Mines Branch Information Circular IC 294

STANDARD REFERENCE ORES AND ROCKS AVAILABLE FROM THE MINES BRANCH

Compiled by

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PREFACE

The current Mines Branch program of producing standard reference ores and rocks is an offshoot of the activities of the Canadian Association for Applied Spectroscopy (CAAS) which, in 1955, set out to produce copper and copper-alloy standards with the assistance of the Mines Branch and various Canadian metallurgical industries.

In 1966, the CAAS which has since become the Spectroscopic Society of Canada (SSC) entered the geochemical field by issuing a syenite rock (SY-1) and a sulphide ore (SU-1) as reference materials with provisional certificates of analysis. The Mines Branch became more actively involved in the standards program in 1968 by preparing two further syenite rock standards, SY-2 and SY-3, as replacements for the exhausted supply of SY-1. This work set the stage for the transfer, in 1969, of the production of standard reference materials from the SSC to the Mines Branch. Such an activity is logical for the Mines Branch because it has the necessary personnel and equipment not only for production but for distribution and sales. Because of its impartiality, the Mines Branch can easily co-ordinate the inter-laboratory programs that are necessary to obtain analyses for the certification of standard reference materials.

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Between 1967 and 1970, it became increasingly apparent that a need existed for standard reference ores that were typical of major deposits in Canada. Consequently, the Mines Branch has recently undertaken to produce a number of standard ores which, it is hoped, will be of value not only to analysts but to other workers in the earth sciences. Materials that have been made available for sale within the past eighteen months include: platiniferous materials PTA and PTM; molybdenum ore PR-1 and a zinc-tin-copper-lead ore MP-1. Other ores are in the process of being characterized and certified.

This circular describes the standard reference ores and rocks that may be purchased from the Mines Branch, through the Standards Co-ordinator, Mineral Sciences Division, as of late 1972. Where possible, the source, mineralogical and chemical composition, the recommended values of the certified elements, and the price are given for each available material. Also included are brief descriptions of materials that are being processed and their approximate date of availability.

It is anticipated that this circular will be revised and enlarged as new information on existing materials becomes available and as new standard ores are added to the list.

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MATERIALS CERTIFIED FOR SELECTED ELEMENTS

(A) ORES

MOLYBDENUM ORE, PR-1

Source and Description of PR-1

Molybdenum ore, PR-1, was obtained from the Preissac molybdenum mine near Cadillac, Quebec in 1970. The Preissac ore is from a vein-type deposit in a sericite granite. The ore minerals are listed in the following table together with the calculated proportions of each.

Mineralogical Composition of PR-1

Minerals	Calculated mineralogical composition of PR-1 (Wt %)
Fluorite	0.96
Calcite	2.37
Garnet	0.07
Chlorite	1.29
Muscovite	2.30
Feldspar	
Na-feldspar	6.17
K -feldspar	12.29
Quartz	70.27
Rutile	0.05
Molybdenite	1.02
Sphalerite	0.03
Galena	0.04
Chalcopyrite	0.03
Bismuth	0.06
Bismuthinite	0.08
Pyrite	0.58
Pyrrhotite	not calculated
Hematite	"
Magnetite	"
$Fe+O+Ni+H_2O$	1.26
TOTAL	98.87

Approximate Chemical Composition of PR-1

O	-	49.2 Wt %	Bi	-	0.12 Wt %
Si	-	39.2	Ti	-	0.03
Al	-	2.39	Pb	-	0.04
Fe	-	1.27	Zn	-	0.02
Ca	-	1.44	Mn	-	0.02
Mg	-	0.09	Ni	-	0.01
Na	-	0.54	Cu	-	0.01
K	-	1.95	F	-	0.47
S	-	0.77	H_2O	-	0.29
Mo	-	0.61	Total C		
			as CO_2	-	1.08
			actual CO_2	-	1.04

Certification of PR-1

Nineteen laboratories participated in the program to certify PR-1 for molybdenum, bismuth, iron, and sulphur. A statistical evaluation of the analytical results for these elements yielded the recommended tabulated values.

Recommended Values for the Means and Their Confidence Intervals for Selected Elements in PR-1

		Wt %			
		Mo	Bi	Fe	S
Mean		0.594	0.111	1.244	0.793
95% Confidence Interval of the Mean	Low	0.578	0.107	1.225	0.777
	High	0.610	0.114	1.263	0.809

A full account of the work done on PR-1 is given in the Mines Branch Technical Bulletin, TB 139, entitled "Molybdenum Ore, PR-1: Its Characterization and Preparation for Use as a Standard Reference Material".

ZINC-TIN-COPPER-LEAD ORE, MP-1

Source and Description of MP-1

The material for ore standard MP-1 was obtained from the deposit of Brunswick Tin Mines Limited in southwestern New Brunswick in 1971. It consists of material from two sulphide veins blended with a small amount of mineralized rock. The calculated mineralogical composition and the approximate chemical composition of MP-1 are given in the following tables.

Calculated Mineralogical Composition of MP-1

Minerals		Calculated Mineralogical Composition (wt %)
Sphalerite*	ZnS-24.0, FeS-0.8, CdS-0.1, InS-0.1, MnS-0.07	25.1
Chalcopyrite	Cu-1.3, Fe-1.2, S-1.3	3.8
Stannite-Kesterite	Cu-0.8, Sn-0.8, Fe-0.2, Zn-0.1, S-0.9	2.8
Galena	Pb-1.9, S-0.3	2.2
Cassiterite	Sn-1.6, O-0.4	2.0
Arsenopyrite	As-0.8, Fe-0.6, S-0.3	1.7
Pyrite	Fe-0.6, S-0.7	1.3
Bismuth		0.03
Wolframite	WO_3-0.03, FeO+MnO-0.01	0.04
Molybdenite	Mo-0.01, S-0.01	0.02
Quartz	SiO_2-34.7	34.7
Chlorite	SiO_2-1.9, Al_2O_3-1.7, FeO-3.0, MgO-0.1, H_2O-0.3	7.0
Fluorite	Ca-3.4, F-3.2	6.6
Topaz	SiO_2-1.8, Al_2O_3-2.9, F-0.9, H_2O-0.5	6.1
Kaolinite	SiO_2-0.5, Al_2O_3-2.3, H_2O-0.8	5.8
Feldspar	SiO_2-0.5, Al_2O_3-0.1, K_2O-0.1, Na_2O-0.1	0.8
Rutile	TiO_2-0.05	0.05
TOTAL		100.14

*The metals Fe, Cd, In, and Mn are incorporated in the lattice of sphalerite, but some In also occurs as the mineral roquesite.

Recommended Values for the Means and Their Confidence Intervals for Selected Elements in MP-1

	Wt %								ppm
	Zn	Sn	Cu	Pb	Mo	In	Bi	As	Ag
Mean	16.33	2.50	2.15	1.93	0.014	0.071	0.025	0.791	59.5
95% Confidence Interval of the Mean									
Low	16.20	2.39	2.12	1.90	0.013	0.068	0.023	0.768	56.3
High	16.45	2.61	2.18	1.96	0.015	0.074	0.027	0.814	60.6

A full account of the work done on MP-1 is given in Mines Branch Technical Bulletin, TB 155, entitled "Zinc-Tin-Copper-Lead Ore, MP-1: Its Characterization and Preparation for Use as a Standard Reference Material".

PLATINIFEROUS BLACK SAND, PTA

Source and Description of PTA

The material used to prepare PTA was supplied by B.H. Levelton and Associates, Vancouver, British Columbia. It is essentially a magnetite concentrate from alluvial material taken from the Tulameen River area of British Columbia. Careful mineralogical examination of material similar to PTA has revealed the presence of at least ten minerals known to contain platinum-group elements, with platinum being predominant.

Approximate Chemical Composition of PTA

Chemical analyses for the major constituents of PTA gave the following values: Fe-63.0%; Ca-1.20%; Al-3.63%; Mg-0.62%; Cr-none detected.

Certification of PTA for Platinum

For purposes of certification, nine laboratories provided platinum analyses. A statistical evaluation of these results yielded the following recommended platinum value and the 95% confidence interval of the mean.

Recommended Mean Value and the Confidence Limits for Platinum in PTA

Recommended Mean		95% Confidence Interval	
		Low	High
ppm	oz/ton	ppm	ppm
3.05	0.089	2.92	3.16

An account of the work done on PTA is given in Mines Branch Technical Bulletin TB 138, entitled "Characterization and Preparation of Standard Reference Materials that Contain Noble Metals: (A) PTA (Ores) and (B) PTM (Nickel-Copper Matte).

(B)

NICKEL-COPPER MATTE, PTM

Source and Description of PTM

Matte PTM was produced from ore from the Sudbury, Ontario, district and was provided by Falconbridge Nickel Mines Limited. This material was chosen for the preparation of a standard reference material because it was known to contain appreciable concentrations of most members of the platinum group of metals.

Approximate Chemical Composition of PTM

Chemical analyses for the major constituents of PTM gave the following values:

Ni-44.8%; Cu-30.2%; Fe-1.58%; S-21.6%.

Certification of PTM for Platinum, Palladium, Rhodium, and Gold

Eight laboratories provided analyses for the certification of PTM for the selected elements. A statistical evaluation of these results yielded the following recommended values and the 95% confidence intervals of the means.

Recommended Values for the Means and Their Confidence Intervals for Selected Elements in PTM

	Element, ppm			
	Pt	Pd	Rh	Au
Mean	5.73	7.80	0.89	1.79
95% Confidence Interval of the Mean Low	5.52	6.96	0.62	1.54
High	6.10	8.78	1.13	2.02

NOTE: 1 ppm = 0.029 troy oz/ton.

An account of the work done on PTM, up to November 1972, is given in Mines Branch Technical Bulletin, TB 138, entitled "Characterization and Preparation of Standard Reference Materials that Contain Noble Metals: (A) PTA (Ores) and (B) PTM (Nickel-Copper Matte)".

Work in Progress

A round-robin program is underway to certify PTM for iridium, ruthenium, and silver. The recommended values for these will ultimately be reported in revised editions of this circular.

MATERIALS WITH PROVISIONAL VALUES FOR SELECTED ELEMENTS

NOTE: Although the ores and rocks listed in this section are referred to as standard reference materials, reliable recommended values obtained by statistical evaluation of analytical results have not yet been assigned for any of their constituents. Therefore, the analyses given for these materials should be considered as provisional.

(A) ORES

NICKEL-COPPER ORE, SU-1

Source and History of SU-1

Ore SU-1 was prepared in 1958 and is a composite of sample rejects from Falconbridge Nickel Mines Limited, Falconbridge, Ontario[1]; it is reasonably representative of the Sudbury nickel-copper ores. SU-1 was originally intended as a standard reference material for use primarily by spectroscopists[1]. It has been widely distributed to laboratories throughout the world and a large number of analytical results for minor and trace elements has been accumulated[2,3]. Most of the analyses, however, were obtained by emission spectroscopy and only single values for each element have been obtained from each participating laboratory. Because of the rather wide range in the results for most elements, recommended values have not yet been assigned. No doubt such an assignment must await the acquisition of chemical and other analyses that can be treated statistically in the manner described in the Technical Bulletins associated with standard reference ores, e.g., PR-1 (see p. 1) and MP-1 (see p. 3).

Approximate Chemical Compositions of SU-1

The following table gives approximate analyses of the more abundant elements (many expressed as oxides) in SU-1. The values are means of individual results reported in Reference (2).

Approximate Chemical Composition of SU-1

Constituent	Wt %
SiO_2	34.6
Al_2O_3	9.5
Total Fe as Fe_2O_3	31.5
MgO	4.1
CaO	4.0
Na_2O	1.0
K_2O	0.6
TiO_2	0.8
MnO	0.1
P_2O_5	0.1
H_2O^+	2.9
S	12.1
Ni	1.3
Cu	0.8
Co	0.05

Provisional Analyses of SU-1 for Minor and Trace Elements

A large number of analyses for minor and trace elements in SU-1 and their mean and median values are given in References (2) and (3).

Work in Progress

Samples of SU-1 are being distributed to commercial, industrial, and government laboratories that have volunteered to provide analyses for nickel, copper, and cobalt, i.e., metals of economic interest.

Ultimately the results will be treated statistically and reliable recommended values will be assigned for each of these elements.

It is expected that this work will be completed by late 1973.

REFERENCES

(1) "Report of Nonmetallic Standards Committee Canadian Association for Applied Spectroscopy", Applied Spectroscopy, 15, 159-161 (1961).

(2) "Second Report of Analytical Data for CAAS Syenite and Sulphide Standards", by G.R. Webber, Geochim. Cosmochim. Acta, 29, 229-248 (1965).

(3) "Third Report of Analytical Data for CAAS Sulphide Ore and Syenite Rock Standards", by N.M. Sine, W.O. Taylor, G.R. Webber and C.L. Lewis, Geochim. Cosmochim. Acta, 33, 121-131 (1969).

(B) ROCKS

SYENITE ROCK STANDARDS SY-2 and SY-3

Source and History of SY-2 and SY-3

The syenite rock used to prepare SY-2 was collected from properties in the Bancroft area of Ontario. This material replaces SY-1[1,3], the supply of which was exhausted in 1966. SY-1 was intended for use by spectroscopists and other workers whose primary interest was in the minor elements, especially uranium, thorium, and the rare earths.

Early analyses of SY-2 indicated that it was appreciably lower than SY-1 in its content of these elements. Therefore, a third rock standard, SY-3, was prepared by "spiking" SY-2 with material containing minerals of uranium, thorium, and the rare earths.

Approximate Chemical Composition of SY-2 and SY-3

The following table gives approximate chemical analyses for the more abundant elements in SY-2 and SY-3.

Approximate Chemical Composition of SY-2 and SY-3

Constituent	SY-2 (Wt %)	SY-3 (Wt %)
SiO_2	60.8	60.3
Al_2O_3	11.3	11.5
CaO	9.7	8.1
MgO	2.0	2.6
Na_2O	4.2	3.9
K_2O	4.2	3.9
Fe	5.0	4.9
TiO_2	0.1	0.1
MnO	0.3	0.3
H_2O^+	0.2	0.8

Provisional Analyses for Minor and Trace Constituents in SY-2 and SY-3

With the exception of the values for uranium and thorium which were determined chemically at the Mines Branch, the provisional analyses given in the following table were obtained by emission spectroscopy at the Geological Survey of Canada.

Constituent	SY-2	SY-3
	ppm	
Sr	270	300
Ba	430	410
Cr	<20	Not detected
Zr	280	260
V	<30	<30
Ni	<20	Not detected
Ce	<500	1900
Cu	<8	18
Y	160	870
Nb	Not detected	130
Co	<20	Not detected
La	<100	1700
Pb	64	120
Sc 1	<10	12
Yb	17	69
Be	16	16
Ag	<0.05	0.054
Zn	200	180
Ga	33	43
Sn	2.5	4.8
B	35	45
Ge	1.0	1.1
Mo	0.99	0.90
Ti	2.0	2.2
Bi	Not detected	0.58
U_3O_8	330	730
ThO_2	300	1020

REFERENCES

(1) "Report of Nonmetallic Standards Committee Canadian Association for Applied Spectroscopy", Applied Spectroscopy, 15, 159-161 (1961).

(2) "Second Report of Analytical Data for CAAS Syenite and Sulphide Standards", by G. R. Webber, Geochim. Cosmochim. Acta, 29, 229-248 (1965).

(3) "Third Report of Analytical Data for CAAS Sulphide Ore and Syenite Rock Standards", by N. M. Sine, W. O. Taylor, G. R. Webber and C. L. Lewis, Geochim, Cosmochim. Acta, 33, 121-131 (1969).

SULPHIDE-BEARING ULTRAMAFIC ROCK STANDARDS UM-1, UM-2 and UM-4

Source and Description

UM-1 is a sulphide-bearing ultramafic rock from the Giant Mascot Mine at Hope, British Columbia. Materials UM-2 and UM-4 are similar to UM-1 but are from the Werner Lake - Gordon Lake district of north-western Ontario. Although these rock samples are classified as standard reference materials, it is to be emphasized that they are intended for a rather special purpose, i.e., to provide standards for the determination of sulphur and ascorbic acid-hydrogen peroxide-soluble copper, nickel, and cobalt in ultramafic rocks. Such standards are useful in the evaluation of the ore potential of ultramafic rocks[(1)].

Mineralogical Composition

The details of the mineralogy of UM-1, UM-2 and UM-4 are given in Geological Survey of Canada Paper 71-35, entitled "Three Geochemical Standards of Sulphide-Bearing Ultramafic Rock: UM-1, UM-2, and UM-4"[(1)].

Approximate Chemical Composition of UM-1, UM-2 and UM-4

Analyses, from G.S.C. Paper 71-35, for the major and minor elements are given in the following table.

Consitituent	UM-1	UM-2 Wt %	UM-4
SiO_2	37.6	39.2	39.35
TiO_2	0.10	0.24	0.35
Al_2O_3	1.00	7.23	8.98
Total Fe as FeO	17.2	12.95	12.8
MnO	0.16	0.08	0.15
MgO	36.05	25.45	22.5
CaO	2.34	4.68	6.27
Na_2O	0.08	0.32	0.45
K_2O	0.03	0.11	0.18
P_2O_5	0.00	0.02	0.02
H_2O	0.42	6.27	4.86
CO_2	0.26	0.10	0.26
S	3.53	0.94	0.44
Cr_2O_3	0.45	1.51	2.59
NiO	1.22	0.49	0.32
CuO	0.51	0.12	0.07
CoO	0.046	0.023	0.014
ZnO	0.012	0.004	0.008

G.S.C. Values for Copper, Nickel and Cobalt by Ascorbic Acid-Hydrogen Peroxide Method

The mean values reported in the following table are from G.S.C. Paper 71-35.

Sample	Cu	Ni Wt %	Co
UM-1	0.41	0.83	0.029
UM-2	0.95	0.29	0.012
UM-4	0.54	0.19	0.007

REFERENCE

(1) "Three Geochemical Standards of Sulphide-Bearing Ultramafic Rock: UM-1, UM-2, UM-4", compiled by E.M. Cameron, Geological Survey of Canada, Paper 71-35 (1972).

STANDARDS PRICE LIST

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(Shipping costs included)

The following may be purchased from the Standards Co-ordinator, Mineral Sciences Division, Mines Branch, Department of Energy, Mines and Resources, 555 Booth Street, Ottawa, Ontario, K1A 0G1.

Material	Price Per Unit
Molybdenum Ore PR-1	$20.00 per 200 grams
Zinc-Tin-Copper-Lead Ore MP-1	$20.00 per 200 grams
Platiniferous Black Sand PTA	$40.00 per 400 grams
Nickel-Copper Matte PTM	$40.00 per 400 grams
Nickel-Copper Ore SU-1	$10.00 per 100 grams
Ultramafic Rock Standards UM-1, UM-2, and UM-4	$15.00 per 100 grams
Syenite Rock Standards SY-1 and SY-3	$15.00 per 100 grams

ORES BEING PROCESSED IN NOVEMBER 1972

ORES BEING PROCESSED IN NOVEMBER 1972

The following descriptions are of ores that are being characterized and prepared for use as standard reference materials by the Mines Branch. In all cases, these are materials that have been tested for homogeneity, packaged, and distributed to laboratories that have volunteered to provide analyses for certification purposes. An indication of the approximate date of availability is given for each material.

Copper-Molybdenum Ore, HV-1

This ore was obtained from the Highland Valley area of British columbia. It is being certified for copper and molybdenum; the nominal values for these elements are 0.5% and 0.06% respectively. HV-1 will be available for purchase not later than the spring of 1973.

Nickel-Copper Ore, SU-1

SU-1 has been described earlier in this circular (p. 10). This ore is currently being issued with provisional analyses (mainly spectrographic) for a large number of minor and trace elements. It is now being certified by chemical and other methods for nickel, copper, and cobalt. The nominal values for these elements are 1.5%, 0.8%, and 0.05% respectively. A report on the certification work will be available in late 1973.

A N N O U N C E M E N T

AVAILABILITY OF STANDARD COPPER - MOLYBDENUM ORE, HV-1

The Canadian Standard Reference Materials Project, Mines Branch, Department of Energy, Mines and Resources announces the availability of a copper-molybdenum ore as a new standard reference material. This ore, coded as HV-1, has been thoroughly characterized; recommended values have been assigned for copper and molybdenum, these are 0.52% and 0.058% respectively. Mines Branch Technical Bulletin, TB 167, entitled "Copper-Molybdenum Ore, HV-1: Its Characterization and Preparation for use as a Standard Reference Material", gives all pertinent details.

HV-1 will be available for purchase after May 1, 1973 at $20.00 per 200-gram bottle, from the Standards Coordinator, Mineral Sciences Division, Mines Branch, Department of Energy, Mines and Resources, 555 Booth Street, Ottawa, Ontario, K1A 0G1.

Platinum Metal-Bearing Flotation Concentrate, PTC

PTC together with the previously described materials PTA (p. 6) and PTM (p. 7) will complete the suite of standard reference materials containing the platinum-group metals. PTC is a flotation concentrate of the Sudbury ore, the contents of its principal constituents are: 5.0% Cu, 9.6% Ni, 0.3% Co, 24.2% Fe, and 24.1% S. It is currently being certified for platinum, palladium, rhodium, ruthenium, gold, and silver. The nominal values (in ppm) for these elements are approximately 3, 13, 1, 1, 1, and 6 respectively. PTC will be available for purchase by mid-1973.

Radioactive Ore Standards, DHG-1, DLG-1, BL-1, BL-2, BL-3 and BL-4

These materials have been prepared to replace the previous standards of the Canadian Uranium Producers Analytical Subcommittee, the supply of which is now exhausted. Materials from both of the uranium-producing areas of Canada have been selected for these standards. Two of the samples, DHG-1 and DLG-1 consist of waste-grade and ore-grade material, respectively, from the Elliot Lake area of Ontario and contain both thorium and uranium. Four samples designated BL-1, BL-2, BL-3, and BL-4, from the Beaverlodge area of northwestern Saskatchewan, are relatively free of thorium, are in radioactive equilibrium, and cover a range of concentrations which should make then useful as standards for radiometric methods of analysis.