Table 1: The Relative Weight Abundance of Earth Crust Elements

Range	Element
>10%	O, Si
1-10%	Al, Fe, Ca, K, Na, Mg
0.1-1.0%	C, H, Mn, P, Ti
0.01-0.1%	Ba, Cl, Cr, F, Rb, S, Sr, V, Zr
10-100 ppm	Cu, Ce, Co, Ga, La, Li, Nb, Ni, Pb, Sn, Th, Zn, Yt
1-10 ppm	As, B, Br, Cs, Ge, Hf, Mo, Sb, Ta, U, W, and most Rare Earths
0.1-1.0 ppm	Bi, Cd, I, In, Tl
0.01-0.1 ppm	Ag, Pd, Se
0.001- 0.01 ppm	Au, Ir, Os, Pt, Re, Rh, Ru

J. D. Gilchrist, **Extraction Metallurgy 3rd ed**, Pergamon Press, New York, 1989

Table 2: Elemental Abundance in Igneous Rocks

Element	Percentage
O	45.6
Si	27.7
Al	8.1
Fe	5.0
Ca	3.63
Na	2.85
K	2.60
Mg	2.09
Ti	0.63
Mn	0.10
Zr	0.026
Ni	0.020
V	0.017
Cu	0.010
U	0.008
W	0.005
Zn	0.004
Pb	0.002
Th	0.002
Co	0.001
Be	0.001
Mo	0.000,n
As	0.000,n
Sn	0.000,n
Sb	0.000,0n
Cd	0.000,0n
Hg	0.000,0n
Ag	0.000,00n
Pt	0.000,000,n
Au	0.000,000,n
Ir	0.000,000,0n
Pd	0.000,000,00n
Ra	0.000,000,000,n

F. W. Clarke and H. S. Washington, *Composition of the Earth's Crust*, U. S. Geol. Survey Professional Paper 127, 1924

Table 3: Mineral Sources of Common Metals

Metal	Mineral	Formula
Iron	Magnetite	Fe_3O_4
	Hematite	Fe_2O_3
	Limonite	$2Fe_2O_3•3H_2O$
	Siderite	$FeCO_3$
Copper	Native Copper	Cu
	Chalcocite	Cu_2S
	Covellite	CuS
	Chalcopyrite	$CuFeS_2$
	Cuprite	Cu_2O
Aluminum	Diaspore	$Al_2O_3•H_2O$
	Gibbsite	$Al_2O_3•3H_2O$
	Kaolinite	$Al_2O_3•2SiO_2•2H_2O$
Lead	Galena	PbS
	Cerussite	$PbCO_3$
	Anglesite	$PbSO_4$
Zinc	Sphalerite	ZnS
	Zincite	ZnO
	Franklinite	(Fe,Zn,Mn)O
Sodium	Halite	NaCl
Lithium	Amblygonite	$LiAlFPO_4$
	Spodumene	$LiAl(Si_2O_6)$
Beryllium	Beryl	$Be_3Al_2(Si_6O_{18})$
Potassium	Sylvite	KCl
Magnesium	Magnesite	MgO
	Dolomite	$MgCO_3•CaCO_3$
	Magnesium Chloride	$MgCl_2$ (from sea water)
Tin	Cassiterite	SnO_2
	Stannite	$(Cu_2S•FeS•SnS_2)$
Nickel	Millerite	NiS
	Garnierite	Ni-Mg hydrosilicate
	Pentlandite	(FeNi)S
Manganese	Pyrolusite	MnO_2
	Rhodochrosite	$MnCO_3$
	Rhodonite	$MnSiO_3$
Chromium	Chromite	$FeCr_2O_4$
Titanium	Ilmenite	$FeO•TiO_2$
	Rutile	TiO_2
Zirconium	Baddeleyite	ZrO_2
	Zircon	$ZrSiO_4$
Vanadium	Patronite	V_2S_5+sulfur
	Carnotite	$K_2O•2UO_3•V_2O_5•3H_2O$
	Vanadinite	$3Pb_3(VO_4)_2PbCl_2$
Molybdenum	Molybdenite	MoS_2
	Molybdite	MoO_3
Tungsten	Wolframite	$FeWO_4$
	Scheelite	$CaWO_4$
Silver	Native Silver	Ag
	Argentite	Ag_2S
	Cerargyrite	AgCl
Gold	Native Gold	Au
	Calaverite	$AuTe_2$
	Sylvanite	$(AuAg)Te_2$

Robert Pehlke. **Unit Processes of Extractive Metallurgy**, American Elsevier, New York , 1973