



Analytical Report

Coastal Zones Research Institute Inc.
 232B Ave De L'Eglise
 Shippagan, NB, E8S 1J2
 Attn: Marion Tetegan Simon

Report ID: A17-02221 Revised 2

Sample Name: HUPLASO

Report Date: 5/2/2018

Analysis Methods

FUS-ICP (Fusion-Inductively Coupled Plasma)

An oxidized sample is dissolved in a borate flux and then diluted in aqueous nitric acid. ICP-OES is used to quantify various elements in the resulting solution.

FUS-MS (Fusion-Inductively Coupled Plasma-Mass Spectrometry)

An oxidized sample is dissolved in a borate flux and then diluted in aqueous nitric acid. ICP-MS is used to quantify various elements in the resulting solution.

TD-ICP (Total Digestion-Inductively Coupled Plasma)

A sample is digested via sequential addition of hydrofluoric, perchloric, and nitric acids. The acids are evaporated and the residue reconstituted in aqua regia. ICP-OES is used to quantify various elements in the resulting solution.

INAA (Instrumental Neutron Activation Analysis)

Samples are bombarded with neutrons to generate radioactive nuclides. Measurement of the energy and intensity of the alpha particles generated by their subsequent decay is used to quantify the various elements present in the original sample.

PGNAA (Prompt Gamma Neutron Activation Analysis)

Similar to INAA, except the energy and intensity of the alpha particles generated during neutron bombardment is used to quantify the various elements present in the original sample.

IR (Infrared)

To determine %C and %S, a sample is burned with an accelerator in an induction furnace to convert all carbon to carbon dioxide and all sulfur to sulfur dioxide. Carbon dioxide and sulfur dioxide are quantified using separate infrared detectors as they absorb infrared light at characteristic frequencies.

	Test Value	Unit Symbol	Detection Limit	Analysis Method
Osmium (Os)	< 2	ppb	2	NI-FINA
Iridium (Ir)	< 0.1	ppb	0.1	NI-FINA
Ruthenium (Ru)	< 5	ppb	5	NI-FINA
Rhodium (Rh)	0.2	ppb	0.2	NI-FINA
Platinum (Pt)	< 5	ppb	5	NI-FINA
Palladium (Pd)	< 2	ppb	2	NI-FINA
Gold (Au)	1.2	ppb	0.5	NI-FINA
Rhenium (Re)	< 5	ppb	5	NI-FINA
Mass	25	g		NI-FINA
Cadmium (Cd)	< 0.3	ppm	0.3	TD-ICP
Lithium (Li)	19	ppm	1	TD-ICP
Gold (Au)	< 2	ppb	2	INAA
Arsenic (As)	1.4	ppm	0.5	INAA
Bromine (Br)	< 0.5	ppm	0.5	INAA
Chromium (Cr)	47	ppm	5	INAA
Iridium (Ir)	< 5	ppb	5	INAA
Antimony (Sb)	0.4	ppm	0.2	INAA
Scandium (Sc)	17.8	ppm	0.1	INAA
Selenium (Se)	< 3	ppm	3	INAA
Mass	34.8	g		INAA
Boron (B)	12	ppm	2	PGNAA
Mass	1.04	g		PGNAA
Silicon (Si)	17.7	%	0.1	FUS-ICP
Silicon dioxide (SiO2)	37.90	%	0.01	FUS-ICP
Aluminium (Al)	7.30	%	0.01	FUS-ICP
Aluminium oxide (Al2O3)	13.79	%	0.01	FUS-ICP
Iron (Fe)	7.08	%	0.01	FUS-ICP
Iron oxide (Fe2O3(T))	10.12	%	0.01	FUS-ICP
Manganese (Mn)	0.174	%	0.003	FUS-ICP
Manganese oxide (MnO)	0.224	%	0.001	FUS-ICP
Magnesium (Mg)	2.54	%	0.01	FUS-ICP
Magnesium oxide (MgO)	4.20	%	0.01	FUS-ICP
Calcium (Ca)	10.80	%	0.01	FUS-ICP
Calcium oxide (CaO)	15.07	%	0.01	FUS-ICP
Sodium (Na)	2.3	%	0.1	FUS-ICP
Sodium oxide (Na2O)	3.14	%	0.01	FUS-ICP
Potassium (K)	1.1	%	0.1	FUS-ICP
Potassium oxide (K2O)	1.34	%	0.01	FUS-ICP
Titanium	1.42	%	0.01	FUS-ICP
Titanium dioxide (TiO2)	2.362	%	0.001	FUS-ICP
Phosphorus (P)	0.18	%	0.01	FUS-ICP
Phosphorus pentoxide (P2O5)	0.42	%	0.01	FUS-ICP
Loss on Ignition (LOI)	10.2	%		FUS-ICP
Total	98.77	%	0.01	FUS-ICP
Scandium (Sc)	25	ppm	1	FUS-ICP
Beryllium (Be)	1	ppm	1	FUS-ICP
Vanadium (V)	267	ppm	5	FUS-ICP
Chromium (Cr)	60	ppm	20	FUS-MS
Cobalt (Co)	29	ppm	1	FUS-MS
Nickel (Ni)	50	ppm	20	FUS-MS
Copper (Cu)	60	ppm	10	FUS-MS
Zinc (Zn)	100	ppm	30	FUS-MS
Gallium (Ga)	18	ppm	1	FUS-MS
Germanium (Ge)	1	ppm	1	FUS-MS
Arsenic (As)	< 5	ppm	5	FUS-MS
Rubidium (Rb)	26	ppm	2	FUS-MS
Strontium (Sr)	381	ppm	2	FUS-ICP
Yttrium (Y)	24	ppm	1	FUS-ICP



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	Test Value	Unit Symbol	Detection Limit	Analysis Method
Zirconium (Zr)	194	ppm	2	FUS-ICP
Niobium (Nb)	38	ppm	1	FUS-MS
Molybdenum (Mo)	< 2	ppm	2	FUS-MS
Silver (Ag)	0.7	ppm	0.5	FUS-MS
Indium (In)	< 0.2	ppm	0.2	FUS-MS
Tin (Sn)	1	ppm	1	FUS-MS
Antimony (Sb)	0.5	ppm	0.5	FUS-MS
Cesium (Cs)	0.5	ppm	0.5	FUS-MS
Barium (Ba)	1,479	ppm	2	FUS-ICP
Lanthanum (La)	30.8	ppm	0.1	FUS-MS
Cerium (Ce)	64.6	ppm	0.1	FUS-MS
Praseodymium (Pr)	7.56	ppm	0.05	FUS-MS
Neodymium (Nd)	30.0	ppm	0.1	FUS-MS
Samarium (Sm)	6.3	ppm	0.1	FUS-MS
Europium (Eu)	2.14	ppm	0.05	FUS-MS
Gadolinium (Gd)	5.9	ppm	0.1	FUS-MS
Terbium (Tb)	0.9	ppm	0.1	FUS-MS
Dysprosium (Dy)	5.1	ppm	0.1	FUS-MS
Holmium (Ho)	1.0	ppm	0.1	FUS-MS
Erbium (Er)	2.7	ppm	0.1	FUS-MS
Thulium (Tm)	0.38	ppm	0.05	FUS-MS
Ytterbium (Yb)	2.3	ppm	0.1	FUS-MS
Lutetium (Lu)	0.34	ppm	0.01	FUS-MS
Hafnium (Hf)	4.0	ppm	0.2	FUS-MS
Tantalum (Ta)	2.6	ppm	0.1	FUS-MS
Tungsten (W)	< 1	ppm	1	FUS-MS
Thallium (Tl)	0.2	ppm	0.1	FUS-MS
Lead (Pb)	< 5	ppm	5	FUS-MS
Bismuth (Bi)	< 0.4	ppm	0.4	FUS-MS
Thorium (Th)	3.8	ppm	0.1	FUS-MS
Uranium (U)	1.2	ppm	0.1	FUS-MS
Total Carbon (C)	2.21	%	0.01	CS
Graphitic Carbon	< 0.05	%	0.05	IR
Organic Carbon (calculated)	< 0.5	%	0.5	IR
Carbon Dioxide (CO2)	7.60	%	0.01	CO2
Total Sulfur (S)	0.14	%	0.01	CS
Sulfate (SO4)	0.31	%	0.05	SO4
Cadmium (Cd)	< 0.5	ppm	0.5	TD-ICP
Copper (Cu)	47	ppm	1	TD-ICP
Nickel (Ni)	28	ppm	1	TD-ICP
Zinc (Zn)	78	ppm	1	TD-ICP
Sulfur (S)	0.120	%	0.001	TD-ICP
Silver (Ag)	< 0.3	ppm	0.3	TD-ICP
Lead (Pb)	< 5	ppm	5	TD-ICP