APPLICATION NOTES

MICROWAVE DIGESTION

SINEO MICROWAVE CHEMISTRY
TECHNOLOGY CO., LTD.
JAPAN

Appendix 1. Biological Reference Materials

Matrix	Analytes	Reagents	Cavity/Vessel	Conditions	Detection
BCR Milk powder 63R	Cd, Cu, Pb	HNO_3, $HClO_4$, H_2SO_4	Multimode/ HP closed	10 min at 85 bar	DP-ASV
BCR Milk powder 150	Hg	HNO_3	Multimode/ LP closed	8 min at 140 W, 8 min at 280 W, 4 min at 420 W	CV-AAS
	Cu, Pb	HNO_3	Multimode/ LP closed	3 min at 650 W	ETV-AAS
	Cd	HNO_3, HCl	Multimode/ HP closed	4 min at 360 W, 10 min at 180 W	ETV-AAS
	Cd, Cu, Fe, Pb	**1.** HNO_3, H_2O, H_2O_2 **2.** Aqua regia, HF (optional)	Multimode/ open	**1.** 15 min at 70 W, 15 min at 150 W, 15 min at 180 W, 1 min at 250 W, 1 min at 600 W **2.** 15 min at 70 W, 1 min at 600 W	ETV-AAS
BCR Skim milk powder 151	Hg	HNO_3	Multimode/ LP closed	8 min at 140 W, 8 min at 280 W, 4 min at 420 W	CV-AAS
	Cd	HNO_3, HCl	Multimode/ HP closed	4 min at 360 W, 10 min at 180 W	ETV-AAS
	Cd, Cu, Fe	**A.** HNO_3, H_2O_2	Multimode/ HP closed	75 sec at 665 W 1 min at 250 W, 3	ETV-AAS

		HNO_3, H_2O_2 **C.** HNO_3, $HClO_4$	HP closed Multimode/ HP closed	min at 400 W, 2 min at 600 W 150 sec at 950 W, 60 sec at 0 W, 90 sec at 300 W, 90 sec at 500 W, 90 sec at 700 W, 90 sec at 850 W	
	Hg	HNO_3	Multimode/ MP closed	8 min at 140 W, 8 min at 280 W, 4 min at 420 W	CV-AFS
BCR **Bovine muscle 184**	Pb	HNO_3, HCl	Multimode/ flow through	18 sec at 700 W (0.4 mL coil, 1.5 mL min^{-1})	ETV-AAS
	Cu, Pb	HNO_3, $HClO_4$, H_2SO_4	Multimode/ HP closed	10 min at 85 bar	DP-ASV
	Ni	HNO_3, HCl	Multimode/ HP closed	4 min at 350 W, 10 min at 140 W	ETV-AAS
	Cd, Cu, Fe, Mn, Pb	**1.** HNO_3, H_2O, H_2O_2 **2.** Aqua regia, HF (optional)	Multimode/ open	**1.** 15 min at 70 W, 15 min at 150 W, 15 min at 180 W, 1 min at 250 W, 1 min at 600 W **2.** 15 min at 70 W, 1 min at 600 W	ETV-AAS
	Cd	HNO_3, HCl	Multimode/ HP closed	4 min at 360 W, 10 min at 180 W	ETV-AAS
	Ni	HNO_3, HCl	Multimode/ HP closed	4 min at 360 W, 10 min at 180 W	ICP-OES

	Pb	HNO_3	Multimode/ LP closed	3 min at 650 W	ETV–AAS
BCR Bovine liver 185	Cd, Pb	HNO_3, $HClO_4$, H_2SO_4	Multimode/ HP closed	10 min at 85 bar	DP–ASV
BCR Pig kidney 186	Pb	HNO_3, HCl	Multimode/ flow through	18 sec at 700 W (0.4 mL coil, 1.5 mL min^{-1})	ETV–AAS
	Hg	HNO_3	Multimode/ LP closed	8 min at 140 W, 8 min at 280 W, 4 min at 420 W	CV–AFS
	Ni	HNO_3, HCl	Multimode/ HP closed	4 min at 350 W, 10 min at 140 W	ETV–AAS
	Cd, Cu, Fe, Mn, Pb	**1.** HNO_3, H_2O, H_2O_2 **2.** Aqua regia, HF (optional)	Multimode/ open	**1.** 15 min at 70 W, 15 min at 150 W, 15 min at 180 W, 1 min at 250 W, 1 min at 600 W **2.** 15 min at 70 W, 1 min at 600 W	ETV–AAS
	Cd	HNO_3, HCl	Multimode/ HP closed	4 min at 360 W, 10 min at 180 W	ETV–AAS
	Ni	HNO_3, HCl	Multimode/ HP closed	4 min at 360 W, 10 min at 180 W	ICP–OES
BCR Whole blood 194	Pb	HNO_3	Multimode/ LP closed	15 min at 540 W, 20 min at 420 W	TXRF

BCR **Whole blood** **195**	Pb	HNO_3	Multimode/ LP closed	15 min at 540 W, 20 min at 420 W	TXRF
BCR **Whole blood** **196**	Pb	HNO_3	Multimode/ LP closed	15 min at 540 W, 20 min at 420 W	TXRF
BCR **Human hair** **397**	Hg	HNO_3	Multimode/ LP closed	8 min at 140 W, 8 min at 280 W, 4 min at 420 W	CV-AFS
	Cd, Hg, Pb, Zn	**A.** **1.** HNO_3 **2.** HNO_3 **3.** H_2O_2 **4.** H_2O **B.** **1.** HNO_3, HCl **2.** HNO_3, HCl **3.** H_2O_2 **4.** H_2O	Single mode/ open Single mode/ open	**1.** 5 min at 10 W, 10 min at 30 W, 10 min at 60 W **2.** 10 min 60 W **3.** 5 min at 60 W **4.** 5 min at 50 W **1.** 5 min at 40 W, 10 min at 50 W **2.** 20 min 54 W **3.** 5 min at 40 W **4.** 5 min at 50 W	ICP-OES ICP-MS HPLC-ICP-MS
BI **Control blood for metals** **620401**	Hg(II), methylmercury, mercurescein, phenylmercury	**1.** HCl, KBr, $KBrO_3$ **2.** $KMnO_4$ **3.** $NaBH_4$, NaOH	Single mode/ flow through	**1.** 25.4 sec at 70 W (14-16 mL min^{-1})	CV-AAS
BI **Control metals in**	Cd	HNO_3	Multimode/ LP closed	3 min at 650 W	ETV-AAS

urine Lanonorm M1	Hg	**1.** $K_2Cr_2O_7$, HNO_3, KBr, $KBrO_3$ **2.** HCl	Single mode/ flow through	1. Offline 2. 65 sec at 90 W (8.5 mL min^{-1})	CV-AAS
BI **Control metals in urine** **Lanonorm M2**	Hg	**1.** $K_2Cr_2O_7$, HNO_3, KBr, $KBrO_3$ **2.** HCl	Single mode/ flow through	1. Offline 2. 65 sec at 90 W (8.5 mL min^{-1})	CV-AAS
BI **Control metals in urine** **Lanonorm M3**	Cd, Pb	HNO_3	Multimode/ LP closed	3 min at 650 W	ETV-AAS
BI **Control blood for metals** **OSSD-20/21**	Hg	HNO_3	Multimode/ HP closed	70 sec at 600 W	CV-AAS
BRL **Urine metals level II** 39202	Hg	**1.** $K_2Cr_2O_7$, HNO_3, KBr, $KBrO_3$ **2.** HCl	Single mode/ flow through	1. Offline 2. 65 sec at 90 W (8.5 mL min^{-1})	CV-AAS
IAEA **Milk powder** **A11**	I	HNO_3, N_2H_4	Multimode/ HP closed	35 sec at 675 W	NAA
	Se	**1.** HNO_3 **2.** H_2SO_4, $HClO_4$ **3.** H_2O	Single mode/ open	**1.** 15 min at 45 W, 10 min at 75 W **2.** 10 min at 90 W, 35 min at 120 W **3.** 8 min at 120 W	ETV-AAS
	Cu, Fe, Ni, Zn	**A.** **1.** HNO_3	Multimode/ LP closed	**1.** 3 min at 280 W, 3.5 min at 0 W	F-AAS ETV-AAS

		B. **1.** HNO_3, H_2SO_4 **2.** HNO_3 **3.** HNO_3 **C.** HNO_3	Single mode/ open Single mode/ open	2–5 min at 0 W, 2 min at 560 W **2.** 2 min at 260 W **1.** 5 min at 80 W **2.** 5 min at 60 W, 5 min at 80 W **3.** 5 min at 80 W (for fat rich foods) 10 min at 80 W (for lower fat foods)	
	Al	HNO_3	Multimode/ HP closed	1 min at 150 W, 30 min at 0 W, 1 min at 450 W	ICP-OES
IAEA **Animal blood** **A13**	Ca, Cu, Fe, K, Ni, P, Pb, Rb, S, Se, Sr, Zn	HNO_3	Multimode/ LP closed	15 min at 540 W, 20 min at 420 W	TXRF
IAEA **Whey powder** **A155**	Al	HNO_3	Multimode/ HP closed	1 min at 150 W, 30 min at 0 W, 1 min at 450 W	ICP-OES
IAEA **Animal muscle** **H4**	I	HNO_3, N_2H_4	Multimode/ HP closed	35 sec at 675 W	NAA
	Se	**1.** HNO_3 **2.** H_2SO_4, $HClO_4$ **3.** Water	Single mode/ open	**1.** 15 min at 45 W, 10 min at 75 W **2.** 10 min at 90 W, 35 min at 120 W **3.** 8 min at 120 W	ETV-AAS
	Al, As, Ba, Ca,	HNO_3	Multimode/	75 sec at 350 W	ICP/MS

	Cu, Fe, La, Li, Mg, Mn, Mo, Ni, Rb, Sb, Se, Sr, Tl, V, Y, Zn		HP closed		
	Al, Ca, Cu, Fe, K, Mg, Mn, Na, P, Sr, Zn	HNO_3	Multimode/ LP closed	10 min at 70 psi 15 min at 450 W	ICP-OES
	Al, Cd, Co, Cu, Fe, Mg, Mn, Mo, Rb, Sr, Zn	HNO_3	Multimode/ LP closed	2 min at 600 W	ICP/MS
IAEA Horse kidney H8	Al, Cd, Co, Cu, Fe, Mg, Mn, Mo, Rb, Sr, Zn	HNO_3	Multimode/ LP closed	2 min at 600 W	ICP/MS
IAEA Horse kidney H8 (contd.)	Ca, Cd, Cu, Fe, K, Mg, Mn, Na, P, Sr, Zn, Residual carbon	**A.** **1.** HNO_3, H_2SO_4 **2.** H_2O_2(x16) **3.** HNO_3 or HNO_3, HCl or NH_3 (aq) **4.** NH_4EDTA **B.** HNO_3	Single mode/ open Multimode/ MP closed	**1.** 4 min at 30 W, 4 min at 120 W **2.** 1 min at 120 W(x16) **3.** 4 min at 30 W 2 min at 20 psi, 5 min at 40 psi, 2 min at 60 psi, 2 min at 80 psi, 2 min at 100 psi, 2 min at 120 psi, 2 min at 140 psi, 15 min at 160 psi	ICP-OES
	Ca, Cd, Fe, Mg, Zn	**A.** HNO_3	Multimode/ stopped flow	2 min at 300 W, 1 min at 0 W,	F-AAS ICP-OES

		B. HNO_3	Multimode/ LP closed	3 min at 150 W 30 min at 420 W	
KL **Heavy metal urine control** **0140**	Hg	HNO_3	Multimode/ HP closed	70 sec at 600 W	CV-AAS
ISS **Green algae** **MMM-2**	Cr, Co, Mn, Ni, Pb	HNO_3, H_2O_2	Multimode/ LP closed	6 min at 700 W	F-AAS ICP-OES
NIES **Human hair** **5**	Ca, Cu, Fe, Mg, Mn, Zn	HNO_3, $HClO_4$, HCl, HF	Multimode/ MP closed	14 min intermittent 200 W	F-AAS
	Cd, Co, Cu, Ni, Pb	HNO_3, HCl, $HClO_4$, HF	Multimode/ MP closed	5 min at 200 W (water load), 3.5 min at 200 W (no load)	ICP-OES ETV-ICP
NIES **Human hair** **5** **(contd.)**	Cu, Pb, Residual carbon	**A.** HNO_3 **B.** HNO_3, H_2O_2 **C.** HNO_3, H_2O_2 **D.** **1.** HNO_3 or H_2O_2 **2.** HNO_3 vapor	Multimode/ LP closed Multimode/ LP closed Multimode/ MP closed Multimode/ MP closed	0.5- 5 min at 550 W (with water ballast) 0.5-5 min at 550 W (with water ballast) 15-60 sec at 550 W (with water ballast) 10 min at 550 W (with water ballast)	ETV-AAS DP-ASV Coulometry
	Cr, Hg, Se	**1.** HNO_3 **2.** H_2O_2	Multimode/ HP closed	**1.** 3 min at 450 W	Radiochemical
NIST	Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Na, P, Pb, S, Sr, Zn	**1.** HNO_3 **2.** $HClO_4$	Multimode/ MP closed	**1.** 1 min at 90 W, 1 min at 0 W (x5)	ICP-OES

Human serum **909**	Ni	HNO_3, HCl	Multimode/ HP closed	4 min at 350 W, 10 min at 140 W	ETV–AAS
NIST **Human serum** **909** **(contd.)**	Ca, Cr, Cu, Fe, K, Mn, Ni, P, Pb, Rb, S, Se, Sr, Zn	HNO_3	Multimode/ LP closed	15 min at 540 W, 20 min at 420 W	TXRF
NIST **Albumin** **926**	No analysis	HNO_3	Multimode/ LP closed	Varied	Temperature Pressure
NIST **Milk powder** **1549**	I	HNO_3, N_2H_4	Multimode/ HP closed	35 sec at 675 W	NAA
	Ca, Mg	**1.** HNO_3, H_2SO_4, H_2O_2, H_2O **2.** H_2O_2 **3.** HNO_3, H_2O **4.** HNO_3, H_2O	Single mode/ stopped flow	**1.** 3 min at 20 W (condenser on), 2 min at 56 W (condenser on), 10 min at 80 W (condenser off) **2.** 3 min at 116 W (condenser on) **3.** 2 min at 80 W (condenser on) **4.** 2 min at 80 W (condenser on)	ICP–OES
	Cr, Cu, Ni, Pb, Sn, Zn	HNO_3, H_2O_2	Multimode/ LP closed	3 min at ? W	ETV–AAS F–AAS
NIST **Milk powder** **1549** **(contd.)**	Al, Ba, Ca, K, Mg, Mn, Na, P, S, Si, Zn	**A.** **1.** HNO_3 **2.** H_2O_2	Multimode/ open	**1.** 5 min at 300 W, 600 W until 1 mL remains	FI–ICP–OES

		B. **1.** HNO_3 **2.** H_2O_2, HF **3.** H_3BO_3	open (with reflux top)	until 1 mL remains **1.** 5 min at 300 W, 20–30 min at 600 W reflux not on **2.** 30 min at 180 W reflux on **3.** 180 W reflux on	
	Ca, Cd, Cu, Fe, K, Mg, Mn, Na, P, Sr, Zn, Residual carbon	**A.** **1.** HNO_3, H_2SO_4 **2.** H_2O_2(x16) **3.** HNO_3 or HNO_3, HCl or NH_3 (aq) **4.** NH_4EDTA **B.** HNO_3	Single mode/ open Multimode/ MP closed	**1.** 4 min at 30 W, 4 min at 120 W **2.** 1 min at 120 W(x16) **3.** 4 min at 30 W 2 min at 20 psi, 5 min at 40 psi, 2 min at 60 psi, 2 min at 80 psi, 2 min at 100 psi, 2 min at 120 psi, 2 min at 140 psi, 15 min at 160 psi	ICP-OES
	Zn, Residual carbon	**A.** HNO_3, H_2SO_4 **B.** HNO_3 or HNO_3, H_2SO_4	Multimode/ LP closed Multimode/ MP closed	2 min at 130 W, 4 min at 260 W, 2 min at 390 W, 2 min at 520 W, 12 24 or 72 min at 650 W 2 min at 20 psi, 5 min at 40 psi,	ICP-OES

		or HNO_3, H_2O_2 or HNO_3, H_2SO_4, H_2O_2 **C.** HNO_3, H_2O_2, H_2SO_4	Single mode/ open	2 min at 60 psi, 2 min at 80 psi, 2 min at 100 psi, 2 min at 120 psi, 2 min at 140 psi, 15 min at 160 psi 4 min at 30 W, 6 9 or 16 min at 120 W, 10 20 or 30 min at 205 W	
NIST **Brewers yeast** **1569**	Al, Ba, Ca, K, Mg, Mn, Na, P, S, Si, Zn	**A.** **1.** HNO_3 **2.** H_2O_2 **3.** H_2O_2 **B.** **1.** HNO_3 **2.** H_2O_2, HF **3.** H_3BO_3	Multimode/ open Multimode/ open (with reflux top)	**1.** 5 min at 300 W, 600 W until 1 mL remains **2.** 30–40 min at 600 W until 1 mL remains **1.** 5 min at 300 W, 20–30 min at 600 W reflux not on **2.** 30 min at 180 W reflux on **3.** 180 W reflux on	FI–ICP–OES
NIST **Bovine liver 1577**	Zn, Cd	HNO_3	Multimode/ open	8 min at 200 W	FI–F–AAS
	Ca, Fe, Mg, Zn	HNO_3	Multimode/ flow through	100 sec at 525 W (10 mL coil, 6 mL min^{-1})	F–AAS
	Ag, Al, As, Ba, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Li	**1.** HNO_3 **2.** $HClO_4$	Multimode/ MR closed	**1.** 1 min at 90 W, 1 min at 0 W (5 times)	ICP–OES

	Si, Sr, Ti, Tl, V, Zn				
	Pb	HNO_3, HCl	Multimode/ flow through	18 sec at 700 W (0.4 mL coil, 1.5 mL min^{-1})	ETV–AAS
	Se	**1.** HNO_3 **2.** H_2SO_4, $HClO_4$ **3.** H_2O	Single mode/ open	**1.** 15 min at 45 W, 10 min at 75 W **2.** 10 min at 90 W, 35 min at 120 W **3.** 8 min at 120 W	ETV–AAS
	I	**1.** HNO_3 **2.** N_2H_4	Multimode/ HP closed	**1.** 35 sec at 675 W	NAA
	Cd	HNO_3	Multimode/ LP closed	2 min on defrost three times	ETV–AAS
	Hg	HNO_3	Multimode/ LP closed	8 min at 140 W, 8 min at 280 W, 4 min at 420 W	CV–AAS
NIST Bovine liver 1577 (contd.)	Na	**1.** HNO_3 **2.** HNO_3, H_2SO_4 **3.** H_2O_2	Multimode/ LP closed	**1.** 1 min at 630 W **2.** 5 min at 273 W, 20 min at 189 W (2–5 samples) or 4 min at 630 W, 8 min at 378 W (6–12 samples)	F–AAS
	Ba, Ca, K, Mg, Mn, Na, P, S, Zn	**1.** HNO_3 **2.** H_2O_2	Multimode/ open	**1.** 30 min at 540 W **2.** 30 min at 540 W	ICP–OES
	Ca, Cu, Fe, Mg, Mn, Zn	HNO_3, $HClO_4$, HCl, HF	Multimode/ MP closed	14 min at 200 W	F–AAS

	Residual amino acids	HNO_3	Multimode/ LP closed	Varied	Fluorimetry
	–	HNO_3	Multimode/ LP closed	Varied	Temperature Pressure
	Al, Ba, Ca, K, Mg, Mn, Na, P, S, Si, Zn	**A.** **1.** HNO_3 **2.** H_2O_2 **3.** H_2O_2 **B.** **1.** HNO_3 **2.** H_2O_2, HF **3.** H_3BO_3	Multimode/ open Multimode/ open (with reflux top)	**1.** 5 min at 300 W, 600 W until 1 mL remains **2.** 30–40 min at 600 W until 1 mL remains **1.** 5 min at 300 W, 20–30 min at 600 W reflux not on **2.** 30 min at 180 W reflux on **3.** 180 W reflux on	FI-ICP-OES
	Se	HNO_3	Multimode/ LP closed	(1.5 h at 60°C on hotplate) 4 min at 287 W	ETV-AAS
	Residual organic species, Cu, Zn	HNO_3	Multimode/ LP closed	5 min at 132 W, 5 min at 207 W (additional 3 min at 230 W if temp not at 180°C for 100 sec)	Voltammetry LC UV-Vis
	As, Co, Cu, Se, Zn	HNO_3, $HClO_4$	Multimode/ open	600 W until first signs of $HClO_4$ fumes	F-AAS NAA
	Ca, Cd, Cu, Fe, K, Mg, Mn, Na, Zn	HNO_3	Multimode/	30 sec at 665 W	F-OES

					ICP-OES
	Cd, Cr, Cu, Fe, Pb, Zn	HNO_3, $H2SO_4$	Multimode/ LP closed	60 sec at 700 W	F-AAS
NIST Bovine liver 1577 (contd.)	Cd, Cr, Cu, Fe, Pb, Zn	HNO_3, H_2SO_4	Multimode/ open	10 sec at 70 W, 180 sec at 0 W (x6)	F-AAS
	Al, As, Ba, Ca, Cd, Ce, Cr, Cs, Cu, Fe, La, Li, Mg, Mn, Mo, Ni, Rb, Sb, Se, Sr, Tl, V, Y, Zn	HNO_3	Multimode/ HP closed	75 sec at 350 W	ICP/MS
	B, Ca, Fe, K, Mg, Mn, Na, Ni, P	HNO_3, $HClO_4$	Multimode/ open	20 min at 600 W	ICP-OES
	Fe	HNO_3, H_2O_2	Multimode/ LP closed	15 min at 150 W	F-AAS
	Cu, Fe, Mn, Zn	HNO_3	Multimode/ LP closed	8 min at 150 W	F-AAS ETV-AAS SIMAAC
	Ca, Cu, Fe, K, Mg, Mn, Na, P , S, Zn	HNO_3	Multimode/ LP closed	10 min at 70 psi, 15 min at 450 W	NAA ICP-OES
	Al, Ba, Ca, Cu, Fe, K, Mg, Mn, Na, P, Zn	**1.** Aqua regia **2.** HBO_3	Multimode/ MP closed (evacuated slightly at start)	**1.** 3 min at 625 W	ICP-OES
	As, Be, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Sb, Se, V, Zn	Aqua regia	Multimode/ LP closed	10 min at 300 W, 5 min at 600 W, 10 min at 480 W	ICP-OES ETV-AAS
	Cu, Mn, Zn	**1.** HNO_3 **2.** $HClO_4$	Multimode/ LP closed	Varied	SPC-IC
	Al, Ba, Ca, Cd, Cu, Fe, Mg, Pb	**A.**	Multimode/	3 min at 720 W	ICP-OES

		Aqua regia **B.** Aqua regia	stopped flow Multimode/ open	2 min at 720 W, 2 min at 0 W, 2 min at 720 W, 2 min at 0 W, 2 min at 720 W (with water load)	
	Al, Cd, Co, Cu, Fe, Mg, Mn, Mo, Rb, Sr, Zn	HNO_3	Multimode/ LP closed	2 min at 600 W	ICP/MS
NIST **Bovine liver** **1577** **(contd.)**	Cu, Fe	HNO_3	Multimode/ LP closed	3 min at 650 W	ETV-AAS
	Residual carbon	HNO_3	Multimode/ HP closed	5 min at 500 W (200 bar)	Total carbon analyzer Carbon dioxide coulometer
	As	**1.** HNO_3, H_2SO_4 **2.** H_2O_2 **3.** H_2O_2	Multimode/ LP closed	**1.** 4 min at 100 W, cool to RT, 6 min at 325 W, cool to RT **2.** 6 min at 325 W, cool to RT, 6 min at 650 W, cool to RT **3.** 1 h at 90°C (waterbath, open)	HG-AAS
	Residual carbon	HNO_3	Multimode/ HP closed	4 min at 90 W	Total carbon analyzer Carbon dioxide coulometer
	Ca, Cd, Cu, Fe, K, Mg, Mn, Na, P, Sr, Zn, Residual	**A.** 1. HNO_3, H_2SO_4	Single mode/	**1.** 4 min at 30 W,	ICP-OES

		2. H_2O_2(x16) **3.** HNO_3 or HNO_3, HCl or NH_3 (aq) **4.** NH_4EDTA **B.** HNO_3	Multimode/ MP closed	**2.** 1 min at 120 W(x16) **3.** 4 min at 30 W 2 min at 20 psi, 5 min at 40 psi, 2 min at 60 psi, 2 min at 80 psi, 2 min at 100 psi, 2 min at 120 psi, 2 min at 140 psi, 15 min at 160 psi	
	Ag, Al, As, Cd, Co, Cu, Fe, Hg, Mn, Mo, Pb, Rb, Sb, Se, Sr, Tl, V, Zn	HNO_3	Multimode/ HP closed	2 min at 300 W	ICP/MS
NIST **Bovine liver** **1577** **(contd.)**	Al	HNO_3	Multimode/ LP closed	40 sec at 700 W, 10 min at 0 W (vent), 60 sec at 700 W, 10 min at 0 W (vent), 90 sec at 700 W, 5 min at 70 W	ETV-AAS
	Cd, Cu, Fe, Mn, Pb	**1.** HNO_3, H_2O, H_2O_2 **2.** Aqua regia, HF	Multimode/ open	**1.** 15 min at 70 W, 15 min at 150 W,	ETV-AAS

				1 min at 600 W **2.** 15 min at 70 W, 1 min at 600 W	
	B	HNO_3, H_2O_2	Multimode/ HP closed	2 min at 100W, 2 min at 0 W, 5 min at 250 W, 3 min at 0 W, 5 min at 500 W, 15 min at 250 W	UV-Vis Fluorimetry ICP-OES ICP/MS
NIST **Bovine liver** **1577** **(contd.)**	Al	HNO_3	Multimode/ LP closed	40 sec at 700 W, 10 min at 0 W (vent), 60 sec at 700 W, 10 min at 0 W (vent), 90 sec at 700 W, 5 min at 70 W	ETV-AAS
	Cd, Cu, Fe, Mn, Pb	**1.** HNO_3, H_2O, H_2O_2 **2.** Aqua regia, HF (optional)	Multimode/ open	**1.** 15 min at 70 W, 15 min at 150 W, 15 min at 180 W, 1 min at 250 W, 1 min at 600 W **2.** 15 min at 70 W, 1 min at 600 W	ETV-AAS
	B	HNO_3, H_2O_2	Multimode/ HP closed	2 min at 100W, 2 min at 0 W,	UV-Vis Fluorimetry

				3 min at 0 W, 5 min at 500 W, 15 min at 250 W	ICP/MS
	Cd	HNO_3, HCl	Multimode/ HP closed	4 min at 360 W, 10 min at 180 W	ETV-AAS
	Se	HNO_3, $HClO_4$	Multimode/ open	Not reported	Fluorimetry
	Fe, Mn, Zn	HNO_3	Multimode/ flow through	2 min at ? W	F-AAS ICP-OES ICP/MS
	Ca, Cu, Fe, Mg, Mn, K, Na, Zn	**1.** HNO_3 **2.** HNO_3 **3.** H_2O_2	Single mode/ open	**1.** 10 min at 60 W, 5 min at 80 W **2.** 5 min at 70 W **3.** 3 min at 60 W	F-AAS
	Se	HNO_3	Multimode/ open	2 min on MedHi, 2 min at 0 W (x3)	ETV-AAS
NIST **Bovine serum** **1598**	Al, As, Cd, Cr, Cu, Mn, Mo, Sb, V	HNO_3	Multimode/ LP closed	8 min at 164 W	NAA
NIST **Freeze dried** **urine** **2670**	Residual amino acids	HNO_3	Multimode/ LP closed	Varied	Fluorimetry
	Hg	**1.** $K_2Cr_2O_7$, HNO_3, KBr, $KBrO_3$ **2.** HCl	Single mode/ flow through	1. Offline 2. 65 sec at 90 W (8.5 mL min^{-1})	CV-AAS
	Ni	HNO_3, HCl	Multimode/ HP closed	4 min at 350 W, 10 min at 140 W	ETV-AAS
NIST	Cd	HNO_3, HCl	Multimode/ HP closed	4 min at 360 W, 10 min at 180 W	ETV-AAS

Freeze dried urine **2670** **(contd.)**	Ca, Cd, Cu, K, Mg, Mn, Na, Residual carbon	**A.** **1.** HNO_3, H_2SO_4 **2.** H_2O_2(x16) **3.** HNO_3 or HNO_3, HCl or NH_3 (aq) **4.** NH_4EDTA **B.** HNO_3	Single mode/ open Multimode/ MP closed	**1.** 4 min at 30 W, 4 min at 120 W **2.** 1 min at 120 W(x16) **3.** 4 min at 30 W 2 min at 20 psi, 5 min at 40 psi, 2 min at 60 psi, 2 min at 80 psi, 2 min at 100 psi, 2 min at 120 psi, 2 min at 140 psi, 15 min at 160 psi	ICP-OES
	Ca, Mg	**1.** HNO_3, H_2SO_4, H_2O_2, H_2O **2.** H_2O_2 **3.** HNO_3, H_2O **4.** HNO_3, H_2O	Single mode/ stopped flow	**1.** 3 min at 20 W (condenser on), 2 min at 56 W (condenser on), 10 min at 80 W (condenser off) **2.** 3 min at 116 W (condenser on) **3.** 2 min at 80 W (condenser on) **4.** 2 min at 80 W (condenser on)	ICP-OES
	Ni	HNO_3, HCl	Multimode/ HP closed	4 min at 360 W, 10 min at 180 W	ICP-OES
NIST	Ca, Cu, Fe, K, Mg, Na	HNO_3	Multimode/	30 sec at 665 W	F-OES

Bovine serum **8419**			HP closed		F-AAS ICP-OES
SERONORM **Trace elements in blood** **B115**	Hg	**1.** $K_2Cr_2O_7$, HNO_3, KBr, $KBrO_3$ **2.** HCl	Single mode/ flow through	1. Offline 2. 65 sec at 90 W (8.5 mL min^{-1})	CV-AAS
SERONORM **Trace elements in urine** **116**	As	**1.** HNO_3, H_2SO_4 **2.** H_2O_2 **3.** H_2O_2	Multimode/ LP closed	**1.** 4 min at 100 W, cool to RT, 6 min at 325 W, cool to RT **2.** 6 min at 325 W, cool to RT, 6 min at 650 W, cool to RT **3.** 1 h at 90°C (waterbath, open)	HG-AAS
SERONORM **Trace elements in blood** **#904**	Pb	HNO_3, HCl	Multimode/ flow through	18 sec at 700 W (0.4 mL coil, 1.5 mL min^{-1})	ETV-AAS
SERONORM **Trace elements in blood** **#905**	Hg(II), methylmercury, mercurescein, phenylmercury	**1.** HCl, KBr, $KBrO_3$ **2.** $KMnO_4$ **3.** $NaBH_4$, NaOH	Single mode/ flow through	**1.** 25.4 sec at 70 W (14-16 mL min^{-1})	CV-AAS
SERONORM **Trace elements in blood** **#906**	Hg(II), methylmercury, mercurescein, phenylmercury	**1.** HCl, KBr, $KBrO_3$ **2.** $KMnO_4$ **3.** $NaBH_4$, NaOH	Single mode/ flow through	**1.** 25.4 sec at 70 W (14-16 mL min^{-1})	CV-AAS
SERONORM **Trace elements in urine**	Bi, Hg	**1.** HCl, KBr, $KBrO_3$ **2.** $NaBH_4$, NaOH	Single mode/ flow through	**1.** 65 sec at 90-120 W (8.5 mL min^{-1})	CV-AAS HG-AAS

# 009024					
SERONORM **Trace elements in blood** **#010010**	Hg(II), methylmercury, mercurescein, phenylmercury	**1.** HCl, KBr, $KBrO_3$ **2.** $KMnO_4$ **3.** $NaBH_4$, NaOH	Single mode/ flow through	**1.** 25.4 sec at 70 W (14–16 mL min^{-1})	CV–AAS
SERONORM **Trace elements in blood** **#010011**	Hg(II), methylmercury, mercurescein, phenylmercury	**1.** HCl, KBr, $KBrO_3$ **2.** $KMnO_4$ **3.** $NaBH_4$, NaOH	Single mode/ flow through	**1.** 25.4 sec at 70 W (14–16 mL min^{-1})	CV–AAS
SERONORM **Trace elements in blood** **#010012**	Hg(II), methylmercury, mercurescein, phenylmercury	**1.** HCl, KBr, $KBrO_3$ **2.** $KMnO_4$ **3.** $NaBH_4$, NaOH	Single mode/ flow through	**1.** 25.4 sec at 70 W (14–16 mL min^{-1})	CV–AAS
SERONORM **Trace elements in blood** **#205052**	Hg(II), methylmercury, mercurescein, phenylmercury	**1.** HCl, KBr, $KBrO_3$ **2.** $KMnO_4$ **3.** $NaBH_4$, NaOH	Single mode/ flow through	**1.** 25.4 sec at 70 W (14–16 mL min^{-1})	CV–AAS
SERONORM **Trace elements in blood #203056**	Hg(II), methylmercury, mercurescein, phenylmercury	**1.** HCl, KBr, $KBrO_3$ **2.** $KMnO_4$ **3.** $NaBH_4$, NaOH	Single mode/ flow through	**1.** 25.4 sec at 70 W (14–16 mL min^{-1})	CV–AAS

Appendix 1.2: Botanical

Matrix	Analytes	Reagents	Cavity/Vessel	Conditions	Detection
BCR **Aquatic plant** **60**	Ca, Cd, Cu, Fe, K, Mg, Mn, Na, Pb, Zn	HNO_3, HCl	Multimode/ LP closed	15 min at 300 W, 5 min at 0 W, 20 min at 510 W	F-AAS ETV-AAS F-OES
	Ni	HNO_3, HCl	Multimode/ HP closed	4 min at 350 W, 10 min at 140 W	ETV-AAS
	Fe	**A.** HNO_3 **B.** **1.** HNO_3 **2.** HF	Multimode/ HP closed Multimode/ HP closed	30 sec at 700 W Same as A	ETV-AAS
	Cd, Cu, Pb	**1.** HNO_3, H_2O, H_2O_2 **2.** Aqua regia, HF (optional)	Multimode/ open	**1.** 15 min at 70 W, 15 min at 150 W, 15 min at 180 W, 1 min at 250 W, 1 min at 600 W **2.** 15 min at 70 W, 1 min at 600 W	ETV-AAS
BCR **Aquatic moss 61** **(contd.)**	Cd	HNO_3, HCl	Multimode/ HP closed	4 min at 360 W, 10 min at 180 W	ETV-AAS
	Cu, Cd, Mn, Pb, Zn	HNO_3	Multimode/ HP closed	30 sec at 665 W	F-OES F-AAS ICP-OES
	Ni	HNO_3, HCl	Multimode/ HP closed	4 min at 360 W, 10 min at 180 W	ICP-OES

BCR **Aquatic moss** **61**	Cu, Cd, Mn, Pb, Zn	HNO_3	Multimode/ HP closed	30 sec at 665 W	F-OES F-AAS ICP-OES
	Fe	**A.** HNO_3 **B.** **1.** HNO_3 **2.** HF	Multimode/ HP closed Multimode/ HP closed	30 sec at 700 W Same as A	ETV-AAS
BCR **Aquatic moss 61** **(contd.)**	Cd	HNO_3, HCl	Multimode/ HP closed	4 min at 360 W, 10 min at 180 W	ETV-AAS
	Ni	HNO_3, HCl	Multimode/ HP closed	4 min at 350 W, 10 min at 140 W	ETV-AAS
	Ni	HNO_3, HCl	Multimode/ HP closed	4 min at 360 W, 10 min at 180 W	ICP-OES
BCR **Olive blossom** **62**	Cu, Cd, Mn, Pb, Zn	HNO_3	Multimode/ HP closed	30 sec at 665 W	F-OES F-AAS ICP-OES
	Ni	HNO_3, HCl	Multimode/ HP closed	4 min at 350 W, 10 min at 140 W	ETV-AAS
	Ni	HNO_3, HCl	Multimode/ HP closed	4 min at 360 W, 10 min at 180 W	ICP-OES
	Ca, Cd, Cu, Fe, K, Mg, Mn, Na, Pb, Zn	HNO_3, HCl	Multimode/ LP closed	15 min at 300 W, 5 min at 0 W, 20 min at 510 W	F-AAS ETV-AAS F-OES

	Cd, Cu, Mn, Pb	**1.** HNO_3, H_2O, H_2O_2 **2.** Aqua regia, HF (optional)	Multimode/ open	**1.** 15 min at 70 W, 15 min at 150 W, 15 min at 180 W, 1 min at 250 W, 1 min at 600 W **2.** 15 min at 70 W, 1 min at 600 W	ETV–AAS
	Pb	HNO_3, HCl	Multimode/ flow through	18 sec at 700 W (0.4 mL coil, 1.5 mL min^{-1})	ETV–AAS
	Cu, Mg, Pb	HNO_3	Multimode/ LP closed	3 min at 650 W	ETV–AAS
BCR **Spruce needles** **101**	Cd, Cu, Pb	HNO_3, $HClO_4$, H_2SO_4	Multimode/ HP closed.	10 min at 85 bar	DP–ASV
	Al, Ca, Mg, Mn, P, Zn	**1.** HNO_3 **2.** HNO_3 **3.** H_2O_2 **4.** H_2O	Single mode/ open	**1.** 5 min at 10 W, 10 min at 30 W, 10 min at 60 W **2.** 10 min 60 W **3.** 5 min at 60 W **4.** 5 min at 50 W	ICP–OES ICP–MS HPLC–ICP–MS

BCR **Wholemeal flour** **189**	Cd, Cu, Fe, Mn, Zn	**A.** HNO_3, H_2O_2 **B.** HNO_3, H_2O_2 **C.** HNO_3, $HClO_4$	Multimode/ HP closed Multimode/ HP closed Multimode/ HP closed	75 sec at 665 W 1 min at 250 W, 2 min at 0 W, 2 min at 250 W, 2 min at 400 W, 2 min at 600 W 150 sec at 950 W, 60 sec at 0 W, 90 sec at 300 W, 90 sec at 500 W, 90 sec at 700 W, 90 sec at 850 W	ETV-AAS
BCR **Ulva lactuca** **279**	Ca, Cd, Cu, Fe, K, Mg, Mn, Na, Pb, Zn	HNO_3	Multimode/ LP closed	5 min at 300 W, 5 min at 0 W, 5 min at 300 W, 5 min at 450 W, 5 min at 0 W, 5 min at 450 W	F-AAS ETV-AAS F-OES

BCR **White clover** **402**	Co, Mo	**A.** **1.** HNO_3 **2.** HNO_3 **3.** H_2O_2 **4.** H_2O **B.** **1.** HNO_3, HCl **2.** HNO_3, HCl **3.** H_2O_2 **4.** H_2O	Single mode/ open Single mode/ open	**1.** 5 min at 10 W, 10 min at 30 W, 10 min at 60 W **2.** 10 min 60 W **3.** 5 min at 60 W **4.** 5 min at 50 W **1.** 5 min at 40 W, 10 min at 50 W **2.** 20 min 54 W **3.** 5 min at 40 W **4.** 5 min at 50 W	ICP-OES ICP-MS HPLC-ICP-MS
IAEA **Hay powder** **V10**	Mo	**1.** HNO_3 **2.** Perhydrol	Multimode/ open then Multimode/ LP closed	**1.** 30 min at 180W (open), 10 min at 420W, 10 min at 600W **2.** 10 min at 600W	MS
	I	HNO_3, N_2H_4	Multimode/ HP closed	35 sec at 675 W	NAA
IAEA **Hay powder** **V10** **(contd.)**	Ca, Cd, Cu, Fe, K, Mg, Mn, Na, Pb, Zn	HNO_3, HCl	Multimode/ LP closed	15 min at 300 W, 5 min at 0 W, 20 min at 510 W	F-AAS ETV-AAS F-OES
	Hg	**1.** HNO_3 **2.** H_2O_2	Multimode/ HP closed	3 min at 450 W	Radiochemical
	Ag, Ba, Bi, Cd, Co, Cr, Cs, Cu, Ga, Hg, Li, Mo, Ni, Pb, Rb, Sn, Sr, Th, U, Zn, Zr	HNO_3	Multimode/ HP closed	1 min at 300 W (x3-5), 7 min at 300 W, 2 min at 600 W	ICP/MS

MOE Vegetation V85-1	Al, Ba, Ca, Cu, Fe, Mg, Mn, Zn	Aqua regia	Multimode/ stopped flow	2 min at 720 W or 32 min at 720 W	ICP-OES
MOE Norway maple	Al, Ba, Ca, Cu, Fe, Mg, Mn, Pb, Zn	**A.** Aqua regia **B.** Aqua regia	Multimode/ stopped flow Multimode/ open	2 min at 720 W 2 min at 720 W, 2 min at 0 W, 2 min at 720 W, 2 min at 0 W, 2 min at 720 W (with water load)	ICP-OES
MOE White birch	Al, Ba, Ca, Cd, Cu, Fe, Mg, Mn, Zn	**A.** Aqua regia **B.** Aqua regia	Multimode/ stopped flow Multimode/ open	2 min at 720 W 2 min at 720 W, 2 min at 0 W, 2 min at 720 W, 2 min at 0 W, 2 min at 720 W (with water load)	ICP-OES
NIES Pepperbush 1	Ca, Fe, Mg, Zn	HNO_3	Multimode/ flow through	100 sec at 525 W (10 mL coil, 6 mL min^{-1})	F-AAS
	Ca, Cu, Fe, Mg, Mn, Zn	HNO_3, $HClO_4$, HCl, HF	Multimode/ MP closed	14 min intermittent 200 W	F-AAS
NIES Pepperbush 1	Co	HNO_3, HCl	Multimode/ MP closed	5 min at 600 W (50 mL water load), 5 min at 600 W	UV-Vis

(contd.)				(no load)	
	Cd, Co, Cu, Ni, Pb	HNO_3, HCl, $HClO_4$, HF	Multimode/ HP closed	5 min at 200 W (water load), 3.5 min at 200 W (no load)	ICP-OES ETV-ICP
	Cd, Cu, Fe, Mn, Zn	**A.** HNO_3, H_2O_2 **B.** HNO_3, H_2O_2 **C.** HNO_3, $HClO_4$	Multimode/ HP closed Multimode/ HP closed Multimode/ HP closed	75 sec at 665 W 1 min at 250 W, 2 min at 0 W, 2 min at 250 W, 2 min at 400 W, 2 min at 600 W 150 sec at 950 W, 60 sec at 0 W, 90 sec at 300 W, 90 sec at 500 W, 90 sec at 700 W, 90 sec at 850 W	ETV-AAS
	Fe, Mn, Zn	HNO_3	Multimode/ flow through	-	F-AAS ICP-OES ICP/MS
	Cd	**1.** HNO_3, $HClO_4$, HCl, HF **2.** $HClO_4$	Multimode/ MP closed	**1.** 5 min at 200 W (using water load), 4 min at 200 W (no load)	F-AAS
NIES	Ca, Cu, Fe, Mg, Mn, Zn	HNO_3, $HClO_4$, HCl, HF	Multimode/ MP closed	14 min intermittent 200 W	F-AAS

Tea leaves **7**	Co	HNO_3, HCl	Multimode/ LP closed	5 min at 600 W (50 mL water load), 5 min at 600 W (no load)	UV–Vis
	Cd, Co, Cu, Ni, Pb	HNO_3, HCl, $HClO_4$, HF	Multimode/ MP closed	5 min at 200 W (water load), 3.5 min at 200 W (no load)	ICP–OES ETV–ICP
NIES **Sargasso** **9**	Ca, Fe, Mg, Zn	HNO_3	Multimode/ flow through	100 sec at 525 W (10 mL coil, 6 mL min^{-1})	F–AAS
	Fe, Mn, Zn	HNO_3	Multimode/ flow through	–	F–AAS ICP–OES ICP/MS
	As, Cr, V	HNO_3, H_2O_2	Multimode/ LP closed	3 min at 300 W	ICP/MS
	Ca, Cu, Fe, Mg, Mn, Zn	HNO_3, $HClO_4$, HCl, HF	Multimode/ MP closed	14 min intermittent 200 W	F–AAS
NIES **Rice flour** **10**	Mo	**1.** HNO_3 **2.** Perhydrol	Multimode/ open *then* Multimode/ LP closed	**1.** 30 min at 180W (open), 10 min at 420W, 10 min at 600W **2.** 10 min at 600W	MS
	Cd	**1.** HNO_3, $HClO_4$, HCl, HF **2.** $HClO_4$	Multimode/ MP closed	**1.** 5 min at 200 W (using load), 4 min at 200 W (no load)	F–AAS
NIST **Apple leaves** **1515**	Ba, Ce, Co, Cr, Eu, Fe, Hf, K, La, Na, Sb, Sc, Sm, Sr, Tb, Zn	**1.** HNO_3, HF **2.** $HClO_4$	Multimode/ LP closed	**1.** 20 min at 373 W (9 vessels) **2.** 20 min at 545 W (6 vessels)	NAA
NIST	Ba, Ce, Co, Cr, Eu, Fe, Hf, K, La,	**1.** HNO_3, HF	Multimode/	**1.** 20 min at 373 W (9	NAA

Peach leaves **1547**	Na, Sb, Sc, Sm, Sr, Tb, Zn	**2.** $HClO_4$	LP closed	vessels) **2.** 20 min at 545 W (6 vessels)	
NIST **Wheat flour** **1567**	Mo	**1.** HNO_3 **2.** Perhydrol	Multimode/ open *then* Multimode/ LP closed	**1.** 30 min at 180 W (open), 10 min at 420 W, 10 min at 600 W **2.** 10 min at 600W	MS
	Se	**1.** HNO_3 **2.** H_2SO_4, $HClO_4$ **3.** H_2O	Single mode/ open	**1.** 15 min at 45 W, 10 min at 75 W **2.** 10 min at 90 W, 35 min at 120 W **3.** 8 min at 120 W	ETV-AAS
	Cd	HNO_3	Multimode/ LP closed	2 min on defrost three times	ETV-AAS
	Hg	HNO_3	Multimode/ LP closed	8 min at 140 W, 8 min at 280 W, 4 min at 420 W	CV-AAS
	Ba, Ca, K, Mg, Mn, Na, P, S, Zn	**1.** HNO_3 **2.** H_2O_2	Multimode/ open	**1.** 30 min at 540 W **2.** 30 min at 540 W	ICP-OES
	Residual amino acids	HNO_3	Multimode/ LP closed	Varied	Fluorimetric
NIST **Wheat flour** **1567** **(contd.)**	Al, Ba, Ca, K, Mg, Mn, Na, P, S, Si, Zn	**A.** **1.** HNO_3 **2.** H_2O_2	Multimode/ open	**1.** 5 min at 300 W, 600 W until 1 mL remains	FI-ICP-OES
		3. H_2O_2	Multimode/	**2.** 30-40 min at 600 W	

		1. HNO_3 **2.** H_2O_2, HF **3.** H_3BO_3	top)	**1.** 5 min at 300 W, 20–30 min at 600 W reflux not on **2.** 30 min at 180 W reflux on **3.** 180 W reflux on	
	Se	HNO_3	Multimode/ LP closed	(1.5 h at 60°C on hotplate) 4 min at 287 W	ETV–AAS
	Ca, Cu, Fe, K, Mn, Zn	HNO_3	Multimode/ HP closed	30 sec at 665 W	F–OES F–AAS ICP–OES
	As, Ca, Cu, Fe, Mg, Mn, Mo, P, S, Se, U, V, Zn	HNO_3, H_2O_2	Multimode/ MP closed (Max 350 psi – power cutoff at 150 psi)	4 min at 296 W, 8 min at 360 W	F–AAS ICP/MS ICP–OES
	Cu, Fe, K, Mn, Zn	HNO_3	Multimode/ LP closed	8 min at 150 W	F–AAS ETV–AAS SIMAAC
	Ca, Cu, Fe, K, Mg, Mn, P, Zn	HNO_3, HCl	Multimode/ LP closed	5 min at 300 W, 5 min at 0 W, 5 min at 300 W, 5 min at 450 W, 5 min at 0 W, 5 min at 450 W	ICP–OES
NIST **Wheat flour**	Cd, Cu, Fe, Mn	**1.** HNO_3, H_2O, H_2O_2 **2.** Aqua regia, HF	Multimode/ open	**1.** 15 min at 70 W, 15 min at 150 W,	ETV–AAS

1567 **(contd.)**		(optional)		15 min at 180 W, 1 min at 250 W, 1 min at 600 W **2.** 15 min at 70 W, 1 min at 600 W	
	Ca, Fe, K, Mg, Mn, Na, P, S	**1.** HNO_3 **2.** H_2O_2 **3.** HCl	Multimode/ LP closed	**1.** 30 min at 540 W, 5 min at 0 W **2.** 5 min at 0 W, 15 min at 540 W, 5 min at 0 W **3.** 10 min at 180 W	ICP-OES
NIST **Rice flour 1568**	Ba, Ca, K, Mg, Mn, Na, P, S, Zn	**1.** HNO_3 **2.** H_2O_2	Multimode/ open	**1.** 30 min at 540 W **2.** 30 min at 540 W	ICP-OES
	Residual amino acids	HNO_3	Multimode/ LP closed	Varied	Fluorimetry
	Al, Ba, Ca, K, Mg, Mn, Na, P, S, Si, Zn	**A.** **1.** HNO_3 **2.** H_2O_2 **3.** H_2O_2 **B.** **1.** HNO_3 **2.** H_2O_2, HF **3.** H_3BO_3	Multimode/ open Multimode/ open (with reflux top)	**1.** 5 min at 300 W, 600 W until 1 mL remains **2.** 30–40 min at 600 W until 1 mL remains **1.** 5 min at 300 W, 20–30 min at 600 W reflux not on **2.** 30 min at 180 W reflux on **3.** 180 W reflux on	FI-ICP-OES

	B	HNO_3, H_2O_2	Multimode/ HP closed	2 min at 100W, 2 min at 0 W, 5 min at 250 W, 3 min at 0 W, 5 min at 500 W, 15 min at 250 W	UV-Vis Fluorimetry ICP-OES ICP/MS
	As, Ca, Cu, Fe, Mg, Mn, Mo, P, S, Se, U, V, Zn	HNO_3, H_2O_2	Multimode/ MP closed (Max 350 psi – power cutoff at 150 psi)	4 min at 296 W, 8 min at 360 W	F-AAS ICP/MS ICP-OES
	Cr, Hg, Se	**1.** HNO_3 **2.** H_2O_2	Multimode/ HP closed	**1.** 3 min at 450 W	Radiochemical
NIST Spinach 1570	I	HNO_3, N_2H_4	Multimode/ HP closed	35 sec at 675 W	NAA
	Ba, Ca, K, Mg, Mn, Na, P, S, Zn	**1.** HNO_3 **2.** H_2O_2	Multimode/ open	**1.** 30 min at 540 W **2.** 30 min at 540 W	ICP-OES
NIST Spinach 1570 (contd.)	Al, Ba, Ca, K, Mg, Mn, Na, P, S, Si, Zn	**A.** **1.** HNO_3 **2.** H_2O_2 **3.** H_2O_2 **B.** **1.** HNO_3 2. H_2O_2, HF **3.** H_3BO_3	Multimode/ open Multimode/ open (with reflux top)	**1.** 5 min at 300 W, 600 W until 1 mL remains **2.** 30-40 min at 600 W until 1 mL remains **1.** 5 min at 300 W, 20-30 min at 600 W reflux not on **2.** 30 min at 180 W reflux on **3.** 180 W reflux on	FI-ICP-OES

	Al, Ba, Ca, Cr, Cu, Fe, K, Li, Mg, Mn, Na, P, Si, Sr, Ti, Zn	**1.** Aqua regia **2.** HBO_3	Multimode/ MP closed (evacuated slightly at start)	**1.** 3 min at 625 W	ICP-OES
NIST **Orchard leaves** **1571**	I	HNO_3, N_2H_4	Multimode/ HP closed	35 sec at 675 W	NAA
	Cd	HNO_3	Multimode/ LP closed	2 min on defrost three times	ETV-AAS
	As	HNO_3, $HClO_4$, H_2SO_4	Multimode/ HP closed.	10 min at 85 bar	DP-ASV
	Al, Ba, Ca, K, Mg, Mn, Na, P, S, Si, Zn	**A.** **1.** HNO_3 **2.** H_2O_2 **3.** H_2O_2 **B.** **1.** HNO_3 **2.** H_2O_2, HF **3.** H_3BO_3	Multimode/ open Multimode/ open (with reflux top)	**1.** 5 min at 300 W, 600 W until 1 mL remains **2.** 30-40 min at 600 W until 1 mL remains **1.** 5 min at 300 W, 20-30 min at 600 W reflux not on **2.** 30 min at 180 W reflux on **3.** 180 W reflux on	FI-ICP-OES
	As, Co, Cr, Cu, Ni, Pb, Se, Zn	HNO_3, $HClO_4$	Multimode/ open	600 W until first signs of $HClO_4$ fumes	F-AAS NAA
NIST **Orchard leaves** **1571 (contd.)**	Cd	**1.** HNO_3, $HClO_4$, HCl, HF **2.** $HClO_4$	Multimode/ MP closed	**1.** 5 min at 200 W (using water load), 4 min at 200 W (no load)	F-AAS
	Al, Ba, Ca, Cr, Co, Cu, Fe, K,	HNO_3	Multimode/	10 min at 70 psi,	NAA

	Mg, Mn, Na, P , S, Zn		LP closed	15 min at 450 W	ICP-OES
	Po	HNO_3	Multimode/ MP closed	60 min at 60 W, cool 60 min at 60 W	a-spectrometry
	Cd, Co, Fe, Ni, Pb	HNO_3, HF	Multimode/ LP closed	1 min at 240 W, cool (x15)	ETV-AAS X-ray Fluorescence
	Al, Ba, Ca, Cu, Fe, K, Mg, Mn, Na, P, Zn	**1.** Aqua regia **2.** HBO_3	Multimode/ MP closed (evacuated slightly at start)	3 min at 625 W	ICP-OES
	Se	HNO_3, $HClO_4$	Not reported	-	Fluorimetry
	Cu, Pb, Zn	HNO_3, $HClO_4$	Multimode/ open	3 min at 600 W	ETV-AAS
	Al, Ba, Ca, Cu, Fe, Mg, Pb, Zn	**A.** Aqua regia **B.** Aqua regia	Multimode/ stopped flow Multimode/ open	2 min at 720 W 2 min at 720 W, 2 min at 0 W, 2 min at 720 W, 2 min at 0 W, 2 min at 720 W (with water load)	ICP-OES
	Al	HNO_3	Multimode/ HP closed	1 min at 150 W, 30 min at 0 W, 1 min at 450 W	ICP-OES
NIST Citrus leaves 1572	Al, Ag, As, Ba, Ca, Cl, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, N, Na, Ni, P, Pb, Rb, S, Sb, Si, Sr, Ti, Zn	HNO_3, $HClO_4$	Multimode/ MP closed	15 min at 0 W, 10 min at 150 W, 10 min at 450 W, 15 min at 0 W	ICP-OES

	I	HNO_3, N_2H_4	Multimode/ HP closed	35 sec at 675 W	NAA
	Cd	HNO_3	Multimode/ LP closed	2 min on defrost three times	ETV–AAS
	Ba, Ca, K, Mg, Mn, Na, P, S, Zn	**1.** HNO_3 **2.** H_2O_2	Multimode/ open	**1.** 30 min at 540 W **2.** 30 min at 540 W	ICP–OES
NIST Citrus leaves 1572 (contd.)	Al, Ba, Ca, K, Mg, Mn, Na, P, S, Si, Zn	**A.** **1.** HNO_3 **2.** H_2O_2 **3.** H_2O_2 **B.** **1.** HNO_3 **2.** H_2O_2, HF **3.** H_3BO_3	Multimode/ open Multimode/ open (with reflux top)	**1.** 5 min at 300 W, 600 W until 1 mL remains **2.** 30–40 min at 600 W until 1 mL remains **1.** 5 min at 300 W, 20–30 min at 600 W reflux not on **2.** 30 min at 180 W reflux on **3.** 180 W reflux on	FI–ICP–OES
	–	HNO_3	Multimode/ LP closed	10 min at 360 W, 5 min at 480 W	–
	Cd	**1.** HNO_3, $HClO_4$, HCl, HF **2.** $HClO_4$	Multimode/ MP closed	**1.** 5 min at 200 W (using water load), 4 min at 200 W (no load)	F–AAS
	Hg	HNO_3	Multimode/ LP closed	800 W until 75°C, 3 min at 75°C	CV–FANES
	Hg	HNO_3	Multimode/ HP closed	90 sec at 600 W (estimated power)	CV–AAS
	Al	HNO_3	Multimode/	4 min at 200 W, cool,	ETV–AAS

			MP closed	4 min at 350 W, cool, 8 min at 250 W, cool, 10 min at 400 W (x4)	
	Sr	HNO_3	Multimode/ open	Heat until dryness.	ID (stable isotope dilution activation analysis)
	As, Ca, Cu, Fe, Mg, Mn, Mo, P, S, Se, U, V, Zn	HNO_3, H_2O_2	Multimode/ MP closed (Max 350 psi – power cutoff at 150 psi)	4 min at 296 W, 8 min at 360 W	F-AAS ICP/MS ICP-OES
NIST **Citrus leaves** **1572** **(contd.)**	Ca, Cu, Fe, K, Mg, Mn, P, Zn	HNO_3, HCl	Multimode/ LP closed	5 min at 300 W, 5 min at 0 W, 5 min at 300 W, 5 min at 450 W, 5 min at 0 W, 5 min at 450 W	ICP-OES
	As, Cr, Hg, Sb	**1.** HNO_3 **2.** H_2O_2	Multimode/ HP closed	3 min at 450 W	Radiochemical
	Ba, Ca, Cu, Mg, Mn, Zn	**1.** HNO_3, HF **2.** HBO_3	Multimode/ LP closed	2 min at 240 W, 2 min 360 W, 16 min at 160°C (600W)	ICP-OES
	Ni	HNO_3, HCl	Multimode/ HP closed	4 min at 350 W, 10 min at 140 W	ETV-AAS
	Ni	HNO_3, HCl	Multimode/ HP closed	4 min at 360 W, 10 min at 180 W	ICP-OES
	Al, Ca, Fe, K, Mg, Mn, Na, P, S	**1.** HNO_3	Multimode/ LP closed	**1.** 30 min at 540 W,	ICP-OES

		2. H_2O_2 **3.** HCl		5 min at 0 W **2.** 5 min at 0 W, 15 min at 540 W, 5 min at 0 W **3.** 10 min at 180 W	
	P	**1.** HNO_3, $HClO_4$ **2.** $HClO_4$	Multimode/ open (with scrubber)	**1.** 15 min at 750 W	ICP-OES
	Al	HNO_3, H_2SO_4	Multimode/ MP closed	5 min at 1170 W	IC
	As	HNO_3, H_2O_2	Multimode/ HP closed	–	ICP/MS
	Ni	HNO_3, HCl	Multimode/ HP closed	4 min at 460 W, 10 min at 180 W (10 mL water load)	ICP-OES
NIST **Citrus leaves** **1572** **(contd.)**	Cu, Fe, Mn, Pb	**1.** HNO_3, H_2O, H_2O_2 **2.** Aqua regia, HF (optional)	Multimode/ open	**1.** 15 min at 70 W, 15 min at 150 W, 15 min at 180 W, 1 min at 250 W, 1 min at 600 W **2.** 15 min at 70 W, 1 min at 600 W	ETV-AAS
	Ca, Fe, K, Mg, Mn, Zn	–	Multimode/ open	30 min at 650 W	F-AAS
	Ca, Cu, Fe, Mg, Mn, K, Na, Zn	**1.** HNO_3 **2.** HNO_3 **3.** H_2O_2	Single mode/ open	**1.** 10 min at 60 W, 5 min at 80 W **2.** 5 min at 70 W	F-AAS

				3. 3 min at 60 W	
	Al	HNO_3	Multimode/ HP closed	1 min at 150 W, 30 min at 0 W, 1 min at 450 W	ICP-OES
	Al, As, Ba, Cr, Cu, Fe, K, Mg, Mn, Ni, P, Pb, Rb, Sr, Zn	**1.** HNO_3 **2.** HF **3.** H_2O_2	Multimode/ HP closed	**1.** 5 min at 300 W, 2 min at 600 W, 2 min at 0 W, 3 min at 300 W **2.** 5 min at 300 W, 2 min at 600 W, 2 min at 0 W **3.** 5 min at 300 W, 2 min at 600 W, 2 min at 0 W, 3 min at 300 W	DCP-OES F-AAS
NIST **Tomato leaves 1573**	Cu, Mn	HNO_3, H_2O_2	Multimode/ flow through	2 min at 650 W (digestate recirculated through oven)	F-AAS
	Ba, Ca, K, Mg, Mn, Na, P, S, Zn	**1.** HNO_3 **2.** H_2O_2	Multimode/ open	**1.** 30 min at 540 W **2.** 30 min at 540 W	ICP-OES
	Al, Ba, Ca, K, Mg, Mn, Na, P, S, Si, Zn	**A.** **1.** HNO_3 **2.** H_2O_2 **3.** H_2O_2	Multimode/ open Multimode/	**1.** 5 min at 300 W, 600 W until 1 mL remains **2.** 30-40 min at 600 W	FI-ICP-OES
		B.	open	until 1 mL remains	

		3. H_3BO_3		reflux not on **2.** 30 min at 180 W reflux on **3.** 180 W reflux on	
	As, Cr, Cu, Fe, Mn, Pb, Rb, Sr, Th, U, Zn	**1.** HNO_3 **2.** HF	Multimode/ MP closed	**1.** Leave overnight, 3 min at 130 W, 6 min at 195 W, 6 min at 260 W, 6 min at 325 W, cool, vent **2.** 6 min at 325 W	ICP/MS
	Cd	**1.** HNO_3, $HClO_4$, HCl, HF **2.** $HClO_4$	Multimode/ MP closed	**1.** 5 min at 200 W (using water load), 4 min at 200 W (no load)	F-AAS
NIST **Tomato leaves** **1573** **(contd.)**	Ca, Cu, Fe, K, Mn, P, Pb, Zn	HNO_3	Multimode/ HP closed	30 sec at 665 W	F-OES F-AAS ICP-OES
	Sr	HNO_3	Multimode/ open	Heat until dryness.	ID (stable isotope dilution activation analysis)
	Al, Ba, Ca, Cd, Cr, Fe, K, Mg, Mn, Na, P	**1.** Aqua regia **2.** HBO_3	Multimode/ MP closed (evacuated slightly at start)	3 min at 625 W	ICP-OES
	Cd, Co, Fe, Ni, Pb	HNO_3, HF	Multimode/ LP closed	1 min at 240 W, cool (x15)	ETV-AAS X-ray Fluorescence
	Cr, Hg, Se	**1.** HNO_3	Multimode/	3 min at 450 W	Radiochemical

		2. H_2O_2	HP closed		
	Fe	**A.** HNO_3 **B.** **1.** HNO_3 **2.** HF	Multimode/ HP closed Multimode/ HP closed	30 sec at 700 W Same as A	ETV-AAS
	Ca, Fe, K, Mg, Mn, Zn	–	Multimode/ open	30 min at 650 W	F-AAS
	B	HNO_3, H_2O_2	Multimode/ HP closed	2 min at 100W, 2 min at 0 W, 5 min at 250 W, 3 min at 0 W, 5 min at 500 W, 15 min at 250 W	UV-Vis Fluorimetry ICP-OES ICP/MS
NIST Tomato leaves 1573 (contd.)	Mn	HNO_3	Multimode/ flow through	2 sec at 650 W (0.5 mL coil, 15.4 mL min^{-1})	F-AAS
	Al, As, Be, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Sb, Se, V, Zn	Aqua regia	Multimode/ LP closed	10 min at 300 W, 5 min at 600 W, 10 min at 480 W	ICP-OES ETV-AAS
	Ca, Fe, K, Mg, Mn, Na, P, S	**1.** HNO_3 **2.** H_2O_2 **3.** HCl	Multimode/ LP closed	**1.** 30 min at 540 W, 5 min at 0 W **2.** 5 min at 0 W, 15 min at 540 W, 5 min at 0 W **3.** 10 min at 180 W	ICP-OES
NIST	Pb	HNO_3, HCl	Multimode/	18 sec at 700 W	ETV-AAS

			flow through	(0.4 mL coil, 1.5 mL min^{-1})	
Pine needles 1575	Ba, Ca, K, Mg, Mn, Na, P, S, Zn	**1.** HNO_3 **2.** H_2O_2	Multimode/ open	**1.** 30 min at 540 W **2.** 30 min at 540 W	ICP-OES
NIST **Pine needles** **1575** **(contd.)**	Al, Ba, Ca, K, Mg, Mn, Na, P, S, Si, Zn	**A.** **1.** HNO_3 **2.** H_2O_2 **3.** H_2O_2 **B.** **1.** HNO_3 **2.** H_2O_2, HF **3.** H_3BO_3	Multimode/ open Multimode/ open (with reflux top)	**1.** 5 min at 300 W, 600 W until 1 mL remains **2.** 30–40 min at 600 W until 1 mL remains **1.** 5 min at 300 W, 20–30 min at 600 W reflux not on **2.** 30 min at 180 W reflux on **3.** 180 W reflux on	FI-ICP-OES
	Al, As, Cr, Cu, Fe, Hg, Mn, Pb, Rb, Sr, Th, U	**1.** HNO_3 **2.** HF	Multimode/ MP closed	**1.** Leave overnight, 3 min at 130 W, 6 min at 195 W, 6 min at 260 W, 6 min at 325 W, cool, vent **2.** 6 min at 325 W	ICP/MS
	Ca, Cu, Fe, K, Mn, P, Pb	HNO_3	Multimode/ HP closed	30 sec at 665 W	F-OES F-AAS ICP-OES
	Hg	HNO_3	Multimode/ LP closed	800 W until 75°C, 3 min at 75°C	CV-FANES
NIST	As, Ca, Cu, Fe, Mg, Mn, Mo, P,	HNO_3, H_2O_2	Multimode/	4 min at 296 W,	F-AAS

Pine needles 1575 (contd.)	S, Se, U, V, Zn		MP closed (Max 350 psi – power cutoff at 150 psi)	8 min at 360 W	ICP/MS ICP-OES
	Al, Ba, Ca, Cr, Fe, K, Mg, Mn, Na, P, Zn	**1.** Aqua regia **2.** HBO_3	Multimode/ MP closed (evacuated slightly at start)	**1.** 3 min at 625 W	ICP-OES
	Al, As, Be, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Sb, Se, V, Zn	Aqua regia	Multimode/ LP closed	10 min at 300 W, 5 min at 600 W, 10 min at 480 W	ICP-OES ETV-AAS
	Cd, Co, Fe, Ni, Pb	HNO_3, HF	Multimode/ LP closed	1 min at 240 W, cool (x15)	ETV-AAS XRF
NIST Pine needles 1575 (contd.)	Ca, Fe, K, Mg, Mn, Na, P, S	**1.** HNO_3 **2.** H_2O_2 **3.** HCl	Multimode/ LP closed	**1.** 30 min at 540 W, 5 min at 0 W **2.** 5 min at 0 W, 15 min at 540 W, 5 min at 0 W **3.** 10 min at 180 W	ICP-OES
	Ca, K, Mg, P	**1.** HNO_3, $HClO_4$ **2.** $HClO_4$	Multimode/ open (with scrubber)	15 min at 750 W	ICP-OES
	Pb	HNO_3	Multimode/ LP closed	3 min at 650 W	ETV-AAS
	Al	HNO_3	Multimode/ LP closed	40 sec at 700 W, 10 min at 0 W (vent), 60 sec at 700 W, 10 min at 0 W (vent),	ETV-AAS

				90 sec at 700 W, 5 min at 70 W	
	Cu	**1.** HNO_3 **2.** H_2O_2	Multimode/ LP closed	9.5 min at 540 W	F-AAS
NIST **Pine needles** **1575** **(contd.)**	Cu, Fe, Pb	**1.** HNO_3, H_2O, H_2O_2 **2.** Aqua regia, HF (optional)	Multimode/ open	**1.** 15 min at 70 W, 15 min at 150 W, 15 min at 180 W, 1 min at 250 W, 1 min at 600 W **2.** 15 min at 70 W, 1 min at 600 W	ETV-AAS
	B	HNO_3, H_2O_2	Multimode/ HP closed	2 min at 100W, 2 min at 0 W, 5 min at 250 W, 3 min at 0 W, 5 min at 500 W, 15 min at 250 W	UV-Vis Fluorimetry ICP-OES ICP/MS
	Ca, Fe	HNO_3, HCl, HF	Multimode/ MP closed	15 min at 540 W	DCP-OES
	Al, As, Ba, Cr, Cu, Fe, K, Mg, Mn, Ni, P, Pb, Rb, Sr, Zn	**1.** HNO_3 **2.** HF **3.** H_2O_2	Multimode/ HP closed	**1.** 5 min at 300 W, 2 min at 600 W, 2 min at 0 W, 3 min at 300 W **2.** 5 min at 300 W, 2 min at 600 W,	DCP-OES F-AAS

				2 min at 0 W **3.** 5 min at 300 W, 2 min at 600 W, 2 min at 0 W, 3 min at 300 W	
NIST **Corn stalks** **8412**	Al, Ba, Ca, K, Mg, Mn, Na, P, S, Si, Zn	**A.** **1.** HNO_3 **2.** H_2O_2 **3.** H_2O_2 **B.** **1.** HNO_3 **2.** H_2O_2, HF **3.** H_3BO_3	Multimode/ open Multimode/ open (with reflux top)	**1.** 5 min at 300 W, 600 W until 1 mL remains **2.** 30–40 min at 600 W until 1 mL remains **1.** 5 min at 300 W, 20–30 min at 600 W reflux off **2.** 30 min at 180 W reflux on **3.** 180 W reflux on	FI-ICP-OES
NIST **Corn kernel** **8413**	Al, Ba, Ca, K, Mg, Mn, Na, P, S, Si, Zn	**A.** **1.** HNO_3 **2.** H_2O_2 **3.** H_2O_2 **B.** **1.** HNO_3 **2.** H_2O_2, HF **3.** H_3BO_3	Multimode/ open Multimode/ open (with reflux top)	**1.** 5 min at 300 W, 600 W until 1 mL remains **2.** 30–40 min at 600 W until 1 mL remains **1.** 5 min at 300 W, 20–30 min at 600 W reflux not on **2.** 30 min at 180 W reflux on **3.** 180 W reflux on	FI-ICP-OES

	Pb	HNO_3, V_2O_5	Multimode/ HP closed	90 sec at 460 W	ETV-AAS
	Hg	HNO_3	Multimode/ HP closed	90 sec at 600 W	CV-AAS

Appendix 1.3: Marine

Matrix	Analytes	Reagents	Cavity/Vessel	Conditions	Detection
BCR Mussel tissue 278	As	HNO_3, H_2O_2	Multimode/ LP closed	1 min at 555 W, 4 min at 300 W	ETV-AAS
	Cu, Pb	HNO_3, $HClO4$, H_2SO_4	Multimode/ HP closed	10 min at 85 bar	DP-ASV
	Cd	HNO_3, V_2O_5	Multimode/ HP closed	90 sec at 600 W	ETV-AAS
	Pb	HNO_3, V_2O_5	Multimode/ HP closed	90 sec at 460 W	ETV-AAS
	Hg	HNO_3	Multimode/ HP closed	90 sec at 460 W	CV-AAS
BCR Plankton 414	Cd, Cr, Cu, Hg, Mn, Ni, Pb, V, Zn	**A.** **1.** HNO_3 **2.** HNO_3 **3.** H_2O_2 **4.** H_2O **B.** **1.** HNO_3, HCl **2.** HNO_3, HCl **3.** H_2O_2 **4.** H_2O	Single mode/ open Single mode/ open	**1.** 5 min at 10 W, 10 min at 30 W, 10 min at 60 W **2.** 10 min 60 W **3.** 5 min at 60 W **4.** 5 min at 50 W **1.** 5 min at 40 W, 10 min at 50 W **2.** 20 min 54 W **3.** 5 min at 40 W **4.** 5 min at 50 W	ICP-OES ICP-MS HPLC-ICP-MS
BCR Cod muscle 422	Cu	HNO_3, $HClO4$, H_2SO_4	Multimode/ HP closed	10 min at 85 bar	DP-ASV

BCR **Cod muscle** **422** **(contd.)**	As, Cu, Fe, Hg, Mn, Zn	**A.** **1.** HNO_3 **2.** HNO_3 **3.** H_2O_2 **4.** H_2O **B.** **1.** HNO_3, HCl **2.** HNO_3, HCl **3.** H_2O_2 **4.** H_2O **C.** **1.** HNO_3, H_2SO_4 **2.** HNO_3 **3.** H_2O_2 **4.** H_2O_2 **5.** H_2O	Single mode/ open Single mode/ open Single mode/ open	**1.** 5 min at 10 W, 10 min at 30 W, 10 min at 60 W **2.** 10 min 60 W **3.** 5 min at 60 W **4.** 5 min at 50 W **1.** 5 min at 40 W, 10 min at 50 W **2.** 20 min 54 W **3.** 5 min at 40 W **4.** 5 min at 50 W **1.** 5 min at 20 W, 10 min at 40 W, 10 min at 100 W **2.** 10 min at 100 W **3.** 5 min at 100 W **4.** 5 min at 100 W **5.** 5 min at 80 W	ICP-OES ICP-MS HPLC-ICP-MS
IAEA **Copepod** **MAA-1**	Cr, Hg, Se	**1.** HNO_3 **2.** H_2O_2	Multimode/ HP closed	**1.** 3 min at 450 W	Radiochemical
IAEA **Fish flesh** **MAA-2**	Se	**1.** HNO_3 **2.** H_2SO_4, $HClO_4$ **3.** H_2O	Single mode/ open	**1.** 15 min at 45 W, 10 min at 75 W **2.** 10 min at 90 W, 35 min at 120 W	ETV-AAS

				3. 8 min at 120 W	
	As	HNO_3, $HClO4$, H_2SO_4	Multimode/ HP closed.	10 min at 85 bar	DP-ASV
	Cr, Hg, Se	**1.** HNO_3 **2.** H_2O_2	Multimode/ HP closed	**1.** 3 min at 450 W	Radiochemical
IAEA Mussel tissue MAM-2	Cr, Hg, Se	**1.** HNO_3 **2.** H_2O_2	Multimode/ HP closed	**1.** 3 min at 450 W	Radiochemical
NIES Chlorella 3	Ca, Fe, Mg, Zn	HNO_3	Multimode/ flow through	100 sec at 525 W (10 mL coil, 6 mL min^{-1})	F-AAS
	Fe, Mn, Zn	HNO_3	Multimode/ flow through	-	F-AAS ICP-OES ICP/MS
	Cd, Co, Cu, Ni, Pb	HNO_3, HCl, $HClO_4$, HF	Multimode/ HP closed	5 min at 200 W (water load), 3.5 min at 200 W (no load)	ICP-OES ETV-ICP
NIES Chlorella 3 (contd.)	I	**1.** HNO_3 **2.** N_2H_4	Multimode/ MP closed	35 sec at 675 W	NAA
NIES Mussel 6	Ca, Fe, Mg, Zn	HNO_3	Multimode/ flow through	100 sec at 525 W (10 mL coil, 6 mL min^{-1})	F-AAS

	Ca, Cd, Cu, Fe, K, Mg, Mn, Na, P, Sr, Zn, Residual carbon	**A.** **1.** HNO_3, H_2SO_4 **2.** H_2O_2(x16) **3.** HNO_3 or HNO_3, HCl or NH_3 (aq) **4.** NH_4EDTA **B.** HNO_3	Single mode/ open Multimode/ MP closed	**1.** 4 min at 30 W, 4 min at 120 W **2.** 1 min at 120 W(x16) **3.** 4 min at 30 W 2 min at 20 psi, 5 min at 40 psi, 2 min at 60 psi, 2 min at 80 psi, 2 min at 100 psi, 2 min at 120 psi, 2 min at 140 psi, 15 min at 160 psi	ICP-OES
	Cd, Co, Cu, Ni, Pb	HNO_3, HCl, $HClO_4$, HF	Multimode/ MP closed	5 min at 200 W (water load), 3.5 min at 200 W (no load)	ICP-OES ETV-ICP
	Cd, Cu, Fe, Mn, Zn	**A.** HNO_3, H_2O_2 **B.** HNO_3, H_2O_2 **C.** HNO_3, $HClO_4$	Multimode/ HP closed Multimode/ HP closed Multimode/	75 sec at 665 W 1 min at 250 W, 2 min at 0 W, 2 min at 250 W, 2 min at 400 W, 2 min at 600 W	ETV-AAS

				90 sec at 700 W, 90 sec at 850 W	
	Se	**1.** HNO_3, H_2SO_4 **2.** H_2O_2 **3.** H_2O_2	Multimode/ LP closed	**1.** 6 min at 330 W, cool **2.** 4 min at 450 W, cool **3.** 4 min at 600 W	DPP
NIES **Mussel** **6** **(contd.)**	Se	**A.** **1.** HNO_3 **2.** H_2O_2 **3.** H_2O_2 **B.** **1.** HNO_3, H_2SO_4 2. H_2O_2 **3.** H_2O_2 **C.** **1.** HNO_3, H_3PO_4 **2.** H_2O_2 **3.** H_2O_2 **D.** **1.** HNO_3, $K_2S_2O_8$ **2.** H_2O_2 **3.** H_2O_2	Multimode/ LP closed Multimode/ LP closed Multimode/ LP closed Multimode/ LP closed	**1.** 6 min at 330 W, cool **2.** 4 min at 450 W, cool **3.** 4 min at 600 W Same as A Same as A Same as A	HG-AAS
	Fe, Mn, Zn	HNO_3	Multimode/ flow through	-	F-AAS ICP-OES

					ICP/MS
	Ca, Cu, Fe, Mg, Mn, Zn	HNO_3, $HClO_4$, HCl, HF	Multimode/ MP closed	14 min intermittent 200 W	F-AAS
	Al	HNO_3	Multimode/ MP closed	4 min at 200 W, cool, 4 min at 350 W, cool, 8 min at 250 W, cool, 10 min at 400 W (x4)	ETV-AAS
NIST Albacore tuna 50	Hg	HNO_3	Multimode/ HP closed	70 sec at 600 W	CV-AAS
NIST Oyster tissue 1566	Zn, Cd	HNO_3	Multimode/ open	8 min at 200 W	FI-F-AAS
	I	**1.** HNO_3 **2.** N_2H_4	Multimode/ HP closed	**1.** 35 sec at 675 W	NAA
	Hg	HNO_3	Multimode/ LP closed	8 min at 140 W, 8 min at 280 W, 4 min at 420 W	CV-AAS
	Hg	HNO_3	Multimode/ LP closed	8 min at 140 W, 8 min at 280 W, 4 min at 420 W	CV-AFS
	Ba, Ca, K, Mg, Mn, Na, P, S, Zn	**1.** HNO_3 **2.** H_2O_2	Multimode/ open	**1.** 30 min at 540 W **2.** 30 min at 540 W	ICP-OES
	As	HNO_3, H_2O_2	Multimode/ LP closed	1 min at 555 W, 4 min at 300 W	ETV-AAS
NIST	Residual amino acids	HNO_3	Multimode/ LP closed	Varied	Fluorimetry

Oyster tissue **1566** **(contd.)**	Al, Ba, Ca, K, Mg, Mn, Na, P, S, Si, Zn	**A.** **1.** HNO_3 **2.** H_2O_2 **3.** H_2O_2 **B.** **1.** HNO_3 **2.** H_2O_2, HF **3.** H_3BO_3	Multimode/ open Multimode/ open (with reflux top)	**1.** 5 min at 300 W, 600 W until 1 mL remains **2.** 30–40 min at 600 W until 1 mL remains **1.** 5 min at 300 W, 20–30 min at 600 W reflux not on **2.** 30 min at 180 W reflux on **3.** 180 W reflux on	FI-ICP-OES
	As, Ca, Cd, Cu, Fe, K, Mg, Mn, Na, Pb, Zn	HNO_3	Multimode/ HP closed	30 sec at 665 W	F-OES F-AAS ICP-OES
	Al, As, Ba, Ca, Cd, Ce, Cr, Cs, Cu, Fe, La, Li, Mg, Mn, Mo, Ni, Rb, Sb, Se, Sr, Tl, V, Y, Zn	HNO_3	Multimode/ MP closed	75 sec at 350 W	ICP/MS
	Al	HNO_3	Multimode/ MP closed	4 min at 200 W, cool, 4 min at 350 W, cool, 8 min at 250 W, cool, 10 min at 400 W (x4)	ETV-AAS
	Al, As, Ba, Ca, Cd, Cu, Fe, K, Mg, Mn, Na, P, Si, Sr, Ti, Zn	**1.** Aqua regia **2.** HBO_3	Multimode/ MP closed (evacuated slightly at start)	**1.** 3 min at 625 W	ICP-OES

	Hg, Se	**1.** HNO_3 **2.** H_2O_2	Multimode/ HP closed	**1.** 3 min at 450 W	Radiochemical
	Cu, Fe, Zn	**1.** HNO_3 **2.** $HClO_4$, HF	Multimode/ LP closed	Variable	SPC-IC
	Residual carbon	HNO_3	Multimode/ HP closed	5 min at 500 W (200 bar)	Total carbon analyzer Carbon dioxide coulometer
NIST **Oyster tissue** **1566** **(contd.)**	Ca, Cd, Cu, Fe, K, Mg, Mn, Na, P, Sr, Zn, Residual carbon	**A.** **1.** HNO_3, H_2SO_4 **2.** H_2O_2(x16) **3.** HNO_3 or HNO_3, HCl or NH_3 (aq) **4.** NH_4EDTA **B.** HNO_3	Single mode/ open Multimode/ MP closed	**1.** 4 min at 30 W, 4 min at 120 W **2.** 1 min at 120 W(x16) **3.** 4 min at 30 W 2 min at 20 psi, 5 min at 40 psi, 2 min at 60 psi, 2 min at 80 psi, 2 min at 100 psi, 2 min at 120 psi, 2 min at 140 psi, 15 min at 160 psi	ICP-OES
	As, arsenocholine, arsenobetaine, tetramethylarsonium iodide	HNO_3	Multimode/ HP closed	90 sec at 500 W	ETV-AAS
	Cd, Cr, Cu, Mn, Mo, Pb	HNO_3	Multimode/ LP closed	3 min at 650 W	ETV-AAS

	Cd, Cu, Mn, Pb, Zn	HNO_3, H_2SO_4	Multimode/ open	1000 W until nitric acid boils off	F-AAS
NRCC Dogfish liver DOLT-1	Cu, Fe, Zn	HNO_3	Multimode/ HP closed	3 min at 418 W	F-AAS
	Residual carbon	HNO_3	Multimode/ HP closed	5 min at 500 W (200 bar)	Total carbon analyzer Carbon dioxide coulometer
	Ni	HNO_3, HCl	Multimode/ HP closed	4 min at 350 W, 10 min at 140 W	ETV-AAS
	As, Se	HNO_3, H_2O_2	Multimode/ LP closed	3 min at 300 W	ICP/MS
	Cd	HNO_3, HCl	Multimode/ HP closed	4 min at 360 W, 10 min at 180 W	ETV-AAS
	Cu, Fe, Zn	HNO_3	Multimode/ HP closed	-	ICP-OES F-AAS
	Cu, Fe, Zn	HNO_3	Multimode/ HP closed	3 min at 418 W	F-AAS
NRCC Dogfish liver DOLT-1 (contd.)	Hg, Se	HNO_3	Multimode/ LP closed	8 min at 75 W, 8 min at 225 W, 4 min at 375 W	CV-AAS HG-AAS
	Ni	HNO_3, HCl	Multimode/ HP closed	4 min at 360 W, 10 min at 180 W	ICP-OES
NRCC Dogfish muscle DORM-1	Hg, Se	HNO_3	Multimode/ LP closed	8 min at 75 W, 8 min at 225 W, 4 min at 375 W	CV-AAS HG-AAS
	Ni	HNO_3, HCl	Multimode/ HP closed	4 min at 350 W, 10 min at 140 W	ETV-AAS

	As, dimethylarsenic acid, arsenite, monomethylarsonic acid, arsenate, methanearsonate	HNO_3	Multimode/ LP closed	–	HPLC-ICP/MS
	As, Cr	HNO_3, H_2O_2	Multimode/ LP closed	3 min at 300 W	ICP/MS
	Ni	HNO_3, HCl	Multimode/ HP closed	4 min at 460 W, 10 min at 180 W (10 mL water load)	ICP-OES
	Cd	HNO_3, HCl	Multimode/ HP closed	4 min at 360 W, 10 min at 180 W	ETV-AAS
	Residual carbon	HNO_3	Multimode/ HP closed	5 min at 500 W (200 bar)	Total carbon analyzer Carbon dioxide coulometer
	Ni	HNO_3, HCl	Multimode/ HP closed	4 min at 360 W, 10 min at 180 W	ICP-OES
NRCC Non-defatted lobster hepatopancreas LUTS-1	Residual carbon	HNO_3	Multimode/ HP closed	5 min at 500 W (200 bar)	Total carbon analyzer Carbon dioxide coulometer
	Cd, Co, Cu, Hg, Mn, Ni, Pb, Sr, Zn	**1.** HNO_3 **2.** H_2O_2	Multimode/ LP closed	**1.** 10 min at 3.5 atm **2.** 5 min at 4 atm	ICP/MS
	Cd	HNO_3	Multimode/ LP closed	2 min at 600 W, 10 min at 90 W	ASV
NRCC Cod liver tissue NOAA-K	Ag, As, Cd, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Sn, Zn	**A.** HNO_3, $HClO_4$ **B.** HNO_3	Multimode/ LP closed Multimode/ LP closed	25 min at 70 psi Same as A	ICP/MS

NRCC **Shellfish tissue** **NOAA-L**	Ag, As, Cd, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Sn, Zn	**A.** HNO_3, $HClO_4$ **B.** HNO_3	Multimode/ LP closed Multimode/ LP closed	25 min at 70 psi Same as A	ICP/MS
NRCC **Lobster** **hepatopancreas** **TORT-1**	As, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Se, Zn	HNO_3, $HClO_4$	Multimode/ LP closed	20 min at 60-65 psi	ETV-AAS F-AAS
	As, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Se, Sr, V, Zn	**A.** HNO_3, H_2O_2 **B.** HNO_3, H_2O_2 **C.** HNO_3, H_2O_2	Multimode/ LP closed Multimode/ LP closed Multimode/ HP closed	3 min at 600 W (Pressure release) 1 min at 600 W 1 min at 600 W	ETV-AAS F-AAS
	Cd, Cr, Pb	HNO_3	Multimode/ LP closed	15 min at 180 W, 10 min at 0 W, 15 min at 180 W	F-AAS
	As, Ni, Co	HNO_3, HClO4, H_2SO_4	Multimode/ HP closed.	10 min at 85 bar	DP-ASV
	Residual carbon	HNO_3	Multimode/ HP closed	5 min at 500 W (200 bar)	Total carbon analyzer Carbon dioxide coulometer
	As, Cd, Co, Cr, Cu, Mn, Ni, Pb, Sn, V, Zn	HNO_3	Multimode/ MP closed	5 min at 60W, 5 min at 90 W, 15 min at 150 W	ETV-AAS F-AAS

	As	HNO_3, H_2O_2	Multimode/ HP closed	–	ICP/MS
NRCC Lobster hepatopancreas TORT-1 (contd.)	Al	HNO_3	Multimode/ LP closed	40 sec at 700 W, 10 min at 0 W (vent), 60 sec at 700 W, 10 min at 0 W (vent), 90 sec at 700 W, 5 min at 70 W	ETV-AAS
	Ni	HNO_3, HCl	Multimode/ HP closed	4 min at 350 W, 10 min at 140 W	ETV-AAS
	As, Cr, Se, V	HNO_3, H_2O_2	Multimode/ LP closed	3 min at 300 W	ICP/MS
	Ni	HNO_3, HCl	Multimode/ HP closed	4 min at 460 W, 10 min at 180 W (10 mL water load)	ICP-OES
	Cd	HNO_3, HCl	Multimode/ HP closed	4 min at 360 W, 10 min at 180 W	ETV-AAS
	Ni	HNO_3, HCl	Multimode/ HP closed	4 min at 360 W, 10 min at 180 W	ICP-OES
	Ca, Cu, Fe, Zn	HNO_3, HCl, HF	Multimode/ MP closed	15 min at 540 W	DCP-OES

Appendix 2.1 Geological and Metallurgical Reference Materials

Table 2-6.1 Rocks and minerals

Matrix	Analytes	Reagents	Cavity/Vessel	MW conditions	Detection
AIS **Vanadium titanium ore** **BH-102**	Al, Si, Ca, Co, Cu, Mg, Fe, Ti, Mn, Ni	HNO_3, HF	Multimode/ LP closed	10 min at 480 W, 8 min at 360 W (for ICP) 10 min at 480 W, 5 min at 360 W (for AA)	ICP-OES F-AAS
AIS **Vanadium titanium ore** **BH-104**	Al, Si, Ca, Co, Cu, Mg, Fe, Ti, Mn, Ni	HNO_3, HF	Multimode/ LP closed	10 min at 480 W, 8 min at 360 W (for ICP) 10 min at 480 W, 5 min at 360 W (for AA)	ICP-OES F-AAS
ANRT **Bauxite** **BX-N**	Al, Ba, K, Li, Ni, Si, Ti, Y, Zr	**1.** HNO_3, HCl, HF **2.** H_3BO_3	Multimode/ LP closed	**1.** 2.5 min at 650 W **2.** 10 min at 650 W	ICP-OES

Appendix 2.2 Steels and alloys

Matrix	Analytes	Reagents	Cavity/Vessel	MW conditions	Detection
BAM **High-alloy steel** **228-1**	Cr	**1.** HNO_3, HCl, HF **2.** HNO_3	Multimode/ LP closed	**1.** 15 min at 55% **2.** 15 min at 55% (if incompletely digested)	Titration with Fe(II)
BAM **High-alloy steel** **277-1**	Cr	**1.** HNO_3, HCl, HF **2.** HNO_3	Multimode/ LP closed	**1.** 15 min at 55% **2.** 15 min at 55% (if incompletely digested)	Titration with Fe(II)
BAM **High-alloy steel** **278-1**	Cr	**1.** HNO_3, HCl, HF **2.** HNO_3	Multimode/ LP closed	**1.** 15 min at 55% **2.** 15 min at 55% (if incompletely digested)	Titration with Fe(II)
BAM **High-alloy steel** **328-1**	Cr	**1.** HNO_3, HCl, HF **2.** HNO_3	Multimode/ LP closed	**1.** 15 min at 55% **2.** 15 min at 55% (if incompletely digested)	Titration with Fe(II)
BAM **Ferro-chromium** **530-1**	Al, Co, Cr, Cu, Fe, Mn, Mo, Ni, Si, Ti, V	H_2SO_4, H_2O, H_3PO_4	Multimode/ LP closed	10 min at 330 W	ICP-OES
BAM **Ferro-chromium** **533-1**	Al, Co, Cr, Cu, Fe, Mn, Mo, Ni, Si, Ti, V	H_2SO_4, H_2O, H_3PO_4	Multimode/ LP closed	10 min at 330 W	ICP-OES
BAM **High-alloy steel** **CrMnMoNiTi1**	Cr	**1.** HNO_3, HCl, HF **2.** HNO_3	Multimode/ LP closed	**1.** 15 min at 55% **2.** 15 min at 55% (if incompletely digested)	Titration with Fe(II)

BAM **High-alloy steel** **CrNiSiMn1**	Cr	**1.** HNO_3, HCl, HF **2.** HNO_3	Multimode/ LP closed	**1.** 15 min at 55% **2.** 15 min at 55% (if incompletely digested)	Titration with Fe(II)
BCS **Ferro-chromium** **203/2**	Al, Co, Cr, Cu, Fe, Mn, Mo, Ni, Si, Ti, V	H_2SO_4, H_2O, H_3PO_4	Multimode/ LP closed	10 min at 330 W	ICP-OES
BCS **Ferro-chromium** **204/1**	Al, Co, Cr, Cu, Fe, Mn, Mo, Ni, Si, Ti, V	H_2SO_4, H_2O, H_3PO_4	Multimode/ LP closed	10 min at 330 W	ICP-OES
BCS **Ferro-manganese** **208/1**	Al, Co, Cr, Cu, Fe, Mn, Mo, Ni, Si, Ti, V	H_2SO_4, H_2O, H_3PO_4, HNO_3	Multimode/ LP closed	10 min at 330 W	ICP-OES
BCS **High-alloy steel** **211/1**	Cr	**1.** HNO_3, HCl, HF **2.** HNO_3	Multimode/ LP closed	**1.** 15 min at 55% **2.** 15 min at 55% (if incompletely digested)	Titration with Fe(II)
BCS **Ferro-manganese** **280**	Al, Co, Cr, Cu, Fe, Mn, Mo, Ni, Si, Ti, V	H_2SO_4, H_2O, H_3PO_4, HNO_3	Multimode/ LP closed	10 min at 330 W	ICP-OES
BCS **Fe-Si alloy** **305**	Al, Ca, Cr, Cu, Fe, Hf, Mn, Ni, Ru, Si, Ti, Zr	H_3PO_4	Multimode/ open	10-15 min to 150-200°C	ICP-OES
BCS **High-alloy steel** **338**	Cr	**1.** HNO_3, HCl, HF **2.** HNO_3	Multimode/ LP closed	**1.** 15 min at 55% **2.** 15 min at 55% (if incompletely digested)	Titration with Fe(II)
BCS	Cr	**1.** HNO_3, HCl,	Multimode/	**1.** 15 min at 55%	Titration with Fe(II)

High-alloy steel 339		HF **2.** HNO_3	LP closed	**2.** 15 min at 55% (if incompletely digested)	
BCS High-alloy steel 340	Cr	**1.** HNO_3, HCl, HF **2.** HNO_3	Multimode/ LP closed	**1.** 15 min at 55% **2.** 15 min at 55% (if incompletely digested)	Titration with Fe(II)
BCS High-alloy steel 341	Cr	**1.** HNO_3, HCl, HF **2.** HNO_3	Multimode/ LP closed	**1.** 15 min at 55% **2.** 15 min at 55% (if incompletely digested)	Titration with Fe(II)
BCS High-alloy steel 342	Cr	**1.** HNO_3, HCl, HF **2.** HNO_3	Multimode/ LP closed	**1.** 15 min at 55% **2.** 15 min at 55% (if incompletely digested)	Titration with Fe(II)
BCS Nickel alloy 345	As	HNO_3, HF	Multimode/ LP closed	15 min at 200 W, 15 min at 325 W, 30 min at 260 W	HG-AAS
BCS Nickel alloy 346	As	HNO_3, HF	Multimode/ LP closed	15 min at 200 W, 15 min at 325 W, 30 min at 260 W	HG-AAS
	As	HNO_3, HF	Multimode/ LP closed	15 min at 200 W, 15 min at 325 W, 30 min at 260 W	HG-AAS
BCS Steel 452	As, Cr, Cu, Mn, Ni, P, Si, Sn, Ti, W	HNO_3, HCl, HF	Multimode/ LP closed	80 sec at 625 W	DCP-OES
BCS	Cr	**1.** HNO_3, HCl, HF	Multimode/ LP closed	**1.** 15 min at 55%	Titration with Fe(II)

High-alloy steel **JK 8F**		**2.** HNO_3		**2.** 15 min at 55% (if incompletely digested)	
BRAMMER **Slag** **ST-100**	Ca, Fe, Mg, Mn, Si	HCl, HF, HNO_3	Multimode/ LP closed	2 min at 650 W	F-AAS
CSAN **Ferro** **silicon** **4-1-01**	Al, Ca, Cr, Cu, Fe, Hf, Mn, Ni, Ru, Si, Ti, Zr	H_3PO_4	Multimode/ open	10-15 min at 150-200°C	ICP-OES
CSAN **Ferro** **silicon** **4-1-02**	Al, Ca, Cr, Cu, Fe, Hf, Mn, Ni, Ru, Si, Ti, Zr	H_3PO_4	Multimode/ open	10-15 min at 150-200°C	ICP-OES
CSAN **Ferro chromium** **4-2-01**	Al, Co, Cr, Cu, Fe, Mn, Mo, Ni, Si, Ti, V	H_2SO_4, H_2O, H_3PO_4	Multimode/ LP closed	10 min at 330 W	ICP-OES
CSAN **Ferro chromium** **4-2-02**	Al, Co, Cr, Cu, Fe, Mn, Mo, Ni, Si, Ti, V	H_2SO_4, H_2O, H_3PO_4	Multimode/ LP closed	10 min at 330 W	ICP-OES
CSAN **Ferro chromium** **4-2-03**	Al, Co, Cr, Cu, Fe, Mn, Mo, Ni, Si, Ti, V	H_2SO_4, H_2O, H_3PO_4	Multimode/ LP closed	10 min at 330 W	ICP-OES
CSAN **Ferro chromium** **4-2-04**	Al, Co, Cr, Cu, Fe, Mn, Mo, Ni, Si, Ti, V	H_2SO_4, H_2O, H_3PO_4	Multimode/ LP closed	10 min at 330 W	ICP-OES
CSAN	Al, Co, Cr, Cu, Fe, Mn, Mo, Ni, Si, Ti, V	H_2SO_4, H_2O, H_3PO_4	Multimode/	10 min at 330 W	ICP-OES

Ferro manganese **4-3-01**			LP closed		
CSAN **Ferro manganese** **4-3-02**	Al, Co, Cr, Cu, Fe, Mn, Mo, Ni, Si, Ti, V	H_2SO_4, H_2O, H_3PO_4	Multimode/ LP closed	10 min at 330 W	ICP-OES
CSAN **Ferro manganese silicon** **4-5-02**	Al, Ca, Cr, Cu, Fe, Hf, Mn, Ni, Ru, Si, Ti, Zr	H_3PO_4	Multimode/ open	10-15 min at 150 - 200°C	ICP-OES
CSAN **Ferro chromium silicon** **4-5-03**	Al, Ca, Cr, Cu, Fe, Hf, Mn, Ni, Ru, Si, Ti, Zr	H_3PO_4	Multimode/ open	10-15 min at 150 - 200°C	ICP-OES
IFM **Slag** **7**	Al, Ca, Fe, K, Mg, Mn, Na, Ti, Si	**A.** **1.** HCl, HF **2.** HBO_3 **B.** **1.** HCl, HF, H_2SO_4 **2.** HBO_3 **C.** **1.** Aqua regia, HF **2.** HBO_3	Multimode/ LP closed Multimode/ LP closed Multimode/ LP closed Multimode/ LP closed	**1.** 10-13 sec at 1470 W **1.** Same as A **1.** Same as A **1.** Same as A	F-AAS

		D. **1.** HCl, HF, H_2O_2 **2.** HBO_3			
IRSID **High-alloy steel** **204-1**	Cr	**1.** HNO_3, HCl, HF **2.** HNO_3	Multimode/ LP closed	**1.** 15 min at 55% **2.** 15 min at 55% (if incompletely digested)	Titration with Fe(II)
NIST **High-alloy stainless steel** **73**	Cr	**1.** HNO_3, HCl, HF **2.** HNO_3	Multimode/ LP closed	**1.** 15 min at 55% **2.** 15 min at 55% (if incompletely digested)	Titration with Fe(II)
NIST **High-alloy stainless steel** **101**	Cr	**1.** HNO_3, HCl, HF **2.** HNO_3	Multimode/ LP closed	**1.** 15 min at 55% **2.** 15 min at 55% (if incompletely digested)	Titration with Fe(II)
NIST **Stainless steel** **Cr-Ni-Ti** **121**	-	HCl, HNO_3, HF	Multimode/ LP closed	30 sec at 300 W (x2)	-
NIST **Solder** **40 Sn - 60 Pb** **127**	-	HBF_4, H_2O, HNO_3	Multimode/ LP closed	Varying time at 600 W	-
NIST **High alloy stainless steel** **133**	Cr	**1.** HNO_3, HCl, HF **2.** HNO_3	Multimode/ LP closed	**1.** 15 min at 55% **2.** 15 min at 55% (if incompletely digested)	Titration with Fe(II)
NIST	Cr	**1.** HNO_3, HCl,	Multimode/	**1.** 15 min at 55%	Titration with Fe(II)

High alloy stainless steel **160**		HF **2.** HNO_3	LP closed	**2.** 15 min at 55% (if incompletely digested)	
NIST **High alloy steel** **161**	Cr	**1.** HNO_3, HCl, HF **2.** HNO_3	Multimode/ LP closed	**1.** 15 min at 55% **2.** 15 min at 55% (if incompletely digested)	Titration with Fe(II)
NIST **Nickel** **copper alloy** **162**	Al, Cu, Fe, Mn, Ni, Si	HCl, HF, HNO_3	Multimode/ LP closed	2 min at 650 W	F-AAS
NIST **High alloy steel 168**	Cr	**1.** HNO_3, HCl, HF **2.** HNO_3	Multimode/ LP closed	**1.** 15 min at 55% **2.** 15 min at 55% (if incompletely digested)	Titration with Fe(II)
	-	HF, HNO_3, H_2O	Multimode/ LP closed	5 min at 600 W	-
NIST **LA steel** **high silicon** **179**	Al, Cr, Cu, Mn, Mo, Ni, P, Si, Sn, Ti, V	HNO_3, HCl, HF	Multimode/ LP closed	80 sec at 625 W	DCP-OES
NIST **High-alloy stainless steel** **343**	Cr	**1.** HNO_3, HCl, HF **2.** HNO_3	Multimode/ LP closed	**1.** 15 min at 55% **2.** 15 min at 55% (if incompletely digested)	Titration with Fe(II)
NIST **High-alloy valve steel** **346**	Cr	**1.** HNO_3, HCl, HF **2.** HNO_3	Multimode/ LP closed	**1.** 15 min at 55% **2.** 15 min at 55% (if incompletely digested)	Titration with Fe(II)

NIST Waspalloy Ni-Co-Cr 349	Co, Cr, Fe, Mo, Ni, W	HCl, HF, HNO_3	Multimode/ LP closed	30 sec at 325 W	ICP-OES
NIST Cast iron steel 890	Cr	**1.** HNO_3, HCl, HF **2.** HNO_3	Multimode/ LP closed	**1.** 15 min at 55% **2.** 15 min at 55% (if incompletely digested)	Titration with Fe(II)
NIST Cast iron steel 892	Cr	**1.** HNO_3, HCl, HF **2.** HNO_3	Multimode/ LP closed	**1.** 15 min at 55% **2.** 15 min at 55% (if incompletely digested)	Titration with Fe(II)

Appendix 2.3 Soils and sediments

Matrix	Analytes	Reagents	Cavity/Vessel	MW conditions	Detection
BCR **Calcareous loam** **141**	Cd, Cr, Cu, Fe, Mn, Pb, Zn	HCl, HNO_3	Multimode/ LP closed	1 min at 180 W, 4 min at 480 W, 60 min at 600 W	F-AAS ETV-AAS
	Cd, Cu, Pb	**1.** HNO_3, H_2O, H_2O_2 **2.** Aqua regia, HF (optional)	Multimode/ open	**1.** 15 min at 70 W, 15 min at 150 W, 15 min at 180 W, 1 min at 250 W, 1 min at 600 W **2.** 15 min at 70 W, 1 min at 600 W	ETV-AAS
BCR **Soil - light sandy** **142**	Cd, Cr, Cu, Fe, Mn, Pb, Zn	HCl, HNO_3	Multimode/ LP closed	1 min at 180 W, 4 min at 480 W, 60 min at 600 W	F-AAS ETV-AAS
BCR **Estuarine** **sediment** **277**	As, Cd, Cr, Cu, Hg, Ni, Pb, Zn	**A.** **1.** HCl, HNO_3 **2.** HCl, HNO_3 **3.** H_2O_2 **4.** H_2O **B.** HCl, HNO_3, HF	Single mode/ open Multimode/ LP closed	**1.** 5 min at 40 W, 10 min at 50 W **2.** 10 min at 54 W **3.** 5 min at 40 W **4.** 5 min at 50 W 10 min at 120 W, 20 min at 240 W, 20 min at 300 W	ICP-OES ICP-MS CV-AAS HPLC-ICP-MS
CANMET **Regosolic C** **horizon soil SO-1**	As	**1.** HNO_3 **2.** HNO_3, $HClO_4$, H_2SO_4	Multimode/ LP closed	**1.** 2.5 min at 639 W, cool, vent **2.** 2.5 min at 639 W, 2 min 0 W (x3)	F-AAS

	Pb	HNO_3, HF	Multimode/ LP closed	7 min at 400 W	DP-ASV
CANMET Podzolic B horizon soil SO-2	As	**1.** HNO_3 **2.** HNO_3, $HClO_4$, H_2SO_4	Multimode/ LP closed	**1.** 2.5 min at 639 W, cool, vent **2.** 2.5 min at 639 W, 2 min 0 W (x3)	F-AAS
	Pb	HNO_3, HF	Multimode/ LP closed	7 min at 400 W	DP-ASV
CANMET Calcareous C horizon soil SO-3	As	**1.** HNO_3 **2.** HNO_3, $HClO_4$, H_2SO_4	Multimode/ LP closed	**1.** 2.5 min at 639 W, cool, vent **2.** 2.5 min at 639 W, 2 min 0 W (x3)	F-AAS
CANMET Calcareous C horizon soil SO-3 (contd.)	Pb	HNO_3, HF	Multimode/ LP closed	7 min at 400 W	DP-ASV
CANMET Black Chernozemic A horizon soil SO-4	As	**1.** HNO_3 **2.** HNO_3, $HClO_4$, H_2SO_4	Multimode/ LP closed	**1.** 2.5 min at 639 W, cool, vent **2.** 2.5 min at 639 W, 2 min 0 W (x3)	F-AAS
	Pb	HNO_3, HF	Multimode/ LP closed	7 min at 400 W	DP-ASV
IAEA Lake sediment SL-1	Al, Ba, Ca, Cr, Cu, Fe, K, Li, Mg, Mn, Na, P, Pb, Si, Sr, Ti, V, Zn	Aqua regia, HF	Multimode/ open	3 min at 625 W	ICP-OES
	Cd, Cr, Cu, Fe, Mn, Pb, Zn	HCl, HNO_3	Multimode/ LP closed	1 min at 180 W, 4 min at 480 W, 60 min at 600 W	F-AAS ETV-AAS

IAEA **Soil** **5**	Hg	HCl, HNO_3, H_2O	Multimode/ LP closed	1 min at 180 W, 4 min at 480 W, 10 min at 600 W	CV-AAS NAA
IAEA **Soil** **7**	Cd, Cr, Cu, Fe, Mn, Pb, Zn	HCl, HNO_3	Multimode/ LP closed	1 min at 180 W, 4 min at 480 W, 60 min at 600 W	F-AAS ETV-AAS
IGGE **Stream sediment** **GSD-2**	Al, Be, Cr, K, La, Li, Nb, Si, Sn, Ti, Y, Zr	**1.** HNO_3, HCl, HF **2.** H_3BO_3	Multimode/ LP closed	**1.** 2.5 min at 650 W **2.** 10 min at 650 W	ICP-OES
IGGE **Stream sediment** **GSD-3**	Al, Cr, K, La, Li, Si, Ti, V, Zr	**1.** HNO_3, HCl, HF **2.** H_3BO_3	Multimode/ LP closed	**1.** 2.5 min at 650 W **2.** 10 min at 650 W	ICP-OES
IGGE **Stream sediment** **GSD-8**	Al, K, Li, Nb, Si, Sn, Ti, Y, Zr	**1.** HNO_3, HCl, HF **2.** H_3BO_3	Multimode/ LP closed	**1.** 2.5 min at 650 W **2.** 10 min at 650 W	ICP-OES
NIES **Pond sediment** **2**	Hg	HNO_3	Multimode/ HP closed	70 sec at 600 W	CV-AAS
NIST **River sediment** **1645**	Ca, Cr, Fe, Mn, Pb, Zn	**Exchangeable:** $MgCl_2$ **Carbonate Bound:** Sodium Acetate **Fe-Mn Oxide:**	Multimode/ open Multimode/ open Multimode/ open	4 min at ? W 5 min at ? W 4 min at ? W (x3) 4 min at ? W 5 min at ? W	F-AAS

		Organic: H_2O_2, HNO_3 **Residual:** HNO_3, HCl, HF	Multimode/ open		
	Al, As, Ba, Ca, Cr, Cu, Fe, K, Mg, Mn, Na, P, Pb, Si, Sr, Ti, Zn	Aqua regia, HF	Multimode/ open	3 min at 625 W	ICP-OES
	Al, K, Li, Si	**1.** HNO_3, HCl, HF **2.** H_3BO_3	Multimode/ LP closed	**1.** 2.5 min at 650 W **2.** 10 min at 650 W	ICP-OES
	Th, U	**1.** HCl, HNO_3, HF **2.** Aqua regia	Multimode/ HP closed	**1.** 4-8 min at 600 W, fume off acid (x3) **2.** If residue 3 min at 600 W	a spectrometry
	Hg	HNO_3	Multimode/ LP closed	Heat to 75°C (800 W), 2 min at 75°C	CV-FANES
	As, Cd, Cu, Mg, Mn, Ni, Pb, Zn	HNO_3, H_2O	Multimode/ LP closed	Heat to 100 psi, 55 min at 100 psi	-
	Al, Ba, Ca, Co, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Sc, Si, Ti, V, Zn, Zr	**1.** HF, Aqua regia **2.** H_3BO_3	Multimode/ LP closed	**1.** 8 min at 300 W, 4 min at 600 W, 7 min at 480 W **2.** 6 min at 600 W	ICP-OES
	Al, As, Ba, Ca, Cd, Cr, Cu, Co, Fe, K, Mg, Mn, Na, Ni, Pb, Sb, Sc, Se, Si, Sn, Ti, Tl, V, Zn, Zr	**1.** HF, Aqua regia **2.** H_3BO_3	Multimode/ LP closed	**1.** 8 min at 300 W, 11 min at 600 W **2.** 6 min at 300 W	ICP-OES F-AAS ETV-AAS
NIST Estuarine sediment 1646	Al, As, Ba, Ca, Cd, Cr, Cu, Co, Fe, K, Mg, Mn, Na, Ni, Pb, Sb, Sc, Se, Si, Sn, Ti, Tl, V, Zn, Zr	**1.** HF, Aqua regia **2.** H_3BO_3	Multimode/ LP closed	**1.** 8 min at 300 W, 11 min at 600 W **2.** 6 min at 300 W	ICP-OES F-AAS ETV-AAS

	Ca, Cr, Fe, Mn, Pb, Zn	**Exchangeable:** $MgCl_2$ **Carbonate Bound:** Sodium Acetate **Fe-Mn Oxide:** Hydroxylamine hydrochloride **Organic:** H_2O_2, HNO_3 **Residual:** HNO_3, HCl, HF	Multimode/ open Multimode/ open Multimode/ open Multimode/ open Multimode/ open	4 min at ? W 5 min at ? W 4 min at ? W (x3) 4 min at ? W 5 min at ? W	F-AAS
	Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Na, Ni, Pb, Ti, V, Zn	HNO_3	Multimode/ LP closed	10 min at 400 W 50 min at 330 W	ICP-OES
	Al, Ba, Ca, Co, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Sc, Si, Ti, V, Zn, Zr	**1.** HF, Aqua regia **2.** H_3BO_3	Multimode/ LP closed	**1.** 8 min at 300 W, 4 min at 600 W, 7 min at 480 W **2.** 6 min at 600 W	ICP-OES
NIST **Buffalo river sediment** **2704**	As, Cr, Cu, Mn, Ni, Pb, Se, Zn	HNO_3, H_2O	Multimode/ LP closed	12 min to 100 psi (651 W), 30 min at 100 psi (651 W, 181°C)	F-AAS ETV-AAS
	Ag, Al, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, Pb, Sr, V, Zn	HNO_3	Multimode/ LP closed	5.5 min to 175°C (574 W), 4.5 min at 175-180°C (574 W)	ICP-OES

	Ag, As, Ba, Cd, Cu, Cr, Hg, Ni, Pb, Se, Tl, Zn	**A.** HNO_3 **B.** HNO_3, HF	Multimode/ LP closed Multimode/ LP closed	2:20 min at 600 W, 9:25 min at 480 W Same as A	ETV-AAS CV-AAS
	Ag, As, Ba, Cd, Cu, Cr, Hg, Ni, Pb, Sb, Se, Tl, Zn	**Extraction**: HNO_3 **Total**: HNO_3, HF	Multimode/ LP closed Multimode/ LP closed	2:20 min at 604 W, 9:25 min at 570 W Same as extraction	
NIST **Buffalo river sediment**	Ba, Cd, Cr, Co, Cu, Pb, Ni, Sr, V, Zn	HNO_3	Multimode/ LP closed	5.5 min to 175°C (574 W), 4.5 min at 175-180°C (574 W)	

2704 **(contd.)**	Co, Cr, Cu, Ni, Pb, Zn	**A.** **1.** HF, HNO_3, HCl **2.** H_3BO_3 **B.** HNO_3 **C.** Same as A **D.** **1.** HF, HNO_3 **2.** H_3BO_3 **E.** HNO_3, HCl **F.** Same as A **G.** Same as E **H.** HF, HNO_3, HCl **I.** HNO_3, H_2O_2 **J.** HNO_3, H_2O_2, HF **K.** **1.** HNO_3, H_2O_2, HF	Multimode/ LP closed (all same)	8 min at 630 W, 15 min at 315 W Same as A 10 min at 630 W, 20 min at 473 W, 5 min at 158 W Same as C Same as C 10 min at 630 W, 20 min at 410 W, 5 min at 189 W 10 min at 630 W, 20 min at 441 W, 5 min at 158 W 15 min at 630 W Same as G Same as G Same as G Same as G 7 min at 441 W,	F-AAS ETV-AAS

NIST Buffalo river sediment 2704 (contd.)	Al, As, Ba, Be, Ca, Co, Cr, Cu, Fe, Hg, Mg, Mn, Ni, P, Pb, S, Se, Tl, U, V, Zn	HNO_3	Multimode/ LP closed	Heat to 175°C within 5.5 min, 4.5 min at 175–180°C	ICP–MS ETV–AAS
	Cd, Cr, Cu, Ni, Pb, Zn	**A.** HNO_3 **B.** HNO_3, HF	Multimode/ LP closed Multimode/ LP closed	Heat to 175°C within 5.5 min, 4.5 min at 175–180°C Heat to 175°C within 5.5 min, 9.5 min at 175–180°C	F–AAS ETV–AAS ICP–MS
NIST Montana soil highly elevated traces 2710	Cd, Cr, Cu, Ni, Pb, Zn	**A.** HNO_3 **B.** HNO_3, HF	Multimode/ LP closed Multimode/ LP closed	Heat to 175°C within 5.5 min, 4.5 min at 175–180°C Heat to 175°C within 5.5 min, 9.5 min at 175–180°C	F–AAS ETV–AAS ICP–MS
NIST Montana soil moderately elevated traces 2711	Cd, Cr, Cu, Ni, Pb, Zn	**A.** HNO_3 **B.** HNO_3, HF	Multimode/ LP closed Multimode/ LP closed	Heat to 175°C within 5.5 min, 4.5 min at 175–180°C Heat to 175°C within 5.5 min, 9.5 min at 175–180°C	F–AAS ETV–AAS ICP–MS
NIST Peruvian soil 4355	As, Cr, Cu, Mn, Ni, Pb, Se, Zn	HNO_3, H_2O	Multimode/ LP closed	12 min to 100 psi (651 W), 30 min at 100 psi (651 W/181°C)	F–AAS ETV–AAS
	Ag, Al, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, Pb, Sr, V, Zn	HNO_3	Multimode/ LP closed	5.5 min to 175°C (574 W), 4.5 min at 175–180°C (574 W)	ICP–OES
NRCC Marine sediment	Al, Ba, Be, Ca, Cd, Cr, Cu, Fe, Hg, Mg, Mn, Na, Ni, P, Pb, Sr, Ti, V, Zn	HNO_3, HCl	Multimode/ LP closed	1–20 min at 720 W	ICP–OES ETV–AAS

BCSS-1	Al, As, Ba, Be, Ca, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, Pb, S, Sb, Ti, V, Zn	**A.** Aqua regia **B.** **1.** Aqua regia, HF **2.** H_3BO_3	Multimode/ LP closed Multimode/ LP closed	2 min at 600 W, 5 min at 360 W, 15 min at 180 W **1.** 1 min at 600 W, 5 min at 360 W, 15 min at 180 W **2.** 15 min at 330 W	ICP-OES NAA
NRCC **Marine sediment** **MESS-1**	Al, Cr, K, Li, Si, Ti, Zr	**1.** HNO_3, HCl, HF **2.** H_3BO_3	Multimode/ LP closed	**1.** 2.5 min at 650 W **2.** 10 min at 650 W	ICP-OES
	Si, Al, Zn, Cr	HCl, HNO_3, HF	Multimode/ LP closed	50 – 60 sec at 700 W	F-AAS
	Al, Ba, Be, Ca, Cd, Cr, Cu, Fe, Hg, Mg, Mn, Na, Ni, P, Pb, Sr, Ti, V, Zn	HNO_3, HCl	Multimode/ LP closed	1–20 min at 720 W	ICP-OES ETV-AAS
	Al, As, Ba, Be, Ca, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, Pb, S, Sb, Ti, V, Zn	**A.** Aqua regia **B.** **1.** Aqua regia, HF **2.** H_3BO_3	Multimode/ LP closed Multimode/ LP closed	2 min at 600 W, 5 min at 360 W, 15 min at 180 W **1.** 1 min at 600 W, 5 min at 360 W, 15 min at 180 W **2.** 15 min at 330 W	ICP-OES NAA
	As, Cd, Co, Cr, Cu, Mn, Ni, Pb, Sn, V, Zn	HNO_3, HF	Multimode/ MP closed	25 min at 210 W	ETV-AAS F-AAS

	As, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Se, Zn	**A.** HNO_3, HF, $HClO_4$ **B.** Same as A	Multimode/ LP closed Multimode/ LP closed	100% power to 60–65 psi, 20 min at 65 psi Heat as in A, vent, repeat A	F-AAS ETV-AAS ICP-OES
NRCC Marine Sediment PACS-1	As, Cr, Cu, Mn, Ni, Pb, Se, Zn	HNO_3, H_2O	Multimode/ LP closed	12 min to 100 psi (651 W), 30 min at 100 psi (651 W/181°C)	F-AAS ETV-AAS
	Al, As, Ba, Be, Ca, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, Pb, S, Sb, Ti, V, Zn	**A.** Aqua regia **B.** **1.** Aqua regia, HF **2.** H_3BO_3	Multimode/ LP closed Multimode/ LP closed	2 min at 600 W, 5 min at 360 W, 15 min at 180 W **1.** 1 min at 600 W, 5 min at 360 W, 15 min at 180 W **2.** 15 min at 330 W	ICP-OES NAA
NRCC Soil SO-2	Cu, Zn	HNO_3, HF	Multimode/ LP closed	15 min at 105 W, vent, 7 min at 350 W	F-AAS
NRCC Soil SO-3	Cu, Zn	HNO_3, HF	Multimode/ LP closed	15 min at 105 W, vent, 7 min at 350 W	F-AAS
NRCC Soil SO-4	Cu, Zn	HNO_3, HF	Multimode/ LP closed	15 min at 105 W, vent, 7 min at 350 W	F-AAS
RMA Standard soil	Ag, As, Ba, Cd, Cu, Cr, Hg, Ni, Pb, Se, Tl, Zn	**A.** HNO_3 Same as A	Multimode/ LP closed	2:20 min at 600 W, 9:25 min at 480 W	ETV-AAS CV-AAS

		B. HNO_3, HF	Multimode/ LP closed		
	Ag, As, Ba, Cd, Cu, Cr, Hg, Ni, Pb, Sb, Se, Tl, Zn	**Extraction:** HNO_3 **Total:** HNO_3, HF	Multimode/ LP closed Multimode/ LP closed	2:20 min at 604 W, 9:25 min at 570 W Same as extraction	
USGS **Soil GXR-2**	Al, K, Li, Si, Ti, Zr	**1.** HNO_3, HCl, HF **2.** H_3BO_3	Multimode/ LP closed	**1.** 2.5 min at 650 W **2.** 10 min at 650 W	ICP-OES
	Nb, Mo, Ta, W	**1.** HNO_3 **2.** HF, H_2O	Multimode/ MP closed	**1.** 30 min at 200 W **2.** 1 min at 1000 W, 30 min at 450 W	ID-ICP-MS
USGS **Fe-Mn-W rich hot spring deposit** **GXR-3**	Al, K, Li, Mg, Si, Ti	**1.** HNO_3, HCl, HF **2.** H_3BO_3	Multimode/ LP closed	**1.** 2.5 min at 650 W **2.** 10 min at 650 W	ICP-OES
USGS **Soil GXR-5**	Al, Cr, K, Li, Si, Ti, Zr	**1.** HNO_3, HCl, HF **2.** H_3BO_3	Multimode/ LP closed	**1.** 2.5 min at 650 W **2.** 10 min at 650 W	ICP-OES
	Nb, Mo, Ta, W	**1.** HNO_3 **2.** HF, H_2O	Multimode/ MP closed	**1.** 30 min at 200 W **2.** 1 min at 1000 W, 30 min at 450 W	ID-ICP-MS
USGS **Marine sediment MAG-1**	Nb, Mo, Ta, W	**1.** HNO_3 **2.** HF, H_2O	Multimode/ MP closed	**1.** 30 min at 200 W **2.** 1 min at 1000 W, 30 min at 450 W	ID-ICP-MS
	Al, K, Li, Si, Ti, Y, Zr	**1.** HNO_3, HCl, HF **2.** H_3BO_3	Multimode/ LP closed	**1.** 2.5 min at 650 W **2.** 10 min at 650 W	ICP-OES

Appendix 3 Miscellaneous Reference Materials

Matrix	Analytes	Reagents	Cavity/Vessel	Conditions	Detection
BCR Sewage amended soil 143	Cd, Cr, Cu, Fe, Mn, Pb, Zn	HCl, HNO_3	Multimode/ LP closed	1 min at 180 W, 4 min at 480 W, 60 min at 600 W	F-AAS ETV-AAS
	Cd, Cu, Ni, Pb, Zn	**1.** HNO_3 **2.** HNO_3 **3.** H_2O_2 **4.** H_2O	Single mode/ open	**1.** 5 min at 10 W, 10 min at 30 W, 10 min at 60 W **2.** 10 min at 60 W **3.** 5 min at 60 W **4.** 5 min at 50 W	ICP-OES ICP-MS
BCR Domestic sewage sludge 144	Pb	HNO_3	Multimode/ flow through	5 min at 650 W	F-AAS
	Cu, Mn	HNO_3, H_2O_2	Multimode/ flow through	3-5 min at 650W (digestate recirculated through oven)	F-AAS
	Cu, Mn	HNO_3, Isoamyl alcohol	Multimode/ LP closed	3 min at 520 W	F-AAS
	Cd, Cu, Fe, Mn, Pb, Zn	HNO_3, 2-ethyl-hexan-1-ol	Multimode/ LP closed	3 min at 520 W	F-AAS
	Cu, Mn, Pb, Zn	HNO_3	Multimode/ flow through	2 sec at 650 W (0.5 mL coil, 15.4 mL min^{-1})	F-AAS
	Al, As, Ba, Ca, Cd, Cr, Cu, Co, Fe, K, Mg, Mn, Na, Ni, Pb, Sb, Sc, Se, Si, Sn, Ti, Tl, V, Zn, Zr	**1.** HF, Aqua regia **2.** H_3BO_3	Multimode/ LP closed	**1.** 8 min at 300 W, 11 min at 600 W **2.** 6 min at 300 W	ICP-OES F-AAS ETV-AAS
BCR Sewage sludge 145	Cd, Cr, Cu, Fe, Mn, Pb, Zn	HCl, HNO_3	Multimode/ LP closed	1 min at 180 W, 4 min at 480 W, 60 min at 600 W	F-AAS ETV-AAS
	Al, As, Ba, Ca, Cd, Cr, Cu, Co, Fe, K, Mg,	**1.** HF, Aqua	Multimode/	**1.** 8 min at 300 W,	ICP-OES

	Mn, Na, Ni, Pb, Sb, Sc, Se, Si, Sn, Ti, Tl, V, Zn, Zr	regia **2.** H_3BO_3	LP closed	11 min at 600 W **2.** 6 min at 300 W	F-AAS ETV-AAS
BCR **Industrial sewage sludge** **146**	Pb	HNO_3,	Multimode/ flow through	5 min at 650 W	F-AAS
	Cu, Mn	HNO_3, H_2O_2	Multimode/ flow through	3-5 min at 650 W (digestate recirculated through oven)	F-AAS
	Cu, Mn, Pb	HNO_3	Multimode/ LP closed	3 min at 90°C (650 W)	ETV-AAS
	Cu, Mn	HNO_3, Isoamyl alcohol	Multimode/ LP closed	3 min at 520 W	F-AAS
BCR **Industrial sewage sludge** **146 (contd.)**	Cu, Mn, Pb, Zn	HNO_3	Multimode/ flow through	2 sec at 650 W (0.5 mL coil, 15.4 mL min^{-1})	F-AAS
	Cd, Cu, Fe, Mn, Pb, Zn	HNO_3, 2-ethyl-hexan-1-ol	Multimode/ LP closed	3 min at 520 W	F-AAS
	Al, As, Ba, Ca, Cd, Cr, Cu, Co, Fe, K, Mg, Mn, Na, Ni, Pb, Sb, Sc, Se, Si, Sn, Ti, Tl, V, Zn, Zr	**1.** HF, Aqua regia **2.** H_3BO_3	Multimode/ LP closed	**1.** 8 min at 300 W, 11 min at 600 W **2.** 6 min at 300 W	ICP-OES F-AAS ETV-AAS
BCR **Brown bread** **191**	Cd, Cu, Pb	HNO_3, $HClO_4$, H_2SO_4	Multimode/ HP closed	10 min at 85 bar	DP-ASV
EPA **Solid** **LCS**	Al, As, Be, Cd, Co, Cr, Cu, Mg, Mn, Ni, Pb, Sb, V, Zn	HNO_3, HCl	Multimode/ MP closed	1 min at 600 W	ICP-OES
IAEA **Human diet H9**	I	HNO_3, N_2H_4	Multimode/ HP closed	35 sec at 675 W	NAA
	Cr, Hg, Se	**1.** HNO_3 **2.** H_2O_2	Multimode/ HP closed	**1.** 3 min at 450 W	Radiochemical

	Cd, Cu, Fe, Mn	HNO_3	Multimode/ LP closed	3 min at 650 W (90°C)	ETV–AAS
	Al	HNO_3	Multimode/ HP closed	1 min at 150 W, 30 min 0 W, 1 min at 450 W	ICP–OES
IAEA Fresh water W4	Cu, Mn, Pb	HNO_3	Multimode/ LP closed	3 min at 650 W (90°C)	ETV–AAS
NIST Trace elements in glass 613	Pb, U	HNO_3, HF, $HClO_4$	Multimode/ LP closed	5 min at 90 W, 15 min at 138 W	ID
NIST Trace elements in glass 615	Pb, U	HNO_3, HF, $HClO_4$	Multimode/ LP closed	5 min at 90 W, 15 min at 138 W	ID
NIST Portland Cement 636	NA	HBF_4, HNO_3	Multimode/ LP closed	2 min at 600 W	NA
NIST Doped Platinum 681	Au, Pd, Pt	Aqua regia	Multimode/ LP closed	1–3 hr at 860 KPa	ETV–AAS
NIST Alumina 699	Ca, Fe, Mn, Ti	H_2SO_4	Multimode/ MP closed	3 min at 630 W, 5–15 min at 315 W (170°C)	ICP–OES
NIST Wear metals in oil 1085	Ag, Al, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, Pb, Sr, V, Zn	HNO_3	Multimode/ LP closed	5.5 min to 175°C (574W) 4.5 min at 175–180°C (574W)	ICP–OES
NIST	Cu, Fe, Mn, Zn	**A.**	Multimode/	75 sec at 665 W	ETV–AAS

Total diet **1548**		HNO_3, H_2O_2 **B.** HNO_3, H_2O_2 **C.** HNO_3, $HClO_4$	HP closed Multimode/ HP closed Multimode/ HP closed	1 min at 250 W, 2 min at 0 W, 2 min at 250 W, 2 min at 400 W, 2 min at 600 W 150 sec at 950 W, 60 sec at 0 W, 90 sec at 300 W, 90 sec at 500 W, 90 sec at 700 W, 90 sec at 850 W	
NIST **Powdered lead base paint** **1579**	Pb	**A.** HNO_3 **B.** Same as A	Multimode/ LP closed HP closed vessel	7 min at 675 W (90 psi max) 3 min at 270 W	F-AAS
	Ag, Al, Ba, Ca, Cd, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Na, P, Pb, S, Sb, Si, Sr, Ti, Zn	**1.** HNO_3 **2.** HF **3.** HBO_3	Multimode/ MP closed	**1.** 15 min at 0 W **2.** 8 min at 60 W, 6 min at 90 W, 9 min at 60 W	ICP-OES
	Al, Ba, Ca, Cu, Mg, Mn, Pb, S, Sb, Ti, Zn	**A.** Aqua regia, H_2O **B.** HNO_3, HF	Multimode/ MP closed Multimode/ LP closed	20 min at 180 psi 20 min at 190 W, 15 min at 0 W	ICP-OES NAA
NIST **Trace elements in fuel oil** **1634**	Ag, Al, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, Pb, Sr, V, Zn	HNO_3	Multimode/ LP closed	5.5 min to 175°C (574 W) 4.5 min at 175-180°C (574 W)	ICP-OES

NIST **Trace elements in water** **1643**	Bi, Hg	**1.** HCl, KBr, $KBrO_3$ **2.** $NaBH_4$, NaOH	Single mode/ flow through	**1.** 65 sec at 90–120 W (8.5 mL min–1)	CV–AAS
NIST **Urban particulate** **1648**	Cd, Cu, Fe, Pb	**1.** HNO_3, H_2O, H_2O_2 **2.** Aqua regia, HF (optional)	Multimode/ open	**1.** 15 min at 70 W, 15 min at 150 W, 15 min at 180 W, 1 min at 250 W, 1 min at 600 W **2.** 15 min at 70 W, 1 min at 600 W	ETV–AAS
NIST **Metals on filter media** **2676**	Al, As, Ba, Be, Ca, Co, Cr, Fe, Mg, Mn, Ni, P, Pb, S, Ti, V, Zn	**A.** HF, Aqua regia **B.** HNO_3	Multimode/ LP closed Multimode/ LP closed	5 min at 200 W, 5 min at 400 W Same as A	ICP–OES
NIST **Multi element mix A** **3171**	Al	HNO_3	Multimode/ MP closed	4 min at 200 W, cool, 4 min at 350 W, cool, 8 min at 250 W, cool, 10 min at 400 W (x4)	ETV–AAS
NIST **Mixed diet** **8431**	Ca, Cu, Fe, K, Mg, Mn, P, Zn	HNO_3, HCl	Multimode/ LP closed	5 min at 300 W, 5 min at 0 W, 5 min at 300 W, 5 min at 450 W, 5 min at 0 W, 5 min at 450 W	ICP–OES
	Cr, Hg, Se	**1.** HNO_3 **2.** H_2O_2	Multimode/ HP closed	**1.** 3 min at 450 W	Radiochemical

	Al	HNO_3	Multimode/ HP closed	1 min at 150 W, 30 min at 0 W, 1 min at 450 W	ICP-OES
NRCC Seawater NASS-2	As, Fe, Se, V	HNO_3, H_2O_2	Multimode/ HP closed	-	ICP/MS
NRCC Riverine water SLRS-2	As, Fe, Se, V	HNO_3, H_2O_2	Multimode/ HP closed	-	ICP/MS