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Present and Future Status of Organic Analytical Reagents – Part II

INORGANIC CHEMICAL ANALYSIS: CLASSICAL METHODS, MOLECULAR SPECTROSCOPY (ABSORPTION AND EMISSION) AND SOLVENT EXTRACTION

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Present and future status of organic analytical reagents — Part II. Inorganic chemical analysis: classical methods, molecular spectroscopy (absorption and emission) and solvent extraction

Abstract - Following the general introduction to the present and future status of organic analytical reagents (OAR), a priori prognosis - a posteriori examination, aspects of inorganic chemical analysis are reviewed with emphasis on current practice, recent developments and trends. The technique areas included are qualitative tests, gravimetric and titrimetric procedures, solvent extraction and molecular absorption and luminescence spectroscopy in the UV-Visible region. Recent trends and developments noted are, in UV-visible absorption spectrophotometry - the use of micellar sensitisation; in luminescence - the use of low temperatures and chemiluminescent reactions; in solvent extraction - an increased interest in ion-association reactions, use of macrocyclic ligands, application of kinetic factors, solid-liquid and flotation systems.

CLASSICAL CHEMICAL PROCEDURES

The development and use of OAR in qualitative analysis established a large number of selective chemical reactions and spot tests for elements and their compounds. Their use in this connection gave rise to the concept of analytical functional groups whose usefulness was also shown during the search for new or improved OAR for quantitative analytical practice. A comprehensive literature is available (1-12).

The interest in OAR for gravimetric analysis was reduced with the fall in popularity of gravimetric procedures. A number of procedures however remain in use, particularly for reference analyses and for standardization. They are carried out in aqueous or mixed solvents where voluminous and not always pure precipitates of OAR complexes or chelates are formed. The excess reagent must be carefully washed from the precipitate before drying or removed by ignition. A low gravimetric conversion factor is of considerable advantage. Procedures requiring ignition of precipitates are less convenient (13-15). Among reagents still considered useful are biacetyldioxime, furildione dioxime or cyclohexanedione dioxime for the determination of nickel and palladium (16), 8-hydroxyquinoline (17, 18), for the determination and separation of various metal ions, N-benzoyl-N-phenylhydroxylamine (19) or α-benzoin oxime (20-22) for the determination and separation of niobium and tantalum or molybdenum and tungsten.

The renaissance of titrimetric procedures just after the end of World War II arose from the ready availability of aminocarboxylic acids (complexans or chelons)

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as novel and universal titration agents for metal ions. Determinations with the most popular, EDTA, are still frequently used in routine laboratories or for the standardisation of metal ion solutions. The theory of complexometric titrations is well established (23 - 26), the titration end point can be evaluated with sufficient reliability to adopt such procedures even for micro-analysis (27). The advantages of complexometric titrations stimulated the development of new OAR as metallochromic (metal) indicators. Detailed texts, manuals and numerous critical review articles deal with the reactions of chelons, complexometric titrations (28 - 30) and metal indicators (31, 32).

MOLECULAR ABSORPTION SPECTROSCOPY IN THE UV–VISIBLE REGION

The most popular and widest range of application of OAR has been in spectrophotometry and solvent-extraction spectrophotometry in the UV-visible region for applied inorganic analysis. The most sensitive spectrophotometric methods are based on binary, ternary or even quarternary complexes, chelates or ion-pairs (ion-association complexes) of metals or non-metals, especially with dye OAR. Most procedures are of limited selectivity and need prior separation of the analyte or sophisticated masking of interferents. Molecular absorption spectrophotometry (UV and visible) is still among the most popularly used methods for the determination of Be, Sc, Ti, Zr, V, Nb, Ta, Mo, W, Re, platinum metals, U, Th and also often for lanthanoids, B, Al, Ga, In, Tl^{III}, P^V, As^V, Si, Ge, Se^{IV}, Cr, Sb, Bi and Mn. The most suitable OAR for spectrophotometric determination of metals and non-metals have been the subject of detailed discussion and review (33 - 50). Sensitive and selective determinations of Zr, Nb, Ta, V^V, lanthanoids, actinoids or platinum metals may be carried out on the basis of inner sphere ternary complexes (51). The interference of absorbing matrix background or reagent excess may be removed by difference (52, 53), derivative (54) or dual-wavelengths spectrophotometry (55, 56).

OARs also play an important role in the simultaneous multielemental spectrophotometric analysis as often there are sufficient differences between the spectra of particular components (eg metal chelates of polyphenols (57 - 59), dithiocarbamates (59, 60), N-heterocyclic azo dyes (61 - 64)). Various mathematical procedures are available to deal with mutual interactions of components (59). There are good long term prospects for multielemental analyses by using mixtures of reagents showing similar sensitivity for various analytes whose OAR chelates or other products have different spectrophotometric properties (mixtures of 1,10-phenanthroline and cuproine derivatives or ferrozine and cuproine derivatives for simultaneous determination of Fe^{II} and Cu^I (64 - 66), or 1,10-phenanthroline, neocuproine and sulphanilic acid and 1-naphthylamine for the determination of Fe^{II}, Cu^I, and NO_2^- (65)).

The spectrophotometric evaluation of analytes during their flow injection analysis is commonly based on absorbing OAR chelates (67 - 69). Kinetic factors in the flow system may, however, influence the composition and the optical properties of the reaction products. The simultaneous spectrophotometric determination of several elements may also be carried out in flow systems using a FIA analyzer containing a diode array and controlled by a micro-processor (70).

Micellar sensitisation has been widely exploited for metal chelates with selected
dye OAR containing several acidic groups such as triphenylmethane dyes having a
salicylic acid or catechol functional group in the molecule [eg Chrome Azurol S(C.I.
43 825), Eriochrome Azurol B(C.I. 43 830), Eriochrome Cyanine R(C.I. 43 820) or
Catechol Violet) or xanthene dyes (9-substituted 2,6,7-trihydroxyxanthen-3-one
Pyrogallol Red, Bromopyrogallol Red)] in the presence of various cationic or
non-ionic surfactants or surfactant mixtures. Species formed in such systems have
high molar absorptivities (ϵ >1.0 x 10^5 1 $mol^{-1}cm^{-1}$) and considerable colour
contrast, especially for Be, Al, Sc, Y, La, lanthanoids, Ga, In, Cu, Fe^{III}, UO_2^{2+}
and Th. The concentration of the dye reagent and surfactant and also the optimum pH
value are critical and different for each particular system. The nature of the
reactivity in the presence of surfactant has not always as yet been completely
elucidated. Stoichiometric ion associates of limited solubility are formed in
aqueous solution for submicellar concentrations of surfactant and soluble complexes
of various structures and stoichiometry. Complicated competition equilibria may
take place in solutions with large surfactant or reagent excess, dependent on the
concentration of components and on pH. Such complicated relations often result in
curved calibration plots (eg 47, 71 - 79). In addition various sparingly soluble
metal chelates may be solubilized in aqueous medium by addition of non-ionic
surfactants, eg 1-(2-pyridylazo)-2-naphthol chelates in the presence of Triton
X-100, and the extraction into organic solvents may be omitted. The same is true
for sparingly soluble high molecular weight ion pairs such as those of
12-heteropolyacids with basic dyes in the presence of non-ionic surfactants (80 - 83).

LUMINESCENCE PROCEDURES

Binary and ternary complexes or chelates of OAR containing oxygen or nitrogen donor
atoms having rigid structures may show intense <u>fluorescence</u>. Examples are complexes
involving reagents such as polyhydroxy-flavones, 8-hydroxy- quinoline and its
analogues, hydroxyarylhydrazones, benzoin, phenolcarboxylic acids,
2-hydroxy-3-naphthoic acid, polyphenols, hydroxy- and aminoxanthene dyes,
o,o'-dihydroxyazo dyes, calcein and others forming fluorescent chelates with metal
and non-metal ions whose outer electronic shell is s^2p^6 or $s^2p^6d^{10}$ [Al^{III}, Ga^{III},
In^{III}, Ca^{II}, B^{III}, Zr^{IV}, Hf^{IV}, Th^{IV}, Sc^{III}, Ge^{IV}, Sn^{IV}, Zn^{II}, La^{III}, Y^{III},
$lanthanide^{III}$s (84 - 86)]. OAR chelates of terbium and europium are an especially
suitable basis for their fluorimetric determination (87 - 90). Various ion pairs or
ion association complexes of rhodamines and other xanthene dye cations with
colourless anionic metal or non-metal complexes may be evaluated fluorimetrically
after their extraction into oxygenated solvents (91).

<u>Low temperature luminescence</u> has enabled increased sensitivity and even selectivity
for the determination of certain metal ions and has created renewed attention to OAR
at the present time (92, 93), eg lumogallion for the determination of niobium (94),
8-hydroxyquinoline for niobium (95), salicyclic acid for boron (96),
dibenzoylmethane for boron (97) or beryllium (98) and 2,3-diaminonaphthalene for
selenium (99). Different <u>quasilinear florescence</u> spectra of various metal ion
chelates, eg with polyhydroxyflavones or azomethines for the determination of Ga,

In, Al, Be, and Cd, being fixed in the crystal lattice of frozen aliphatic
hydrocarbons (n-hexane, n-octane, n-pentane) enable selective determinations of
several analytes, the high quantum yields of luminescence cause considerable
sensitivity increase over solution measurements (100, 101). Recently, the
enhancement of fluorescence in micellar solutions of non-ionic surfactants (eg for
metal ion chelates of poly-hydroxyflavones or some 2,2'-dihydroxyazo dyes (102 -
105)) has been successfully used for analytical purposes. Room temperature
phosphorescence in micellar solutions of surfactant (MS-RTP) in the absence of
oxygen is of interest for selected metal ion OAR complexes (106). In addition,
differences in luminescence life times at low temperatures of various metal ion
chelates with particular OAR in mixture decrease mutual interferences (97, 107).

The chemiluminescence of certain OAR may also be exploited for analytical purposes.
Luminol (3-aminophthalic acid hydrazide), lucigenine (10,10'-dimethyl-9,9'-
biacridinium dinitrate) or lophine (2,4,5-triphenylimidazole) used for the
determination of traces of activators or oxidants (108). Rhodamine B (C.I. 45 170)
is a valuable substrate for the chemiluminescence of ozone (109, 110) and luminol
for the determination of nitrogen dioxide (111).

SOLVENT EXTRACTION

The extraction of cations and anions with OAR into non-aqueous solvents is widely
used for group or for more selective separations, the elimination of matrix
components or the separation and preconcentration of minor or trace elements and has
been reviewed in detail (112-124). Such separations have been usefully associated
with radiochemical, electrochemical and spectrochemical procedures, in particular
with spectrophotometry in the UV and visible regions. In early studies organic
chelating agents such as enolizable 1,3-diketones, 8-hydroxyquinoline,
8-mercaptoquinoline, dithiocarbamates, monoximes or dioximes of aldehydes and
ketones, hydroxamic acids, acylpyrazolones, 1,5-diphenylthiocarbazone (dithizone),
N-benzoyl-N-phenylhydroxylamine, N-heterocyclic azo dyes were commonly used for the
determinations of a wide range of metal ions. In addition, inner sphere (covalent)
ternary complexes with a saturated coordination envelope show increased extractivity
or synergistic phenomena compared with binary species (51).

Recently, charged OAR species forming ion-pairs or ion-association complexes with
anions and cations became of considerable interest since ion-pair extraction is at
present a most important and widely used basis for solvent extraction (125, 126).
Ion-pairs may consist of anionic or cationic OAR complexes associated with tertiary
amines, quaternary ammonium, arsonium or phosphonium cations, non-chelating ionized
cationic or anionic dyes, voluminous anions such as tetraphenylborate or surface
active macrocations or macroanions, some of them being suitable for direct
spectrophotometric purposes (46, 47, 74, 127 - 130). For example extraction of
various transition elements form highly absorbing anionic chelates with pyrocatechol
(131, 132) or with 4-(2-pyridylazo)resorcinol (133) which may be extracted into
chloroform with alkyl or phenyl arsonium and phosphonium cations respectively. The
extraction spectrophotometric determination of Cu, Cd, Zn and Hg in the form of

ternary species of anionic PAR chelates with cationic surfactant in chloroform is of theoretical and practical interest (134-139). The extraction may fail in the presence of a large excess of surfactant in aqueous solution, due to micellar competition.

Some new types of OAR have recently become available for chelate-ion-pair solvent extraction. Macrocyclic crown ethers form extractable ion-pairs between the positively charged metal ion crown ether complex with some simple or complex anions, or complex zwitterions with proton dissociable crown ethers. These can be very selective extracting agents for metal ions and are now often used for the determination of alkali and alkaline earth elements. Their chemistry and analytical use including extraction have been comprehensively reviewed (140 - 147). The extraction properties and complexation are controlled by the ring size, the cavity in the structure of the reagent which is influenced by the number and position of oxygen donor atoms, by the position and nature of substituents and the stability of the ion-pairs with anions which may also be chromogenic. Thus, crown ethers containing incorporated chromophoric groups and also crown ether complex ion-pairs with selected dye anions are suitable for the sensitive extraction spectrophotometric determination of alkali and alkaline earth elements (140). Ion-pairs of the frequently used dibenzo-18-crown-6 with picrate and containing alkali metal ions are extracted into benzene or chloroform in the order: $K^+ > Rb^+ > Cs^+ > Na^+ > Li^+$. Thus K^+ is readily extracted for spectrophotometric determination of K^+ in the presence of excess Na^+ as an ion-pair with picrate, tropeoline OO (148), Bromocresol Green, Methyl Orange, or Metanil Yellow (149). In addition, Rb^+, Ag^+, Tl^+, Pb^{2+}, NH_4^+ and alkaline earth metal ions may also be extracted into chloroform by 18-crown-6 ethers in the presence of various coloured anions (150, 151). 14-crown-4-ethers were shown to be suitable for the selective separation and spectrophotometric determination of Li^+ (152 - 154), 15-crown-5 ethers for the determination of Na^+ and 18-crown-6 ethers for the determination of K^+ and Rb^+ (155 - 157). Various monoproton-, diproton-dissociable crown ethers and neutral crown ether dyes, in particular side-armed crown ethers with azo-linked side arms or azobenzene crown ethers have been prepared and applied in spectrophotometry (145, 158, 159). 15-crown-5-ethers with substituted azo linked side arms were recommended as chromogenic reagents for Na^+, 4'-picrylaminobenzo-15-crown-5- or 4-picrylaminobenzo-18-crown-6-derivatives are valuable reagents for K^+ (160 - 163). Another way of using potassium complexes of crown ethers is in association with coloured anionic metal complexes and the extraction of the large ion association species into solvents of limited polarity. The extraction of $[NbOCl_2(SCN)_3]^{2-}$ or Cu^{2+}-Zincon chelate anion with the dibenzo-18-crown-6-complex of K^+ are good examples (164 - 166). Azolinked or dinitrophenylmethyl diazatetraoxa crown ethers are convenient for the spectrophotometric determination of alkaline earth metal ions, especially calcium but can be used even for sodium, after extraction into 1,2-dichloroethane (167 - 169). Macrocyclic compounds with different sizes of macrocyclic rings and different kinds and numbers of donor atoms such as O, N, S may show different extractivity and selectivity. More than 30 macrocyclic compounds have been prepared and tested for the extraction of 17 metal ions into chloroform,

in the presence of picrate as counter ion. Crown-diaza compounds and crown formazans including those with a tetraazamacrocyle selectivity extract Cu^{2+} forming various types of complexes. Hg^{2+}, Pb^{2+} and Ag^+ may also be extracted at pH 5,0-5.5 with porphyrins. Macrocyclic compounds containing sulphur atoms besides oxygen extract copper, silver, mercury and palladium to variable extents (170 - 173). At present, active development of macrocyclic compounds proceeds for separation and determination of various metal ions. Heterocyclic crown ethers with mixed donor atoms have been used for the extractive determination of mercury (174). Macrocyclic Schiff bases and tetraazamacro- cycles are available for the extraction and spectrophotometric determination of copper (175-176).

Cryptands eg [2.2.2]cryptand, also show novel analytical prospects, especially for alkali metal ions, and also for Pb^{2+} (177 - 179). Na^+ was selectively extracted into chloroform in the form of ion-pairs with picrate or various dye anions and determined spectrophotometrically (180), Pb^{2+} in the presence of eosinate was determined fluorimetrically (181).

Heteropolyacids of molybdenum with phosphorus, arsenic, silicon or germanium form sparingly soluble ion association complexes with basic triphenylmethane or xanthene dye cations in acid medium which can be extracted into alkyl acetates, ketones or higher aliphatic alcohols. The reagents are often co-extracted and hence high blanks may be observed. The precipitates of such ternary species may also be floated on water-organic solvent interfaces where the solvent has low permittivity and polarity (eg xylene, hexane, cyclohexane, diisopropyl ether, toluene), washed and finally dissolved in ethanol or acetone (182 - 192). Even more complicated heteropolyacids have been used eg phosphorus or vanadium can be determined via Brilliant Green (C.I. 42040) molybdovanadophosphate after dissolution of the precipitate formed at pH 0.2-1.8 in acetone (193).

Flotation spectrophotometric procedures are also useful for the determination of various platinum metals via sparingly soluble ion-pairs of thiocyanato-complexes with rhodamine and thiazine dyes (194 - 198). In practice, although flotation procedures are especially sensitive, with conditional molar absorptivities reaching values larger than 1×10^5 l $mol^{-1}cm^{-1}$, the variance of the results of determinations may be considerable.

A voluminous anionic complex species of a polyhedral sandwich-type, dicarbaundecaborane cobaltate(III) $\{[\pi-(3)-1,2-B_9C_2H_{11}]_2Co^{III}\}^-$, (a heteroborane anion) has recently been shown to be an excellent agent for the extraction into nitrobenzene of caesium and other alkali metal, alkaline earth metal and some other cations. (199).

Kinetic factors may sometimes be important in the extraction of metal ions with OAR species. The extraction time may differ if the reagent is dissolved in a solvent immiscible with water, or if previously added to the aqueous analyte solution in the form of a solution in a water miscible solvent (119). The extraction of chelates of some transition metal ions may be slow enough to be used as the basis of separations. Thus, Ni^{2+} can be selectively removed from other divalent metal ions

by a rate-controlled extraction separation since its azo dye chelates are extracted into chloroform much slower than those of other divalent metal ions (200). On the other hand, various types of synergistic co-extraction in systems with OAR have been explained by the formation of ternary species such as $[Ca(Sr)ScL_4]_2$ where HL corresponds with 8-hydroxyquinoline (120). For neutral OAR chelates the solvent can be regarded as a continuous structureless dielectric medium immiscible with water (119). However, for the extraction of ion-pairs the role of the organic solvent may be crucial (201). Propylene carbonate is a useful solvent being denser than water, almost odourless and of low toxicity and has been used for the extraction of a variety of ion pairs (202 - 208). Its solubility in water decreases with ionic strength but increases rapidly with temperature. This latter effect may be exploited by the formation of complexes in homogenous solution at $80^{\circ}C$ with subsequent phase and analyte separation after cooling (208). Propylene carbonate has been shown to be a non-inert solvent in the extraction of the tetrathiocyanatocobaltate(II) anion (202). Recently solid-liquid separation after liquid-liquid extraction using molten naphthalene as extractant became popular. The equilibrium between both phases is rapidly established at the elevated temperature and the sensitivity is high due to the ease of separation of the solidified organic phase. Such techniques are useful for the extraction of complexes which are stable at higher temperatures. The precipitated naphthalene with the entrained analyte-OAR-species (chelate or ion-pair) is filtered off or separated as a pellet and dissolved in a suitable solvent (benzene, toluene, acetonitrile) and the analyte determined spectrophotometrically or by another instrumental finish (201). Useful examples are tellurium as its pyrrolidine-1-carbodithioate (209), Fe^{II} as its ternary complex with 2,2'-bipyridine and tetraphenylborate (210) and the determination of transition elements with 8-hydroxyquinoline (211). Molten 8-hydroxyquinoline is a suitable extracting medium for various of its metal complexes. The solid phase after cooling can be pulverized and pressed into pellets and the metals determined by X-ray fluorescence spectrometry (212). A convenient alternative to liquid naphthalene is the use of microcrystalline naphthalene for a solid-liquid separation (213). Other low melting point substances such as 8-hydroxy- quinoline or benzophenone (214) may also be used. Microcrystalline naphthalene results from mixing a solution of naphthalene in acetone with an aqueous phase at room temperature. It shows excellent extractive- coprecipitative properties. Examples include procedures for the determination of cobalt in the form of its ternary complex with 4'-(p-methoxyphenyl)-2, 2',6',2"-terpyridine or 5,6-diphenyl-3-(2-pyridyl) -1,2,4-triazine and tetrathiocyanatocobaltate(II) with Brilliant Green (216).

REFERENCES

1.   Feigl F., Spot Tests in Inorganic Analysis, 5th Ed., Elsevier, Amsterdam, 1958.

2.   Feigl F., and Anger V., Spot Tests in Inorganic Analysis, 6th Ed., Elsevier, Amsterdam, 1972.

3.   Feigl F., Chemistry of Specific, Selective and Sensitive Reactions, Academic Press, New York, 1949.

4.1   van Nieuwenburg C. J., (Ed), <u>Tables of Reagents for Inorganic Analysis</u>, Akadem. Verlagsges., Leipzig, 1938. (1st Report of the "International Committee on New Analytical Reactions and Reagents" of the Union Internationale de Chimie).

4.2   Wenger P. E. and Duckerts R. (Ed), <u>Reagents for Qualitative Inorganic Analysis</u>, Elsevier, Amsterdam, 1948. (Second Report of the International Committee on New Analytical Reactions and Reagents of the International Union of Chemistry).

4.3   <u>Tableau des Réactifs pour l'Analyse Minérale</u>, Lib. Istra, Paris, 1948.

(Troisième Rapport de la Commission Internationale des Réactions et Réactifs Analytiques Nouveaux de l'Union Internationale de Chemie).

4.4   Wenger P. E. and Rusconi Y. (Ed), Quatrième Rapport, <u>Réactifs pour l'Analyse Qualitative Minérale</u>. Recommandés par la Commission des Réactions et Réactifs Analytiques Nouveaux de l'Union Internationale de Chimie Pure et Appliquée, 1937-47, Soc. d'Edition d'Enseignement Superieur, Paris, 1950.

4.5   <u>Reagents and Reactions for Qualitative Inorganic Analysis</u>, Fifth Report, Pure Appl. Chem. 8, X, 1-88, 1964.

5.   McAlpine P. K. and Soule B. A., <u>Qualitative Chemical Analysis</u>, van Nostrand, New York, 1933.

6.   Noyes A. A. and Bray W. C., <u>A System of Qualitative Analysis for the Rare Elements</u>, MacMillan, New York, 1948.

7.   Thorburn Burns D., Townshend A. and Catchpole A. G., <u>Inorganic Reaction Chemistry</u>, <u>Systematic Chemical Separation</u>, Horwood, Chichester, 1980.

8.   Thorburn Burns D., Townshend A. and Carter A. H., <u>Inorganic Reaction Chemistry</u>, Vol. 2 Pts A and B, Horwood, Chichester, 1981.

9.1   Okáč A., <u>Analitická Chemie Kvalitativní</u>, Academia, Prague, 1966.

9.2   Okáč A., <u>Qualitative Analytische Chemie</u>, Akadem. Verlagsges. Geest und Portig, Leipzig, 1960.

10.   Ackermann G., <u>Einfuhrung in die Qualitative Anorganische Halbmikroanalyse</u>, Dtsch. Verlag f. Grundstoffind., Leipzig, 1968.

11.   Charlot G., <u>Les Réactions Chimiques en Solution</u>, <u>L'Analyse Qualitative Minérale</u>, Masson, Paris, 1969.

12.   Jungreis E., <u>Spot Test Analysis</u>, Wiley, New York, 1985.

13.   Prodinger W., <u>Organische Fallungsmittel in der Qualitativen Analyse</u>, Enke, Stuttgart, 1957.

14.   Erdey L., <u>Gravimetric Analysis</u>, pt. 1-3, Pergamon Press, Oxford, 1963-1965.

15.   Flagg J. F., <u>Organic Reagents Used in Gravimetric and Volumetric Analysis</u>, Interscience Publ., New York, 1948.

16.   Diehl H., <u>The Application of the Dioximes to Analytical Chemistry</u>, G. F. Smith Chem. Corp., Columbia, Ohio, 1940.

17.   Berg R., <u>Die Analytische Verwendung von o-Oxychinolin (Oxin) und seiner Derivate</u>, Enke, Stuttgart, (1938).

18.   Welcher F. J., Organic Analytical Reagents, Vol. 1, p. 264-323, van Nostrand, Princeton, New York, 1947.

19.   Majumdar A. K., <u>N-Benzoylphenylhydroxylamine and its Analogues</u>, Pergamon Press, Oxford, 1972.

20.   Majumdar A. K. and Mukherjee A. K., Anal. Chim. Acta, 19, 23 (1958); 23, 246
      1960; Fresenius'Z. Anal. Chem.189, 339 (1962).

21.   Langmyhr F. J. and Hongslo T., Anal. Chim. Acta, 22, 301 (1960).

22.   Hoenes H. J. and Stone K. G., Talanta, 4, 250 (1960).

23.   Schwarzenbach G. and Flaschka H., Die Komplexometrische Titration, Enke,
      Stuttgart, 1965.

24.   Duewer D. L. and Freiser H., Anal. Chem., 49, 1940 (1977).

25.   Martell A. E., Pure Appl. Chem., 50, 813 (1978).

26.   Irving H. N. M. N., Pure Appl. Chem., 50, 1129 (1978).

27.   Kotrly St., Sb. Ved. Pr.. Vys. Sk. Chem. Technol. Pardubice, 14, 165 (1966).

28.   West T. S., Complexometry with EDTA and Related Reagents, BDH Chemicals, Ltd.,
      Poole, 1969.

29.   Dyatlova N. M., Temkina V. Ya., and Kolpakova I. D., Komleksony, Isd.
      Khimiya, Moscow, 1970.

30.   Přibil R., Analytical Applications of EDTA and Related Compounds, Pergamon
      Press, Oxford, 1972.

31.   Wänninen E. in Bishop E. (Ed), Metal Indicators and their Application,
      Pergamon Press, Oxford, 1972.

32.   Hulanicki A., Głab S. and Ackermann G., Pure Appl. Chem., 55, 1137 (1983).

33.   Umland F. and Janssen A., Verwendung von Chelaten in der photometrischen
      Analyse, Fortschr. Chem. Forsch. 6, H. 4 (1966).

34.   Savvin S. B., Crit. Rev. Anal. Chem., 8, 55 (1979).

35.   Fries J. and Getrost H., Organische Reagenzien für die Spurenanalyse, E Merck,
      Darmstadt, 1977.

36.   Snell F. D. and Snell C. T., Colorimetric Methods of Analysis, Various Vol.
      and Suppl., Reinhold, New York and Chapman Hall, London, 1921-1971.

37.   Sandell E. B. and Onishi H., Photometric Determination of Traces of Metals,
      General Aspects 4th Ed., Wiley, New York, 1978.

38.   Sandell E. B., Colorimetric Determination of Traces of Metals, 3rd Ed.,
      Interscience Publ., New York, 1959.

39.   Snell F. D., Photometric and Fluorometric Methods of Analysis, Metals Pt. 1
      and 2, Wiley, New York. 1978

40.   Marczenko K., Separation and Spectrophotometric Determination of Elements, 2nd
      Ed., Horwood, Chichester, 1986.

41.   Malát M., Absorpční Anorganická Fotometrie, Akademia, Prague, 1973.

42.   Charlot G., Colorimetric Determination of Elements, Elsevier, Amsterdam, 1964.

43.   Patrovský V., Chem Listy, 65, 1121, (1971).

44.   Pilipenko A. T. and Savranskii L. I., Zh. Anal. Klim., 32, 421, (1977).

45.   Pilipenko A. T., Wiss. Z. Karl-Marx-Univ. Leipzig. Math.-Naturwiss. R., 24,
      367, (1975).

46.   Marczenko Z., Mikrochim. Acta, 651 (1977,II).

47. Marczenko Z., <u>Chem. Anal.</u>, Warsaw, <u>24</u>, 551, (1979).

48. Boltz D. F., <u>Record Chem. Progess</u>, <u>24</u>, 167, (1963).

49. Patrovský V., <u>Chem. Listy</u>, <u>64</u>, 715, (1970).

50. Savvin S. B., <u>Usp. Khim.</u>, <u>54</u>, 1814, (1985).

51. Pilipenko A. T. and Tananaiko M. M., <u>Raznoligandnye i Raznometal'nye Kompleksy i ikh Primenenie V Analiticheskoi</u> Khimii, Isd. Khimia, Moscow, 1983.

52. Prange Th., Lechner-Knoblauch V. and Umland F., <u>Fresenius' Z Anal. Chem.</u>, <u>306</u>, 201 (1981).

53. Popov P. and Sommer L., <u>Scripta Fac. Sci. Nat. Univ. Purk.Brun.</u>, <u>16</u> Nr. 9 (Chemia) 419 (1986).

54. Perfil'ev V. A., Mishchenko V. T. and Poluektov N. S., <u>Zh. Anal. Klim.</u>, <u>40</u>, 1349 (1985).

55. Shibata Sh., Furukawa M. and Goto K., <u>Anal. Chim. Acta</u>, <u>46</u>, 271 (1969); <u>53</u>, 369 (1971).

56. Shibata Sh., <u>Angew. Chem.</u>, 88, 750 (1976).

57. Dočekalová-Klapalová H. and Vrchlabský M., <u>Hutn. Listy</u>, <u>31</u>, 356 (1976).

58. Gai Mungli and Wang Churyang, <u>Fenxi Huaxue</u>, <u>13</u>, 613 (1985).

59. Otto M. and Wegscheider W., <u>Anal. Chem.</u>, <u>57</u>, 63 (1985).

60. Chilton J. M., <u>Anal Chem.</u>, <u>25</u>, 1274 (1953).

61. Püschel R., Lassner E. and Katzengruber K., <u>Fresenius' Z Anal. Chem.</u>, <u>223</u>, 414 (1966).

62. Buršík V., Kubáň V. and Sommer L., <u>Collect. Czechoslov. Chem. Commun.</u> in press.

63. Dolezel P. and Kubáň V., <u>Collect. Czechosolov. Chem Commun</u> 53 1162 (1988).

64. Popov P. and Sommer L., <u>Scripta Fac. Sci. Nat. Univ. Park. Brun.</u> in press.

65. Lázaro F., Ríos A., Lugue de Castro M. D. and Valcárcel M., <u>Anal. Chim. Acta</u>, <u>179</u>, 279 (1986).

66. Kubáň V. and Gladilovich D. B., <u>Collect. Czechoslov. Chem. Commun.</u>, <u>53</u> 1461 (1988)

67. Ružička J. and Hansen E. H., <u>Flow Injection Analysis</u>, Wiley, New York, 1981.

68. Gladilovich D. B., Kubán V. and Sommer L., <u>Talanta</u>. <u>35</u> 259 (1988).

69. Kubáň V., Gladilovich D. B. and Sommer, L., <u>Talanta</u> <u>36</u> 463 (1989).

70. Doležel P. and Kubáň V., Collect. <u>Czechoslov. Chem. Commun.</u><u>53</u> 543, (1988).

71. Chernova R. K., Sukhova L. K. and Amelin V. G., <u>Zh. Anal. Khim.</u>, <u>33</u>, 1934 (1978).

72. Savvin S. B., Chernova R. K. and Kudryavtseva L. M., <u>Zh. Anal. Khim.</u>, <u>33</u>, 2127 (1978); <u>34</u>, 66 (1979).

73. Evtimova B. and Nonova D., <u>Anal. Chim. Acta</u>, <u>67</u>, 107 (1973).

74. Marczenko Z., <u>Crit. Revs. Anal. Chem.</u>, <u>11</u>, 195 (1981).

75. Kock S. and Ackermann G., <u>Z Chem.</u>,<u>20</u>, 228 (1980).

76.   Callahan J. H. and Cook K. D., Anal. Chem., 56, 1632 (1984).

77.   Pilipenko A. T., Savranskii L. I. and Kulichenko S. A., Ukr. Khim. Zh., 51, 563 (1985).

78.   Jančář L., Havel J. and Sommer L., Collect. Czechoslov. Chem Commun., 53 1424 (1988).

79.   Sommer L. and Jančář L., Scripta Fac Sci. Nat. Univ. Purk. Brun., 18 No. 3-4 (Chemie) 115 (1988).

80.   Watanabe H., Talanta, 21, 295 (1974).

81.   Watanabe H. and Matsunaga H., Bunseki Kagaku, 25, 35 (1976).

82.   Watanabe H. and Sasaki Y., Bunseki Kagaku, 23, 396 (1974).

83.   Qian-Feng W. and Peng-Fei L., Talanta, 30, 275 (1983).

84.   White C. E. and Argauer R. J., Florescence Analysis, a Practical Approach, Dekker, New York, 1970.

85.   Holzbecher Z., Chem. Listy, 56, 249 (1962).

86.   Haddad P. R., Talanta, 24, 1 (1977).

87.   Poluektov N. S., Alakaeva L. A. and Tishchenko M. A., Zh. Anal. Khim., 25, 2351 (1970).

88.   Kononenko L. I., Lauer R. S. and Poluektov N. S., Zh. Anal. Khim., 18, 1468 (1963).

89.   Kononenko L. I., Poluektov N. S. and Nikonova M. P., Zav. Lab., 30, 779 (1964).

90.   Belcher R., Perry R. and Stephen W. I., Analyst, 94, 26 (1969).

91.   White C. E. and Argauer R. J., Fluorescence Analysis, Dekker, New York, 1970 pp 60-61.

92.   Soloviev E. A. and Bozhevol'nov E. A., Zh. Anal. Khim., 27, 1817 (1972).

93.   Zel'tser L. E., Talipov S. H., and Vereshchagina N. G., Talanta, 34, 873 (1987).

94.   Boshevol'nov E. A. and Solov'ev E. A., Dokl. Akad. Nauk (USSR), 148, 335 (1963).

95.   Kirkbright G. F., Thompson J. V. and West T. S., Anal. Chem., 42, 782 (1970).

96.   Podchainova V. N., Anikeenko L. V., Vedernikov G. S. and Bogomolov S. G., Ural Knof. Spectrosc., 1971 Nr. 2,110.

97.   Marcantonatos M., Gamba G. and Monnier D., Anal Chim. Acta, 67, 220 (1973).

98.   Solov'ev J. A. and Bozhevol'nov J. A., Metody Analiza Klimicheskikh Reaktiviv i Preparatov, IREA Moscow, 1965, p 21.

99.   Luft B. D., Novikov, V. B., Khusid L. B. and Shemet V. V., Zh. Anal. Khim., 28, 536 (1973).

100. Zel'tser L. E., Talipov Sh. T. and Vereshchagina N. G., Zh. Anal. Khim., 41, 420 (1986).

101. Zel'tser L. E., Bolotin B. M. and Vereshchagina N. G., Zh. Anal. Khim., 41, 154 (1986).

102. Hernandez F., Medina E.J. and Gasco A. M. T., Talanta, 33, 537 (1986).

103. Medina E.J., Hernandez F., Marin R. and Lopez F. J., <u>Analyst</u>, <u>111</u>, 235 (1986).

104. Sanz-Medel A., Fernandez P. M. M., de la Guardia Cirugeda M. and Carrion D. J. L., <u>Anal. Chem.</u>, <u>58</u>, 2161 (1986).

105. Pilipenko A. T., Volkova A. I. and Vasil'chuk T. A., <u>Zh. Anal. Khim.</u>, <u>41</u>, 1608 (1986).

106. Love L. J. C., Skrilec M., and Harbata J. G., <u>Anal. Chem.</u>, <u>52</u>, 754 (1980).

107. Aaron J. J. and Winefordner J. D., <u>Analusis</u>, <u>10</u>, 299 (1982).

108. Babko A. K., Dubovenko L. I. and Lukovskaya N. M., <u>Khemiluministsentnyi Analiz</u>, Isd. Tekhnika, Kiev, (1966).

109. Seitz W. R. and Neary M. P., <u>Anal. Chem.</u>, <u>46</u>, 188A (1974).

110. Birks J. W. and Kuge M. C., <u>Anal. Chem.</u>, <u>52</u>, 897, (1982).

111. Maeda Y., Aoki K., and Munemori M., <u>Anal. Chem.</u>, <u>52</u>, 307 (1980).

112. Morrison G. H. and Freiser H., <u>Solvent Extraction in Analytical Chemistry</u>, Wiley, New York, 1962.

113. Starý J., <u>Solvent Extraction of Metal Chelates</u>, Pergamon Press, Oxford, 1964.

114. De A. K., Khopkar S. M. and Chalmers R. A., <u>Solvent Extraction of Metals</u>, Van Nostrand, New York, 1970.

115. Zolotov Yu. A., <u>Extraction of Chelate Compounds</u>, Ann Arbor - Humphrey Science Publ., Ann Arbor, 1970.

116. Marcus Y. and Kertes A. S., <u>Ion Exchange and Solvent Extraction of Metal Complexes</u>, Interscience, New York, 1969.

117. Sekine T. and Hasegawa Y., <u>Solvent Extraction Chemistry</u>, Dekker, New York, 1977.

118. Freiser H., <u>Crit. Rev. Anal. Chem.</u>, <u>1</u>, 47 (1970).

119. Zolotov Yu. A., <u>Koord. Khimiya</u>, <u>5</u>, 467 (1979).

120. Zolotov Yu. A., Bodnya V. A. and Zagruzina A. N., <u>Crit. Rev. Anal. Chem.</u>, 14, 93 (1982).

121. Zolotov Yu. A. and Kuz'min N. M., <u>Ekstraktsiya Metallov Atsilpirazolonami</u>, Isd. Nauka, Moscow, 1977.

122. Zolotov Yu. A. and Kuz'min N. M., <u>Konsentrirovanie Mikroelementov</u>, Isd. Khimiya, Moscow, 1982.

123. Mizuike A., <u>Enrichment Techniques for Inorganic Trace Analysis</u>, Springer, Berlin, 1983.

124. Thorburn Burns D., <u>Trends Anal. Chem.</u>, <u>2</u> Nr. 6, IV (1983).

125. Thorburn Burns D., <u>Anal. Proc.</u>, <u>19</u>, 355 (1982).

126. Thorburn Burns D., <u>Trends Anal. Chem.</u>, <u>4</u> Nr. 2, VII (1985).

127. Blyum I. A. and Pavlova N. N., <u>Zav. Lab.</u>, <u>29</u>, 1407 (1963).

128. Blyum I. A. and Oparina L. I., <u>Zav. Lab.</u>, <u>36</u>, 897 (1970).

129. Fogg A. G., Burgess C., and Burns D. T., <u>Talanta</u>, <u>18</u>, 1175 (1971).

130. Ducret L. and Drouillas M., <u>Anal. Chim. Acta</u>, <u>21</u>, 86 (1959).

131. Vrchlabský M. and Sommer L., <u>Talanta</u>, <u>15</u>, 887 (1968).

132. Nardillo A. M. and Catoggio J. A., _Anal. Chim. Acta_, _66_, 359 (1973).

133. Marič L., Široki M. and Herak M. J., _J Inorg. Nucl. Chem._, _37_, 2309 (1975).

134. Nonova D., Nenov V. and Likhareva N., _Talanta_, _23_, 679 (1976).

135. Nonova D. and Pavlova S., _Anal. Chim. Acta_, _123_, 289 (1981).

136. Tananaiko M. M. and Ozerova N. L., _Ukr. Khim. Zh._, _48_, 126 (1982).

137. Nonova D. and Stoyanov K., _Anal. Chim. Acta_, _138_, 321 (1982).

138. Yotsuyanagi T., Yamashita R. and Aomura K., _Bunseki Kagaku_, _19_, 981 (1970).

139. Anjaneyulu Y., Mouli P. C., Reddy M. P. R. and Sekhar K. P. C., _Analyst_, _110_, 391 (1985).

140. Kolthoff I. M., _Anal. Chem._, _51_, 1R (1979).

141. Takagi M. and Ueno K., _Topics in Current Chem._, _121_, 39 (1984).

142. Christensen J. J., Eatough J. D. and Izatt R. M., _Chem Rev._, 74, 351 (1979).

143. Poonia N. S. and Bajaj A. V., _Chem. Rev._, 79, 389 (1979).

144. Nelson G. A. (Ed.), _Coordination Chemistry of Macrocyclic Compounds_, Plenum Press, New York 1979.

145. Tagaki M. and Nakamura H., _J. Coord. Chem._, _15_, 53 (1986).

146. Blasius E. and Janzen K. P., _Topics in Current Chem._, _98_, 163 (1981).

147. Bubnis B. P., Steger J. L., Wu Y. P., Meyers L. A. and Pacey G. E., _Anal. Chim. Acta_, _139_, 307 (1982).

148. Nazarenko A. Yu., Pyatnitskii I. V. and Stolyarchuk T. A., _Zh. Anal. Khim._, _36_, 1719 (1981).

149. Sumiyoshi H., Nakahara K. and Ueno K., _Talanta_, _24_, 763 (1977).

150. Pyatnitskii I. V. and Nazarenko A. Yu., _Zh. Neorg. Khim._, _25_, 1064 (1980).

151. Pyatnitskii I. V., Aleksyuk N. P. and Nazarenko A. Yu., _Zh. Anal. Khim._, 38, 2176 (1983).

152. Kimura K., Tanaka M., Kitazawa S. and Shono T., _Chem. Lett._, 1239 (1985).

153. Kaneda T., Umeda Sh., Tanigawa H. and Misumi S., _J. Am. Chem. Soc._, _107_, 4802 (1985).

154. Kobiro K., Matsuoka T., Takada S., Kakichu K., Tobe Y. and Odaira Y., _Chem. Lett._, 713 (1986).

155. Xi G. and Yang X., _Fenxi Huaxue_, _13_, 452 (1985).

156. Mohite B. S. and Khopkar S. M., _Talanta_, _32_, 565 (1985).

157. Sanz-Medel A., Blanco Gomis D. and Garcia Alvarez J. R., _Talanta_, _28_, 425 (1981).

158. Shiga M., Nakamura H., Takagi M. and Ueno K., _Bull. Chem. Soc. Japan_, 57, 412 (1984).

159. Shiga M., Takagi M. and Ueno K., _Chem. Lett._, 1021 (1980).

160. Nakamura H., Nishida H., Takagi M., and Ueno K., _Bunseki Kagaku_, _31_, E 131 (1982).

161. Nakamura H., Takagi M. and Ueno K., _Talanta_, _26_, 921 (1979).

162. Takagi M., Nakamura H. and Ueno K., <u>Anal. Lett.</u>, <u>10</u>, 1115 (1977).

163. Nakamura H., Takagi M. and Ueno K., <u>Anal. Chem.</u>, <u>52</u>, 1668 (1980).

164. Gomis D.B., Jimeno S.A. and Sanz-Medel A., <u>Talanta</u>, <u>29</u>, 761 (1982).

165. Yoshio M., Ugamura M., Noguchi H. and Nagamatsu M., <u>Anal. Lett.</u>, A 13, 1431 (1980).

166. Masaki Y. and Naguchi H., <u>Anal. Lett.</u>, <u>15</u>, 1197 (1982).

167. Nishida H., Tazaki M., Takagi M. and Ueno K., <u>Mikrochim. Acta</u> (I), 281, (1981).

168. Shiga M., Nishida H., Nakamura H., Takagi M. and Ueno K., <u>Bunseki Kagaku</u>, <u>32</u>, E 293 (1983).

169. Katayama Y., Nakamura H. and Takagi M., <u>Anal. Sci.</u>, <u>1</u>, 393 (1985).

170. Krasnushkina E. A. and Zolotov Yu. A., <u>Trends Anal. Chem.</u>, <u>2</u>, 158 (1983).

171. Zolotov Yu. A., Ionov V. P., Bodnya V. A., Larikova G. A., Niz'eva N. V., Vlasova G. E. and Rybakova E. V., <u>Zh Anal Khim.</u>, 1543 (1982).

172. Niz'eva N. V., Ionov V. P., Pletner I. V., Kumina D. M., Ostrovskaya V. M. and Zolotov Yu. A., <u>Dokl. Akad. Nauk USSR</u>, <u>274</u>, 611 (1984).

173. Morosanova E. I., Matveeva E. D., Bundel' Yu. G., Bodyna V. A. and Zolotov Yu. A., <u>Dokl. Akad. Nauk (USSR)</u>, <u>277</u>, 1151 1984.

174. Zolotov Yu. A., Poddubnykh L. P., Dimitrenko S. G., Kuz'min N. M. and Formanovskii A. A., <u>Zh. Anal. Klim.</u>, <u>41</u>, 1046 (1986).

175. Zolotov Yu. A., Ionov V. P., Niz'eva N. V. and Formanovskii A. A., <u>Dokl. Akad. Nauk (USSR)</u>, <u>277</u>, 1145 (1984).

176. Pyatnitskii I. V., Nazarenko A. Yu. and Sichkar' N. E., <u>Zh. Anal. Khim.</u>, <u>40</u>, 1423 (1985).

177. Nakamura H., Nishida H., Takagi M. and Ueno K., <u>Anal. Chim. Acta</u>, <u>139</u>, 219 (1982).

178. Yakshin V. V., Fedorova A. T. and Laskorin B. N., <u>Dokl. Akad. Nauk (USSR)</u>, <u>276</u>, 169 (1984).

179. Takagi M., Nakamura H., Sanui Y. and Ueno K., <u>Anal. Chim. Acta</u>, <u>126</u>, 185 (1981).

180. Yakshin V. V., Fedorova A. T. and Laskorin B. N., <u>Zh. Anal. Klim.</u>, <u>40</u>, 45 (1985).

181. Gomis D.B., Alonso F.F. and Sanz-Medel A., <u>Talanta</u>, <u>32</u>, 915 (1985).

182. Babko A. K., Shkaravskii Yu. F. and Golkowska A., <u>Chem. Anal. (Warsaw)</u>, <u>11</u>, 1091 (1966).

183. Babko A. K., Shkaravskii Yu. F. and Kulik V. I., <u>Zh. Anal Khim.</u>, <u>21</u>, 196 (1966).

184. Gołkowska A., <u>Chem. Anal. (Warsaw)</u>, <u>14</u>, 803 (1969).

185. Gołkowska A., <u>Chem. Anal. (Warsaw)</u>, <u>15</u>, 59 (1970).

186. Gołkowska A. and Pszonicki L., <u>Talanta</u>, <u>20</u>, 749 (1973).

187. Mirzoyan F. V., Tarayan V. M. and Karapetyan Z. A., <u>Zh. Anal. Klim.</u>, <u>34</u>, 1515 (1979).

188. Pilipenko A. T. and Shkaravskii Yu. F., Ukrain. Khim Zh., 42, 1183 (1976).

189. Babko A. K., Shkaravskii Yu. F. and Ivashkovich E. M., Ukrain. Khim. Zh., 33, 951 (1967).

190. Pilipenko A. T. and Shkaravskii Yu. F., Zh Anal Khim., 29, 716 (1974).

191. Popa Gr. and Paralescu J., Talanta, 16, 315 (1969).

192. Alimarin I. P., Dorokhova E. N., Zhivopistsev V. P., Bondareva E. G. and Kaz'min P. G., Zh. Anal. Khim., 39, 965 (1984).

193. Lebedeva L. I. and Nikolaeva D. N., Zh Anal Khim., 37, 260 (1982).

194. Marczenko Z. and Jarosz M., Analyst, 106, 751 (1981).

195. Marczenko Z. and Uscinska J., Anal Chim Acta, 123, 271 (1981).

196. Marczenko Z. and Jarosz M., Talanta, 28, 561 (1981).

197. Marczenko Z. and Maruszak J., Chem Anal (Warsaw), 24, 341 (1979).

198. Marczenko Z. and Kowalczyk E., Anal Chim Acta, 108, 261 (1979).

199. Makrlik E. and Vaňura P., Talanta, 32, 423 (1985).

200. Sakku H., Nakamura H., Takagi M. and Ueno K., Bunseki Kagaku, 32, E 335 (1983).

201. Thorburn Burns D., Jones J. M. and Tungkananuruk N., Trends Anal. Chem., 4, (2) VI, VIII (1985).

202. Thorburn Burns D., and Keawpintong S., Anal. Proc., 20, 595 (1983).

203. Thorburn Burns D., and Kheawpintong S., Anal. Chim. Acta, 156, 329 (1984).

204. Stephens B. G., Loftin J. C., Looney W. C. and Williams K. A., Analyst, 96, 230 (1971).

205. Stephens B. G. and Suddeth H. A., Anal. Chem., 39, 1479 (1967).

206. Stephens B. G. and Suddeth H. A., Analyst, 95, 70 (1970).

207. Stephens B. G., Felkel H. L. jr and Spinelli W. M., Anal. Chem., 46, 692 (1974).

208. Murata K., Yokoyama Y. and Ikeda Sh., Anal. Chem., 44, 805 (1972).

209. Kumar A., Sethi C. L., Satake M. and Puri B. K., Bunseki Kagaku, 32, E 61 (1983).

210. Satake M., Nagahiro T. and Puri B. K., Analyst, 109, 31 (1984).

211. Fujinaga T., Kuwamoto T., Yonekubo T. and Satake M., Bunseki Kagaku, 18, 1113 (1969).

212. Magyar B. and Lobanov F. I., Talanta, 20, 55 (1973).

213. Mehra M. C., Nagahiro T. and Satake M., Microchem. J., 33, 198 (1986).

214. Thorburn Burns D. and Tungkanuruk N., Anal. Chim. Acta, 182, 219 (1986).

215. Nagahiro T., Satake M., Lin J.-L. and Puri B. K., Analyst, 109, 163 (1984).

216. Thorburn Burns D. and Tungkananuruk N., Anal. Chim Acta, 189, 383 (1986).