



Mineral Resources: Geology, Exploration, Economics and Environment

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Mineral Deposits

- ❖ Geology: How, Where and When they formed
- ❖ Exploration: How and Where we will find
- ❖ Exploitation: How to use the deposit
- ❖ Economics: How and When to use these deposits
- ❖ Environment: How it affects

Mineral Resource

Mineral Resource: Mineral & Resource

Mineral: Inorganic+crystalline+solids

(Mineral: naturally occurring homogeneous solid with a definite chemical composition and a highly ordered atomic arrangement; it is usually formed by inorganic processes)

Resources: Any thing for economic development

Mineral Resource: Minerals which are direct raw materials of industries having high economic value

Minerals:

- Silicates: Common Rock Forming which constitutes bulk crust which constitutes as raw material for industries like ceramic, glass, refractories, etc
- Non Silicates: Mostly they constitute metallic mineral deposits

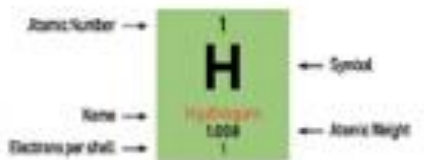
Non Silicate Minerals:

- Oxides/Hydroxides: Al, Fe, Ti, Cr, Mn, Sn, U (Generally oxidation products of other metallic minerals)
- Carbonates: Rarely metals carbonates are important but they form in nature. Backbone of cement and Steel industry
- Sulphides/sulfates: Most important group (most sought)
- Halides: Alkali metals, precious metals
- Phosphates: Th, REE's & Apatite
- Tungstates: W in form of Ca and Fe-Mn tungstates
- Native elements/ metals: Au, Pt, Cu, C, S

Periodic Table of the Elements

1 IA H Hydrogen 1.008 1	2 IIA He Helium 4.003 2											13 IIIA B Boron 10.81 5	14 IVA C Carbon 12.01 6	15 VA N Nitrogen 14.01 7	16 VIA O Oxygen 16.00 8	17 VIIA F Fluorine 18.99 9	18 VIIIA Ne Neon 20.18 10
3 Li Lithium 6.94 3	4 Be Beryllium 9.01 4											19 Al Aluminum 26.98 13	20 Si Silicon 28.09 14	21 P Phosphorus 30.97 15	22 S Sulfur 32.06 16	23 Cl Chlorine 35.45 17	24 Ar Argon 39.95 18
19 K Potassium 39.10 19	20 Ca Calcium 40.08 20	21 Sc Scandium 44.96 21	22 Ti Titanium 47.88 22	23 V Vanadium 50.94 23	24 Cr Chromium 51.99 24	25 Mn Manganese 54.94 25	26 Fe Iron 55.85 26	27 Co Cobalt 58.93 27	28 Ni Nickel 58.69 28	29 Cu Copper 63.55 29	30 Zn Zinc 65.38 30	31 Ga Gallium 69.72 31	32 Ge Germanium 72.64 32	33 As Arsenic 74.92 33	34 Se Selenium 78.96 34	35 Br Bromine 79.90 35	36 Kr Krypton 83.79 36
37 Rb Rubidium 85.47 37	38 Sr Strontium 87.62 38	39 Y Yttrium 88.91 39	40 Zr Zirconium 91.22 40	41 Nb Niobium 92.91 41	42 Mo Molybdenum 95.94 42	43 Tc Technetium 98 43	44 Ru Ruthenium 101.07 44	45 Rh Rhodium 102.91 45	46 Pd Palladium 106.42 46	47 Ag Silver 107.87 47	48 Cd Cadmium 112.41 48	49 In Indium 114.82 49	50 Sn Tin 118.71 50	51 Sb Antimony 121.76 51	52 Te Tellurium 127.60 52	53 I Iodine 126.91 53	54 Xe Xenon 131.29 54
55 Cs Cesium 132.91 55	56 Ba Barium 137.33 56	57-71 Lanthanides	72 Hf Hafnium 178.49 72	73 Ta Tantalum 180.95 73	74 W Tungsten 183.85 74	75 Re Rhenium 186.21 75	76 Os Osmium 190.23 76	77 Ir Iridium 192.22 77	78 Pt Platinum 195.08 78	79 Au Gold 196.97 79	80 Hg Mercury 200.59 80	81 Tl Thallium 204.38 81	82 Pb Lead 207.2 82	83 Bi Bismuth 208.98 83	84 Po Polonium 209 84	85 At Astatine 210 85	86 Rn Radon 222 86
87 Fr Francium 223 87	88 Ra Radium 226 88	89-103 Actinides	104 Rf Rutherfordium 261 104	105 Db Dubnium 262 105	106 Sg Seaborgium 263 106	107 Bh Bohrium 264 107	108 Hs Hassium 265 108	109 Mt Meitnerium 266 109	110 Ds Darmstadtium 267 110	111 Rg Roentgenium 268 111	112 Cn Copernicium 285 112	113 Nh Nihonium 284 113	114 Fl Flerovium 285 114	115 Mc Moscovium 286 115	116 Lv Livermorium 287 116	117 Ts Tennessine 289 117	118 Og Oganesson 289 118

89 La Lanthanum 138.91 57	90 Ce Cerium 140.12 58	91 Pr Praseodymium 140.91 59	92 Nd Neodymium 144.24 60	93 Pm Promethium 145 61	94 Sm Samarium 150.36 62	95 Eu Europium 151.96 63	96 Gd Gadolinium 157.25 64	97 Tb Terbium 158.93 65	98 Dy Dysprosium 162.50 66	99 Ho Holmium 164.93 67	100 Er Erbium 167.26 68	101 Tm Thulium 168.93 69	102 Yb Ytterbium 173.05 70	103 Lu Lutetium 174.97 71
99 Ac Actinium 227 89	90 Th Thorium 232.04 90	91 Pa Protactinium 231.04 91	92 U Uranium 238.03 92	93 Np Neptunium 237 93	94 Pu Plutonium 244 94	95 Am Americium 243 95	96 Cm Curium 247 96	97 Bk Berkelium 247 97	98 Cf Californium 251 98	99 Es Einsteinium 252 99	100 Fm Fermium 257 100	101 Md Mendelevium 258 101	102 No Nobelium 259 102	103 Lr Lawrencium 260 103



State of matter (color of name): GAS LIQUID SOLID UNKNOWN

Subcategory in the metal-metalloid-nonmetal trend (color of background):
 Alkali metals (red), Alkaline earth metals (orange), Transition metals (blue), Lanthanides (light blue), Actinides (green), Post-transition metals (purple), Metalloids (yellow), Reactive nonmetals (light green), Noble gases (pink), Unknown chemical properties (grey)

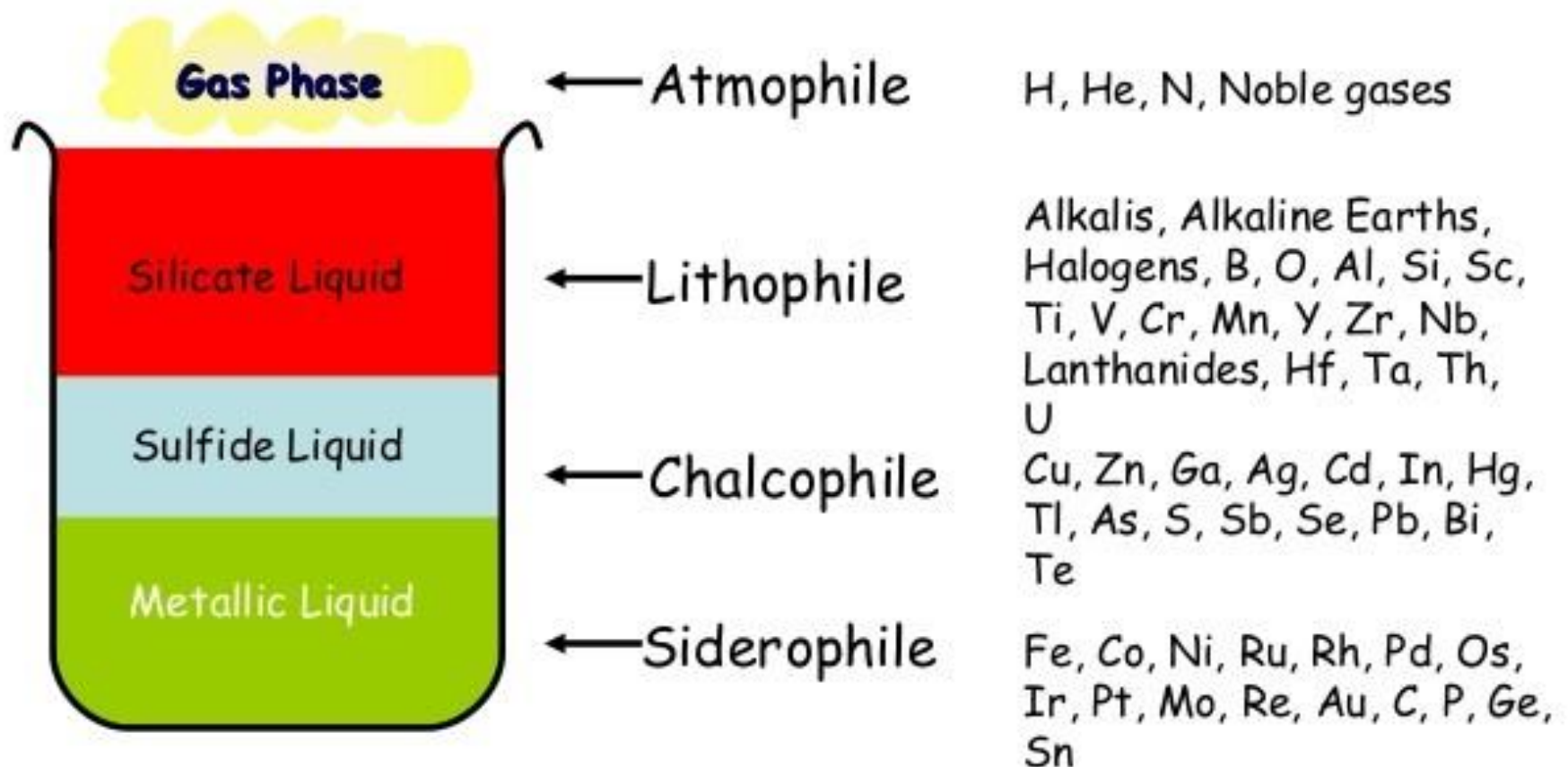
Geochemical Classification:

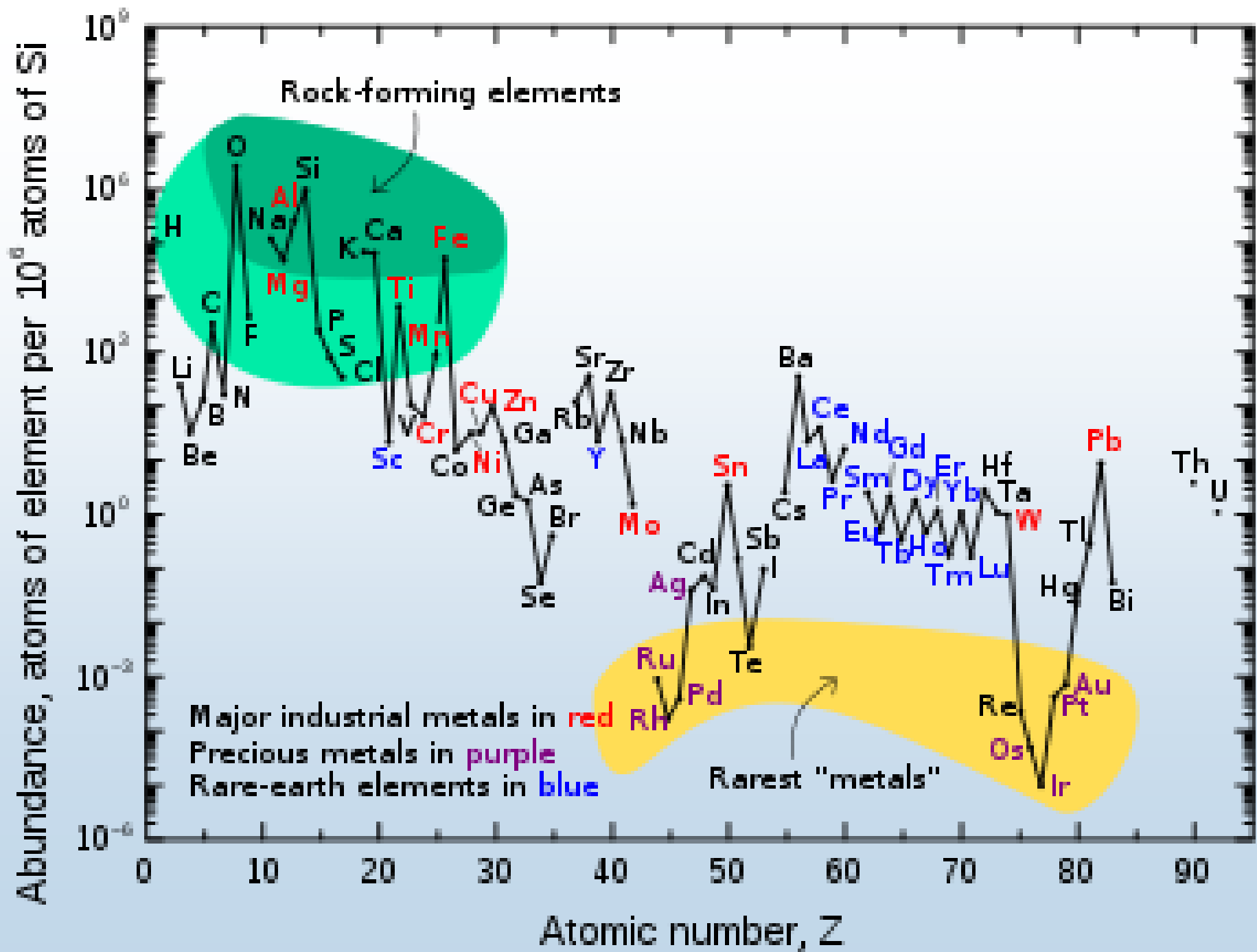
Atmophile	Siderophile
Lithophile	Artificial
Chalcophile	

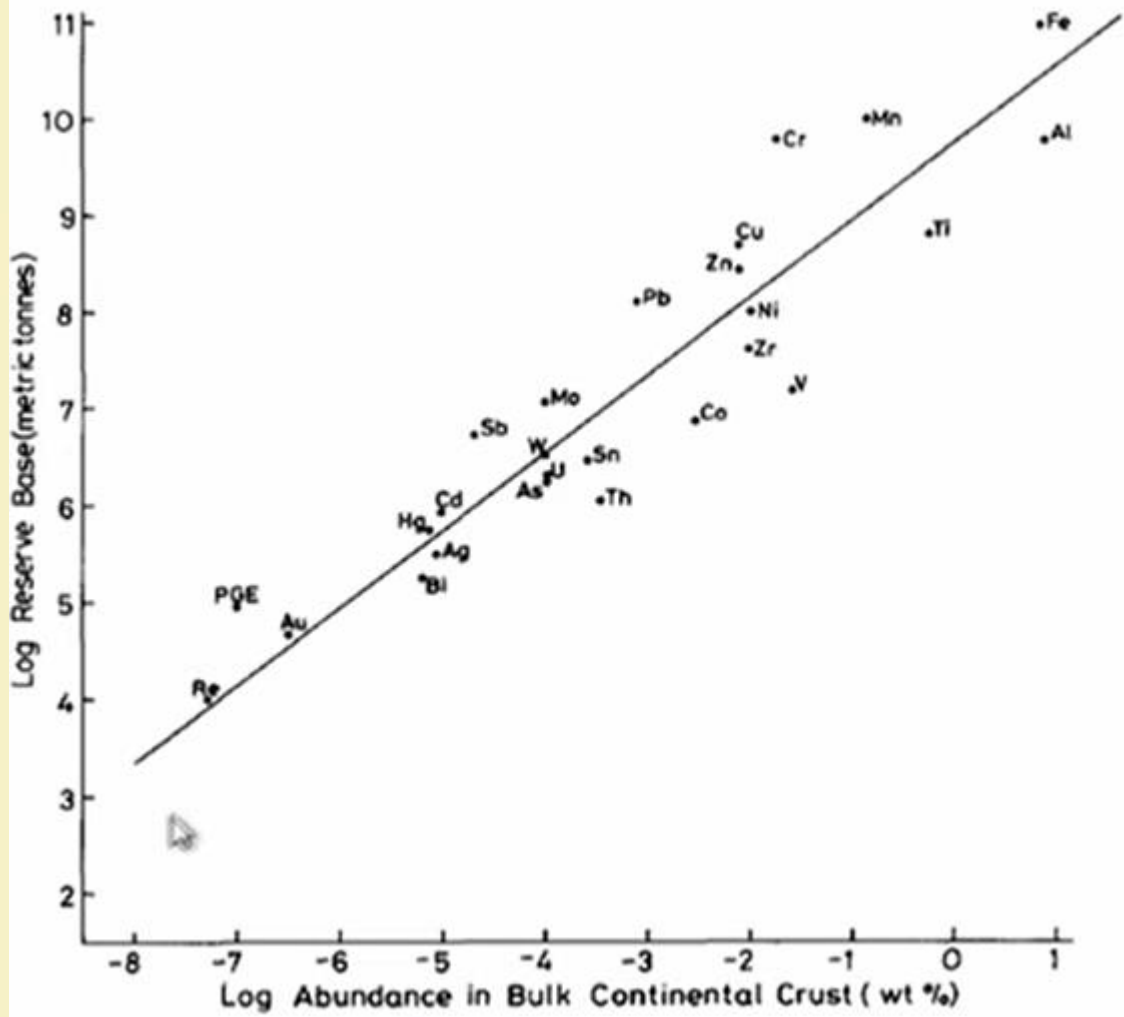
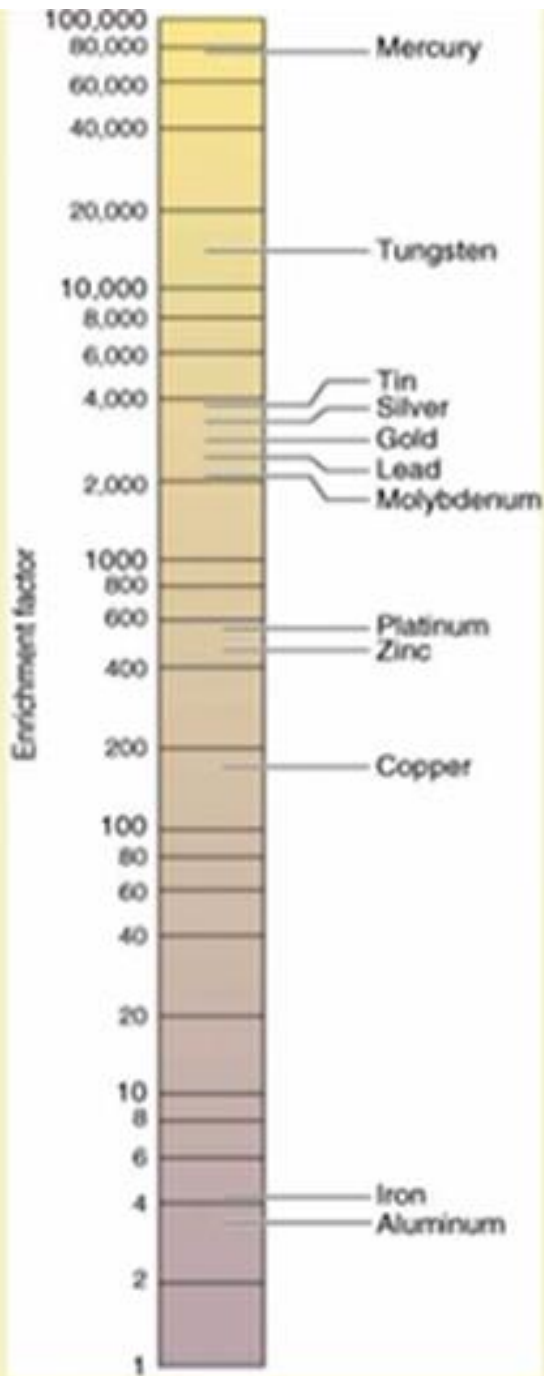
	IA	IIA											IIIA	IVA	VA	VIA	VIIA	VIIIA	
1	1 H																	2 He	
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne	
3	11 Na	12 Mg	IIIB	IVB	VB	VIB	VII B	VIII B		IB	IIB	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar		
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr	
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe	
6	55 Cs	56 Ba		72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn	
7	87 Fr	88 Ra		104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt										
Lanthanides			57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu		
Actinides			89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr		

Geochemical Affinity

In the classification scheme of Goldschmidt, elements are divided according to how they partition between coexisting silicate liquid, sulfide liquid, metallic liquid, and gas phase...







Deposits Vs Resources

Mineral /Ore
Deposit



Mineral
Resource

Distinct Quantity:
Measurable

Generalised
Qualitative
Representative

Where are they found: Mostly but not limited to upper crust

Domains

Exposed at
the surface



Up to 5 kms

Recent Sedimentary Basins

Ancient Sedimentary Basins

Magmatic bodies

Crustal scale brittle/ductile deformation zones (shear zones, fracture zones, folds)

Where are they found: Mostly but not limited to upper crust

Basic terminologies:

- Ore: It is a rock (aggregate of minerals) which contains one or more minerals of appreciable commercial/economic value.
- Alternatively, it is rock that contains one or more metals (elements) with sufficiently higher concentrations than a 'threshold' or 'background' value or 'Clarke' value

Any Questions??

Thank You !!!

