CANMET

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Canada Centre for Mineral and Energy Technology

Centre canadien de la technologie des minéraux et de l'énergie

CERTIFIED REFERENCE MATERIALS

H.F. STEGER

MINERALS RESEARCH PROGRAM
MINERAL SCIENCES LABORATORIES

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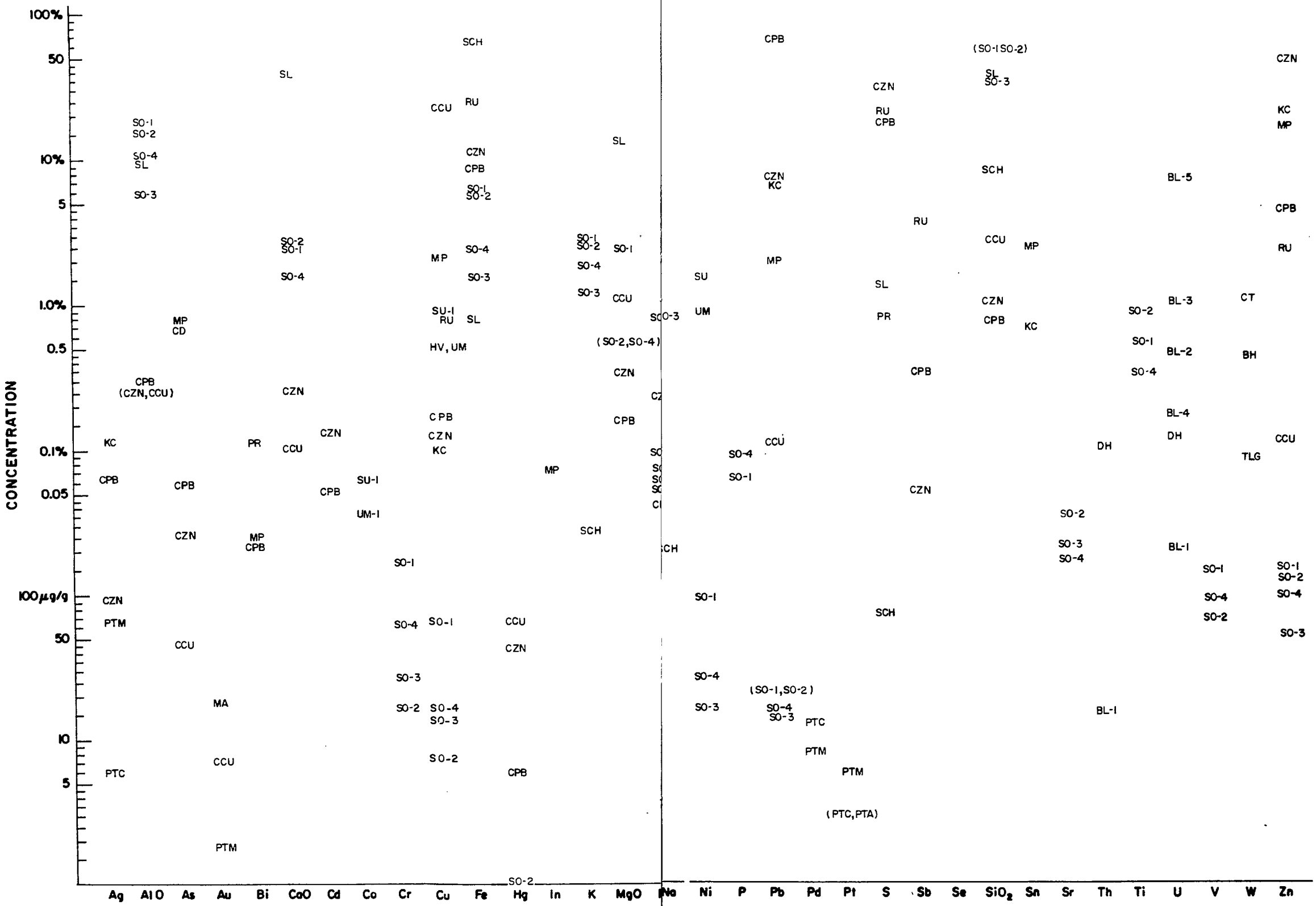

Figure 1 Summary of Certified Elements/Constituents

CERTIFIED REFERENCE MATERIALS

Compiled by

H.F. Steger*

PREFACE

The Canadian Certified Reference Materials Project (CCRMP) is a facet of the Mineral Technology Development Activity of CANMET's Minerals Research Program.

Although emphasis in CCRMP is on producing compositional reference materials for use in analytical laboratories associated with mining, metallurgy and the earth sciences, demand from commercial and industrial laboratories has also resulted in the certification of commercial-grade purity, copper alloys, a blast furnace slag and a suite of four soil samples, the latter in collaboration with Agriculture Canada. A summary of certified elements/constituents and their levels of concentration is presented in Fig. 1 as a convenience for potential users in selecting the reference material most suitable for the intended purpose.

This catalogue describes the certified and provisional reference materials that may be purchased from CANMET through the coordinator of CCRMP. Where possible, source, chemical composition, recommended values of the certified elements, and price are given for each available material. Revised catalogues will be issued periodically as new certified reference materials become available.

The price of certified reference materials has been increased effective January 1, 1980. This increase is appropriate when taking into account the overall increases in costs incurred by CCRMP since the last price increase in 1971.

Previous practice of CCRMP has been to provide each purchaser of a reference material with a copy of the appropriate detailed certification document. This will be continued for materials certified prior to 1979. For uranium ore BL-5, soils SO-1 to SO-4, zinc, lead and copper concentrates CZN-1, CPB-1, and CCU-1, respectively, nickel-copper-cobalt ore SU-1a and uranium-thorium ore DL-1a, a certificate of analysis conveying the necessary pertinent information will be issued. The detailed certification document is available without charge on request.

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MATERIAUX DE REFERENCE CERTIFIES

Compilé par

H.F. Steger*

AVANT-PROPOS

Le Programme canadien des matériaux de référence certifiés (CCRMP) forme un des aspects de l'Activité de développement de la technologie des minéraux du Programme de recherche sur les minéraux du CANMET. Quoique le CCRMP ait surtout mis l'emphase sur la production des matériaux de référence de composition à être utilisés dans les laboratoires analytiques ayant trait à l'exploitation minière, la métallurgie et les sciences du sol, la demande provenant de laboratoires commerciaux et industriels a aussi entrainé l'homologation des alliages de cuivre, d'un laitier de haut-fourneau et de quatre échantillons de sol canadien; ces derniers ont été effectués en collaboration avec Agriculture Canada. Un sommaire des éléments/constituants homologués et leur degré de concentration est exposé à la Fig. 1 afin de permettre aux futurs usagers de choisir le matériau de référence le mieux approprié à leurs besoins.

Ce catalogue décrit les matériaux de référence certifiés et provisoires en vente au CANMET par l'entremise du coordinateur du CCRMP. Lorsque c'est possible, l'origine, la composition chimique, les valeurs recommandées des éléments certifiés et le prix seront donnés pour chacun des matériaux disponibles. Des catalogues remis à jour seront publiés périodiquement lorsque de nouveaux matériaux de référence certifiés seront disponibles.

Le prix des matériaux de référence certifiés sera augmenté à partir du 1er janvier 1980. Cette augmentation est justifiée si l'on tient compte de l'augmentation globale des coûts subie par le CCRMP depuis 1971, date de la dernière augmentation de prix.

Par les années passées, le CCRMP avait l'habitude d'expédier à chaque acheteur d'un matériau de référence une copie du document détaillé de certification. Cette pratique continuera pour les matériaux certifiés avant 1979. Pour le minérai d'uranium BL-5, les sols SO-1 à SO-4, les concentrés de zinc, de plomb et de cuivre, CZN-1, CPB-1 et CCU-1 respectivement, le minerai de nickel-cuivre-cobalt SU-1a et le minerai d'uranium et thorium DL-1a, un certificat d'analyse donnant les renseignements pertinents sera fourni.

Le document détaillé de certification sera disponible sans frais sur demande.

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CONTENTS

CERTIFIED REFERENCE MATERIALS

ORES AND RELATED MATERIALS

CAVEAT PERTAINING TO SULPHIDE-BEARING ORES

Finely ground sulphide-bearing ores are susceptible to oxidation on long or repeated exposure to air. All bottles of such reference materials have therefore been sealed under nitrogen in laminated foil pouches to provide long-term protection against oxidation at CANMET. The stability of these pouched materials is being monitored on a regular basis.

The assigned values for the certified constituents pertain to the date when issued and CCRMP is not responsible for changes occurring after receipt by the user. It is strongly recommended that unsealed bottles be stored under an inert gas in a dessicator or in a new heat-sealed foil pouch. Moreover, the contents of the bottles should be exposed to air for the shortest time possible.

Antimony Ore CD-1

CD-1 was prepared in 1975 from ore of the Lake George mine of Consolidated Durham Mines and Resources Limited at Prince William, New Brunswick. It contains significant concentrations of antimony and arsenic, and thus should be especially useful in assessing methods in which there is potential interference between these elements. The following minerals are present in approximate decreasing order of abundance: quartz, mica, clay minerals, stibnite, pyrite, arsenopyrite, pyrrhotite, and traces of chalcopyrite and chalcostibnite. The approximate chemical composition of CD-1 is given in the following table.

Approximate chemical composition of CD-1 (wt %)

Sb	3.57
As	0.66
Si	32.9
Al	5.5
Ca	1.4
Mg	0.6
Fe	2.8
Na	0.1
K	1.8
Pb	0.02
Cu	<0.01
S	3.1
Total C	0.2
Moisture (105°C)	0.2
L.O.I. (950°C)	4.0

Twenty laboratories provided analytical results for either antimony or arsenic or both.

RECOMMENDED VALUES AND CONFIDENCE LIMITS FOR SELECTED ELEMENTS IN CD-1 (wt %)

	Sb	As
Recommended value	3.57	0.66
95% Confidence limits		
Low	3.53	0.65
High	3.60	0.68

A copy of CANMET Report 77-63 "Antimony-arsenic ore CD-1 - A certified reference material" will be provided with each order of CD-1.

Blast Furnace Slag SL-1

SL-1 was prepared in 1975 from material donated by the Steel Company of Canada Ltd. at Hamilton, Ontario for use in analytical laboratories associated with the iron and steel industry.

Although the interlaboratory program which involved 21 laboratories yielded results for 13 constituents, only six met the criteria for certification; values for the others are provisional.

RECOMMENDED VALUES AND CONFIDENCE LIMITS FOR SELECTED ELEMENTS IN SL-1 (wt %)

	SiO_2	CaO	MgO	Al_2O_3	Total Fe as FeO	S
Recommended value	35.73	37.48	12.27	9.63	0.92	1.26
95% Confidence limits						
Low	35.61	37.30	12.12	9.56	0.89	1.23
High	35.86	37.65	12.41	9.71	0.96	1.28

Provisional values for SL-1 (wt %)

	TiO_2	MnO	Na_2O	K_2O
Provisional value	0.38	0.86	0.39	0.51

A copy of CANMET Report 77-57 "Blast furnace slag SL-1: Its preparation for use as a certified reference material" will be provided with each order of SL-1.

Copper Concentrate CCU-1

CCU-1 was prepared from a sample of a flotation concentrate from the Ruttan mine of Sherritt Gordon Mines Limited, at Lynn Lake, Manitoba. It contains a number of minor and trace elements at analytically useful levels of concentration.

Approximate mineralogical composition of CCU-1

Mineral	wt %
Chalcopyrite	82
Pyrite	9
Sphalerite	9
Pyrrhotite	trace

Thirty-three laboratories provided analytical results for one or more of the constituents. Preliminary data for 10 other elements are also available.

RECOMMENDED VALUES AND CONFIDENCE INTERVALS FOR CCU-1 (wt %)

Constituent	Recommended value (95% CL)
Cu	24.71 ± 0.05
Zn	3.22 ± 0.03
SiO_2	2.61 ± 0.08
Al_2O_3	0.247 ± 0.007
Pb	0.106 ± 0.005
Ag	139 ± 3 µg/g
Hg	61 ± 2 µg/g
Au	7.5 ± 0.3 µg/g

A certificate of analysis will be issued with each order of CCU-1. A copy of CANMET Report 79-16 "Copper concentrate CCU-1 - A certified reference material" will be forwarded free of charge, on request, to the Coordinator, CCRMP.

Copper-Molybdenum Ore HV-1

HV-1 is a mixture of materials taken from large, low-grade copper-molybdenum porphyry deposits in the Highland Valley area of British Columbia; it is intended to be representative of samples analyzed in large numbers by enterprises associated with the exploitation of these deposits.

Mineralogical composition of HV-1 (wt %)

Mineral	Calculated mineral composition
Bornite	0.6
Chalcopyrite	0.3
Pyrite	0.1
Molybdenite	0.1
Quartz	40.7
Plagioclase	26.9
Orthoclase	10.6
Sericite	12.3
Biotite	2.3
Amphibole and pyroxene	2.0
Clay minerals	1.0
Zircon	trace
Calcite	1.5
Hematite and magnetite	0.6
Rutile	0.3
Barite	0.1
Tramp iron (presence indicated from polished section; calculated by difference)	0.4
Total	99.8

Approximate chemical composition of HV-1 (wt %)

O	49.2
Si	33.9
Al	6.61
Fe (total)	1.88
Ca	1.40
Mg	0.34
Na	2.26
K	2.82
Ti	0.16
Mn	0.03
Cu	0.52
Mo	0.058
S (comb)	0.34
S (grav)	0.35
C (total)	0.20
H_2O (980°C)	1.42
Total	101.1
Correction for O in H_2O	1.3
Adjusted total	99.8

Twenty-three laboratories provided analytical results for copper and molybdenum for certifying HV-1.

RECOMMENDED VALUES AND CONFIDENCE LIMITS FOR SELECTED ELEMENTS IN HV-1 (wt %)

	Cu	Mo
Recommended value	0.522	0.058
95% Confidence limits		
Low	0.517	0.056
High	0.526	0.059

A copy of Mines Branch Technical Bulletin TB 167 "Copper-molybdenum ore HV-1: Its characterization and preparation for use as a standard reference material" will be provided with each order of HV-1.

Gold Ore MA-1

MA-1 was prepared from mill feed from Willroy Mines Limited, Macassa Division, Kirkland Lake, Ontario. It is a relatively simple siliceous ore containing elemental gold. Although CCRMP has issued several certified gold-bearing materials (PTC-1 and PTM-1), these are rich in one or more of copper, nickel and iron, and contain platinum-group metals, thus being unsatisfactory for laboratories needing a simple gold ore as a reference material.

Approximate chemical composition of MA-1 (wt %)

O*	45
Si	24.9
Al	5.7
Fe	5.3
Ca	4.4
Na	1.5
K	4.2
S	1.5
Total C	2.1
C from CO_2	1.8
H_2O (1000°C)	2.0
H_2O (105°C)	0.1
L.O.I.	6.5

*Determined by neutron activation analysis, Mineral Sciences Laboratories.

Twenty-four laboratories provided gold results by one or more of three methods.

RECOMMENDED GOLD VALUE AND CONFIDENCE LIMITS

	oz/ton	ppm
Recommended value	0.519	17.8
95% Confidence limits		
Low	0.514	17.6
High	0.523	17.9

A copy of report MSL 75-29(TR) "Gold ore MA-1: Its preparation and characterization for use as a certified reference material" will be provided with each order of MA-1.

Iron Ore SCH-1

Reference ore SCH-1 was donated to CCRMP by the Iron Ore Company of Canada in 1973. It is from the Schefferville, Quebec area and is hematite with a mixture of unidentified hydrons oxides of iron, minor magnetite and trace pyrolusite. The gangue consists mainly of quartz with minor amounts of feldspar and traces of biotite, chlorite and amphibole.

Twenty-four laboratories provided analytical results for one or more of the selected elements in SCH-1.

RECOMMENDED VALUES AND LIMITS FOR SELECTED ELEMENTS IN SCH-1 (wt %)

	Fe	Si	Al	Ca	Mg	Na	K	Mn	Ti	S	P
Recommended value	60.73	3.78	0.509	0.029	0.020	0.019	0.026	0.777	0.031	0.007	0.054
95% Confidence limits											
Low	60.65	3.74	0.500	0.027	0.019	0.017	0.024	0.769	0.029	0.007	0.051
High	60.82	3.81	0.517	0.032	0.021	0.020	0.027	0.785	0.033	0.008	0.057

A copy of report MSL 75-168(TR) "Iron ore SCH-1: Its characterization and preparation for use as a certified reference material" and CANMET Report 78-5 "Certification of reference iron ore SCH-1 for sodium and potasium" will be provided with each order.

Lead Concentrate CPB-1

CPB-1 was prepared from a sample of a flotation concentrate from the Sullivan mine of Cominco Ltd., at Kimberley, British Columbia. It is mineralogically complex with a relatively large number of minor and trace elements at analytically useful levels of concentration.

Approximate mineralogical composition of CPB-1

Mineral	wt %
Galena	72.5
Pyrrhotite	12
Sphalerite	7
Pyrite	3
Iron oxides	1
Aluminosilicates	1
Carbonates	1
Chalcopyrite	0.5
Boulangerite	0.5

Twenty-five laboratories provided analytical results for one or more of the constituents. Preliminary data for eight other elements are also available.

RECOMMENDED VALUES AND CONFIDENCE INTERVALS FOR CPB-1

Constituent	Recommended value (95% CL) (wt %)
Pb	64.74 ± 0.12
S	17.8 ± 0.2
Fe	8.43 ± 0.06
Zn	4.42 ± 0.04
SiO_2	0.74 ± 0.04
Sb	0.36 ± 0.03
Al_2O_3	0.28 ± 0.02
Cu	0.254 ± 0.004
As	0.056 ± 0.003
Bi	0.023 ± 0.002
Cd	0.0143 ± 0.0005
Ag	626 ± 6 µg/g
Hg	5.5 ± 0.5 µg/g

A certificate of analysis will be issued with each order for CPB-1. A copy of CANMET Report 79-15 "Lead concentrate CPB-1 - A certified reference material" will be forwarded free of charge on request to the Coordinator, CCRMP.

Molybdenum Ore PR-1

Molybdenum ore PR-1 was obtained from the Preissac Molybdenum mine near Cadillac, Quebec in 1970. It is from a vein-type deposit in a sericite granite.

Mineralogical composition of PR-1 (wt %)

Mineral	Calculated content
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	nc*
Hematite	nc
Magnetite	nc
Fe + O + Ni + H_2O	1.26
Total	98.87

*not calculated

Approximate chemical composition of PR-1 (wt %)

O	49.2
Si	39.2
Al	2.39
Fe	1.24
Ca	1.44
Mg	0.09
Na	0.54
K	1.95
S	0.79
Mo	0.59
Bi	0.11
Ti	0.03
Pb	0.04
Zn	0.02
Mn	0.02
Ni	0.01
Cu	0.01
F	0.47
H_2O	0.29
Total C	
as CO_2	1.08
actual CO_2	1.04

Nineteen laboratories participated in the program to certify PR-1 for molybdenum, bismuth, iron, and sulphur.

RECOMMENDED VALUES AND CONFIDENCE INTERVALS FOR SELECTED ELEMENTS IN PR-1 (wt %)

	Mo	Bi	Fe	S
Recommended value	0.594	0.111	1.244	0.793
95% Confidence intervals				
Low	0.578	0.107	1.225	0.777
High	0.610	0.114	1.263	0.809

A copy of Mines Branch Technical Bulletin TB 139 "Molybdenum ore, PR-1: Its characterization and preparation for use as a standard reference material" will be provided with each order of PR-1.

Nickel-Copper-Cobalt SU-1a

SU-1a is intended as a replacement for reference ore SU-1, the supply of which has been exhausted. The material is typical of the Sudbury region and is a sample of feed to the Clarabelle mill of the International Nickel Company.

Mineralogical composition of SU-1a

Mineral	Weight %
Chlorite	27
Quartz	19
Feldspar	18
Mica	15
Amphibole	15
Calcite	1
Siderite	1
Sphalerite	2.0
Pyrrhotite	1.1
Pentlandite	0.8
Chalcopyrite	0.1

Twenty-three laboratories provided results for one or more of nickel, copper, cobalt, platinum, palladium and silver. Preliminary data for gold and rhodium are also presented.

Approximate Chemical composition of SU-1a

Constituent	wt %
SiO_2	38
Fe	20
S	10
Al	5
Ca	3.5
Mg	3.0
Ni	1.3
Cu	1.0
Co	0.04
Pb	0.01
Ag	5.6 ppm
Pd	0.6 ppm
Pt	0.5 ppm
Au	0.2 ppm

RECOMMENDED VALUES AND CONFIDENCE LIMITS

Constituent	Recommended value (95% CL) wt %
Ni	1.233 ± 0.008
Cu	0.967 ± 0.005
Co	0.041 ± 0.001
Ag	4.3 ± 0.3
Pt	0.41 ± 0.06 µg/g
Pd	0.37 ± 0.03 µg/g

A certificate of analysis will be issued with each order of SU-1a. A copy of CANMET Report 80-9 "SU-1a: A certified nickel-copper-cobalt reference ore" will be forwarded on request to the Coordinator, CCRMP.

Nickel-Copper-Cobalt UM-1

UM-1 is an ultramafic rock from the Giant Mascot mine at Hope, British Columbia. It is one of a suite of three ultramafic rocks that have been termed geochemical standards for the determination of ascorbic acid/hydrogen peroxide-soluble nickel, copper, and cobalt. Because UM-1 contained ore-grade concentrations of nickel, copper, and cobalt it was chosen along with SU-1 as a suitable reference material for these elements.

For the certification of UM-1, twenty-five laboratories provided analytical results for nickel, copper, and cobalt.

Approximate chemical composition of UM-1 (wt %)

O	36.5
Si	17.6
Al	0.53
Fe	13.4
Ca	1.67
Mg	21.7
Na	0.06
K	0.02
Ti	0.06
Cr	0.31
Mn	0.12
Ni	0.88
Cu	0.43
Co	0.035
S	3.53
H (from H_2O)	0.05
C (from CO_2)	0.07

RECOMMENDED VALUES AND CONFIDENCE LIMITS

	Ni	Cu	Co
Recommended value	0.88	0.43	0.035
95% Confidence limits			
Low	0.87	0.43	0.034
High	0.89	0.44	0.035

A copy of Mines Branch Technical Bulletin TB 177 "Nickel-copper-cobalt ores SU-1 and UM-1: Their characterization and preparation for use as standard reference materials" will be provided with each order of UM-1.

Noble Metals-Bearing Sulphide Concentrate PTC-1

PTC-1, PTM-1 and PTA comprise a suite of certified reference materials containing the platinum-group metals. PTC-1 is a flotation concentrate of Sudbury ore, its principal constituents being Cu-5.2%; Ni-9.4%; S-23.5%; and Fe-26.9%.

Ten laboratories provided analyses for the certification of five selected elements.

RECOMMENDED VALUES AND CONFIDENCE LIMITS FOR SELECTED ELEMENTS IN PTC-1

	Pt		Pd		Rh		Au		Ag	
	(oz/ton)	(ppm)	(oz/ton)	(ppm)	(oz/ton)	(ppm)	(oz/ton)	(ppm)	(oz/ton)	(ppm)
Recommended value	0.087	3.0	0.37	12.7	0.018	0.62	0.019	0.65	0.17	5.8
95% Confidence limits										
Low	0.081	2.8	0.35	12.0	0.016	0.55	0.016	0.55	0.16	5.5
High	0.093	3.2	0.38	13.0	0.020	0.69	0.021	0.72	0.18	6.2

(ppm = µg/g)

A copy of Mines Branch Technical Bulletin TB 176 "Noble-metals-bearing sulphide concentrate PTC-1: Its characterization and preparation for use as a standard reference material" will be provided with each order of PTC-1.

Noble Metals-Bearing Nickel-Copper Matte PTM-1

Matte PTM-1 was produced from Sudbury ore and was provided by Falconbridge Nickel Mines Limited. This material contains appreciable concentrations of most platinum-group metals. Approximate chemical analyses for the major constituents gave the following values: Ni-44.8%; Cu-30.2%; Fe-1.58%; S-21.6%.

RECOMMENDED VALUES AND THEIR CONFIDENCE LIMITS FOR SELECTED ELEMENTS IN PTM-1

	Pt		Pd		Rh		Au		Ag	
	(oz/ton)	(ppm)	(oz/ton)	(ppm)	(oz/ton)	(ppm)	(oz/ton)	(ppm)	(oz/ton)	(ppm)
Recommended value	0.17	5.8	0.24	8.1	0.026	0.9	0.052	1.8	1.9	66
95% Confidence limits										
Low	0.16	5.5	0.22	7.4	0.021	0.7	0.047	1.6	1.7	59
High	0.18	6.2	0.26	8.8	0.030	1.0	0.057	1.9	2.1	73

(ppm = µg/g)

A copy of Mines Branch Technical Bulletin TB 182 "Noble-metals-bearing nickel-copper matte PTM-1: Its characterization and preparation for use as a standard reference material" will be provided with each order of PTM-1.

Platiniferous Black Sand PTA-1

PTA-1 was supplied by B.H. Levelton and Associates, Vancouver. It is from the Tulameen River area of British Columbia. Mineralogical examination of similar material revealed the presence of at least ten minerals known to contain platinum-group elements with an iron-bearing platinum alloy being predominant. Approximate chemical analyses for the major constituents of PTA-1 gave the following values: Fe-63.0%; SiO_2-3.6%; Al-2.9%; Ca-1.2%; and Mg-0.6%.

Nine laboratories provided platinum analyses for the certification of PTA-1.

RECOMMENDED VALUES AND CONFIDENCE LIMITS FOR PLATINUM IN PTA-1

	(ppm)	(troy oz/ton)
Recommended value	3.05	0.089
95% Confidence limits		
Low	2.91	0.085
High	3.17	0.092

(ppm = µg/g)

A copy of Mines Branch Technical Bulletin TB 138 "Characterization and preparation of standard reference materials that contain noble metals: (A) PTA (Ores) and (B) PTM (Nickel-Copper-Matte)" will be provided with each order of PTA-1.

Tungsten Ores CT-1, BH-1, and TLG-1

CT-1 is a sample of a scheelite ore obtained in 1973 from Canada Tungsten Corporation, Tungsten, N.W.T. In decreasing order of abundance, the minerals present are: pyroxene, quartz, pyrrhotite, amphibole, calcite, mica, dolomite, feldspar, scheelite, chalcopyrite, and clay minerals.

BH-1 is a sample of wolframite ore, handpicked in 1973 from a stockpile at the Burnt Hill deposit neat Fredericton, New Brunswick, the deposit being owned by International Paper Company Limited. Minerals present in decreasing order of abundance are: quartz, biotite, chlorite, muscovite, feldspar, pyrrhotite, beryl and topaz, wolframite, cassiterite and rutile, pyrite, molybdenite, bismuth, bismuthinite and galena, and chalcopyrite.

TLG-1 is a sample of a low-grade scheelite ore from Browne's Lake mine, Beaverhead County, Montana, and was donated by General Electric Company, Cleveland, Ohio. In decreasing order of abundance, minerals present are: quartz, calcite, hydrogarnet, amphibole, dolomite, chlorite, feldspar, mica, clay minerals, scheelite, hematite, magnetite, sphalerite and chalcopyrite.

RECOMMENDED TUNGSTEN VALUES AND CONFIDENCE LIMITS IN CT-1, BH-1 AND TLG-1 (wt %)

	CT-1	BH-1	TLG-1
Recommended value	1.04	0.42	0.083
95% Confidence limits			
Low	1.025	0.415	0.080
High	0.058	0.430	0.087

A copy of CANMET Report 76-5 "Tungsten ores CT-1, BH-1 and TLG-1: Their characterization and preparation for use as certified reference materials" will be provided with each order of CT-1, BH-1 or TLG-1.

Uranium-Thorium Ores DH-1, BL-1, BL-2, BL-3, and BL-4

These materials have been prepared to replace the previous reference materials of the Canadian Uranium Producers Analytical Sub-committee, the major supply of which is now exhausted. Materials from both of the principal uranium producing areas of Canada have been selected.

DH-1 is ore-grade material from the Elliot Lake area of Ontario. 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 secular equilibrium, and cover a range of concentrations that should make them useful as reference materials for radiometric methods of analysis.

RECOMMENDED VALUES FOR URANIUM AND THORIUM AND 95% CONFIDENCE INTERVALS (wt %)

Designation	Thorium as Th	Uranium as U
DH-1	0.104 ± 0.005	0.177 ± 0.003
BL-1	15 ± 1	0.022 ± 0.001
BL-2		0.453 ± 0.005
BL-3		1.02 ± 0.01
BL-4		0.173 ± 0.004

A copy of CANMET Report 77-64 "Radioactive ores DH-1, DL-1, BL-1, BL-2, BL-3 and BL-4: Certified reference materials" will be provided with each order of one or more of the samples.

Uranium-Thorium Ore DL-1a

DL-1a is intended as a replacement for reference ore DL-1 the supply of which is exhausted. DL-1 had been part of a popular suite of seven uranium-thorium ores the remainder of which are still available - see preceding page. DL-1a is waste-rock typical of the property of Denison Mines Limited in Elliot Lake, Ontario. It is a pale yellow arkose sandstone containing uraninite and brannerite and possibly traces of monazite and uranothorite.

Twenty laboratories and fourteen laboratories provided results for uranium and thorium, respectively. Preliminary data for iron, sulphur and lead are also reported. Evidence for the state of secular equilibrium of DL-1a is presented.

Approximate chemical composition of DL-1a

Constituent	wt (%)
SiO_2	85.5
Al	5.3
Fe	0.9
S	0.4
Ca	0.3
K	0.2
Mg	0.2
Na	0.09
Ti	0.09
LOI (900°C)	1.4
H_2O (105°C)	0.2

RECOMMENDED VALUES AND CONFIDENCE LIMITS

Constituent	Recommended value (95% CL) (wt %)
U	0.0116 ± 0.0003
Th	0.0076 ± 0.0004

A certificate of analysis will be issued with each order of DL-1a. A copy of CANMET Report 80-10 "DL-1a: A certified uranium-thorium reference ore" will be forwarded free of charge on request to the Coordinator, CCRMP.

Uranium Ore BL-5

The raw material for BL-5 was donated to CCRMP in September 1976, by the Resource Geophysics and Geochemistry Division of the Geological Survey of Canada at Ottawa, Ontario. This material is essentially a low-grade concentrate from Beaverlodge, Saskatchewan.

Mineralogical composition of BL-5

Minerals in order of abundance
Plagioclase feldspar
Quartz
Uraninite
Calcite + dolomite
Hematite
Chlorite + muscovite
Galena
Carbon
Pyrite
Magnetite
Anatase + rutile
Chalcopyrite
Bornite
Pyrrhotite
Apatite

Approximate chemical composition of BL-5 (wt %)

Constituent	X-ray fluorescence*	Chemical**
Si	22.2	21.8
Al	6.0	6.0
Fe	5.8	5.9
Ca	3.9	4.1
Mg	1.4	1.5
Na	3.5	3.6
K	0.4	0.4
Ti	0.4	0.4
V	-	0.1
Mn	0.05	-
Pb	1.5	1.4
Cr	0.01	-
Sr	0.03	-
Zr	0.04	-
P	0.07	-
S	0.3	-
Th	-	0.004
U	7.06	7.09
C	-	1.9
Moisture (105°C)		

*Mean of 10 and **mean of 2 replicate determinations, respectively.

Twenty-seven laboratories provided uranium results by one or more of seven methods.

RECOMMENDED URANIUM VALUE AND CONFIDENCE LIMITS (wt %)

Recommended value	7.09
95% Confidence limits	
Low	7.06
High	7.12

A certificate of analysis will be issued with each order of BL-5. A copy of CANMET Report 79-4 "Uranium ore BL-5 - Certified reference material" will be forwarded free of charge on request to the Coordinator, CCRMP.

Zinc Concentrate CZN-1

CZN-1 was prepared from a sample of a flotation concentrate from the Sullivan mine of Cominco Ltd., at Kimberley, British Columbia. It is mineralogically complex and with a relatively large number of minor and trace elements at analytically useful levels of concentration.

Approximate mineralogical composition of CZN-1

Mineral	wt %
Sphalerite (~10% Fe)	84
Galena	8.5
Pyrrhotite	4
Pyrite	1
Iron oxides	1
Quartz	0.5
Aluminosilicates	0.5
Carbonates	0.5

Thirty laboratories provided analytical results for one or more of the constituents. Preliminary data for eight other elements are also available.

RECOMMENDED VALUES AND CONFIDENCE INTERVALS FOR CZN-1

Constituent	Recommended value (95% CL) (wt %)
Zn	44.74 ± 0.11
S	30.2 ± 0.2
Fe	10.93 ± 0.06
Pb	7.45 ± 0.05
Al_2O_3	0.25 ± 0.01
Mn	0.219 ± 0.07
Cu	0.144 ± 0.003
Cd	0.132 ± 0.002
Sb	0.052 ± 0.003
As	0.026 ± 0.002
Ag	93 ± 3 µg/g
Hg	43 ± 4 µg/g

A certificate of analysis will be issued with each order of CZN-1. A copy of CANMET Report 79-14 "Zinc concentrate CZN-1 - A certified reference material" will be forwarded on request to the Coordinator, CCRMP.

Zinc-Lead-Tin-Silver Ore KC-1

KC-1 was prepared from material hand-picked at the Kidd Creek deposit of Ecstall Mining Company Limited, Timmins, Ontario. KC-1 serves to complement the certified base metal ore MP-1 which contains lower zinc, lead and silver values but higher copper and tin values.

Recommended values for five elements in KC-1 were assigned in 1974. However, after discovery in early 1977 that the overall composition of KC-1 had changed significantly by oxidation, another interlaboratory program established a new value for zinc, which in turn permitted revising the recommended values for the other four constituents by using a correction factor.

All bottles of KC-1 have been sealed under nitrogen in protective envelopes; thus the new recommended values should be valid indefinitely.

Approximate chemical composition of KC-1 (wt %)

O	14*
Si	11
Al	0.8
Fe	16
Ca	0.3
Mg	0.05
Na	0.2
K	0.1
Mn	0.05
S	28
C	0.2
Zn	20.07
Pb	6.87
Sn	0.67
Cu	0.112
Ag	0.112
H_2O (1800°F)	0.7

*Determined by neutron activation analysis, Mineral Sciences Laboratories.

Mineralogical composition of KC-1 (wt %)

Mineral	Calculated content
Sphalerite	32.7
Pyrite	29.9
Galena	8.1
Cassiterite	0.9
Siderite	0.4
Pyrrhotite	0.3
Chalcopyrite	0.3
Silver	0.1
Tetrahedrite + stephanite	0.05
Quartz	20.6
Feldspar	5.0
Chlorite	0.9
Carbon	0.2
Total	99.5

RECOMMENDED VALUES AND CONFIDENCE LIMITS FOR SELECTED CONSTITUENTS IN KC-1 (1978) (wt %)

	Zn	Pb	Sn	Cu	Ag
Recommended value	20.07	6.87	0.67	0.112	0.112
95% Confidence limits					
Low	20.01	6.83	0.66	0.110	0.110
High	20.14	6.91	0.68	0.114	0.113

A copy of Technical Bulletin TB 193 "Zinc-lead-tin-silver ore KC-1: Its preparation and characterization for use as a certified reference material" and CANMET Report 78-2 "Revision of recommended values for reference ores MP-1 and KC-1" will be provided with each order of KC-1.

Zinc-Tin-Copper-Lead Ore MP-1

Reference ore 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.

Mineralogical composition of MP-1 (wt %)

Mineral	Calculated content
Sphalerite	25.1
Chalcopyrite	3.8
Stannite-kesterite	2.9
Galena	2.2
Cassiterite	2.0
Arsenopyrite	1.7
Pyrite	1.3
Bismuth	0.03
Wolframite	0.04
Molybdenite	0.02
Quartz	34.7
Chlorite	7.0
Fluorite	6.6
Topaz	6.1
Kaolinite	5.8
Feldspar	0.8
Rutile	0.05
Total	100.14

Approximate chemical composition of MP-1 (wt %)

O	26.8
Si	19.4
Al	3.63
Fe	5.68
Mg	0.04
Ca	3.36
K	0.10
Na	0.01
Ti	0.07
Mn	0.05
S	11.8
H_2O (980°C)	1.57
C	0.10
F	4.04
Zn	15.90
Sn	2.43
Cu	2.09
Pb	1.88
As	0.77
In	0.069
Bi	0.024
Mo	0.014
Cd	0.07
W	0.02
Total	100.5
Corrected for O in H_2O	1.4
Corrected total	99.1

Recommended values for nine elements in MP-1 were assigned in 1972. However, after discovery in early 1977 that the overall composition of MP-1 had changed significantly through oxidation, another interlaboratory program established a new value for zinc, which in turn permitted revising recommended values for the other eight constituents using a correction factor.

All bottles of MP-1 have been sealed under nitrogen in protective envelopes; thus, the new recommended values should be valid indefinitely.

(See overleaf for Recommended Values)

RECOMMENDED VALUES AND CONFIDENCE LIMITS FOR SELECTED CONSTITUENTS IN MP-1 (1978) (wt %)

	Recommended value	95% Confidence limits
Zn	15.90	15.84 - 15.96
Sn	2.43	2.32 - 2.54
Cu	2.09	2.06 - 2.12
Pb	1.88	1.85 - 1.91
Mo	0.014	0.013 - 0.015
In	0.069	0.066 - 0.072
Bi	0.024	0.022 - 0.026
As	0.77	0.75 - 0.79
Ag	57.9 (ppm)	55.7 - 60.1

ppm = µg/g

A copy of Technical Bulletin TB 155 "Zinc-tin-copper-lead ore MP-1: Its characterization and preparation for use as a standard reference material" and CANMET Report 78-2 "Revision of recommended values for reference ores MP-1 and KC-1" will be provided with each order of MP-1.

ROCKS

Syenites SY-2 and SY-3 and Gabbro MRG-1

SY-2 is a syenite from the Bancroft area of eastern Ontario. SY-3 is a batch of syenite from the same source as SY-2 that was ground autogeneously with lumps of a concentrate containing uraninite, allanite and betafite to increase the concentration of uranium, thorium and rare earths.

SY-2 and SY-3 were prepared several years ago, but samples distributed internationally were analyzed on a casual basis only, to provide provisional values for a number of constituents. Only recently however were they analyzed in a systematic round-robin program to certify them as compositional reference materials.

MRG-1 is an augite-olivine gabbro from Mount Royal at Montreal, Quebec, intruded into sedimentary rocks of the lower Paleozoic. MRG-1 is compositionally different from other certified reference rock samples and the recommended values should be of interest to rock analysts.

RECOMMENDED VALUES — "COMPLETE ANALYSIS" (wt %)

Constituents	SY-2	SY-3	MRG-1
SiO_2	60.10	59.68	39.32
Al_2O_3	12.12	11.80	8.50
Fe_2O_3	2.28	2.44	8.26
FeO	3.62	3.58	8.63
MgO	2.70	2.67	13.49
CaO	7.98	8.26	14.77
Na_2O	4.34	4.15	0.71
K_2O	4.48	4.20	0.18
H_2O^+	0.43	0.42	0.98
CO_2	0.46	0.38	1.00
TiO_2	0.14	0.15	3.69
P_2O_5	0.43	0.54	0.06
F	0.51	0.66	0.025
S	0.011	0.05	0.06
MnO	0.32	0.32	0.17
Others*	0.43?	1.18?	0.33?
Σ	100.35?	100.48?	100.18?
O/etc	0.22?	0.31?	0.04?
Σ (corr.)	100.13?	100.17?	100.14?
Fe_2O_3TR**	6.28	6.42	17.82
Fe_2O_3TC***	6.27	6.42	17.85

*Others represent the sum of the "equivalent percentages" of the trace elements, adjusted upward to allow for additional rare-earth elements for which reported results were too limited to justify assigning values.

**Fe_2O_3TR: Total iron, expressed as ferric oxide, reported as such.

***Fe_2O_3TC: Total iron, expressed as ferric oxide, calculated from FeO and Fe_2O_3.

A copy of CANMET Report 79-35 "SY-2, SY-3 and MRG-1: Three rock samples as reference materials" will be forwarded with each order for SY-2, SY-3 or MRG-1.

SOILS

Soil Samples SO-1 to SO-4

Information on the samples follows.

SO-1: The sampling site was 23 km northwest of Hull, Quebec at 45°30'N, 75°58'40"W. The sample is somewhat weathered Champlain Sea clay from 35 to 75 cm below the surface in an upland position. In pedological terms, the sample is of the C horizon of Rideau clay, a Regosolic soil. It contains about 80% clay (<2 μm) of mixed mineralogy.

SO-2: The sampling site was in Montmorency Forest about 47°20'N, 71°9'W, 72 km north of Quebec City. Sampling depth was 10 to 30 cm. The sample, supplied by C.R. DeKimpe, is of the B horizon of a Ferro-Humic Podzol developed in sandy till. The organic matter content is approximately 10%.

SO-3: The sampling site was near Guelph, Ontario at 43°33'N, 80°19'W. The sample, supplied by R. Protz, is of the calcareous till parent material of the Guelph series, a Gray Brown Luvisol. The sample has an appreciable content of both calcite and dolomite.

SO-4: The sampling site was northeast of Saskatoon, Saskatchewan at 53°2'N, 106°42'W. The sample, supplied by H.B. Stonehouse, is of the A horizon of a Black Chernozemic soil developed in silty glacial lacustrine deposits.

Thirty-six laboratories provided analytical results for one or more elements. Preliminary data (given in CANMET Report 79-3) for 47 other elements is also available.

RECOMMENDED VALUES AND CONFIDENCE INTERVALS FOR SOIL SAMPLES (wt %)

	SO-1	SO-2	SO-3	SO-4
Al	9.38 ± 0.17	8.07 ± 0.18	3.05 ± 0.11	5.46 ± 0.15
Ca	1.80 ± 0.07	1.96 ± 0.10	-	1.11 ± 0.06
Fe	6.00 ± 0.13	5.56 ± 0.16	1.51 ± 0.06	2.37 ± 0.07
K	2.68 ± 0.08	2.45 ± 0.04	1.16 ± 0.05	1.73 ± 0.03
Mg	2.31 ± 0.10	0.54 ± 0.03	-	0.56 ± 0.04
Mn	0.089 ± 0.003	0.072 ± 0.002	0.052 ± 0.002	0.060 ± 0.002
Na	-	-	0.74 ± 0.04	-
P	0.062 ± 0.01	-	-	0.090 ± 0.07
Si	25.72 ± 0.22	24.99 ± 0.23	15.86 ± 0.19	-
Ti	0.53 ± 0.02	0.86 ± 0.02	-	0.34 ± 0.02
	(μg/g)	(μg/g)	(μg/g)	(μg/g)
Cr	160 ± 15	16 ± 2	26 ± 3	61 ± 6
Cu	61 ± 3	7 ± 1	17 ± 1	22 ± 1
Hg	0.022 ± 0.003	0.082 ± 0.009	0.017 ± 0.007	-
Ni	94 ± 7	-	16 ± 3	26 ± 3
Pb	21 ± 4	21 ± 4	14 ± 3	16 ± 3
Sr	-	340 ± 50	217 ± 29	170 ± 18
V	139 ± 8	64 ± 10	-	90 ± 11
Zn	146 ± 5	124 ± 5	52 ± 3	94 ± 3

Each order for SO-1 to SO-4 will be issued a certificate of analysis. A copy of CANMET Report 79-3 "Soil samples SO-1, SO-2, SO-3 and SO-4 - Certified reference materials" will be forwarded on request to the Coordinator, CCRMP.

METALS AND ALLOYS

Commercial Purity Copper Rods, SSC-1, SSC-2, and SSC-3

The copper rods were intended as reference materials for spectrographic purposes. They were prepared and tested for homogeneity in the Mines Branch, between 1964 and 1966; the starting materials were donated by Canadian Copper Refiners Limited, Montreal, Quebec, and Metals and Alloys Limited, Leaside, Ontario.

To dope the copper matrix, impurities in granulated form were mixed with high-purity anode swarf, the mixture was cold-pressed into pellets 25.4 mm (1 in.) in diameter, and then the pellets were added to molten high-purity copper in appropriate quantities. The alloys are in the form of hot-rolled rods, 300 mm x 8 mm (12 in. x 5/6 in.).

For certifying the copper rods, ten laboratories provided analytical results for one or more elements. The results are based on a minimum of four and a maximum of eleven laboratories. The minimum number of determinations per element was seven, and the maximum fifty-one. The coefficient of variation ranged from 5.4% to 60.7%, with an overall mean of 25% at the 10 µg/g (ppm) level.

RECOMMENDED VALUES FOR COPPER RODS SSC-1, SSC-2 AND SSC-3

Element	SSC-1		SSC-2		SSC-3	
	Recommended value	Std dev	Recommended value	Std dev	Recommended value	Std dev
	(Concentration in ppm, µg/g)					
Ag	18.8	5.81	13.9	3.38	16.1	3.59
As	1.16	0.483	1.18	0.612	5.45	1.93
Bi	1.15	0.325	0.097	0.044	0.59	0.012
Cd	N.F.	-	10.0	1.05	N.F.	-
Fe	39.2	7.18	31.9	7.05	40.0	8.82
Ni	17.6	3.36	3.17	1.04	48.0	7.68
O	216	68.3	176	59.3	176	46.7
Pb	65.3	7.02	6.12	1.20	4.58	1.51
S	19.6	6.79	28.9	8.53	16.7	8.93
Sb	2.64	0.543	5.80	0.662	1.63	0.989
Se	7.28	1.61	2.58	0.821	3.87	0.744
Sn	54.9	6.70	10.0	1.93	12.0	1.68
Te	4.57	0.775	1.24	0.514	2.53	0.629
Zn	33.3	7.91	16.3	5.15	15.3	3.60

N.F. - Not found.

A copy of report MRP/MSL 75-149(TR) "Commercial purity copper rod SSC-1, SSC-2, SSC-3, SSC-4: Their generation and certification as certified reference materials will be provided with each order of one or more of these alloys.

Phosphor Bronze Discs 293, 304 , and 477

These 60-mm x 7-mm phosphor bronze discs, weighing 160 g each, are intended as reference alloys for spectrographic purposes; they were cast and tested for homogeneity in the Mines Branch in 1962.

For each phosphor bronze, a composite of chips from 10 randomly selected discs was prepared and a 100-g sample of this material was sent to each of five participating laboratories for analysis.

RECOMMENDED VALUES FOR PHOSPHOR BRONZES (wt %)

	293	304	477
Cu	94.89	86.48	91.24
Sn	4.96	9.67	7.15
Fe	0.026	0.035	0.071
Pb	0.01	0.46	0.053
Zn	0.037	2.99	0.75
P	0.030	0.007	0.43
Al	-	0.05	-

A copy of report MRP/MSL 74-148(TR) "Phosphor bronze discs, No. 293, 304 and 477: Their preparation and certification as certified reference materials" will be included with each order of one or more of these materials.

MATERIALS WITH PROVISIONAL VALUES FOR SELECTED ELEMENTS

Sulphide-Bearing Ultramafic Rocks UM-1, UM-2, and UM-4

UM-1 is a sulphide-bearing ultramafic rock from the Giant Mascot mine at Hope, British Columbia. UM-2 and UM-4 are from the Werner Lake - Gordon Lake district of northwestern Ontario. These rock samples are intended as reference materials for the determination of ascorbic acid/hydrogen peroxide-soluble copper, nickel, and cobalt in ultramafic rocks to evaluate their ore potential.

Details of the mineralogy of UM-1, UM-2, and UM-4 are given in Geological Survey of Canada Paper 71-35 "Three geochemical standards of sulphide-bearing ultramafic rock: UM.1, UM.2 and UM.4". The following table by E.M. Cameron provides values for the major and minor elements; they are intended for information purposes only.

Approximate chemical composition (wt %)

Constituent	UM-1	UM-2	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
ZnO	0.012	0.004	0.008

GSC VALUES FOR COPPER, NICKEL, AND COBALT BY ASCORBIC ACID/HYDROGEN PEROXIDE METHOD (wt %)

Sample	Cu	Ni	Co
UM-1	0.41	0.83	0.029
UM-2	0.095	0.29	0.012
UM-4	0.054	0.19	0.007

PRICE LIST

Ores and related materials	Quantity (g)	Prices ($ Can.) (Shipping cost included)
Antimony ore CD-1	200	70
Blast-furnace slag SL-1	200	70
Copper concentrate CCU-1	200	70
Copper-molybdenum ore HV-1 ...	200	70
Gold ore MA-1	200	70
Iron ore SCH-1	200	70
Lead concentrate CPB-1	200	70
Molybdenum ore PR-1	200	70
Nickel-copper-cobalt ore SU-1a	200	70
Nickel-copper-cobalt ore UM-1	100	35
Noble-metals-bearing sulphide concentrate PTC-1	200	70
Noble-metals-bearing copper-nickel matte PTM-1 ...	400	140
Platiniferous black sand PTA-1	400	70
Tungsten ores CT-1	200	70
Tungsten ores BH-1	200	70
Tungsten ores TLG-1.....	200	70
Uranium-thorium ore DH-1	200	70
Uranium-thorium ore DL-1a	200	70
Uranium-thorium ore BL-1	100	35
Uranium ore BL-2	100	35
Uranium ore BL-3	100	35
Uranium ore BL-4	200	70
Uranium ore BL-5	100	35
Zinc concentrate CZN-1	200	70
Zinc-lead-tin-copper-silver ore KC-1	200	70
Zinc-tin-copper-lead ore MP-1	200	70
ROCKS		
Gabbro MRG-1	100	35
Syenite SY-2	100	35
Syenite SY-3 (enriched in radioactive minerals).....	100	35
Ultramafic rock UM-1 UM-2, UM-4 .....each	100	35

Price List (cont'd)

SOILS		
Regosolic clay soil sample SO-1	200	70
Podzolic B horizon soil sample SO-2	200	70
Calcareous C horizon soil sample SO-3	200	70
Chernozemic A horizon soil sample SO-4	200	70
METALS AND ALLOYS		
Commercial purity copper rods (300 mm x 7.9 mm) Set of SSC-1, -2, -3		150
Phosphor-bronze discs (57 mm x 9.5 mm) (Sn-5, 7 and 10% nominal) ..... Set of three		80

PURCHASE PROCEDURE

Purchase orders for reference materials should be addressed to:

Coordinator
Canadian Certified Reference Materials Project
Canada Centre for Mineral and Energy Technology
555 Booth Street
Ottawa, Ontario, Canada
K1A 0G1
Phone: (613) 995-4738
Telex: 053-3395

Prices are subject to revision; when possible, customers will be notified of such change before orders are dispatched. No discounts are given on purchase of reference materials. All shipping and insurance charges are prepaid; such charges are not added to invoice.

Shipments in Canada will be made by first class mail; elsewhere in North and South America and overseas by air parcel post.

Payment is expected within 30 days of receipt of invoice. Payment on foreign orders can be made by:

- banker's draft against a Canadian bank
- bank to bank transfer to a Canadian bank
- international money order or UNESCO coupons

Cheques, drafts, etc., are payable to: Receiver General for Canada (re: Canadian Certified Reference Materials Project).

The original and one copy of the following documents will be furnished:

- commercial invoices
- packing list
- postal receipt for material shipped by international air parcel post
- airway bill.

A Certificate of Origin can be furnished for a fee of $10; delivery in 6 to 8 weeks.