. Anal. Chem. *229*, 261 (1967)
8. Dragomireczky et al.: Photometrische Analyse anorganischer Roh- und Werkstoffe, VEB. D. V. f. Grundstoffindustrie, Leipzig, 1968.
9. Peregud, E. A., Gernet, E. V.: Chemical analysis of the air of industrial plants, 1970 (in Russian) Izd. Khimiya, Leningrad, 1973.
10. Budova et al.: Analysis of aluminum and magnesium alloys, Izd. Metallurgy, Moscow, 1966
11. Official Methods of Analysis of the Association of Official Analytical Chemists, 11. ed. Washington, 1970. pp. 346
12. Jacobs, M. B.: The analytical toxicology of industrial inorganic poisons, Interscience, New York, 1967

13–16. see Al 7–10.

17. Moroshanova, S. A., Grishko, A. G., Shkatova, L. A.: Zh. Anal. Khim. *29*, 529 (1974)
18. Gastinger, E.: Microchim. Acta, 526 (1972)
19. Knopp, J. F.: Anal. Chem. *45*, 1786 (1973).
20. Basadre-Pampin, M., Alvarez-Devesa-Bermejo-Martinez, F., Ballagin-Rodriguez, M. H.: Microchem. J. *23*, 360 (1978)
21. Budensinsky, B. W.: Microchem. J. *24*, 80 (1979)
22. Ganago, L. J., Ishchenko, N. N.: Zh. Anal. Khim. *34*, 1768 (1979)
23. Malyutina, T. M., Savvin, S. B., Orlova, V. A., Mineeva, B. A., Kirillova, T. I.: Zh. Anal. Khim. *29*, 925 (1974)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Au	p-diethylaminobenzylidene rhodanine, 0.1 N HCl	500			— reagents [1]
	Rhodamine B, 1 N HCl, benzene	565	9, 7	4–8	— in soil, rocks [2]
	methyl violet, 1 N HCl, trichlorethylene	600	11.5		— in Cu 0.01 ppm conc. [3]
	HBr, pH 1	380	0.48		
	Michler thioketone, toluene-butanol		12.0	9–10	
	Crystal violet			8, 11, 2	
	Brillant green			12, 2	
	Chromopyrazol I			13	
	Rhodanine and derivatives			14–16	

Literature

1. Krobot, E. P.: Analysis of non-ferrous metals and their products, Izd. Metallurg. Moscow, 1971 (in Russ.)
2. Stanton, E. R., McDonald, A. I.: Analyst, *89*, 767 (1964)
3. Mizuike, A.: Talanta, *9*, 948 (1962)

4–7. see Al 7–10.

8. Nabivanetch, B. I., Zadorozhnaya, E. M., Masler, N. N.: Zh. Anal. Khim. *28*, 1901 (1973)
9. Tsukahara, I.: Talanta, *24*, 633 (1977)
10. Pilipenko, A. T., Ryabushko, O. P., Matsibura, G. S.: Zh. Anal. Khim. *34*, 1088 (1979)
11. Kothny, E. L.: Analyst, *94*, 198 (1969)
12. Fogg, A. G., Burgess, C., Burns, D. T.: Analyst, *95*, 1012 (1970)
13. Gorbunova, N. N., Busev, A. I., Ivanov, V. M.: Zh. Anal. Khim. *25*, 461 (1970)
14. Lichtenstein, I. E.: Anal. Chem., *47*, 465 (1975)
15. Borissova, R.: Talanta, *22*, 797 (1975)
16. Propistchova, R. F., Savvin, S. B., Rozovsky, Y. G.: Zh. Anal. Khim., *26*, 2424 (1971)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
B	Carminic acid, cc. H_2SO_4	610 or 585	7,0	1, 4, 10, 11, 12–15	– separation [1–4]
	Curcumin, ethanol, methanol, oxalic acid, ethanol	555, 540	18, 4	1, 4, 9	– photometric reagents [1–4, 6]
	Crystal violet (methyl violet), acidic, BF_4-benzene	600		1, 2, 11, 16	– in SiO_2 [7] – in soil [8]
	H-resorcin, acetic acid, pH 5.5	500	30.0	5	– in rocks [11]
	Brilliant green + HF, benzene		2.0	17	
	Methylene blue, HF, dichloroethane	645	6.5	13–15	
	Quinalizarin, cc. H_2SO_4	620			

Literature

1. Nemodruk, A., Karalova, Z. K.: Analytical chemistry of boron, Izd. Nauka, Moscow, 1964 (in Russian)
2. Eristavi, D. I., Broutchek, F. J.: Analytical methods of boron determination, Izd. Metsniereba, Tbilisi, 1965 (in Russian)
3. Boltz, D. F.: Colorimetric determination of nonmetals, Interscience, New York, 1958.
4. Babko, A. K., Pilipenko, A. T.: Photometric analysis, Determination methods of nonmetals, Izd. Khimiya, Moscow, 1964 (in Russian)
5. Grizo, V. A., Poluektova, E. N.: Zh. Anal. Khim. *13*, 435 (1958).
6. Östling, F.: Anal. Chim. Acta, *78*, 507 (1957)
7. Safran, I. G.: Preparation of chemical reagents, TREA, Moscow, 1961 (in Russian)
8. Keresztény, B.: Agricultural chemistry and geology, *15*, 1, (1966)
9. Methods of soil analysis, Part 2, Am. Soc. Agronomy, Publ. Madison, 1963.
10. Aryushkina, E. V.: Handbook of the chemical analysis of soil, 1970 (in Russian)
11. Chemical analysis of stones and minerals, Izd. Niedra, Moscow, 1974 (in Russian)

12–14. see Al 8–10

15. Boltz, D. F., Howell, J. (Eds). Colorimetric Determination of Nonmetals, 2nd ed., John Wiley, New York, 1978.
16. Buldini, P. L.: Anal. Chim. Acta *82*, 187 (1976)
17. Kuwada, K., Motomizu, S., Toei, K.: Anal. Chem., *50*, 1788 (1978)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Ba	see Sr				
Be	Acetylacetone, pH 7–8, EDTA, ion exchange separation	300	3.1	1, 10	– interfering effects [3]
	Beryllon II, pH 12–13, EDTA	620	1.2	1, 2, 8	– extraction [4]
	Beryllon IV, pH 6–8, EDTA	530	1.9		– in rocks [5–7]
	2-phenoxy-quinalizarin-3,3'-disulphanic acid-K salt, pH 6.0	550	1.12	11, 12	– in Al alloys [9]
	Aluminon, pH 7.6	535	0.22		
	Chrome azurol S, pH 5 + cetyltrimethyl-ammonium ion	615	2, 4		
			9.45	13	
	Eriochrome cyanine R + cetyltrimethyl-ammonium ion + EDTA, pH 7.0	590	8.7		
	Rhodamine B			14	

Literature

1. Hovoselova, A. V., Bakanova, L. R.: Analytical chemistry of beryllium, Izd. Nauka, Moscow, 1966 (in Russian)
2. Lukin, A. M., Zavarahina, G. V.: Zh. Anal. Khim. *11*, 393 (1956)
3. Karanovich, G. G.: Zh. Anal. Khim. *11*, 400 (1956)
4. Plotnikova et al.: Zav. Lab. *32*, 1063 (1966)

5. Shcherbov, D. P.: Zav. Lab. *27*, 1058 (1961)
6. Moyseyeva, L. M. et al.: Zh. Anal. Khim. *20*, 799 (1965)
7. Analytical chemical methods of mineral substances, 11. Niedra, Moscow, 1968 (in Russian)
8. Bichkov, L. A., Nevzorov, A. N.: Zav. Lab. *38*, 927 (1972)
9. Budanova, L. M., Voladarskaya, R. S., Kanayev, N. A.: Analysis of Mg and Al alloys, Metallurg., Moscow, 1966 (in Russian)
10. Merill, J. R. et al.: Anal. Chem. *32*, 1420 (1960)
11. Kusnyetsov, V. I. et al.: Zh. Anal. Khim. *18*, 160 (1963)
12. Owens, E. G.–Yoe, J. H.: Anal. Chem. *32*, 1345 (1960)
13. Nishida, H., Nishida, T., Ohtomo, H.: Bull. Chem. Soc. Japan, *49*, 571 (1976)
14. Poluiektova, N. S., Meshkova, S. B., Beltyukova, S. V., Tsepik, E. I.: Zh. Anal. Khim. *27*, 1721 (1972)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Bi	Dithizone, pH 2.8–3.2, CCl_4	490	7.9	5, 9–13	– ion pair formation,
	Thiourea, 0.5N acid	470	9; 0	6	extraction [1]
	KI, 0.5N acid or 1N H_2SO_4 + i-amylalcohol	460, 337	10–30	3, 14	– analytical evaluation [2–4]
	Dimercapto thiopiron, 0.5N H_2SO_4	360	2.2		– in minerals [5, 6]
	Diethyl dithiocarbamate, pH 7–10, CCl_4	400	6.3		– in alloys [7]
	Complexone III, pH 4.5	264	9.4		– in metals [8]
	Oxine, pH 4–5.2, $CHCl_3$	395	11		
	6N HCl	327	14.9		
	Rhodamine 6G	15.0	1.1–1, 3		
	Rhodamine B			15, 16, 17	
	Butyl rhodamine B				
	3-Nitrophenyl fluorone		5.0	18	

Literature

1. Antonovich, V. P.: Zh. Anal. Khim. *30*, 1566 (1975)
2. Busev, A. I.: Usp. Khim. *21*, 1502 (1952)
3. Acasevich, I. N., Stolyanov, K. P.: Chemical instrumental methods of analysis, Izd. Leningrad Univ., 1973 (in Russian)
4. Usatyenko, Ju. I.: Zav. Lab. *31*, 788 (1965)
5. Filippova, N. A. et al.: Spectrochemical methods of material analysis, Izd. Metallurg., Moscow, 1964 (in Russian)
6. Senderova, V. M.: Chemical analysis of minerals, Izd. Nauka, Moscow, 1964 (in Russian)
7. Cheng, K. L. et al.: Anal. Chem. *27*, 24 (1955)
8. Styopin, U. V. et al.: Analysis of non-ferrous metals and alloys, Izd. Metallurg., Moscow, 1965 (in Russian)
9–12. see Al 7–10.
13. see Ag 7

14. see Al 8.
15. Chwastowska, J.–Pruskowski, K.: Chem. Anal. (Warsaw) *21*, 525 (1976)
16. Kiss, E.: Anal. Chim. Acta, *72*, 127 (1974)
17. Toei, K., Motomizu, S., Korenaga, T.: Analyst, *100*, 629 (1975)
18. Korenaga, T.: Microchim. Acta II. 419 (1977)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Ca	Murexide, pH 12.5	514	1.4	1, 4	– in Ba [7]
	Calcium irea (Calcichrome, calcion),				– reagents [3]
	pH 12.5 15%, acetone	500	0.76	2, 4, 9	– in steel alloys [8]
	Chlorophosphonazo III, pH 7	664	5.4	6	– in trace amounts [15]
	Azo-azoxy-BN, pH 12–14, tributyl--phosphate			1, 4	
	Glyoxal-bis-(2-oxyanil), 0.04n NaOH, methanol	516	1.8	4, 5, 10–14	
	Arsenazo III, pH 6.5	655	1.0		

Literature

1. Gorbenko, F. P.: New methods of analysis in metallurgic works (in Russian)
2. Lukin, A. M. et al.: Zh. Anal. Khim. *18*, 444 (1963)
3. Howell, D. S. et al.: Anal. Chem. *38*, 343 (1966)
4. Marczenko, Z.: Photometric determination of elements, Izd. Mir, Moscow, 1971 (in Russian)
5. Gorbenko, F. P. et al.: Zh. Anal. Khim. *18*, 1198 (1963)
6. Yakovlev, P. J., Zhukova, M. P.: Zav. Lab. *36*, 1169 (1970)
7. Gorbenko, F. P., Satsko, V. V.: Zh. Anal. Khim. *20*, 309, (1965)
8. Yakovlev, P. J., Zhukova, M. P.: Zav. Lab. *37*, 1292 (1971)
9. West, T. S.: Analyst, *87*, 630 (1962)
10–12. see Al 8–10
13. Kuczerpa, A. V.: Anal. Chem. *40*, 581 (1968)
14. Keil, R.: Z. Anal. Chem. *253*, 15 (1971)
15. Brittain, H. G.: Anal. Chem. *49*, 969 (1977), Anal. Chim. Acta *96*, 165 (1978)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Cd	Dithizone, pH 4–12, CCl_4 or 5% NaOH, $CHCl_3$	520, 520	8.8, 8.0	1, 7–11	– comprehension [1]
	Br-Benzthiazo, 3% NaOH, xylene	580		2	– in rocks [6]
	Kadion irea, pH 9.4, acetone	410		3	– zinc-metal [4]
	Chromopyrazol II, 2N HCl+0.8N HBr, benzene	560	2.4	4	
	Sulpharsasene, pH 9.5–10	510	5.1	5	
	Diethyl-dithiocarbamate, pH 9, CCl_4	440	0.21		
	4-hydroxy-3-nitrophenyl-arsonic acid, pH 4–12, CCl_4	410			
	Br-PADAP		14.1	12	
	Crystal violet (I^-)		13.0	13	
	Malachite green			14	
	Rhodamine B			14	

Literature

1. Shcherbov, D. P., Matvejec, M. A.: Analytical chemistry of indium, Izd. Nauka, Moscow, 1973 (in Russian)
2. Skrobot, E. P.–Bakinovskaya, L. M.: Zav. Lab. *32*, 1452 (1966)
3. Lukin, A. M. et al.: Tr. IREA, *23*, 55 (1959)
4. Zhipopistzev, V. P., Chelnekova, M. N.: Zh. Anal. Khim. *18*, 71 (1963)
5. Partosnikova, M. Z., Safran, I. G.: Tr. IREA, *25*, 258 (1963)
6. Sandell, E. B.: Colorimetric determination of trace elements. Izd. Univ., Moscow, 1964 (in Russian)

7–10. see Al 7–10.

11. see Ag 7.
12. Shibata, S., Kamata, E., Nakashima, R.: Anal. Chim. Acta *82*, 169 (1976)
13. Courtot-Coupez, J., Guerder, P.: Bull. Soc. Chim. Fr. 1942 (1961)
14. Kish, P. P., Balog, I. S.: Zh. Anal. Khim. *34*, 2326 (1979)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Ce	see Rare earth metals				
Cl^-	Hg^{2+} + diphenyl-carbazone, pH 3.2	520	1.0	3	– indirect methods [1, 2, 9, 6]
Cl^-	Methyl orange		4.02	6–8	– in water [3]
↓					
Cl_2	Methyl red		1.17	9–10	– in blood serum [4]
	o-Tolidine		3.4	5, 10, 11	– in water active chlorine [5]
	$SCN^- + Hg^{2+} + Fe^{3+}$			12, 13	
ClO_4^-	Crystal violet			14, 15	
	Brilliant green		9.4	16	

Literature

1. Babko, A. K., Pilipenko, A. T.: Photometric analysis. Determination methods of nonmetals, Moscow, Izd. Khim. 1974. (in Russian)
2. Boltz, D. F.: Colorimetric determination of nonmetals, New York, Interscience, 1958.
3. Kemula, et al.: Talanta, *7*, 65 (1960)
4. Gerlach, J. Z., Frazier, R. G.: Anal. Chem. *30*, 1142 (1958)
5. Lurye, Ju. Ju. (ed.): Unified methods of water analysis, Izd. Khim., Moscow, 1973 (in Russian)
6. see B 15.
7. Laitinen, H. A., Boyer, K. W.: Anal. Chem. *44*, 920 (1972)
8. D'Amboise, M., Meyer-Grall, F.: Anal. Chim. Acta, *104*, 355 (1979)
9. see Al 8.
10. see B 15.
11. see Al 10.
12. Rodabaugh, R. D., Upperman, G. T.: Anal. Chim. Acta, *60*, 434 (1972)
13. Florence, T. M., Farrar, Y. I.: Anal. Chim. Acta, 54, 373 (1971)
14. Uchikawa, S.: Bull. Chem. Soc. Japan, *40*, 798 (1967)
15. Tsubouchi, M.: Anal. Chim. Acta, *54*, 143 (1971)
16. Fogg, A. G., Burgess, C., Burns, D. T.: Analyst, *96*, 854 (1971)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
CN^-	Pyridine + benzidine, water-ethanol	520	6.9	1–4	
	Pyridine + sulphanilic acid	450	6.2	1–4	
	Pyridine + barbituric acid	584	12.4	1–4	
	Ag + 1,10-Phenanthroline + bromo-pyrogallol red or eosin			5 6	

Literature

1. see Al 8.
2. see Al 10.
3. see B 15.
4. Nagashima, S.: Anal. Chim. Acta, *91*, 303 (1977)
5. Dagnall, R. M.–El-Ghamry, M. T.: West, T. S.: Talanta, *15*, 107 (1968)
6. Buhl, F., Kania, K.: Chem. Anal. (Warsaw) *24*, 1943 (1973)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Co	SCN^-, 0.1-1N HCl, organic solvent	620	0.17	5	– analysis [1]
	Nitroso-R-salt, 1-2N H^+	500	1.5	9–12	– in rocks [4–6]
	1-Nitroso-2-naphthol, pH 4–5, organic solvent	425 or 317	3.0, 2.6	1, 9–12	– in Ni-salts [5]
	PAR, 2–5 N H^+	510	5.6	2	– in iron ores [7]
	PAN, 2–5 N H^+	625	2.1	3	– in alkali hydroxides [8]
	3,5-Br-PADAB, 2–5 N H^+	590	12	4	
	Arsenazo I, aqueous medium	600	2, 5		
	Dithizone, pH 6–8, CCl_4	542	5.9		
	Diethyl-dithiocarbamate, pH 6.3, $CHCl_3$	650	0.5		
	2,2',2"-Terpyridyl, pH 2–10	482–502			
	2-Nitroso-1-naphthol		2.7–3.7	9–13	
	2-Nitroso-5-diethyl-aminophenol		6.2	14, 15	
	Cl-PADAB		1.13	16	
	Br-PADAB			17	
	3,5-dichlor-PADAT		1.19	18	
	Malachite green			19	
	Rhodamine 6G			20	

Literature

1. Pyatnitskii, O. V.: Analytical chemistry of cobalt, Izd. Nauka, Moscow, 1965 (in Russian)
2. Radovskaya, T. L.: Zav. Lab. *42*, 398 (1976)
3. Ersova, N. S. et al.: Zav. Lab. *41*, 913 (1975)
4. Kish, E.: Anal. Chim. Acta, *77*, 320 (1975)
5. Jackwerth, E., Schneider, E. L.: Z. Anal. Chem. *207*, 188 (1965)
6. Görbicz, M., Upor, E.: Acta Chim, Acad. Sci. Hung. *66*, 373 (1970)
7. Volkova, L. P., Pahamova, K. S.: Zav. Lab. *33*, 414 (1967)
8. Sustova, M. V., Nazarenko, V. A.: Zav. Lab. *39*, 18 (1973)
9–12. See Al 2–5
13. Wünsch, G.: Talanta, *26*, 177 (1979)
14. Motomizu, S.: Anal. Chim. Acta. *64*, 217 (1973), Talanta *21*, 654 (1974)
15. Toei, K., Motomizu, S.: Analyst, *101*, 497 (1976)
16. Shibata, S., Furukawa, M., Ishigura, Y., Sasaki, S.: Anal. Khim. Acta, *55*, 231 (1971)
17. Kish, E.: Anal. Chim. Acta, *66*, 385 (1973) *77*, 320 (1975)

18. Shibata, S., Furukawa, M., Kamata, E.: Anal. Chim. Acta, *73*, 107 (1974)
19. Kotelanskaya, K. I., Kish, P. P.: Zh. Anal. Khim. *28*, 1999 (1973)
20. Minczewski, J., Chwastowska, J., Lachowicz, E.: Chem. Anal. (Warsaw) *21*, 373 (1976)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Cr	1,5-Diphenyl carbazide, 0.01–0.2 N H_2SO_4	542	4.3	3, 4, 6, 7, 14, 15, 16	– separation [1]
	Arsenazo III,	550		11, 1	– photometric reagents [2]
	Complexone III, pH 3–5				
	Oxine, $CHCl_3$	420	0.8		– in rocks [4, 5]
colour of	CrO_4^{2-}-ions alkaline solution	370	0.49		– in minerals [6]
colour of	$Cr_2O_7^{2-}$-ions 0.9N H_2SO_4	455	0.18		– in water [7, 8]
	0.5-5N H_2SO_4 (Chromotropic acid)	400	0.34		– in steels, alloys, [9, 10, 12, 13]
	PAR, $CHCl_3$		4.7	17	

Literature

1. Beyerman, K.: Z. Anal. Chem. *190*, 4 (1962)
2. Tatajev, O. A., Abdulayev, R. R.: Zh. Anal. Khim. *25*, 930 (1970)
3. Van der Walt, C. F. J., van der Merwe, A. J.: Analyst, *63*, 809 (1938)
4. Jeffery, P. G.: Chemical methods of rock analysis, Pergamon, Oxford, 1970
5. Easton, A. J.: Anal. Chim. Acta, *31*, 189 (1965)
6. Pilkington, E. S., Smith, P. R.: Anal. Chim. Acta, *39*, 321 (1967)
7. Kovalenko, E. V.: Tr. Komissii po Anal. Khim. *15*, 101 (1965)
8. Adam, J.: Hutn. Listy, *29*, 739 (1974)
9. Dragomireczky, A. et al.: Photometrische Analyse Roh- und Werkstoffe, VEB Deutscher Verlag, Leipzig, 1968
10. Adam J.: Talanta *18*, 91 (1971)
11. Tatayev, O. A., Guseinov, V. K.: Zh. Anal. Khim. *30*, 935 (1975)
12. Kinhikar, G. M., Dara, S. S.: Talanta *21*, 10208 (1974)
13. Ahmedov, S. A. et al.: Zav. Lab. *37*, 756 (1974)
14. Adam J., Pribil, R.: Talanta *21*, 616 (1974)
15. Onishi, H., Koshima, H.: Bunseki Kagaku, *27*, 726 (1978)
16. Shimogawa, K., Mori H., Takada, H.: Bunseki Kagaku, *28*, 473 (1979)
17. Yotsuyanagai T., Takeda, Y., Yamashita R., Aomura K.: Anal. Chim. Acta *67*, 297 (1973)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Cu	Sodium diethyldithiocarbamate, pH 9	436	1.28	1, 8, 9	– in rocks [1, 7, 10]
	NH_4OH, pH 10	578		6, 8, 9	– in plants [2]
	Cuproin Cu^+, pH 4–7.5	546	0.63	9, 10, 14–23	– in natural and industrial waters [3, 4]
	Neocuproin, pH 3–10	460		9, 10 14–23	waters [3, 4]
	Bathocuproin, pH 4–10	480		9, 10 14–23	– in Cd-salts [5] – in raw and cast iron [8, 9]
	8,8'-Diquinolyldisulphide, pH 2–13	432	0.95	12, 13	– in soil [11]
	Cupron, pH 11.3–12.0, $CHCl_3$	440	0.3		– in rare earth
	8-Mercaptoquinoline, 2.5 N HCl, toluene	432	0.8		metals and alloys [12]
	Oxine, pH 2.7–14, 0; $CHCl_3$	410	0.5		
	Pyridine + SCN^-, weak acid sol., $CHCl_3$	415	0.2		
	1,3-Dimethyl-4-imino-5-oxy-imino-alloxane, pH 7–9.5	482			
	Zinc-dibenzyl dithiocarbamate, 1N HCl	435			
	Complexone I., 1N HCl	700			
	Complexone III., pH 10	725			
	$Cu(CN)_2^-$ + methylene blue, 1,2--dichloroethane		9.8	24	
	Pyrocatechol violet + tridodecyl--ethyl-ammonium ion, benzene		7.9	25	
	Cyclohexyl fluorone		19.1	26	
	Dithizone, 0.1 N HCl, CCl_4				
	pH 6, CCl_4	545	4.5	27, 28	
		445	2.3		

Literature

1. Görbicz, M., Upor E.: Acta Chim. Acad. Sci. Hung. *66*, 373 (1970)
2. Page, E. R.: Analyst, *90*, 435 (1965)
3. The Testing of Water, 5. ed. Darmstadt, Merck
4. Lurye, Ju. Ju., Ribinkova, A. I.: Chemical analysis of waste waters in plants. 4. ed. Moscow, Khim. 1974 (in Russian)
5. Podchaynova, V. N. et al.: Zav. Lab. *38*, 411 (1972)
6. Grant, D. M., Kollrack, R.: J. Inorg. Nucl. Chem. *23*, 35 (1961)

7. Upor E., Mohai, M., Novák G.: Photometric methods of trace analysis, Budapest, Műszaki Könyvkiadó, 1978
8. Spauszus, S.: Methoden der Chemischen Stahl- und Eisenanalyse, Leipzig, VEB, Deutscher Verlag, 1968
9. Dragomireczky, N. et al.: Photometrische Analyse anorganischer Roh- und Wertkstoffe, Leipzig, VEB, Deutscher Verlag, 1968
10. Simo B.: Magy. Kem. Lapja, *26*, 408 (1971)
11. Vazenina, I. G.: (ed.). Determination methods of microelements in soils, plants and waters. Moscow, Kolosz, 1974
12. Analytical chemistry of inorganic compounds. Sverdlovsk, Akd. Nauka, 1974 (in Russian)
13. Bankovski, Ju. A. et al.: Zh. Anal. Khim. *16*, 150 (1961)
14. Smith, G. F., Wilkins, D. H.: Anal. Chem. *25*, 510 (1953)
15.–18. see Al 7.–10.
19. see Ag 7.
20. Bailey, B. W., Dagnall, R. M., West T. S.: Talanta, *13*, 753 (1966)
21. Gershuns, A. L., Adamovich, L. P., Skorobopatov, V. M.: Zh. Anal. Khim., *29*, 1905 (1974)
22. Skorobogatov, V. M., Gershuns, A. L., Adamovich, L. P., Kogan, I. M.: Zh. Anal. Khim. *30*, 1704 (1975)
23. Skorobogatov, V. M., Gershuns, A. L., Adamovich, L. P.: Zh. Anal. Khim. *32*, 1450 (1977)
24. Koh, T., Aoki Y., Suzuki Y.: Anal. Chem. *50*, 881 (1978)
25. Shijo, Y.: Bull. Chem. Soc. Japan, *47*, 1642 (1974)
26. Asmus, E., Kossmann, U., Ortlepp, W.: Z; Anal. Chem. *298*, 150 (1979)
27. Turkington, R. W., Tracy, F. M.: Anal. Chem. *30*, 1699 (1958)
28. Stoner, R. E., Dasler, W.: Anal. Chem. *32*, 1207 (1960)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
F	Alizarin S + Th^{4+}, pH 2	525	1, 4	1, 21–28	– reagents [2–7]
	Alizarin S + Zr^{4+}, 0.6–1 M H_2SO_4	525		1	– separation [8–10]
	Sulphosalicylic acid + Fe^{3+}, pH 2.9	500			– in rocks [17–20]
	Eriochrome cyanine R + Zr^{4+}			11, 12, 16, 21–23	
	Alizarin + La^{3+}, pH 4.0 water-acetone		1.4	1, 13	
	Pyrocatechol violet + Zr^{4+}			19	
	$Fe(SCN)_3$, amyl alcohol			14, 15	
	Alizarin derivatives			29–31	
	Zn-sulphochlorophenol S		3.0	32–33	
	Th-xylenol orange		3.0	32–33	

Literature

1. Belcher, R., West T. S.: Talanta, *8*, 853 (1961)
2. Nikolayev, N. S.: Analytical chemistry of plants. Moscow, Izd. Nauka, 1970 (in Russian)
3. Babko, A. K., Pilipenko, A. T.: Photometric analysis, determination methods of nonmetals. Moscow, Izd. Khim. 1974 (in Russ)
4. Boltz, D. F.: Colorimetric determination of nonmetals. New York. Interscience, Publ. 1958

5. Moraru, L.–Suten, A.: St. cerc. Chim. *19*, 757 (1971)
6. Tusl, J.: Chem. Listy. *61*, 1302 (1967)
7. Crosby, N. T. et al.: Analyst, *93*, 643 (1968)
8. Lorec, S.: Chim. Anal. *49*, 557 (1967)
9. Richter, F.: Z. Anal. Chem. *124*, 161 (1942)
10. Tusl, J.: Chem. Listy. *63*, 777 (1969)
11. Cooke, J. R.: Proc. Soc. Water Treat. Exam. *14*, 145 (1965)
12. Huang, P. M., Jackson, M. L.: Am. Mineral *52*, 1053 (1967)
13. Frambe A.: Vom Wasser, *42*, 161 (1974)
14. Pantyeleyeva, E. P.: Zh. Khim. *21*, 183 (1974)
15. Moucmanova, A., Malinovsky, M.: Chem. Zvesti, *19*, 287 (1965)
16. Huang, W. H., Johns, W. D.: Anal. Chim. Acta *37*, 508 (1967)
17. Dedkova, V. P. et al.: Organic ragents in analytical chemistry. Kijev, 129 Izd. Nauka Dumka, 1976 (in Russian)
18. Prilutskaya, T. A., Arapova, C. A.: Chemical, physico-chemical methods of the determination of rocks, ores and minerals Moscow, Izd. Nauka, 1974, pp 45 (in Russian)
19. Minyin, AA., Filippova, R. P.: Alizarin complexone, Moscow, Nitehim, 1970 (in Russian)
20. Hall, A., Walsh J. N.: Anal. Chim. Acta *45*, 341 (1969)
21. see Al 8.
22. see Al 10.
23. see B 15.
24. Flaschka, H., Weiss, R.: Mikrochem. J. 14, 318 (1969) 15, 653 (1970)
25. Kirsten, W. J., Shah, Z. H.: Anal. Chem. *47*, 184 (1975)
26. Haarsma, J. P., Agterdenbos, J.: Talanta, *18*, 747 (1971)
27. Marczenko, Z., Lenarczyk, L.: Chem. Anal. (Warsaw) *21*, 151 (1976)
28. Rudenko, E. J., Popov, V. A.: Zav. Lab. *45*, 388 (1979)
29. Minin, A. A., Barmina, A. G., Khakhalkina, I. G.: Zh. Anal. Khim. *30*, 2196 (1975)
30. Deane, S. F., Leonard, M. A., Me Kee, V., Svehla, G.: Analyst, *33*, 1164 (1978)
31. Deane, S. F., Leonard, M. A.: Analyst, *102*, 340 (1977)
32. Gzhashi, D. O., Dedkova, V. P., Savvin, S. B.: Zh. Anal. Khim. *33*, 1164 (1978)
33. Yurkevitzinte, J., Malat, M.: Collect. Czech. Chem. Comm. *43*, 2885 (1978)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Fe	SCN^-, 0.5–1 N HNO_3	475	0.74	1, 2, 3, 10,	– in yttrium-
	0.2 N HNO_3 + extraction	500	2.4	14–17	oxide [3]
	Sulphosalicylic acid, pH 8.5–11.5	420	0.56	9	– in natural water [5]
	Diethyl dithiocarbamate, pH 0–10, $CHCl_3$	514	0.27		– in rocks [6, 7, 9]
	Cupferron, 1 : 9 H_2SO_4, $CHCl_3$	420	0.36		– in blood serum [8]
	1-Nitroso-2-naphthol, weakly alkaline	700	0.63		
	solution, ethyl acetate, $CHCl_3$	407	0.29		
	Oxine, weakly acidic sol., $CHCl_3$	470	0.58		
	Salicylic acid, pH 2.6–2.8	520	0.16		
	Salicylaldoxime, pH 6.2–6.6	480			
	Ferron, pH 2.7–3,1	610	0.36		

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Fe	6.7 N HCl	342	0.29		
	Tartaric acid, pH 1.5–2.3	360			
	Dimethyl glyoxime, NH_4OH	550	1.0		
	2, 2', 2"-Terpyridyl, pH 3–10	552			
	Complexone, III. 1N HCl	260			
	Hexacyanoferrate (III) and (II) ion, pH 2–2.5	610	0.5	1, 4, 10	
	2, 2'-Dipyridyl, pH 3–9	522	0.86	6	
	1, 10-Phenanthroline, pH 2–9	512	1.1	11, 14–18	
	Bathophenanthroline, $CHCl_3$-ethanol	535	2.2	8, 12, 13–17 19–23	
	Rhodamine B + $(FeCl_4)^-$, benzol		9.0	23–25	
	Eriochrome cyanine R, xylene		17.0	26, 27	
	TPTZ			28	
	PPDT			29, 30	
	Ferroine + methyl orange or bromophenol blue		4.8 5.9	31 32	

Literature

1. Babko, A. K., Pilipenko, A. T.: Colorimetric analysis, Budapest, Akadémiai Kiadó, 1953 (in Hungarian)
2. Babko, A. K., Pilipenko, A. T.: Photometric analysis, General aspects and instruments. Moscow, Khim. 1968 (in Russian)
3. Szalai J., Upor E.: Pécsi Műszaki Szemle, *16*, 1 (1971)
4. Upor E.: Acta Chim. Acad. Sci. Hung. *73*, 133 (1972)
5. The Testing of Water, 5. ed. Darmstadt, E. Merck
6. French, W. J., Adamo, S. J.: Analyst, *97*, 828 (1972)
7. Kish E.: Anal. Chim. Acta, *72*, 127 (1974)
8. Richterich, R.: Klinische Chemie, 3. ed. S. Karger, 1971
9. Moizesz, I. B. (ed.). Handbook to the analysis of phosphour, phosphoric acid and chemical fertilizers, Khim, Leningrad, 1973 (in Russian)
10. Luke, C. L.: Anal. Chim. Acta, *36*, 122 (1966)
11. Fadrus, H., Maly J.: Anal. Chim. Acta, *77*, 315 (1975)
12. Gahler, A. R. et al.: Anal. Chem. *33*, 1937 (1961)
13. Clark L. J.: Anal. Chem. *34*, 349 (1962)

14.–17. see Al 7.–10.

18. Analytical Methods Committee: Analyst, *103*, 391 (1978)
19. Perry R. D.–San Clemente, C. L.: Analyst, *102*, 114 (1977)
20. Analytical Methods Committee: Analyst, *103*, 521 (1978)
21. Stookey, L. L.: Anal. Chem. *42*, 779 (1970)
22. Carter, P.: Microchim. Acta, 410 (1972)
23. Likussar, W., Wawschinek, O., Beyer, W.: Anal. Chim. Acta, *40*, 538 (1968)
24. Imai, H.–Yamada, T.: Bull. Chem. Soc, Jap., *42*, 237 (1969)
25. Korenaga, T., Motomizu S, Toei, K.: Anal. Chim. Acta, *65*, 335 (1973)

26. Marczenko Z., Kalowska H.: Anal. Chim. Acta, *123*, 279 (1981)
27. Shijo, Y.: Bull. Chem. Soc. Japan. *48*, 2793 (1975)
28. Stephens, B. G., Suddeth, H. A.: Anal. Chem. *39*, 1478 (1967)
29. Schilt, A. A.–Hoyle, W.: Anal. Chem. *39*, 114 (1967)
30. see Bi 16.
31. Hulaniczki, A.–Nieniewska, J.: Talanta, *21*, 896 (1974)
32. Kobyakowa, S. O., Savostina, V. N., Peshkova, V. M.: Zh. Anal. Khim. *29*, 300 (1974)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Ga	Quinalizarine, pH 5	500	1.1		– analysis [1, 2]
	Aluminon, pH 3.5–4	490	1.8		– in alloys [3–8]
	Brilliant green, 6N HCl, $CHCl_3$, benzene	635	1.5	18, 19	– separation by extraction [9–11]
	Malachite green, 6N HCl, $TiCl_3$, benzene	635	7.6	3–5	– in bauxite, in rocks [1, 4, 12]
	Methyl violet, 6N HCl, $CHCl_3$	580	27		– in In-Ga alloys [13]
	Rhodamine B, 6N HCl+$TiCl_3$, benzol	565	10.0	6–8, 14–17, 20	
	Butyl rhodamine B, 6N HCl+$TiCl_3$, benzene	565	9.0		
	Gallion IREA, pH 3.6	600	2.5		
	Eriochrome cyanine R		12.0	21	
	Pirocatechol violet		10.8	22	
	Methylene blue			23	
	Methyl green			24	
	Victoria blue 4R			25, 26	
	Chromoazurol S			27	
	PAR		8.2	28	

Literature

1. Dimov, A. M. et al.: Analytical chemistry of gallium. Moscow, Izd. Nauka, 1968 (in Russian)
2. Savostyin, A. P. Zav. Lab. *9*, 1045 (1964)
3. Iankovsky, J.: Talanta, *2*, 29 (1959)
4. Klein, P. et al.: Chem. Prumysl. *13*, 250 (1963)
5. Urbanek, E.: Paliva *41*, 88 (1961)
6. Onishi, H.: Anal. Chem. *27*, 832 (1955)
7. Culkin, F., Riley, J. P.: Anal. Chim. Acta, *24*, 413 (1961)
8. Parissakis, G., Issopoulos, P. B.: Microchim. Acta, 28, (1965)
9. Grahame, D. C. et al.: Am. Chem. Soc. *60*, 2524 (1938)
10. Irving, H. M. et al.: Analyst, *77*, 801 (1952)
11. Busev, A. I. et al.: Zh. Anal. Khim. *17*, 56 (1962)
12. Thakur, R. S., Sant, B. R.: J. of Sci, and Ind. Research *31*, 384 (1972)
13. Nishimura, K. et al.: C. A. *61*, 10029d (1964)
14.–17. see Al 2.–5.

18. Armeanu, V., Costinescu, P.: Talanta, *14*, 699 (1967)
19. Fogg, A. G., Burgess, C., Burns, D. T.: Analyst, *98*, 347 (1973)
20. Prabhu, B. N., Khopkar, S. M.: Talanta, *25*, 109 (1978)
21. Marczenko, Z., Kalowska, H.: Microchim. Acta, *2*, 507 (1979)
22. Akhmedly, M. K., Gluschenko, E. L., Gasanova, Z. L.: Zh. Anal. Khim. *26*, 1947 (1971)
23. Kish, P. P., Bukovich, A. M.: Zh. Anal. Khim. *24*, 1653 (1969)
24. Tarayan, V. M., Ovsepyan, E. N.–Pogosyan, A. N.: Zav. Lab. *36*, 656 (1970)
25. Kish, P. P., Bukovich, A. M.: Ukr. Khim. Zh. *35*, 1290 (1969)
26. Uesugi, K., Shigematsu, T.: Talanta, *24*, 391 (1977)
27. Evtimova, B., Nonova, D.: Anal. Chim. Acta, *67*, 107 (1973)
28. Siroki, M., Herak, N. J.: Anal. Chim. Acta, *87*, 193 (1976)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Ge	Phenyl-fluorone, pH 5	510	5.3 17.0	3, 4, 5, 12	– extraction [1, 2, 4, 6, 13, 16]
	Resaron	560		10	– in rocks [1, 7]
	PAN	560		11	– in carbon and carbon products [1, 8, 9]
	Brilliant green		19.0	13, 14	
	Rhodamine 6G		29.0	15	– in silver alloys [10]
	Malachite green		14.0	16	
	Pyrocatechol violet		5.0	17	

Literature

1. Nazarenko, V. A.: Analytical chemistry of Ge. Moscow, Izd. Nauka, 1973 (in Russ)
2. Marczenko, Z.: Photometric determination of elements, Moscow, Izd. Mir. 1971 (in Russ)
3. Lukin, A. M. et al.: Zh. Anal. Khim. *21*, 970 (1966)
4. Luke, C. J., Campbell, M. E.: Anal. Chem. *28*, 1273 (1956)
5. Shijo, Y., Takeuchi, J.: Japan Analyst *16*, 51 (1967)
6. Schneider, W. A., Sandell, E. B.: Microchim. Acta, 263 (1954)
7. Popov, N. P., Stolyarova, I. A.: Chemical analysis of minerals, Moscow, Izd. Nedra, 1974 (in Russian)
8. Ura, M.: J. Chem. Soc. Japan, Pure Chem. Sect, *78*, 316 (1957)
9. Nazarenko, V. A. et al.: Zav. Lab. *24*, 9 (1958)
10. Budiak, N. F., Yekimenkova, T. A.: Analysis of contacts and conducting alloys. Izd. Metallurg, Moscow, 1975 (in Russian)
11. Chang, S. K., Goydish, B. L.: Anal. Chim. Acta, *34*, 154 (1966)
12. Nazarenko, V. A., Makrinichi, N. I., Shustova, M. B.: Zh. Anal. Khim. *25*, 1595 (1970)
13. Nazarenko, V. A., Lebedeva, N. V., Vinarova, L. J.: Zh. Anal. Khim. *27*, 128 (1972)
14. Ganago, L. I., Prostak, I. A.: Zh. Anal. Khim, *30*, 1349 (1975)
15. Fyantikova, T. V., Korolenko, L. I.: Zh. Anal. Khim, *30*, 1349 (1975)
16. Nazarenko, V. A., Vinarova, L. I., Lebedeva, N. V., Lyakh. R. A.: Ikr. Khim. Zh. *43*, 1325 (1977)
17. Leong, C. L.: Talanta, *18*, 845 (1971)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Hg	Dithizone, pH 4–5, CCl_4	490	7.0	1, 2, 5, 6, 7, 23–26	– in air [4]
	Furacylline, pH 3.5–4.5	420–480		3	– in rocks [8, 9]
	2-(Quinolyl-azo)-4,5-diphenyl--imidazol		8.0	14	– in biological substances [10]
	PAN, pH 7.5	560		1, 13	– in waters [11, 12]
	Diethyl-dithiocarbamate pH 5–6, $CHCl_3$	492	7.0		– extraction [15, 16]
	pH 3.7 CCl_4	340	1.0		
	Diphenyl carbazone, pH 5.7				
	Malachite green (I^-, benzol)		8.7	17	
	Michler-thioketone, pH 5.8, 30% n-Propanol		15.1	18, 19	
	Methyl green			16	
	Methyl violet			17, 20, 21, 22	
	Brilliant green			22	
	Rhodamine B			22	

Literature

1. Gladisev, V. P. et al.: Analytical chemistry of Hg. Moscow, Izd. Nauka, 1974 (in Russian)
2. Chilov, S.; Talanta, *22*, 205 (1975)
3. Bagdasarov, K. N. et al.: Zav. Lab. *34*, 390 (1968)
4. Peregud, E. A., Garnet, E. V.: Chemical analysis of the air of industrical plants, Leningrad, Khim, 1970 (in Russian)
5. Iwantseff, G.: Das Dithizon und seine Anwendung in der Mikro- und Spuranalyse, Weinheim, Verlag Chemie, 1972
6. Gladiseva, K. V.: Sb. Trud. Vses. Nauk. Issl. Gorn. Met. Inst. Cvet. Met. 7, 325 (1962)
7. Vasilyevskaya, A. E. et al.: Zh. Anal. Khim. *19*, 1200 (1964)
8. Knipovich, Ju. N., Morachevskiy, Ju. V.: Analysis of minerals, Leningrad, GHJ, 1959 (in Russian)
9. Dragomireczky, A. et al.: Photometrische Analyse anorganischer Roh- und Werkstoffe, Leipzig, VEB, 1968
10. Woidich, H., Pfaunhauser, W. H.: Anal. Chem. *261*, 31 (1972)
11. Lurje, Ju. Ju.: General methods of water analysis. 2. ed. Moscow, Khim. 1973 (in Russian)
12. Lurje, Ju. Ju., Ribnikova, A. J.: Chemical analysis of industrial waste waters. Khim. Moscow, 1974 (in Russian)
13. Shozo Shibala: Anal. Chim. Acta, *25*, 348 (1961)
14. Shibata, S., Furukawa, M., Nakashima, R.: Anal. Chim. Acta, *81*, 131 (1976)
15. Tsubouchi, M.: Anal. Chem. *42*, 1087 (1970)
16. Tarayan, V. M., Ovsepyan, E. N., Lebedeva, S. P.: Zh. Anal. Khim. *26*, 1745 (1971)
17. De, A. K., Pal, B. K.: Microchim. Acta, *2*, 201 (1979)
18. Cheng, K. L., Goydish, B. L.: Microchem. J., *10*, 158 (1966)
19. Ackermann, G., Röder, H.: Talanta, *24*, 99 (1977)
20. see Au 11.

21. Pilipenko, A. T., Kish, P. P., Witenko, G. M.: Ukr. Khim. Zh. *40*, 850 (1974)
22. Kish, P. P., Spirakov, B. Y., Roman, V. V., Zolotov, Y. A.: Zh. Anal. Khim. *32*, 1942 (1977)
23.–26. see Al 7.–10.

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
I, I^-	Starch-iodine		10.8	1, 2	
	Nile blue A, $CHCl_3$		3.6	3.4	
	Crystal violet			5	
	Ferroin			6	
	Bis(neocuprin)CuI			7	
	Dithizone + Hg^{2+} (indirect)			8	
	2-Nitroso-5-diethyl-aminophenol + Pd^{2+} (indirect)			9	

Literature

1. see Al 8.
2. Flaschka, H., Hornstein, J. V.: Mikrochem. J. *23*, 488 (1978)
3. Likussar, W., Pokorny, G., Zechman, H.: Anal. Chim. Acta, *49*, 97 (1970)
4. Brown, L. C., Boyd, G. E.: Anal. Chem. *42*, 291 (1970)
5. Lomonosov, S. A., Shukolyukova, N. I.; Chernoukhova, V. I.: Zh. Anal. Khim. *28*, 2389 (1973)
6. Yamamoto, Y., Tarumoto, T., Tsubouchi, M.: Bull. Chem. Soc. Japan *44*, 2124 (1971)
7. Yamamoto, Y., Kumamaru, T., Hayashi, Y., Yamamoto, M.: Anal. Chim. Acta, *69*, 311 (1974)
8. Agterdenbos, J., Jülte, B., Elberse, P. A.: Talanta *17*, 1085 (1970)
9. Hamada, S., Motomizu, S., Töei, K.: Analyst *104*, 880 (1979)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
In	Dithizone, pH 9, CCl_4	510	11.9	8–10	– separation [1, 6]
	Chromoazurol S			11	– reagents [2]
	Oxine, pH 3.5, $CHCl_3$	395	6.7		– in rocks, alloys [5]
	2, 3, 7-Trioxy-9, 2', 4'-disulphophenyl--fluorone, 6N HCl, buthyl acetate	530			– in silver wire [7]
	5, 7-dibromo-8-hydroxyquinoline				
	Rhodamine 6 Z, benzene	625		4	
	Thiooxine			2–4	
	Brilliant green + $InBr_4^-$, butanol, $CHCl_3$		9.3	12, 13	
	Rhodamine B and buthylrhodamine B + $InBr_4$, diisopropyl ether, benzene		11.0		
			11.2	14	
	Eriochrome cyanine R, pH 5.2		1–1.2	15	
	Malachite green			16	

Literature

1. Chemical analysis of stones and minerals. Izd. Niedra, Moscow, 1974 (in Russian)
2. Busev, A. J.: Analytical chemistry of indium. Moscow, Izd. ANSSSR, 1958 (in Russian)
3. Marczenko, Z.: Photometric determination of elements, Moscow, Izd. Mir, 1971 (in Russian)
4. Röbisch, G.: Z. Vhem. *13*, 64 (1973)
5. Nazarenko, V. A., Ravitskaya, R. V.: Zav. Lab. *31*, 1301 (1965)
6. Levin, I. S., Nazarenko, T. G.: Zav. Lab. *28*, 1313 (1962)
7. Budiak, N. F., Yekimenkova, T. A.: Analysis of contacts and conducting alloys. Izd. Metallurg., Moscow, 1975 (in Russian)
8. see Al 9.
9. see Al 10.
10. see Ag 7.
11. see Ga 27.
12. see Ga 19.
13. Zolotov, A., Kish, P. P., Bagreev, V. V., Pogoida, I. I.: Zh. Anal. Khim. *29*, 221 (1974) *30*, 1962 (1975)
14. Garcic, A., Sommer, L.: Collect. Czech. Chem. Comm. *35*, 1047 (1970)
15. Marczenko, Z., Kalowska, H.: Chem. Anal. (Warsaw), *25*, 555 (1980)
16. Kish, P. P., Pogoida, I. I.: Zh. Anal. Khim. *29*, 52 (1974)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Ir	see Plantinum metals				
K	Dipicrylamine, pH 9, CCl_4	510	11.9		– in natural waters [3]
	Nitroso-R-salt				
Li	Nitroanthranylazo, alkaline, H_2O-acetone (also for Na)	530	1.2	1, 2, 5	– Na-determination [4]
	Thoron, pH 13, acetone:water = 7 : 3	486	0.6	5, 6	
Na	dipicrylamine (indirect)			5, 6	
Rb	Picric acid (indirect)			5, 6	
Cs	Cobalt nitrite (indirect)			5.6	
	Phosphor-molybdenum blue (indirect)			5.6	

Literature

1. Dziomko, V. M. et al.: Zh. Anal. Khim. *23*, 170 (1968)
2. Morgen, E. A., Vlasov, N. A.: Z. Prik. Khim. *44*, 2752 (1971)
3. Lurie, Ju. Ju.: General methods of analysis of water. Moscow, Izd. Khim. 1973 (in Russ)
4. Lundell, G. E. F., Bright, H. A., Hoffman, J. I.: Applied Inorganic Analysis, 1955
5. see Al 8.
6. see Al 7.

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Mg	Chromotrop 2R, pH 10, 5–11.0	570	3.7	1, 14	– reagents [1–3]
	Erichrome black T, pH 10–10.2	545	2.2	1, 9–11	– in plants [4]
	Chlorophosphonazo III, pH 7	669	4.8	1, 12	– in biological
	Magneson IREA, pH 9.8–11.2	520	1.6	1, 2	tissues [5]
	Titanium yellow, 0.6–0.8n NaOH by				– in silicates [6]
	extraction	545	3.6	1, 4,	– in Ag alloys [7]
			5.5	9–11	– in Fe alloys [8]
	Phenazo, 1–2 N NaOH	560	3.5	1, 2, 13	
	Oxine, pH 10.5–11.5 n-butyl amine, $CHCl_3$	380	0.5	3	

Literature

1. Tihonov, V. N.: Analytical chemistry of Mg. Moscow, Izd. Nauka, 1973 (in Russian)
2. Tihonov, V. N.: Zh. Anal. Khim. *26*, 1616 (1971)
3. Fries, J., Gehost, H.: Organische Reagenzien für die Spuranalyse, Merck, 1975.
4. Bradfield, E. G.: Analyst, *85*, 667 (1960) *86*, 269 (1961)
5. Butler, E. J. et al.: Anal. Chim. Acta *30*, 524 (1964)
6. King, H. G., Pruden, G.: Analyst, *92*, 83 (1967)
7. Budiah, N. F., Yekimonkova, T. A.: Analysis of contacts and conducting alloys. Izd. Metallurg. Moscow, 1975 (in Russian)
8. Kulikovskaya, Z. B., Gregorenski: A. S.: Zav. Lab. *39*, 949 (1973)
9. see Al 7.
10. see Al 8.
11. Marczenko, Z., Moyski, M., Barcezak, M.: Mikrochim. Acta *I*, 539 (1975)
12. Ferguson, J. W., Richard, J. J., O'Laughlin, J. W., Banks, C. V.: Anal. Chem. *36*, 796 (1964)
13. Piatnisku, I. V., Pinaeva, S. G., Pospelova, N. N.: Zh. Anal. Khim. *30*, 2316 (1975)
14. Shibata, S., Uchiumi, A., Sasahi, S., Goto, K.: Anal. Chim. Acta, *44*, 345 (1969)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Mn	MnO_4^- own colour, 0.1 N H_3PO_4	525	0.24	2	— analysis [1]
	Formaldoxime, pH 10–13	455	1.1	6, 11–16	
	PAN, pH 9.5, CCl_4, $CHCl_3$	568	4.7	11, 13	— MnO_4^--ion
			5.8	17, 18	[1, 3, 9, 10]
	Diethyl dithiocarbamate (DTK), pH 6.5, $CHCl_3$	500	0.4	19	— in iron ores [4]
	Carboxybenzene S, $CHCl_3$		15.0		— in plants [5]
	PAR			20, 21	— in waters [7, 8]
	Dithizone + pyridine + phenol		5.7	22	
			4.6	19, 23	

Literature

1. Lavruhina, A. K., Yukina, L. V.: Analytical chemistry of Mn. Moscow, Izd. Nauka, 1974 (in Russian)
2. Gottschalk, G.: Z. Anal. Chem. *212*, 303 (1965)
3. Bane, R. W.: Analyst, *90*, 756 (1965)
4. Ponomariev, A. I.: Analytical chemical methods of Se, magnetic Ti and Cr ores. Nauka, Moscow 1966, (in Russian)
5. Vazenina, I. G.: Determination methods of microelements in soils, plants and waters. Kolos, Moscow, 1974 (in Russian)
6. Marczenko, Z.: Photometric determination of elements, Moscow, Mir, 1971 (in Russian)
7. Katsumi, Goto et al.: Anal. Chim. Acta, *27*, 331 (1962)
8. Henriksen, A.: Analyst *91*, 647 (1966)
9. Strickland, J. D. H., Spicer, G.: Anal. Chim. Acta, *3*, 517 (1949)
10. Nydahl, F.: Anal. Chim. Acta, *3*, 144 (1949)

11–13. see Al 8.–10.

14. Marczenko, Z.: Anal. Chim. Acta, *31*, 224 (1964)
15. Adam, J., Pribil, R.: Talanta *19*, 1105 (1972)
16. Gine, M. F., Zaggatto, E. A., Filko, H. B.: Analyst *104*, 371 (1979)
17. Goto, K., Taguchi, S., Fukue, Y., Ohla, K., Watanabe, H.: Talanta *24*, 752 (1977)
18. Betteridge, D., Fernando, Q., Freiser, H.: Anal. Chem. *35*, 294 (1963)
19. Savvin, S. B., Petrova, T. V., Dzherayan, T. G.: Zh. Anal. Khim. *33*, 516 (1978)
20. Nonova, D., Evtimova, B.: Talanta *20*, 1347 (1973)
21. Ahrland, S., Herman, R. G.: Anal. Chem. *47*, 2422 (1975)
22. Marczenko, Z., Moyshi, M.: Anal. Chim. Acta, *54*, 469 (1971)
23. Akaiwa, H., Kawamoto, H., Kogure, S.: Bunseki Kagaku *28*, 498 (1979)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Mo	SCN^-, 4 N H_2SO_4, n-amyl-acetate, or	475	1.9	1–3,	
	$SnCl_2$-i-amylalcohol		2.0	7–13	
	Dithiol, 3.6 N H_2SO_4, $CHCl_3$	680	2.1	1–7	
	Phenyl fluorone				
	Thioglycolic acid, pH 0.7–7	352			
	Thioglycolic acid, pH 3–6	365			
	Thiomalic acid, 0.5 N HCl	352			
	Thiomalic acid, pH 3–6	365			
	Sulphonitrophenol K, pH 3–4		5.0	14	
	Crystal violet		23.0	15	
	Rhodamine B, SCN^-		11.0	16	

Literature

1. Popova, N. P., Stolyarova, I. A.: Chemical analysis of minerals, Izd. Niedra, Moscow, 1974 (in Russian)
2. Jeffery, P. G.: Chemical methods of rock analysis, Pergamon, Oxford, 1970
3. Stepanova, N. A., Yakushina, G. A.: Zh. Anal. Khim. *17*, 858 (1962)
4. Quinn, B. F., Brooks, R. R.: Anal. Chim. Acta *74*, 75 (1975)
5. Chan, K. M., Riley, J. P.: Anal. Chim. Acta *39*, 103 (1967)
6. Quinn, B. F., Brooks, R. R.: Anal. Chim. Acta *58*, 301 (1972)
7. Dragomireczki, A. et al.: Photometrische Analyse anorganischer Roh- und Werkstoffe, VEB Deutscher Verlag, Leipzig, 1968

8–11. see Al. 7–10.

12. Silva, M. E.: Analyst *100*, 517 (1975)
13. Tamhina, B., Herak, M. J., Yagodic, V.: Anal. Chim. Acta, *76*, 417 (1975)
14. Savvin, S. B., Mineeva, V. A., Okhanova, L. A., Pachadzhanov, D. N.: Zh. Anal. Khim. *26*, 532 (1971)
15. Ganaga, L. I., Ivanova, I. F.: Zh. Anal. Khim. *27*, 713 (1972)
16. Haddad, P. R., Alexander, P. W., Smythe, L. E.: Talanta *22*, 61 (1975)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
N	NO_3^-, aqueous solution	302	0.72	3	— Photometry of NO_2^- [1–3, 14]
	2,6-Dimethyl phenol + NO_3^-	310	0.21	4	
	2,4-Phenoldisulphonic acid + NO_3^-· NH_4OH solution	410	0.94	15–17	— N-compound s' analysis [1, 2, 13]
	Brucine " + NO_3^-	410	0.15	1	— NO_3^- geology [4]
	Phenol, 2,4-xylenol, 2,6-xylenol + NO_3^-			18, 15, 19, 20	— NO_3^-, NO_2^- in drinking water [5]
	Salicylic acid + NO_3^-	410		5	
	Methylene blue + NO_3^-			21	— NO_3^- in meat products [6]

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
N	Crystal violet $+NO_3^-$			22	— NH_3 [1]
	Sulphanilic acid $+NO_2^-$ + α-naphthlylamine	520	3.3	15, 17, 14, 23–26	— NH_3 in urine [7] NO_2 in air [8–10]
	N(1-naphthyl)ethylene diamine + sulphanilamide $+NO_2^-$, pH 2–2.5	380	4.0	8	— CN^- in waste water [11, 12]
	$HgI_4^{2-} + NH_3$	375	0.21	1	
	Phenol $+ClO^- + NH_3$	680	0.53	1, 15–17, 27–29	
	Nessler-method (NH_3)			15–17, 30	
	Barbituric acid + Chloramine T + Pyridine + CN^-	580	14	11	

Literature

1. Babko, A. K., Pilipenko, A. T.: Photometric analysis, determination of nonmetals. Moscow, Izd. Khim. 1974 (in Russian)
2. Bolz, D. F.: Colorimetric Determination of Nonmetals, New York, Interscience, 1958
3. Wetters, J. H., Kenneth, L. U.: Anal. Chem. *42*, 335 (1970)
4. Hajós, P., Inczédy, J.: Hung. Sci. Instr. *34*, 25 (1975)
5. Analysis of drinking water, nitrate and nitrite-ion determination, MSZ 448/12–74
6. Official Method of Analysis of the Association of Official Analytical Chemists, 11, ed. 1970
7. van Slyka D. D., Cullen, G. E.: J. Biol. Chem. *19*, 211 (1914)
8. Jacobs, M. B., Hochheiser, S.: Anal. Chem. *30*, 426 (1958)
9. Adley, F. E., Skillern, P. C.: Am. Ind. Hyg. Assoc. J. *19*, 233 (1958)
10. Kinosian, J. R., Hubbard, B. R.: Am. Ind. Hyg. Assoc. J. *19*, 453 (1958)
11. Lurje, Ju. Ju (ed.): General methods of water analysis, Moscow. Izd. Khim. 1973 (in Russian)
12. Habik, F. J.: Galvanotechnik, *66*, 309 (1975)
13. Strenli, C. A., Avarell, P. R.: Analytical Chemistry of Nitrogen and its Compounds, New York, Interscience, 1968
14. Sawicki, E. et al.: Talanta, *10*, 641 (1963)
15. 16, 17. see Al 8. 10. B 15.
18. Elton-Bott, R. R.: Anal. Chim, Acta *108*, 285 (1979)
19. Norwitz., G., Keliher, P. N.: Anal. Chim. Acta *98*, 323 (1978) *109*, 373 (1979)
20. Norwitz, G., Farino, J., Keliher, P. N.: Anal. Chim. Acta *105*, 335 (1979)
21. Ciesielski, H., Soignet, G., Catoire, M., Vancayzeele, P.: Analusis *6*, 38 (1978)
22. Baca, P., Freiser, H.: Anal. Chem. *49*, 2249 (1977)
23. Celardin, F., Marcantonatos, M., Monnier, D.: Anal. Chim. Acta *68*, 61 (1974)
24. Dongherty, J. A., Laban, G. A.: Anal. Chem. *47*, 1130 (1975)
25. Keh-Chung Chao-Higuchi, T., Sternson, L. A.: Anal. Chem. *50*, 1670 (1978)
26. Fox, J. B. Jr.: Anal. Chem. *51*, 1493 (1979)
27. Glebko, L. I., Ulkina, Zn. I., Lognenko, E. M.: Mikrochim. Acta *II* 61 (1975)
28. Patton, C. J., Crouch, S. R.: Anal. Chem. *49*, 464 (1977)
29. Oliver, R.: Analysis *6*, 126 (1978)
30. Krug, F. J., Ruzicka, J., Hansen, E. H.: Analyst *104*, 47 (1979)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Nb	KSCN, 2,9 N HCl, methyl isobutyl ketone or diethyl ether	385	3.7	1, 7–12	— spectrophotometry [1, 3, 6]
	Bromopyrogallol red, pH 5.8, tartaric acid,	610	5.3	1, 8, 13	— in rocks, ores [4]
	Complexone III.				— in steels [5]
	PAR + Tartrate and acetate, pH 6	555	3.9	1, 8, 10, 14, 15	
	Lumogallion, 0.5–2 N H_2SO_4, 2,4-sulphochlorophenol S_2, 1 – 3 N HCl, Complexone III, tartaric acid	515	1.7	1, 2	
		650	3.0	1, 5	
	Oxine, 2% tartaric acid	385	4.8	1	
	Phenyl fluorone, 0.8% H_3PO_4	520	3.7	1, 16	
	H_2O_2, ccH_2SO_4	365	0.09		
	Pyrogallol, 1 : 40 H_2SO_4	400	0.7		
	$NH_4SCN + SnCl_2$, 2–3 N HCl, water : acetone 1 : 1 or	383	3.8		
	4 N HCl, diethyl ether	385	3.6		
	Sulphonitrophenol M, 0.5 m H_2SO_4		5.3	17, 18	
	o-Nitrophenylfluorone, 1m HCl, $CHCl_3$		17.0	19	

Literature

1. Gibalo, J. M.: Analytical chemistry of Nb and Ta. Moscow, Izd. Nauka, 1967 (in Russian)
2. Shcherbov, D. P. et al.: Chemical and physical methods in the research of the analysis of mineral ores, Alma Ata, 1971 (in Russian)
3. Jelinson, S. V.: Spectrophotometry of Nb and Ta, Moscow, Atomisdat, 1973 (in Russian)
4. Mohai, M., Upor E.: Magy. Kem. Foly. *72*, 394 (1966)
5. Savvin, S. B.: Organic reagents of arsenazo group III. Moscow, Atomisdat, 1971 (in Russian)
6. Mari, E. A.: Anal. Chim. Acta, *29*, 303 (1963)

7–10. see Al 7–10.

11. Pilipenko, A. T., Eremenko, O. M.: Zh. Anal. Khim. *25*, 1330 (1970)
12. Lobanov, F. I., Zatonskaya, V. M., Gibalo, I. M.: Zh. Anal. Khim. *29*, 826 (1974)
13. Belcher, R., Ramakrishna, T. V., West, T. S.: Talanta, 12, 681 (1965)
14. Belcher, R., Ramakrishna, T. V., West, T. S.: Talanta, *9*, 943 (1962) *10*, 1013 (1963)
15. Siroki, M., Maric, L., Herak, M. J., Djrordjevic, C.: Anal. Chem. *48*, 55 (1976)
16. Nazarenko, V. A., Yaghyatinskaya, G. Y.: Zav. Lab. *38*, 1427 (1972)
17. Alimarin, I. P., Savvin, S. B., Okhanova, L. A.: Talanta *15*, 601 (1968)
18. Gerkhardt, L. I., Okhanova, L. A., Savvin, S. B., Vagan, V. G.: Zav. Lab. *39*, 769 (1973)
19. Ganago, L. I., Bukhteene, L. N.: Zh. Anal. Khim. *34*, 2186 (1979)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Ni	Dimethyl glyoxime, NH_4OH	450	1.4	5, 6, 7,	— in rocks [6]
	Dimethyl glyoxime, $+Br_2$, pH 3–5	530		10–14	— in water [7]
	Dimethyl glyoxime, pH 6.5–8.5, $CHCl_3$	360			— in steel [3]
	2,2-Furyl dioxime, pH 7.5–9	436	2.0	4,8,10–13	– reagents [9]
	Bis(4-sodium tetrazolyl-azo-5)-ethylacetate, pH 4.0	490	2.7	1, 5	
	1-(2-thiazolylazo)-2-naphthol-3,6-disulphonic acid, pH 8–10	596	2.6	3	
	Diantipyril methane dithiooxalate, 2, 5 N HCl	505	0.32	2	
	PAN, PAR				
	PAQH		6.7	15	
	NH_4OH, 1.5 N NH_3	582	0.006		
	Diethyl dithiocarbamate, pH 4–11, CCl_4	430	0.2		
	Dithizone, 0.3 N NH_4OH, $CHCl_3$	480	2.7		
	Formaldoxime			16	
	Oxine, pH 6.7, $CHCl_3$	395	0.5		
	Salicyl-aldoxime, $CHCl_3$	400	0.6		
	Complexone III, pH 5.5–6.8	580–720			
	β-mercapto propionic acid	330			
	Sodium diethyl dithiocarbamate, pH 5–11, CCl_4	328			
	2-(5-Nitro-2-pyridylazo)-1-naphthol		7.4	17	
	Br-PADAP		12.8	18	
	Rhodamine 6G + Chlorooxine		7.5	19	
	4-Chloro-2-nitroso-1-naphthol + Crystal violet		8.2	20	
	Indirect method: Dimethyl glyoxime + diphenyl boric acid			21	

Literature

1. Frumina, N. S. et al.: Zh. Anal. Khim. *22*, 1523 (1967)
2. Pilipenko, A. T. et al.: Zh. Anal. Khim. *23*, 227 (1968)
3. Busev, A. I. et al.: Zh Anal. Khim. *29*, 1758 (1974)
4. Budanova, L. M., Volodarskaya, R. S., Kasayev, N. A.: Analysis of Al- and Mg-compounds. Moscow, Metallurg. 1966 (in Russian)
5. Peskova, V. M., Savostina, V. M.: Analytical chemistry of Ni. Moscow, Nauka, 1966 (in Russian)
6. Görbicz, M., Upor, E.: Acta Chim. Acad. Sci. Hung. *66*, 373 (1970)
7. Pahomova, K. S. et al.: Zh. Anal. Khim. *19*, 1085 (1964)
8. Nowlan, G. A.: Geol. Surv. Profess. Pap. *700-B*, 177 (1970)
9. Marczenko, Z.: Photometric determination of elements. Moscow, Mir, 1971 (in Russian)

10–13. see Al 7–10.

14. Zolotov, Y. A., Vlasova, G. E.: Zh. Anal. Khim. *28*, 1540 (1973)

15. Afghan, B. K., Ryan, D. E.: Anal. Chim. Acta, *41*, 167 (1968)
16. See Mn 14.
17. Sakai, Y.: Bunseki Kagaku *28*, 10 (1979)
18. Shibata, S., Furukawa, M., Toei, K.: Anal. Chim. Acta, *66*, 397 (1973)
19. Chwastowska, J., Lachowitz, E.: Chem. Anal. (Warsaw) *24*, 369 (1979)
20. Toei, K., Motomizu, S., Yokosu, H.: Anal. Chim. Acta, *110*, 329 (1979)
21. Umland, F., Thierig, D.: Z. Anal. Chem. *197*, 151 (1963)

Os	see Platinum metals				
Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
P, PO_4^{3-}	Ammonium molybdate, 0.25 N HNO_3	360	0.48	1–3, 6, 12	— in natural waters [5]
	Ammonium molybdate, + $SnCl_2$, 0.25 N HNO_3	735	1.85		— in soil [7]
	Ammonium molybdate,	315	2.0		— in serum,
	+ Ammonium vanadate, 0.05 m HCl	400	2.5		urine [9]
	Ammonium molybdate, + Crystal violet		27.0	13	— in silicate rocks [10]
	Ammonium molybdate, + Methylene blue		17.0	14	— in steel [11]
	Ammonium molybdate, + Malachite green			15	— analysis [4, 8, 12]
indi-	Ammonium molybdate, + Thiocyanate			16	
rect	Ammonium molybdate, + 2-amino-4--chlorobenzene-thiol		9.7	17	
	Ammonium molybdate, + Phenyl fluorone		11	18	
	Dithiol or sulphonitrophenol S		17	19	

Literature

1. Kazansky, L. P. et al.: Uspehi Khim. *43*, 1137 (1974)
2. Babko, A. K., Pilipenko, A. T.: Photometric analysis, determination of nonmetals. Moscow, Khim. 1974 (in Russian)
3. Ljalikov, Ju. S.: Analytical chemistry of P. Moscow, Nauka, 1974 (in Russian)
4. Kakac, B., Vejdelek, Z. J.: Handbuch der Kolorimetrie III. Jena, VEB. G. Fischer. 1966
5. Goriusina, V. G. et al.: Zh. Anal. Khim. *25*, 1610 (1970)
6. Fedorov, A. A.: New methods of phosphorus determination. Moscow, Metallurg. 1965 (in Russian)
7. Arinuskina, E. V.: Handbook of the chemical analysis of soils, 2. Ed. Izd. Moscow Univ. Moscow, 1970 (in Russian)
8. Murphy, J., Riley, J. P.: Anal. Chim. Acta, *27*, 31 (1962)
9. Burtels-Roijers: Clin. Chim. Acta, *61*, 135 (1975)
10. Emerglin, U., Bremley, L.: Anal. Geochemistry, Elsevier, Amsterdam, 1971

11. Umland, F., Wünsch, G.: Z. Anal. Chem. *225*, 362 (1967)
12. Boltz, D. G.: Colorimetric Determination of Nometals, New York, Interscience, 1958
13. Pilipenko, A. T., Shkaravskii, Y. F.: Zh. Anal. Khim. *29*, 716 (1974)
14. Matsuo, T., Shida, J., Kurihara, W.: Anal. Chim. Acta, *91*, 385 (1977)
15. Altmann, H. J., Fürstenau, E., Gielewski, A., Scholz, L.: Z. Anal. Chem. *256*, 274 (1971)
16. Ulmand, F., Wünsch, G.: Z. Anal. Chem. *213*, 186 (1965)
17. Djurkin, V., Kirkbright, G. F., West, T. S.: Analyst *91*, 89 (1966)
18. Halász, A., Polyák, K., Pungor, E.:Talanta *18*, 691 (1971)
19. see As 23.

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Pb	Dithizone + cyanide, pH 6.5–10.5	520	6.9	2, 5, 9–13	— in Mg and Mg alloys [4]
	Sodium-diethyl dithiocarbamate, pH 10.5–12.5	440	1.2	1, 8	— in plants [5]
	Diethyl dithiocarbamate, pH 4–14, CCl_4	340	0.93		— in foods [6]
	Sulpharsazene, pH 8–10	500	4.5	7, 3	— in fresh and mineral waters [3]
	Arsenazo III, pH 4.5	655	1.0		
	Tetramethyl diamino diphenyl metane	585			
	Phenyl pyridine ketoxime	340			
	1-Nitroso-2-naphthol, pH 1–2	370			
	p-Nitroso-diphenyl amine	525			
	p-Nitroso-dimethyl aniline, pH 1.2				
	Diphenyl carbasone			14	
	PAR			10, 12, 15, 16	
	5-Br-PAAP		4.9	17	
	Phenol + eosin, $CHCl_3$		11.0	18	

Literature

1. Keil, R.: Z. Anal. Chem. *229*, 117 (1967)
2. Iwantscheff, G.: Das Dithizon und seine Anwendung in der Mikro- und Spurenanalyse, 2. ed. Weinheim, Chemie, 1972
3. Markova, A. J.: Zh. Anal. Khim. *117*, 952 (1962)
4. 1966 Book of ASTM Standard, Baltimore, Am. Soc. for Testing and Mat., 1966
5. Kerin, Z.: Mikrochim. Acta 927 (1968)
6. Testing methods and qualitative requirements of preserved products. Budapest, Közgazd. és Jogi Könyvkiadó, 1963, MSZ 3612/1 and MSZ 3612/3–62 (in Hungarian)
7. Petrova, G. S. et al.: Zav. Lab. *36*, 776 (1970)
8. Fries, J., Gebrost, H.: Organische Reagenzien für die Spurenanalyse, Merck, E., Darmstadt, 1975

9–12 see Al 7.–10.

13. see Ag 7.
14. Trinder, N.: Analyst, *91*, 587 (1966)

15. Dagnall, R. M., West, T. S., Young, P.: Talanta, *12*, 583 (1965)
16. Kleckova, Z., Langova, M., Havel, J.: Coll. Czech. Chem. Comm. *43*, 3163 (1978)
17. Gusev, S. I., Nikolaeva, E. M.: Zh. Anal. Khim. *24*, 1674 (1969)
18. Tananaiko, M. M., Bilenko, N. S.: Zav. Lab. *42*, 761 (1976) and Zh. Anal. Khim. *34*, 1899 (1979)

Pd see Platinum metals

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Pt Ir	see Rh	313			— analysis [1–3, 7–9, 12]
and Os	Diphenyl carbazide			14–22	7, 8
Pt-	SCN^- + methylene blue		22	9	— separation [4]
met-	Thiourea, 4N HCl	450–530			— concentration with fire [5]
als					
Pd	Pyridine + Bengal rose			10–13	— in Ag wire Pd [6]
	Rhodamine 6G + Br^-		30	10–13	
	p-Nitroso-diphenyl amine		11.4	14	
	Sulphonitrophenol		8.0	15	
	Dithizone, 0.5 m H_2SO_4, CCl_4	450	3.44		
	Dimethyl glyoxime, 0.2–0.3 N HCl, $CHCl_3$	383	0.16		
	KI, 2N HCl	408	0.94	16	
	Michler-thioketone		16	17, 18	
	8-Mercapto-quinoline, 6N HCl	485	0.80		
	α-Furfuryl dioxime, strongly acidic, $CHCl_3$	380	2.38		
Pt	Tetrabromo fluorescein ethyl ester			19	
	Crystal violet		8.4	20	
	p-Nitroso-methylaniline, pH 2–5, ethanol	525	6.7		
	KI, pH 1.6	495	1.2		
	$Sn Cl_2$, 1:9HCl	405	1.0		
	p-Nitroso diethylaniline (for Pd, as well)		5.7	21–26	
Rh	Complexone III	313			
Ir	Reagents of Pt			21–24	
	Organic bases + extraction			27	
	Eriochromecyanine R (to Rh, as well)		5.0	28	
	Malachite green		14.4	29	
Ru	Rubeanic acid	650			
	1, 10-Phenanthroline	448			
	Thiourea, 0,1-4N HCl				
	1,4-Diphenyl thiosemicarbazide		1.0	30	
	PDT		2.1	31	

Literature

1. Beamish, F. E.: The Analytical Chemistry of the Noble Metals, Oxford, Pergamon Press, 1966
2. Ginzburg, S. I. et al.: Analytical chemistry of platinum metals, Moscow, Izd. Nauka 1972 (in Russian)
3. Symposium: Analytical Chemistry of the Platinum-Group Metals, Johannesburg, 1972
4. Beamish, F. E.: Minerals Sci. Eng. *4*, 3 (1972)
5. Faye, G. H., Moloughney, P. E.: Talanta, *19*, 269 (1972)
6. Budjak, N. F., Yekimenkova, T. A.: Analysis of contacts and conducting alloys, Izd. Metallurg. 1975 (in Russian)
7. Goldstein, G., Monning, D. L., Menis, O., Dean, J. A.: Talanta, *7*, 307 (1961)
8. Marczenko, Z., Kulaga, J.: Chem. Anal. (Warsaw), *24*, 841 (1979)
9. Marczenko, Z., Uscinska, J.: Anal. Chim. Acta, *123*, 271 (1981)
10. Duchkova, H., Malat, M., Cermakova, L.: Anal. Lett. *9*, 487 (1976)
11. Tikhonov, V. N., Petukhova, Y. A., Vashurkina, Y. A.: Khim. Tekhnol. *21*, 43 (1978)
12. Uesugi, K., Shigematsu, T.: Anal. Chim. Acta, *84*, 377 (1976)
13. Dagnall, R. M., El-Ghamry, M. T., West, T. S.: Talanta, *15*, 1353 (1968)
14. Kothny, E. L.: Mikrochim. Acta *I*, 425 (1978)
15. Gurieva, R. F., Savvin, S. B., Romanov, P. N., Akimova, T. G., Syanova, E. M.: Zh. Anal. Khim. *32*, 1009 (1977)
16. see Al 8.
17. see Hg 18.
18. Tsukahara, I.: Bunseki Kagaku *28*, 253 (1979)
19. El-Ghamry, M. T., Frei, R. W.: Talanta *16*, 235 (1969)
20. Marczenko, Z., Maruszak, J.: Chem. Anal. (Warsaw) *24*, 341 (1979)

21.–24. see Al 7.–10.

25. Basargin, N. N., Rozovskii, Y. G., Merzlyakova, A. N.: Zav. Lab. *38*, 260 (1972)
26. Savvin, S. B., Propistsova, R. F., Rozovskii, Y. G.: Zh. Anal. Khim. *27*, 1554 (1972)
27. Pilipenko, A. T., Danilova, V. N., Lisichenak, S. L.: Zh. Anal. Khim. *25*, 1154 (1970)
28. Duchkova, H., Cermakova, L., Malat, M.: Anal. Lett. *8*, 115 (1975)
29. Marczenko, Z., Kowalczyk, E.: Anal. Chim. Acta *108*, 261 (1979)
30. Hara, T., Sandell, E. B.: Anal. Chim. Acta *23*, 65 (1960)
31. Kamra, L. C., Ayres, G. H.: Anal. Chim. Acta *78*, 423 (1975)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Re	$SCN^- + SnCl_2$, 5.4 N HCl,	425	2.3	1	— analysis [1, 2]
	n-butylalcohol or 4–7 N H_2SO_4, diethyl ether or isoamyl alcohol	432	3.8		— photometric reagents [1–3]
	Diethyl dithio phosphoric acid $+SnCl_2$, 1-3N HCl, benzol	436	0.6	1	— in minerals [1, 4]
	Thiourea + Sn Cl_2 1,5–6 N HCl	390	1.05	1, 3	
	8-Mercaptoquinoline, 9–10 N HCl, $CHCl_3$	438	0.85	1, 3	
	Dimethyl glyoxime + $SnCl_2$	440	0.69	1, 3	
	α-Furyldioxime + $SnCl_2$, HCl,	330	4.05	1, 3	

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Re	acetone, ethyl alcohol, $CHCl_3$				
	4-Methyldioxime, 4-Methyl-1,2-cyclohexane diondioxime + $SnCl_2$ + + HCl, $CHCl_3$	436	6.9	3	
	Methylene blue, pH 3.5–5, toluene	600	3.95		
	Brilliant green, benzene		10.0		
	1,4-Diphenyl thiosemicarbazide, $CHCl_3$	510	1.0	5	
	PDT		2.1	6	

Literature

1. Lebegiev, K. B.: Renium, Moscow, Metallurg. 1963
2. Borisova, L. B., Esmakov, A. N.: Analytical chemistry of Rh, Moscow, Izd. Nauka, 1974 (in Russian)
3. Tarayan, V. M., Vartanyan, S. V.: Zav. Lab. *11*, 1301 (1964)
4. Pensionierova, V. M., Paukova, V. E.: Chemical analytical methods of minerals, Moscow, Izd. Niedra, 1965 (in Russian)
5. see Pt 30.
6. see Pt 31.

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Rh	see Pt metals				
Rare earth metals and *Y*	Arsenazo III, pH 2.5	650		3, 5, 6, 19–21	— analysis [1, 2, 4, 7]
	Colour of ions			1, 2, 11	— reagents [2]
	Chlorophosphonazo III + diphenylguanidine, butanol		16.0	22, 23	— in rocks ores, castiron [5–7]
	Carboxynitrazo		16.0	24, 25	
	1,10-Phenanthroline		12.0	26	— in Th-compounds [8]
	Eosin		16.0	26	— in minerals [9–11]
	Xylenol orange			27, 28	— Ce determinations [2, 12–16]
	Erithrosine				— Eu determinations [17–18]

Literature

1. Náray Szabó I.: Inorganic Chemistry, II. Budapest, Akadémiai Kiadó, 1957 (in Hungarian)
2. Riabczikov, D. J., Riabuhin, V. A.: Analytical chemistry of the elements. Rare earth metals and ittrium. Moscow, Izd. Nauka, 1966 (in Russian)

3. Savvin, S. B.: Talanta, *8*, 673 (1961) and *11*, 1 (1964)
4. Budanova, L. M., Pineyeva, S. M.: Zh. Anal. Khim. *20*, 320 (1965)
5. Mohai, M., Upor, E.: Magy. Kém. Folyóirat, *74*, 270 (1968)
6. Upor, E.: Magy. Kém. Folyóirat, *73*, 479 (1967)
7. Sajó, I.: Complexometry, Budapest, Műszaki Könyvkiadó, 1973. 162 pp. (in Hungarian)
8. Mohai, M., Klesch, K., Upor, E.: Magy. Kém. Folyóirat, *79*, 2 (1973)
9. Misczenko, V. T. et al.: Ukr. Khim. Zh., *11*, 1188 (1965)
10. Misczenko, V. T. et al.: Zh. Anal. Khim. *20*, 1073 (1965)
11. Poluektov, N. S., Kononenko, L. I.: Spectrophotometric methods for the determination of rare earth metals. Kijev, Izd. Nauka Dumka, 1968 (in Russian)
12. Yeremin, Ju. G. et al.: Zav. Lab. *30*, 1427 (1964)
13. Harlamova, L. I. et al.: Zav. Lab. *40*, 1169 (1974)
14. Mohai, M., Upor, E.: Magy. Kém. Folyóirat. *73*, 489 (1967)
15. Ganopolsky, V. I., Krivonozhnikova, L. G.: AN BSSR Ser. Khim. N. *4*, 134 (1965)
16. Ganopolsky, V. I. et al.: Izv. Vis. Uchebn. Zav. Khimia i Khim. Techn. *6*, 913 (1963)
17. Poluektov, N. S., Nikonova, M. P.: Rare earth metals. Izd. AN USSR, 1959, 208 (in Russian)
18. Fábián-Mohai, M., Upor, E., Nagy, G.: Acta Chim. Acad. Sci. Hung. *68*, 1 (1971)
19. see A1 8.
20. Onishi, H., Sekine, K.: Talanta *19*, 473 (1972)
21. Surin, I. G., Spitsyn, P. K., Barkovsky, V. G.: Zh. Anal. Khim. *34*, 1103 (1979)
22. Taketatsu, T., Sato, A., Kurihara, H., Maeda, S.: Anal. Chim. Acta, *93*, 327 (1977)
23. Merikov, A. A., Nepomnyashchaya, N. A.: Zh. Anal. Khim. *32*, 1409 (1977)
24. Savvin, S. B., Petrova, T. V., Romanov, P. N.: Talanta *19*, 1437 (1972)
25. Savvin, S. B., Petrova, T. V., Romanov, P. N.: Zh. Anal. Khim. *28*, 272 (1973), *29*, 1929 (1974)
26. Alinovskaya, L. A., Ganago, L. I.: Zh. Anal. Khim. *25*, 2347 (1970)
27. Vernande, C., Munshi, K. N.: Microchem. J. *23*, 28 (1978)
28. Belousova, V. V., Chernova, R. K., Sukhova, L. K.: Zav. Lab. *44*, 390 (1978)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Ru	see Pt metals				
S	$S^{2-} + Fe^{3+}$ + N,N-dimethyl-p-	670	9.6	1, 13–18	— in uranium plant
	-phenylene-diamine + methylene blue	740	3.5		solutions polythionate [6]
	SO_2 + pararosaniline		3.0	13–16, 18,19	— H_2S and sulphides [7, 12]
	$SO_3 + Hg^{2+} + CH_2O$ + p-fuchsin	560	3.0	2	— in water [8]
	$SO_4^{2-} + Ba^{2+}$ + Nitroorthanilic S or			4	— in rocks [9]
	Chlorophosphonazo III			21	— in air SO_2 [10]
	or Dimethylsulphonazo III or			22	— in water SO_4^{2-} [3, 4]
	iodometrically or			23	— analysis [11, 12, 20]
	Orthanilic K or	650	6.2	3	
	Nitrochromazo	640	5.0	4	
	$S_4O_6^{2-} + CN^- + Fe^{3+}$	460		5, 6	

Literature

1. Mecklenburg, W., Rosenkronzer, F.: Z. Anorg. Chem. *86*, 143 (1914)
2. Babko, A. K., Pilipenko, A. T.: Photometric analysis. Determination methods of non-metals, Moscow, Izd. Chim. 1974. (in Russian)
3. Savvin, S. B., Akimova, T. G., Dedkova, V. P.: Organic reagents for the determination of Ba^{2+} and SO_4^{2-}, Moscow, Izd. Nauka, 1971. (in Russian)
4. Basargin, N. N., Menshikova, Z. S., Bielava, Z. S., Myasichoheva, R. G.: Zh. Anal. Khim. *23*, 732 (1968)
5. Urban, P. J.: Z. Anal. Chem. *179*, 415 (1961)
6. Upor, E., Nagy, G.: Magy. Kem. Lapja, *28*, 340 (1973)
7. Marczenko, Z., Cholni-Lenarczyk, L.: Anal. Chem. *10*, 729 (1965)
8. Cline, J. D.: Limnol and Oceanogr. *14*, 454 (1969)
9. van Loon, J. C. et al.: Anal. Chim. Acta *40*, 334 (1968)
10. Peregud, E. A., Garnet, E. V.: Chemical analysis of the air of chemical plants, Leningrad, Izd. Khim. 1973 (in Russian)
11. Karchemer, J. H.: Analytical Chemistry of Sulfur and its Compounds, New York, Interscience, 1969
12. Hoffmann, K., Hamm, R.: Z: Anal. Chem. *232*, 167 (1967)
13.–16. see Al 8.–10. and B 15.
17. Matheson, N. A.: Analyst *99*, 577 (1974)
18. Kirsten, W. I.: Mikrochem. Acta II, 403, (1978)
19. Arikawa, Y., Ozawa, T., Iwasaki, I.: Bull. Soc. Jap. *41*, 1454 (1968)
20. King, H. G., Pruden, G.: Analyst *94*, 43 (1969)
21. Lukin, A. M., Chernyshova, T. V., Avgushevich, I. V., Kulikova, E. S.: Zadov. Lab. *40*, 22 (1974)
22. Reijnders, H. F., Stadeuvan, J. J., Griepink, B.: Z. Anal. Chem. *295*, 122 (1979)
23. Hinze, W. L., Humphrey, R. E.: Anal. Chem. 45, 814 (1973)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Sb	KI, 2.4–3.8 N H_2SO_4	420		1, 3	– in ores [7, 8]
	Diantiphyrylmethane + KI, 0.2–3 N HCl, $CHCl_3$	340		11	– in rocks [9–15]
	Rhodamine B, 6N HCl, benzene	552	9.7	4, 5, 18–22	– alkaline dye [2, 17]
	Crystal violet, 2.5 N HCl, benzene	610		9	– in As [10]
	4,4-Bis(N-methyl-N--benzylaminophenyl)-antipyrylcarbinol, 1–3N HCl, benzene	590		6	– in steels [12] – in raw materials [15] – beside Sn [16]
	Brilliant green			17, 23–25	
	Malachite green			17, 26–27	
	Butylrhodamine B			17, 26–27	
	Rhodamine 6G			17, 26–27	
	Salicylfluorone		9.0	28	
	Dibromophenylfluorone			29	
	Iodometry		30	19	

Literature

1. Various antimony reagents. Moscow, Izd. IREA, 1970 (in Russian)
2. Blum, I. I. A.: Extractive photomeric methods of analysis. Moscow, Izd. Nauka, 1970 (in Russian)
3. Mc Chesney, E. W.: Ind. Eng. Chem. Anal. Ed. *18*, 146 (1946)
4. Marczenko, Z.: Photometric determination of elements. Moscow, Izd. Mir, 1971 (in Russian)
5. Dragomirechky, A. et al.: Photometrische Analyse anorganischer Roh- und Werkstoffe. Leipzig, 1968
6. Busev, A. I. et al.: Zh. Anal. Khim. *20*, 812 (1965)
7. Jankowski, J.: Hutn. Listy, *20*, 205, (1965)
8. Nielsch, E., Böltz, G.: Z. Anal. Chem. *143*, 81
9. Analytical chemical methods of minerals. Book 8, Moscow, Nedra, 191 (1965) (in Russian)
10. De Soza, T. L. C., Kerbysen, J. D.: Anal. Chem. *40*, 1146 (1968)
11. Afanasyev, Yu. A.: Zh. Anal. Khim. *30*, 1830 (1975)
12. Yakovlev, P. Ya. et al.: Ref. Zurn. Himia, *11G*. 158 (1972)
13. Stanton, R. F.: Analyst, *87*, 299 (1962)
14. Bihovseva, T. T., Cerkovnitskaya, I. A.: Zav. Lab. *30*, 943 (1964)
15. Dal Cortivo, L. A. et al.: Analytic. Biochem. *1*, 491 (1960)
16. Kovács, E., Guyer, H.: Z. Anal. Chem. *186*, 267 (1962)
17. Kis, P. P., Onisczenko, Ju. K.: Zh. Anal. Khim. *29*, 102 (1974)
18.–21. see Al 7.–10.
22. Schnepte, M. M.: Talanta, *20*, 175, (1973)
23. see Ga 19.
24. Fogg, A. G., Jillings, J., Mariott, D. R., Burns, D. T.: Analyst, *94*, 768 (1969)
25. Yadav, A. A., Khopkai, S. M.: Bull. Chem. Soc. Jap. *43*, 693 (1971)
26. Kish, P. P., Onisczenko, Yu. K.; Popoida, I. I.: Zh. Anal. Khim. *28*, 1746 (1973)
27. Kish, P. P., Onisczenko, Y. K.: Zh. Anal. Khim. *26*, 514 (1971)
28. Nevskaya, E. M., Antonovich, V. P., Nazarenko, V. A.: Zh. Anal. Khim. *28*, 1104 (1973)
29. Antonovich, V. P., Nevskaya, E. M., Suvorova, E. N., Nazarenko, V. A.: Zh. Anal. Khim. *33*, 458 (1978)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Sc	Xylenol orange		2.9	1, 2	
	Erichrome brilliant violet B		6.4	3	
	TAR		5.1	4	
	Chrome azurol S			5	
	Erichrome cyanine R		15	6	
	Chromal blue		16.5	7	

Literature

1. see Al 8.
2. see Al 10.
3. Uesugi, K.: Anal. Chim. Acta, *49*, 597 (1970)

4. Shimizu, T., Mono, E.: Anal. Chim. Acta, *52*, 146 (1970)
5. Jurkevicinte, J., Malet, M.: Collect. Czech. Chem. Commun. *44*, 3236 (1979)
6. Tikhonov, V. N., Samarkina, T. V.: Khim. Khim. Technol., *21*, 1116 (1978)
7. Uesugi, K., Miyawaki, M.: Bunseki Kagaku, *27*, 209 (1978)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Se	3,3'-Diaminobenzidine (DAB), pH 4.5–7, $CHCl_3$	420	1.02	1–6, 11, 13–15	– in biological substances [1]
	2,3-Diaminonaphthalene, pH 2, toluene	380	2.4	1, 2	– in colloid state [6–9]
	o-Phenylene diamine, pH 2.5, $CHCl_3$, toluene	335	1.8	1, 2, 13, 16	– sensitivity increase [7–9]
	4,5-Diamino-6-thiopyrimidine, pH 1.5–2.5	380	1.9	2	– in rocks [6, 10]
	1,1'-Diantrimid, 96% H_2SO_4	480 585		2	– photometric methods [11, 12]
	2-Mercaptobenzimidazo HCl, butanol + $CHCl_3$	335	1.04	2	
	Dithizone, 6–7 N HCl, CCl_4	420	7.35	1, 2, 17	
	Indirect method with azo dyes		19.0	18	

Literature

1. Nazarenko, I. I., Jermakov, A. N.: Analytical chemistry of Selenium and Tellurium, Moscow, Izd. Nauka, 1971 (in Russian)
2. Sczerbov, D. P., Ivankova, A. I., Gladysheva, G. P.: Zavod. Lab. *33*, 683, (1967)
3. Roquebert, J.: Bull. Soc. Pharm. Bordeaux, *101*, 29 (1962)
4. Cheng, K. L.: Anal. Chem., *28*, 1738 (1956)
5. Barcza, L.: Z. Anal. Chem., *199*, 10 (1963)
6. Szalay, J., Upor, E., Klesch, K.: Magy. Kem. Folyoirat, *74*, 507 (1968)
7. Vinogradov, A. P.: Determination methods for the analysis of rare earth metals, Izd. AN USSR, 1961. 598 (in Russian)
8. Blum, I. A.: Chemical, physicochemical and spectral determination methods of rare earth metals and trace elements. Gosgeolteh. Moscow, 1961. 13 (in Russian)
9. Tarajan, V. M., Arstamjan, Z. M.: Izv. AN., Arm. SSSR, *15*, 415 (1962)
10. Bock, R., Jakob, D.: Z. Anal. Chem. *200*, 81 (1964)
11. Boltz, D. F.: Colorimetric determination of nonmetals. New York, Interscience, 1958
12. Babko, A. K., Pilipenko, A. T.: Photometric analysis. Determination methods of nonmetals. Izd. Khim., Moscow, 1974 (in Russian)
13.–15. see Al 8.–10.
16. Shkrobot, E. P., Shebarshina, N. I.: Zavod. Lab. *35*, 417 (1969)
17. Mabuchi, H., Nakahara, H.: Bull. Chem. Soc. Jap. *36*, 151 (1963)
18. Osburn, R. L., Shendrikar, A. D., West, P. N.: Anal. Chem. *43*, 594 (1971)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Sn	Phenylfluorone		7.7	1, 13–18	– reagents [2–6]
	3-Pyridine fluorone		11	19	– in rocks [6–7]
	Dithiol, pH > 1	530	0.58		– in steel [8]
	Hematoxylin, pH 2.5–4	580	4.3		– in brass [9]
	Diethyl dithiocarbamate, pH 4.5–8, CCl_4	415	0.24		– in nickel [10]
	Quercetin, pH 3–4	440	3.55		– in lead [11]
	Pyrocatechol violet, pH 2.3–4.5	610	6.8	4, 13–16, 20–23	– in vegetable tins [12]
	Dihydroxyfluorescein		10.8	24	
	Brilliant green		17.5	25	
	Nile blue A		13.0	25	
	Malachite green			26	
	Crystal violet			27	
	Rhodamine 6 G			28	

Literature

1. Luke, C. J.: Anal. Chem. *28*, 76 (1956)
2. Asmus, E., Kraetsch, J.: Z. Anal. Chem. *216*, 391 (1966)
3. Lukin, A. M., Bozhevolnov, E. A.: Zh. Anal. Khim, *15*, 43 (1960)
4. Newmann, E. I., Jones, P. D.: Analyst, *91*, 406 (1966)
5. Onishi, H., Sandell, E. B.: Anal. Chim. Acta, *14*, 153 (1956)
6. Gregory, G., Jeffery, P. G.: Analyst, *92*, 293 (1967)
7. Onishi, H., Sandell, E. B.: Geochim. Cosmochim. Acta, *12*, 262 (1957)
8. Luke, C. L.: Anal. Chim. Acta. *39*, 304 (1967)
9. Stiapin, V. V. et al.: Analysis of non-ferrous metals and alloys, Moscow, Metallurgy Izd. 1965 (in Russian)
10. Jakovlev, P. J. et al.: New methods of metal determination (collection) 24, Moscow, 168 (1962) (in Russian)
11. Hofer, A., Landl, B.: Z. Anal. Chem. *244*, 103 (1969)
12. Determination of tin-content in vegetable and fruit products. MSZ 3612 (in Hungarian)
13.–16. see Al 7.–10.
17. Dymov, A. M., Ivanov, I. G., Romantseva, T. I.: Zh. Anal. Khim. *26*, 2360 (1971)
18. Kulkarni, V. H., Good, M. L.: Anal. Chem. *50*, 973 (1979)
19. Asmus, E., Kraetsch, J.: Z. Anal. Chem. *223*, 401 (1966)
20. Shestidesyatnaya, N. L., Kotelyanskaya, L. I., Yanik, M. I.: Zh. Anal. Khim. *31*, 67 (1976)
21. Dagnall, R. M., West, T. S., Young, P.: Analyst, *92*, 27 (1967)
22. Chernova, R. K., Kharmlamova, L. N., Belousova, V. V., Kulapina, E. G., Sumina, E. G.: Zh. Anal. Khim. *33*, 858 (1978)
23. Ashton, A., Fogg, A. G., Burns, D. T.: Analyst, *98*, 202 (1973)
24. Ackermann, G., Heegn, H.: Talanta, *21*, 431 (1974)
25. Nazarenko, V. A., Lebedeva, N. V., Knarova, L. I.: Zh. Anal. Khim. *28*, 1100 (1973)
26. Ackermann, G., Köthe, J.: Chem. Anal. (Warsaw) *17*, 445 (1972)
27. Ducret, L., Maurel, U.: Anal. Chim. Acta, *21*, 79 (1959)
28. Shestidesyatnaya, N. L.; Milyaeva, N. M., Koshalyanskaya, L. I.: Zavod. Lab. *41*, 653 (1975)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Si	Ammonium molybdate	815	1.7	1–5, 10–16	– photometry [1, 3, 9, 10]
	Safranine T		15	17	– in iron metal [5]
	Rhodamine B		50	18	– in rocks [6]
	Crystal violet		43	19	– in minerals [7]
	Phenylfluorone		11	20	– in mineral water [8]
	2-Amino-4-chlorobenzenethiol		16	21	

Literature

1. Mislyayeva, L. V., Krasnosczekov, V. V.: Analytical chemistry of silicon. Moscow, Nauka, 1972 (in Russian)
2. Nemodruk, A. A., Bezrogova, J. V.: Zh. Anal. Khim. *25*, 1587 (1970)
3. Babko, A. K., Pilipenko, A. T.: Photometric analysis. Determination methods of nonmetals. Moscow, Khimiya, 1974 (in Russian)
4. Ringbom, A. et al.: Anal. Chim. Acta *20*, 78 (1959)
5. Pakalns, P., Flynn, W. W.: Anal. Chim. Acta, *38*, 403 (1967)
6. Jeffery, P. G., Wilson, A. D.: Analyst, *85*, 478 (1960)
7. Bihovczozva, T. T.: Zav. Lab. *10*, 25 (1974)
8. Fresenius, W., Schneider, W.: Anal. Chem. *207*, 16 (1965)
9. Mustafin, I. S. et al.: Various silicon reagents, Moscow, NITEHIM, 1969 (in Russ)
10. Boltz, D. F.: Colorimetric Determination of Nonmetals, New York, Interscience, Publ. 1958.
11.–14. see Al 7.–10.
15. Pakains, P., Flynn, W. W.: Anal. Chim. Acta, *38*, 403 (1967)
16. Bazzi, A., Boltz, D. F.: Microchem. J. *20*, 462 (1975)
17. Pilipenko, A. T., Shkaravskii, Y. F.: Ukr. Khim. Zh. *42*, 1183 (1976)
18. Golowska, A., Psoniczky, L.: Talanta, *20*, 749 (1973)
19. Mirzoyan, F. V. Tarayan, V. M., Karapetian, Z. A.: Zh. Anal. Khim. *34*, 1515 (1979)
20. see P 18.
21. Trudell, L. A., Boltz, D. F.: Talanta, *19*, 37 (1972)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Sr Ba	Chromotropic acid bis-azo--derivatives, pH 2–6			1–4	
	Sulphonazo III (Orthonil S), pH 2 (Ba)	640		2, 5	
	Nitrochromoazo, pH 3.7	650		3	
	Nitroorthonil S (Sr)			5–7	
	Murexide			5–7	
	Chlorophosphonazo III			5–7	
	Arsenazo III			5–7	
	o-Cresolphthalein			5–7	
	Diphenylcarbazide (indirect)			5–7	

Literature

1. Savvin, S. B., Akimova, T. G., Dedkova, V. P.: Organic reagents for the determination of Ba^{2+} and SO_4^{2-}, Moscow, Izd. Nauka, 1971 (in Russ.)
2. Savvin, S. B. et al.: Zh. Anal. Khim. *17*, 43 (1962)
3. Kreskov, A. P., Kusnieczov, V. V.: Zav. Lab. *34*, 134 (1968)
4. Lukin, A. M.: Various reagents for strontium and barium, Moscow, NITEHIM, 1972 (in Russian)
5. Kemp, J., Williams, M. B.: Anal. Chem. *45*, 124 (1973)
6. see Al 8.
7. see Al 10.

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Ta	Methyl violet		7.5	1–3	
	Malachite green			3, 4, 9	
	Methylene blue			5	
	Capri blue			6	
	Nitrochromopyrasol			7	
	9-(2'-hydroxyphenyl)-2,3,7--trihydroxy-6-fluorone	505	25	8	

Literature

1. see Al 8.
2. see Al 10.
3. Nevsorov, A. N., Mondvinova, S. N., Kapitsa, A. V.: Zh. Anal. Khim. *29*, 2281 (1974)
4. Eberle, A. R., Lerner, M. W.: Anal. Chem. *39*, 662 (1967)

5. Tarayan, V. M., Asepyan, E. N., Barkhudaryan, S. R.: Zh. Anal. Khim. *27*, 19 (1972)
6. Elinson, S. V., Nevsorov, A. N., Belogortseva, M. V., Mirzoya, N. A., Mordvinowa, S. N.: Zh. Anal. Khim. *29*, 1234 (1974)
7. Podchainova, V. N., Freidenson, L. N.: Zh. Anal. Khim. *31*, 1312 (1976)
8. Tsykanskii, V. D., Konusova, V. V., Nazarenko, V. A.: Zh. Anal. Khim. *30*, 2390 (1975)
9. see Al 9.

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Te	Sodium diethyl dithiocarbamate	340	0.32	2–4	— analysis [1, 10, 11]
	Bismuthol, 3.5–6 N HCl, chloroform	330	3.6	10, 13–15	— separation [6, 7, 12]
	Iodide ion + CTA		4.9	16	— in sulphide ores [5, 8, 9]
	Diantripyryl-propyl-methane, 2 N H_2SO_4, saturated KBr solution, dichloroethane	330	1.35		— in copper and lead [1]
	Butyl- or ethylrhodamine C, 10 N H_2SO_4 + saturated H_3BO_3, benzene + butylacetate	565	0.77	5	
	5,5-methylene-bis-salicylfluorone		5.5 10.7	17, 18	
	Bromopyrogallol red		5.7	19	
	Rhodamine 6 G + $TeBr_6^{2-}$		17.0	20	
	Victoria blue + $TeBr_6^{2-}$		8.0	21	

Literature

1. Nazarenko, I. I., Jermakov, A. N.: Analytical chemistry of selenium and tellurium, Moscow, Izd. Nauka, 1971 (in Russian)
2. Bode, H.: Z. Anal. Chem. *144*, 90 (1955)
3. Pavlova, V. N. et al.: Zav. Lab. *27*, 965 (1961)
4. Goto, H., Kakita, I.: C. A. 506252a (1956)
5. Ivankova, A. I., Blum, I. A.: Zav. Lab. *27*, 371 (1961)
6. Blum, I. A. et al.: Chemical, physico-chemical and spectro-chemical methods in the research of rare earth metals and trace elements. Gosgeolteh. Moscow, 1961 (in Russian)
7. Arstamyan, S. M., Tarayan, V. M.: Arm. Him. Z. *19*, 590 (1966)
8. Vladimirova, V. M. et al.: Zav. Lab. *29*, 1419 (1963)
9. Voronkova, M. A.: Analytical chemical methods of mineral salts, *11*, 51 (1968) (in Russian)
10. Boltz, D. F.: Colorimetric determination of nonmetals, New York, Interscience, 1958
11. Babko, A. K., Pilipenko, A. T.: Photometric analysis. Determination methods for nonmetals. Moscow, Izd. Khimiya, 1974 (in Russian)
12. Havesov, I., Yordanov, I.: Talanta, *21*, 1013 (1974)
13. see Al 8.
14. see Al 9.

15. Marczenko, Z., Krasieko, M., Czarneczka, I.: Chem. Anal. (Warsaw) *22*, 275 (1977)
16. Viyayakumar, M., Ramakrishna, T. V., Aravamudan, G.: Talanta *26*, 323 (1979)
17. Nazarenko, V. A., Shitareva, G. G., Poluektova, E. N., Yakovleva, T. P.: Zh. Anal. Khim. *29*, 1850 (1974)
18. Nazarenko, V. A., Shitareva, G. G., Poluektova, E. N., Veshchikova, N. A.: Zh. Anal. Khim. *34*, 2359 (1979)
19. Shitareva, G. G., Poluektova, E. N., Nazarenko, V. A.: Zh. Anal. Khim. *30*, 1166 (1975)
20. Skripchuk, V. G., Murashova, V. I.: Zh. Anal. Khim. *29*, 1823 (1974)
21. Kish, P. P., Kremeneva, S. G.: Zh. Anal. Khim. 25, 2200 (1970)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Th	Arsenazo II and III, 8 N HCl	655			— analysis [7]
		665	12.7	3, 4, 8–12	
	Carboxygallanilide, pH 4.5	413	2.5		— in rocks,
	Morin, pH 2	410	4.2		in uranium ore [5]
	PAR, pH 6.4–6.7	500	3.89		— in minerals [6]
	Thoron, pH 0.8	545	1.65	1	
	Quercetin, pH 2.7–3.5	422			
	SPADNS			2	
	Iodide ion		1.7	8, 13–15	
	Chlorophosphonazo III			16	
	p-dimethylarsenazo III			17	
	Chromoazurol S + CTA		14.0	18	

Literature

1. Kusnyeczov, V. I.: Dok. ANSSSR, 31, 895 (1941)
2. Banerjee, G.: Anal. Chim. Acta, *16*, 56 (1957)
3. Kusnyeczov, V. I.: Zh. Anal. Khim. *14*, 7 (1959)
4. Savvin, S. B.: Arsenazo III, Moscow, Atomisdat, 1966
5. Mohai, M., Upor, E., Jurcsik, I.: Magy. Kém. Folyóirat, *71*, 334 (1965)
6. Mohai, M., Upor, E.: Magy. Kém. Folyóirat, *77*, 553 (1971)
7. Ryabczikov, D. I., Golybray, E. K.: Analytical chemistry of thorium, Moscow, Izd. Akad. Nauk SSSR, 1960 (in Russian)
8. see Al 8.
9. see rare earth metals 3.
10. see rare earth metals 20.
11. Bakhmatova, T. K., Bockareva, I. A.: Zavod. Lab. *42*, 1164 (1976)
12. Cospito, M., Rigali, L.: Anal. Chim. Acta, *106*, 385 (1979)
13. see Al 7.
14. see Al 9.
15. see Al 10.
16. Yamamoto, T.: Anal. Chim. Acta, *63*, 65 (1973)

17. Lukyanov, V. F., Duderova, E. P., Novak, E. F., Barabanova, T. E., Polyakova, I. A.: Zavod. Lab. *42*, 1302 (1976)
18. Evtimova, B.: Anal. Chim. Acta, *68*, 222 (1974)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Ti	Tiron, pH 4.3–9.3	390–410	1.3	11	— reagents [1–3]
	H_2O_2, 1.5–3.5 N H_2SO_4	410	0.07	4	— in rocks [4, 5]
	Chromotropic acid, pH 3–5	460	1.7	4	— in steel [6, 7, 10]
	Diantipyrylmethane, 0.3–6 N HCl	360–380	1.3	4, 7, 8	— in vanadium [7]
	Thiocyanate ion		8.0	14–17	— in Ge, Si [12, 13]
	Salicylic acid, pH 2, 3, $CHCl_3$	380	5.9	9	
	Sulphosalicylic acid, pH 3.2–4.9	370	1.5		
	Dibromotihromine + diphenylguanidine, 0.5–5 N HCl, n-butanol	480	1.03	6	
	Thiocyanato diantipyryl methane, 2–3 N HCl, $CHCl_3$	420	6.0	8	
	9-(2,4'-disulphophenyl)-(2,3,7-trioxy)-6-fluorone, pH 6	570	12.0	12, 18, 19	
	Ascorbic acid, pH 3.5–6	360			
	Salicylic-hydroxane acid, pH 3–5	445			
	Salicyl-fluorone + SCN^-, $CHCl_3$		14.4	20	
	Propylfluorone + DAM, $CHCl_3$ + + C_2H_5OH		13.0	21	

Literature

1. Melentiev, B. N.: Determination methods of rare metal analysis. Izd. AN SSSR, 1961, 238 (in Russian)
2. Dolgarjev, A. V.: Spectral analytical etalons and standards collected by research institutes of the Soviet Union, 1965, 67 (in Russian)
3. Gyeinikina, R. S. et al.: New determination methods of metals, Izd. Metallurg. 1972 (in Russian)
4. Jeffery, P. G.: Chemical Methods of Rock Analysis, Oxford, Pergamon, 1970.
5. Upor, E., Klesch, K., Szalai, J.: Magy. Kém. Folyóirat, *82*, 385 (1976)
6. Basargin, N. N. et al.: Zav. Lab. *39*, 1043 (1973)
7. Bausova, N. V., Restnikova, G. A.: Ref. Zh. Khim. *4 G*, 116 (1967)
8. Tananajko, M. M., Niebiliczkaya, S. L.: Zav. Lab. *28*, 263 (1962)
9. Ramakrishna, R. S., Gunawardona, H. D.: Talanta, *20*, 21 (1973)
10. Pilipenko, A. T. et al.: Zav. Lab., *2*, 151 (1965)
11. Fries, J., Getrost, H.: Organische Reagenzien für die Spurenanalyse, Merck, Darmstadt, 1975.
12. Nazarenko, V. A., Biriuk, E. A.: Zh. Anal. Khim. *15*, 306 (1960)
13. Various organic reagents working on inorganic ions: disulphophenylfluorone, Moscow, IREA, 1968 (in Russian)
14. Tribalat, S., Caidero, J. M.: Bull. Soc. Chim. Fr. 3187 (1964)

15. Tananaiko, M. M., Lozovik, A. S.: Zh. Anal. Khim. *24*, 844 (1969)
16. Talipov, S. T., Karibyan, E. E., Shesterova, I. P., Smolkova, O. A.: Zh. Anal. Khim., *32*, 724 (1977)
17. Tamhina, B., Maul, V., Herak, M. I.: Microchem. J. *22*, 275 (1977)
18. Chernova, R. K.: Zh. Anal. Khim. *32*, 1477 (1977)
19. Belousova, V. V., Chernova, R. K.: Zh. Anal. Khim. *32*, 1669 (1977) Zav. Lab. *44*, 658 (1978)
20. Antonovich, V. P., Shelikhina, E. I., Lozovaya, S. A.: Zh. Anal. Khim. *28*, 1506 (1973)
21. Ganago, L. I., Mosina, L. A.: Zh. Anal. Khim. *31*, 1470 (1976)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Tl	Dithizone, 0.8 N NaOH	505	3.3		— analysis [1]
	Diethyl dithiocarbamate, pH 4–11, CCl_4	426	1.3		— photometry [2–5]
	Methylene blue, 0.5 N HCl, benzene,	560	7.5	8–10	— in rocks, ores [6, 3]
	0.2–0.3 N HCl, toluene	530			
	Oxine, pH 4–8, $CHCl_3$	401	0.68		— in Pb, Cd, Ir and Zn [5]
	Brilliant green, 0.1–0.2 N HCl	630			— in industrial waste water [7]
	Rhodamine B, 2 N HCl, benzene	565			
	Nitrochrompyrazol			11	
	Malachite green			10, 12, 13	
	Methylene blue			14	
	Capri blue		10.07	15	
	9-(2'-Hyperoxyphenyl)-2,3,7-trihydroxy-6-fluorone + antipyrine	505	25	16	

Literature

1. Korenman, I. M.: Analytical chemistry of thallium, Moscow, Izd. AN SSSR, 1960 (in Russian)
2. Marczenko, Z.: Photometric determination of elements, Moscow, Izd. Mir, 1971 (in Russian)
3. Yefremov, G. V., Parsina, N. V.: Spectral and analytical chemical methods of materials, Moscow, Izd. Metallurg. 1964 (in Russian)
4. Keil, R.: Z. Anal. Chem., *258*, 97 (1972)
5. Ywao Tsukahara et al.: Anal. Chim. Acta, *83*, 251 (1976)
6. Chemical analysis of rocks and minerals. Izd. Niedra Moscow, 1974 (in Russian)
7. Raykova, I. G. et al.: Scientific report of the research institutes for rare metals. *47*, 233 (1973) (in Russian)
8. see Al 8.
9. see Al 10.
10. see Ta 3.
11. see Ta 7.
12. see Al 9.
13. see Ta 4.

14. see Ta 5.
15. see Ta 6.
16. see Ta 8.

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
U	Theonyl trifluoro-acetone, pH 3.5–8, benzol	410	0.2	3	— reagents [1–5] in uranium ore [6]
	SCN^--ion, 0.1–2 N HCl, $CHCl_3$	350	0.53	3, 5, 12–15	— in rocks [7, 8]
	Na-DDTK, pH 2.5–7, ether, $CHCl_3$, alcohols	350	0.45	1	— in waste water of uranium plant [9–11]
	Dibenzoyl methane, pH 5–9, butyl acetate	400	2.0	1, 3, 5, 12–15	
	Arsenazo I, pH 4.5–8	595	2.3	1, 5, 12–15	
	Arsenazo III, 4–10 N HCl	650	10.0	5, 7, 8, 13,16–19	
	Chlorophosphonazo III, pH 1–3	650	7.3	1, 5, 20, 21	
	H_2O_2, 10% Na_2CO_3 solution	380–450	0.07	1, 11	
	BrPADAP, pH 7.6, trioctylphosphine oxide	578	7.4	6	
	Acetylacetone, pH 6–7, butyl acetate	360			
	Oxine, pH 4.5–9, $CHCl_3$	425–500			
	PAN, pH 5–10, $CHCl_3$	560			
	Thioglycolic acid, pH 8–11	380			
	Potassium-(hexacyanoferrate (II)), pH 1–2	525	0.37		
	Quinalizarin, pH 6.8–7.5	610	0.28		
	Chromoazurol S		10.0	22, 23	
	Malachite green			24	
	Methylene blue			21	

Literature

1. Riabczikov, D. I., Seniavin, M. M. (ed.): Analytical chemistry of uranium. Izd. Khim. 1962 (in Russian)
2. Korkisch, J., Hecht, F.: Handbuch der Analytischen Chemie Uran, Berlin, Springer, 1972
3. Havel, J., Sommer, L.: Chromogenic reaction of uranium, Brno, Folia Fac. Sci. *14*, 12 (1973)
4. Suten, A., Hodisan, T.: St. cerc. chim, *18*, 85 (1970)
5. Savvin, S. A.: Arsenazo III, Moscow, Atomizdat, 1966
6. Johnson, D. A., Florence, T. M.: Anal. Chim. Acta, *53*, 73 (1971)
7. Mohai, M., Upor, E., Jurczik, I.: Magy. Kém. Folyóirat, *71*, 334 (1965)
8. Mohai, M.: Uranium determination methods based on spectrophotometry of UO_2^{2+}-arsenazo III complex, Paper presented on Euroanalysis II. 1975

9. Mohai M.: Magy. Kém. Folyóirat, *81*, 164 (1975)
10. Savvin, S. B.: Uspehi Khimii, *32*, 195 (1963)
11. Upor, E., Görbicz, L., Novák, G.: Magy. Kém. Lapja, *21*, 487 (1966)
12. see Al 7.
13. see Al 8.
14. see Al 9.
15. see Al 10.
16. see rare earth metals 3
17. see rare earth metals 20
18. Perez-Bustamente, J. A., Delgado, F. P.: Analyst, *96*, 407 (1971)
19. Strelow, F. W., Van der Walt, T. N.: Talanta, *26*, 537 (1979)
20. Yamamoto, T.: Anal. Chim. Acta, *65*, 329 (1973)
21. Bykhovtsova, T. T., Tserkovnitskaya, J. A.: Zh. Anal. Khim. *32*, 745 (1977)
22. Leong, C. L.: Anal. Chem., *45*, 201 (1973)
23. Evtimova, B.: Anal. Chim. Acta, *83*, 397 (1976)
24. Dubey, S. C., Nadkarni, M. N.: Talanta, *24*, 266 (1977)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
V	N-Benzoyl-N-phenylhydroxylamine (BPHA), 2.9 N HCl	510	0.48	1–3	— in minerals [3]
	N-Furoylphenylhydroxyl amine, 6 N HCl	536	0.56	4, 5	— in steel, alloys [6]
	PAR + H_2O_2, pH 0.5	540	1.64	6	
	Nievasol NS, pH 1.8–2	565	1.5	7	— in rocks [9–10]
	H_2O_2, 1.5 N H_2SO_4	460	0.03	8	
	Phosphor vanadotungstate, 0.5 M H_3PO_4	365	0.2	8, 9	
	3,5-Br-MEPADAP + H_2O_2, 0.5 M H_2SO_4	615	5.43	10	
	Tungstite + H_3PO_4, 0.5 N HNO_3, i-butylalcohol	400	0.22		
	Diethyl-dithiocarbamate, pH 4–5.9, CCl_4	400	0.38		
	Oxine, pH 4	550	0.33		
	Hydroxamic acid				
	Aniline, ethylacetate	390			
	Pyrocatechol violet		3.7	11	
	Sulphonitrophenol K			12	
	Ferroine		5.5	13	
	PAR + Crystal violet		11.0	14	

Literature

1. Ryan, D. E.: Analyst, *85*, 569 (1960)
2. Usha Priyadorshini-Tandon, S. G.: Anal. Chem. *33*, 435 (1961)
3. Pilkington, E. S., Wilson, W.: Anal. Chim. Acta, *43*, 461 (1969)

4. Pilipenko, A. T. et al.: Zav. Lab. *32*, 660 (1966)
5. Pilipenko, A. T. et al.: Zh. Anal. Khim. *22*, 1014 (1967)
6. Bagdasarov, K. N. et al.: Zav. Lab. *35*, 12 (1969)
7. Basargin, N. N. et al.: Zav. Lab. *35*, 411 (1969)
8. Dragomireczky et al.: Photometrische Analyse anorganischer Roh- und Werkstoffe, Leipzig, VEB Deutscher Verlag für Grundstoffind., 1968
9. Popova-Stolyarova (ed.): Chemical analysis of rocks and minerals. Niedra, Moscow, 1974 (in Russian)
10. Kiss, E.: Anal. Chim. Acta, *77*, 205 (1975)
11. Janssen, A., Umland, F.: Anal. Chem. *254*, 286 (1971)
12. Savvin, S. B., Mineeva, V. A., Okhanova, L. A., Pachadzhanov, D. N.: Zh. Anal. Khim. *26*, 2364 (1971)
13. Simonzadeh, N., Muraskas, E., Jaselskis, B.: Talanta, *26*, 935 (1979)
14. Minczewski, J., Chwastowska, J.: Pham Thi Hong Mai, Analyst, *100*, 708 (1975)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
W	SCN^- ion, 6 N H_2SO_4—HCl, n-amyl acetate	407	1.6	1–7, 9, 12–17	— analysis [10]
	Dithiol, 0.3 N H_2SO_4, $CHCl_3$	645	1.9	1, 7, 9, 12–17	— separation [3, 8, 11]
	Pyrocatechol violet, pH 5	600	8.0	18–20	
	Oxine, pH 3.5–4.5 and pH 2.4, resp. $CHCl_3$	550 365			
	Hydroquinone, cc. H_2SO_4	478			
	Gallein + CTA		6.0	15, 21, 22	
	W—SCN^- + Crystal violet		21.0	12	
	Brilliant green + 3,5-dinitro-pyrocatechol		13.0	23	

Literature

1–7. see Mo 1–7.
8. Peng Ping, Y., Sandell, E. B.: Anal. Chim. Acta, *29*, 325 (1963)
9. Fogg, A. G. et al.: Analyst, *95*, 848 (1970)
10. Busev, A. N.: Zav. Lab., *28*, 1414 (1962)
11. Ivanov, V. M.: Zh. Anal. Khim. *30*, 1784 (1975)
12. Ivanova, I. F., Ganago, L. J.: Zh. Anal. Khim. *30*, 1395 (1975)
13. see Al 7.
14. see Al 8.
15. see Al 9.
16. see Al 10.
17. Fogg, A. G., Marriott, D. R., Burns, D. T.: Analyst, *95*, 848 (1970)
18. Yatirajam, V., Phamija, S.: Talanta, *22*, 760 (1975)
19. Chernova, R. K., Kharlamova, L. N., Belousova, V. V.: Zh. Anal. Khim. *32*, 2197 (1977)
20. see Ti 18.

21. Nazarenko, V. A., Ibragimov, G. J., Poluektova, E. N., Shitareva, G. G.: Zh. Anal. Khim. *33*, 938 (1978)
22. Shijo, Y., Takenchi, T.: Bunseki Kagaku, *22*, 1341 (1973)
23. Nazarenko, V. A., Poluektova, E. N., Shitareva, G. G.: Zh. Anal. Khim. *28*, 1966 (1973)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Y	rare earth metals				
Zn	Dithizone, pH 4.5–6	536	9.26	1, 2, 11–16	— in rocks [3, 4, 9]
	Zincon, pH 8.5–9.5	625	2.4	9–11	— in soil [5, 6]
	PAN, pH 6.6	546	6.2	10, 11, 17–19	— in natural waters [7, 8]
	NAAN, pH 6.4	646	3.9	1, 11	
	PAR		8.7	17–20	— in iron ore [10]
	Br-PADAP		13.3	21	
	Eosine, $CHCl_3$		12.0	22	
	8-(8-Quinolylazo)-4.5-diphenyl-imidazol		8.3	23	

Literature

1. Kamayeva, L. V. et al.: Zav. Lab. *37*, 258 (1971)
2. Iwantsheff, G.: Das Dithizon und seine Anwendung in der Mikro- und Spurenanalyse, 2. Ed. Weinheim, Verlag Chemie, 1972
3. Upor, E., et al.: Acta Chim. Acad. Sci. Hung. *61*, 1 (1969)
4. Görbicz, M., Upor, E.: Acta Chim. Acad. Sci. Hung. *66*, 373 (1970)
5. Vazhenina, I. G. (ed.): Determination methods of microelements in soils, plants and waters. Kolos, Moscow, 1974 (in Russian)
6. Page, E. R.: Analyst, *90*, 435 (1965)
7. Freier, R. K.: Wasseranalyse, Berlin, de Gruyter, 1964
8. The Testing of Water, 5. ed. Merck. Darmstadt
9. Huffmann, C. et al.: Geochim. Cosmochim. Acta, *27*, 209 (1963)
10. Pohl, H.: Erzmetall, *16*, 18 (1965)
11. Zhivopisczev, V. P., Selezhnieva, E. A.: Analytical chemistry of zinc, Moscow, Nauka, 1975 (in Russian)
12. see Al 7.
13. see Al 8.
14. see Al 9.
15. see Al 10.
16. see Ag 7.
17. Ackermann, G., Köthe, J.: Talanta, *26*, 693 (1979)
18. Shibata, S., Furukawa, M., Sasaki, S.: Anal. Chim. Acta, *51*, 271 (1970)
19. see F 24.
20. Nonova, D., Nenov, V., Lihareva, N.: Talanta, *23*, 679 (1976)

21. see Ni 18.
22. Tananaiko, M. M., Bilenko, N. S.: Zav. Lab. *42*, 1161 (1976)
23. Watanabe, H., Yamaguchi, N.: Bunseki Kagaku, *28*, 154 (1979)

Element	Reagent, medium	Wavelength of measurement, nm	Mol. abs. coeff. $\times 10^{-4}$	Literature	Determination (matrix) [Literature]
Zr	Arsenazo III, 9 M HCl	665	12.0	2, 6–10	— analysis [1–5]
	Picramine II, 1.2 HCl		3.4		
	Picraminazochrome, 0.5–1 N HCl		2.98		— in cast iron [4]
	Xylenol orange, pH 1.5		7.5	11	
	Sulphochlorophenol S, 1.2 N HCl			3, 4	
	Arsenazo I, pH 1.6	600	0.97		
	Alizarine S, pH 0.6–15	520	0.65		
	Quercetin, 0.5 N HCl, ethanol	440	3.14		
	SPADNS, pH 0.9–1.1	580	1.89		
	Thoron, pH 2	570	0.3		
	Chlorophosphonazo III		21.0	12	
	2-Quinolylfluorone		16.5	13	
	Ethylrhodamine B			14	

Literature

1. Yelinson, S. V., Petrov, K. I.: Analytical chemistry of Zr and Hf elements. Moscow, Izd. Nauka, 1965 (in Russian)
2. Dolgorev, A. V. et al.: Zav. Lab. *40*, 129 (1974)
3. Savvin, S. B.: Arsenazo III, Moscow, Atomizdat, 1966
4. Dedkov, Ju. M. et al.: Zav. Lab. *30*, 654 (1964)
5. Mukherji, A. K.: Analytical chemistry of Zirconium and Hafnium, Oxford, Pergamon, 1970.
6. see Al 8.
7. see rare earth metals 3.
8. see rare earth metals 20.
9. Pakalns, P.: Anal. Chim. Acta, *44*, 73 (1969)
10. Nemodruk, A. A., Boganova, A. N.: Zh. Anal. Khim. *32*, 1131 (1977)
11. Shtokalo, M. J., Ryzhenko, V. L., Ostrovskaya, T. V.: Zav. Lab. *44*, 925 (1978)
12. Yamamoto, T., Muto, H., Kato, Y.: Bunseki Kagaku, *26*, 515 (1977)
13. Asmus, E., Klank, W.: Z. Anal. Chem. *265*, 260, 267 (1973)
14. Dedkov, Y. M., Podvigina, T. J.: Zh. Anal. Khim. *32*, 437 (1977)

Compounds used as spectrophotometric reagents

(The trivial names of reagents are listed in alphabetical order and below their names referring to the chemical composition can be found. In the lack of trivial name the latter is included in the list. The name of the compound is followed by the elements to be determined.)

Acetyl-acetone: Be, U
Alizarin: F
1,2-dihydroxyanthraquinone
Alizarin S (sodium alizarin sulphonate): Zr, rare earth metals, Sc
1,2-dihydroxyanthraquinone-3-sulphonic acid-sodium salt
Aluminon: Al, Be, Ga
4', 4"-dioxyfuchsone tricarboxylic acid-ammonium salt and aurine-tricarbocylic acid ammonium salt, resp.
Ammonium hydroxide: Ni, Cu
Ammonium vanadate: PO_4^{3-}
Ammonium molybdate: PO_4^{3-}, Si
ammonium-[tetraoxo-molybdenate(VI)]
Aniline: W, V
Arsenazo I: Zr, In, Co, rare earth metals, U
2-(2'-arsono-phenylazo)-1,8-dihydroxynaphthalene-3,6-disulphonic acid disodium salt
Arsenazo II: In, Th
diphenyl-4-4'-diarsonic acid-3,3'-dis(azo-1,8-dioxynaphthalene-3,6-disulphuric acid
Arsenazo III: Zr, In, Ca, Cr, Pb, rare earth metals, Sc, U
1,8-dioxynaphthalene-3,6-disulphonic acid-2,7-bis(1-azo)-1,2-phenylarsonic acid
Ascorbic acid: Ti
Azo-azoxy BN: Ca
2-[2"-hydroxynaphthalene-(1"-azo-2')-phenylazoxy]-4-metylphenol
Barbituric acid: CN^-
2,4,6(1 H, 3 H, 5 H)-pyrimidinetrion or hexahydro-2,4,6-pyrimidinetrion
Bathocuproine: Cu
2,9-dimethyl-4,7-diphenyl-1,10-phenanthroline
Bathophenanthroline: Fe
4,7-diphenyl-1,10-phenanthroline
Bathophenanthroline-disulphonic acid: Fe
Bengali pink: Pt and Pt-metals
4,5,6,7-tetrachloro-2',4',5',7'-tetraiodofluorescein sodium salt
Benzidine: rare earth metals
diphenyl amine
N-Benzoyl-N-Phenylhydroxylamine (BPHA); V
p-Benzylidenerhodanine (see Rhodanine): Ag
Beryllon II: Be
1,8,8'-trioxy-2,1'-azonaphthalene-3,6,3',6'-tetrasulphonic acid sodium salt

Beryllon IV: Be
[Benzene-2-arsonic acid-(1-azo-2)-oxynaphthalene-6-imino diacetic acid-3-sulphonic acid]
Bismuthiol I: Te
1,3,4-thiadizolidine-2,5-dithion
Bis(neocuprin): I, I^- (see neocuprin)
4,4'-bis(N-methyl-N-benzylaminophenyl)-antipyrylcarbinol: Sb
Bis(4-sodium-tetrazolyl-azo-5)ethyl acetate: Sb, Ni
Br-Benzothiazo: Cd
6-Bromobenzothiazo-(2-azo-1)-2-naphthol
Brilliant green: B, Ga, An, Tl
N,N'-diethyl-4'-diethylaminofuchsone-immonium hydrogensulphate
3,5-Br-MEPADAB: V
[2-(3,5-dibromo-4-methyl-2-pyridylazo)-4 diethylaminophenol]
9-(5-bromohydroxyphenyl)-fluorone: Al
Bromophenol blue: Sc
3,3',5,5'-tetrabromophenol sulphophthalein
Bromopyrogallol red: Nb, rare earth metals
Pyrogallol red: 2-(4,5,6-trihydroxy-3-oxo-3H-xanthene-9-il)-benzolsulphonic acid
5-Br-PADAB: Pb
2-[2(-bromopyndyl)azo]-5-diethylaminophenol
3,5-Br-PADAB: Co, U
[4-(3,5-dibromo-2-pyridylazo)2,4-diamino-toluene]
Brucine: NO_3^-, rare earth metals
10,11-dimethoxy-strychnine ($C_{23}H_{26}O_4N_2$)
Butylrhodanine: Au, In, Te
Cadion Irea: Cd
4-(p-sulpho-phenyl-azo)-2'-sulpho-4'-nitro-diazoaminobenzene-disodium salt
Calcium Irea = Calcichrome = calcion: Ca
5-[(1, 8-dihydroxy-3, 6-disulpho-2-naphthalinyl)azo]-4-hydroxy-3-[(8-hydroxy-3, 6-disulpho-1-naphthalinyl)azo]-2,7-naphthalinedisulphonic acid-hexasodium salt
Capri blue: Ta
Carboxybenzene S: Mn
Carboxygallanilide: Th
4-(3', 4', 5'-trihydroxy-benzoyl-amino)-benzoic acid
Carboxynitrazo: rare earth metals
Carminic acid: B
2, 5, 7, 8-tetrahydroxy-4-methyl-6-(2', 3', 4', 5'-tetrahydroxy-hexanoyl)-antraquinone-1-carboxylic acid

Chloramine T: CN^-
p-toluene-sulphochloroamide-Na
Chlorophosphonazo III: Ca, Mg, U, rare earth metals, Sr, Ba, Th, Zn
[1, 8-dioxynaphthalene-3, 6-disulphonic acid-2, 7-bis(azo-2-phosphono--4-chlorobenzene)]
Chlorosulphonazo III: (see Sulphonazo III): Ca
Chromal blue: Sc
5-[3-carboxy-5-methyl-4-oxo-2,5-cyclohexadiene-1-ilidene) (2-chloro--4-nitrophenyl)methyl]-2-hydroxy-3-methyl-benzoic acid-disodium salt
Chromoazurol S: Al, Th
5,5-dimethyl-4'-oxy-2", 6"-dichloro-3"-sulphofuchsone-3,3'-carbonyl acid sodium salt
Chromopyrazol I: Au
4-[[4-(dimethylamino)phenyl]hydroxy[4-methyl(phenyl-methyl)amino]phenyl]methyl 1,2-dihydro-1,5-dimethyl-2-phenyl-3H-pyrazol-3-on
Chromopyrazol II: Cd
bis(4-methyl-benzyl-aminophenyl-antipyridyl-carbinol)
Chromotrop 2 R: Ti, Cr, Mg
chromotropic acid-bisodium salt (see Chromotropic acid)
Chromotropic acid: Ti
1,8-dihydroxy-naphthalene-3,6-disulphonic acid
CI-PADAB: Co
4-(5-chloro-2-pyridylazo)-1,3-diaminobenzene
3,5-di-Cl-Padat: Co
5-(3,5-dichloro-2-pyridylazo)-2,4-diaminotoluene
Cobalt-nitrite: Na, Rb, Cs
Complexon I (NTE): Cu
nitrilo-triacetic acid
Complexon II (EDTE)
ethylene-diamine-tetraacetic acid
Complexon III (EDTA): Bi, Cr, Ir, Ni, Cu, Fe
ethylene-diamine-tetraacetic acid-disodium salt
o-Cresolphthalein: Ba, Sr
Crystal violet = Methylene violet: Sb, B, Ga, Au, Tl
N,N-dimethyl-4',4"-bis-(dimethyl-amino)-fuchsone-immonium chloride, monohydrate
CTA
cetyl-trimethyl-ammonium ion: Al
Cupferron: Fe
N-nitrozo-N-phenyl-hydroxyl-amin-ammonium salt

Cuproin: Cu(I)
2,2'-diquinoyl
Cupron: Cu
α-benzoin-oxime
Curcumin: B
1,7-bis(3-methoxy-4-hydroxyphenyl)-hepta-1,6-diene-3, 5-dion
Cyanide ion + Iron(III) ion: SnO_6^{2-}
Cyclohexylfluorone: Cu
2,6,7-trioxy-9-(cyclohexyl)-3H-xanthene-3-on
3,3'-Diaminobenzidine: Se
2,3-Diaminonapthalene: Se
4,5-Diamino-6-thiopyrimidine: Se
1,1'-Dianthrimide: Se
Diantipyrylmethane (DAM): Sb, Ti
Diantipyrylmethane dithioxalate: Ni
Diantipyrylpropyl methane: Te
Dibenzoyl methane: U
5,7-dibromo-8-hydroxyquinoline: In
Dibromophenylfluorone: Al
2,6,7-trioxy-9-(dibromphenyl)-3H-xantane-3-on
Dibromochromine: Ti
[N-methyl-N,N-bis(methylene-chromotropic acid)-amine]
p-Diethylamino benzylidene rhodanine: Au
Diethyl-dithiocarbamate (DDTK): As, Bi, Hg, Cd, Co, Mn, Ag, Ni, Pb, Sn, Tl, V, Fe
Diethyl-dithio-phosphoric acid: Re
Dimercaptothiopiron: Bi
Dimethylamino-benzylidene rhodanine: Ag
p-Dimethyl arsenazo III: Th (see arsenazo III)
Dimethylglioxime: Pd, Ni, Re, Fe
diacetyl dioxime
1,3-dimethyl-4-imino-5-oxy-imino-alloxane: Cu
2,6-Dimethylphenol: NO_3^-
N,N-dimethyl-p-phenylene diamine: S^{2-}
1,5-Diphenyl carbazide: Cr, Sr, Ba
Diphenyl carbazone: Hg, Cl^- (in the presence of Hg^{2+}), Pb
1,5-diphenyl carbazone
Diphenyl guanidine: Ti
2,4-Diphenyl thiosemicarbazide: Re, Ru
Dipicrylamine: K, Na, Rb, Cs
2,2'-dipyridyl: Fe
7,7'-diquinolyl-disulphide: Cu

9-(2,4'-disulphophenyl)-2,3,7-trioxy-6-fluorone: Ti
Dithiol: Mo, W, Sn, As
1-methyl3,4-dimercaptobenzene
Dithio-oxamide (see rubeanic acid)
Dithizone: Bi, Zn, Hg, In, Cd, Co, Ag, Pd, Ni, Pb, Cu, Se, Tl
1,5-diphenylthiocarbazone
Eosine: Pb, rare earth metals
2',4',5',7'-tetrabromofluorescein sodium salt
Eriochrome black T: Mg
[1-(1-hydroxy-2-naphthylazo)-6-nitro-2-naphthol-4-sulphonic acid]
Eriochrome brilliant violet: Sc
5-[(3-carboxy-5-methyl-4-oxo-2,5-cyclohexaethylene-1-ilidene) [2-chloro-4-(dimethylamino)phenyl]-methyl}-benzoic acid
Eriochrome cyanine R: Al, F, Sc
5,5'-dimethyl-4'-oxy-2''-sulfofuchsone-3-3'-dicarboxylic acid-sodium salt
Erithrosine: Rare earth metals
tetraiodofluorescein sodium salt
Ethylrhodamine B: Zr
(see rhodamines)
Ferroin: Fe, V
Fe(II)ion: phenanthroline = 1 : 3
Ferron: Fe
7-iodo-8-quinolinol-5-sulphonic acid
Formaldoxime: Mn
$CH_2=N-OH$
Fuchsin: SO_3^{2-} (in the presence of aldehyde)
α^4-(3-aminophenyl)α^4-(4-imino-2,5-cyclohexadiene-1-ilidene)-2,4-xylidine
Furacilin: Hg
Semicarbazon-5-nitrofurfurol
α-furfuryldioxime: Pd, Ni
N-Furoyl-phenylhydroxylamine: V
2,2'-furyldioxime: Re
Gallein: W
4',5'-dihydroxyfluorescein
Gallion irea: Ga
1-hydroxy-2-(2'-hydroxy-3'-chloro-5'-nitrophenylazo)-8-aminonaphthalene-3,6-disulphonic acid monohydrate
Germanium-molybdenum-heteropoly acid
Glyoxal-bis-(2-oxyanil): Ca

Haematoxylin: Sn
cis-(+)-7,11b-dihydro-benz [b] indano [1,2-d] pirane-3, 4, 6a, 9, 10 (6H)-pentol
[Hexacyanoferrate(II)] and [hexacyanoferrate(III)]-ion: Fe
HgI_4^{2-}-ion: NH_3
Hydrazine sulphate: As
Hydrochloric acid: Bi, Fe
Hydrogen chloride
Hydrogen bromide: Au
Hydrogen peroxide: Nb, Ti, U, V
Hydroquinone: W
1,4-dihydroxybenzene
9-(2'-Hydroxyphenyl)-2,3-7-trihydroxy-6-fluorone: Ta
Iron(III)-thocyanete: F
Isothiocyanate-ion: Mo, Nb, W, Re
NCS^-
Lumogallion: Nb
2,2',4'-trihydroxy-5-chloro(1-azo-1')-benzene-3-sulphonic acid
Magnezon Irea: Mg
1-(2-hydroxy-3-sulpho-5-chlorophenylazo)-2-naphthol sodium salt monohydrate
Malachite green: Ca
[bis-(dimethyl-amino-phenyl)-phenyl-methane]
2-Mercapto-benzimidazol: Se
β-Mercapto-propionic acid: Ni
8-Mercapto-quinoline: Pd, Re, Cu
4-Methyl-1,2-cyclohexane-diondioxime: Re
4-Methyl-dioxime: Re
5,5-Methylene-bis-salicylfluorone
Methylene blue: B, Re
3,7-bis(dimethylamino)-phenothiazinium-chloride
Methylene violet, see Crystal violet
Methyl green: Ga, Hg
4-[[4-dimethylamino)phenyl] [4-(dimethylamino)-2,5-cyclohexadiene-1]-ilidene]methyl]-N,N,N,-trimethylphenyl ammoniumdichloride
Methyl red: Cl^-, Cl_2
4'(dimethylamino)-azo-benzene-2-carboxylic acid
Methyl orange: Cl^-, Cl_2
4'-(dimethyl-amino)-azobenzene-4-sulphonic acid-Na salt
Michler thioketone Ag, Au
4,4'-bis(dimethyl-amino)-thiobenzophenon

Morin: Th, Al
3,5,7,2',4'-pentahydroxyflavon
Murexide: Ca
ammoniumpurpurate
NAAN: Zn
5-nitrophenol-(2-azo-1')-2'-(β-acetyl-hydrazin-naphthalene)
α-Naphthylamine: NO_2^-
N(1-naphthyl)ethylene diamine: NO_2^-
Neocuproin: Cu
2,9-dimethyl-1,10-phenanthroline
Nevasol NS: V
[2-oxy-3-sulpho-5-nitro-benzene(-1-azo-2')-1'-oxynaphthalene-4'-sulphonic acid]
Nitroanthranylazo: Li
2-carboxy-4-nitrobenzene-⟨1-azo-4'⟩1'-phenyl-3'-methylpyrazolon-5'
Nitrochromoazo: Ba, SO_4^{2-}
[1,8-dioxynaphthalene-3,6-disulphonic acid-bis-⟨2,7,4-nitro-2-sulpho-1-azo-benzene⟩]
3-Nitrophenylfluorone: Bi, Nb
2-Nitroso-5-diethylamino phenol: I^-
p-Nitroso-dimethyl aniline: Pt, Pb
p-Nitroso-diphenyl amine: Pb, Pd
p-Nitroso-methylaniline: Pt
1-Nitroso-2-napthol: Co, Pb, Fe
Nitroso-R salt: K, Co
1-nitroso-2-naphthol-3,6-disulphonic acid disodium salt
Orthonyl K: SO_4^{2-}
[2-sulphobenzene-(1-azo-2)-1,8-dioxynaphthalene-3,6-disulphonic acid-(7-azo-1)-2-carboxybenzene]
Orthanyl S(sulphonazo III): Ba, Sr
[1,8-dioxy-naphthalene-3, 6-disulphonic acid-2,7-bis(azo-2-sulpho-benzol)]
Oxine = Hydroxyquinoline: Al, Bi, In, Cr, Mg, W, Ni, Nb, Cu, rare earth metals, Sc, Tl, U, V, Fe
8-oxyquinoline
PAN: Zn, Ge, Hg, Co, Mn, Ni, U
[1-(2-pyridylazo)-2-naphthol]
PAR: Co, Ni, Nb, Th, V
4-(2-pyridylazo)-resorcinol
Pararosaniline: SO_2
tris(4-aminophenyl)-methanol

PAQH: Ni
Pyridine-2-aldehyde-2-quinolylhydrazon
PDT: Ru, Re
3-(2-pyridyl)-5,6-diphenyl-1,2,4-triazine:
1,10-Phenanthroline: Ru, Fe, Ag, rare earth metals
Phenazo: Mg
{3,3'-dinitrobiphenyl-4,4'-bis[(azo-4)-i-oxybenzene]}
Phenol: NH_3 (in the presence of ClO^-) Pb (in the presence of eosine)
2-phenoxyquinalizarin-3,3'-disulphonic acid potassium salt: Be
2,4-phenyldisulphonic acid: NO_3^-
o-Phenylenediamine: Se
Phenylfluorone: Mo, Nb, Sn, Ge
2,6,7-trihydroxy-9-phenyl-3-H-xanthenon
Phenyl-α-pyridine-ketoxime: Pb
Phosphor molybdenum blue; Cs, K, Tl, Ti, SO_2
phosphormolybdenic acid or molybdato phosphoric acid $H_3[P(Mo_3O_{10})_4]$
Phosphorvanadotungstate: V
Picramin II: Zr
2,3-nitrosulphophenol Sz
Picraminazochrome: Zr
4,5-dihydroxy-3,6-bis(2-hydroxy-3,5-dinitrophenyl)azo-naphthalene-disulphonic acid
Picric acid: Na, Rb, Cs
Potassium hexacyanoferrate(II): U
Potassium iodide: Sb, Bi, Pd, Pt
PPDT: Fe
3-(4-phenyl-2-pyridyl)-5,6-diphenyl-1,2,4 triazine
Propylfluorone: Ti
Pyridine: $SnO_6^{2-}Cu^{2+}$ present), CN^-, Cu
3-Pyridylfluorone: Sn
2,6,7-trioxy-9-(3-pyridyl)-3H-xantene-3-on
Pyrogallol: Nb
1,2,3-trihydroxybenzene
Pyrokatechol violet: F, W, Sn, rare earth metals, Cu
3,3-bis(3,4-dihydroxyphenyl)3H-2,1-benzoxathiol-1,1-dioxide
Quercetin: Zr, Sn, Th
3,4,7,3',4'-pentahydroxy-flavon
Quinalizarin: B, Ga, U
1,2,5,8-tetrahydroxy-antraquinone
2-(Quinolylazo)4,5-diphenylimidazol: Hg
Quinolylfluorone: Zr

Rezaron: Ge
Rhodamines = dialkylamino-xanthenes: Te
Rhodamine B: Sb, Ga, Au, Tl
tetraethyl-diamino-o-carboxyphenyl-xanthenylchloride
Rhodamine 6 G: In, Bi
diethyl-amino-o-carboxyphenyl-xanthenylchloride-ethylether
Rhodamine 6 Zs: In
N,N'-diethylamino-carboxyphenyl-xanthenylchloride
Rhodanine: Au
2-thoxo-4-thiazolydinone
Rubeanic acid: Ru
dithiooxamide
Safranine T: Si
2-methyl-3,7-diamino-5-phenylphenazin
Salicylaldoxime: Ni
Salicylfluorone: Sb, Ti
2,6,7(-trioxy-9-12-oxyphenyl)-3H-xantene-3-on
Salicylic acid: NO_3, Ti
2-hydroxybenzoic acid
Salicyl hydrosamic acid: Ti
Sodium-diethyl dithiocarbamate (Na-DDTK): Ni, PB, Cu(II), Te, U
Sodium-molybdate: As
Sodium-vanadate: As
SPADNS: Zr, Th
2-sulphophenylazo-1,8-dioxynaphthalene-3,6-disulphonic acid
Stilbazo: Al
4,4-bis(3,4-dihydroxy-phenylazo)-stilbene-2,2-disulphonic acid disodium salt
Sulphanilic acid: NO_2^-
p-amino-benzene-sulphonic acid
Sulphanilic amide: NO_2^-
Sulpharsasene: Cd, Pb
4"-nitro-benzene-1", 4-diazoamino-1,1-azobenzene-2"-arseno-4, sulphonate-Na
Sulphochlorophenol S: Zr, Nb
2,7-bis⟨azo-2-oxy-3-sulpho-5-chlorobenzene⟩-1,8-dioxynaphthalene 3,6-disulphonic acid
Sulphonazo III: Ba, SO_4^{2-}
3,6-bis[(2-sulphophenyl)-azo]-4,5-dihydroxy-naphthalene disulphonic acid
Sulphonitrophenol K: Mo; M: Nb, P, Pb, V

Sulphosalicylic acid: F, Ti, Fe
4-hydroxy-5-sulphobenzoic acid
Tartaric acid: Fe
Tenoyl trifluoracetone (TTA): U
1-(2-tenoyl)-3,3,3-trifluoracetone
2,2',2"-Terpyridyl: Co, Fe
Tetramethyl diaminodiphenylmethane: Pb
1-(2-thiazolylazo)-2-naphthol-3,6-disulphonic acid: Ni
Thiocyanate ion: Co, Mo, W, Re, Nb, U, Fe, SCN
Thiocyanato-diantipyryl methane: Ti
Thioglicolic acid: Mo, U
Thiomalic acid: Mo
mercapto malic acid
Thiooxine: In
8-quinolinethiol sodium salt, trihydrate
Thiourea: Bi, Ru, Os, Re, Te
Thoron: Li, Zr, Th
1-(o-arzono-phenyl-azo)-2-hydroxynaphthalene-3,6-disulphonic acid trisodium salt
Tin-chloride(reducing agent): PO_4^{3-}, Nb
Tiron: Ti
1,2-dioxy-benzene-3,5-disulphonic acid disodium salt
Titanium yellow: Mg
p,p'-bis(6-methyl-2-benzthiazolyl)-diazoaminobenzene-o,o'-disulphonic acid disodium salt
o-Tolidine: Cl_2, Au
TPTZ: Fe
2,4,6-tri(2'-pyridyl)-sim triazin
2,3,7-trioxy-9,2',4-disulphophenylfluoron: In
Tungstite: V
iron-tungstate + manganese tungstate
Victoria blue: Te
bis(4-dimethyl-aminophenyl)-(4-anilino-1-naphthyl)-methyliumhydrochloride
Xylenol orange: Zr, Sc, rare earth metals
3,3-bis[2-methyl-3-hydroxy-4-di(carboxy-methyl)-aminophenyl]-3H-2,1-benzoxathiol-1,1-dioxide
Zinc dibenzyl-dithiocarbamate: Cu
Zincon: Zn
[5-(-carboxyphenyl)-1-2(oxy-5-sulphophenyl)3-3-phenyl phormasane]

Dr. Klára ERŐSS-KISS H-1521 Budapest