Solar Abundance of elements

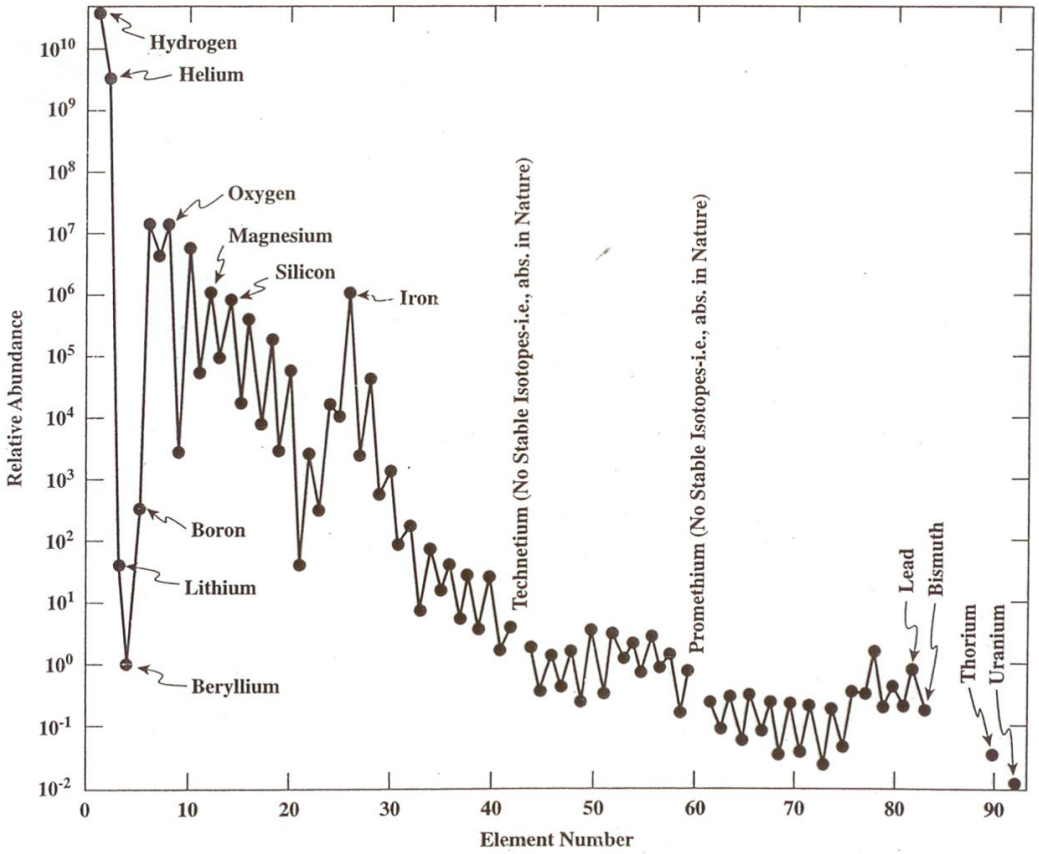
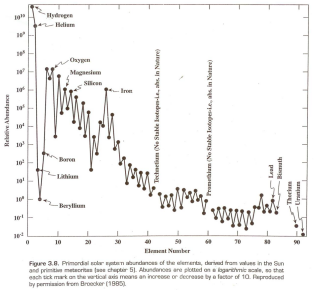


Figure 3.8. Primordial solar system abundances of the elements, derived from values in the Sun and primitive meteorites (see chapter 5). Abundances are plotted on a *logarithmic* scale, so that each tick mark on the vertical axis means an increase or decrease by a factor of 10. Reproduced by permission from Broecker (1985).

Solar Abundance of elements



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Relation with mass number

a) Rapid exponential decrease for elements

b) Pronounced peak for Fe26

c) Even atomic number more common than odd numbers on both sides

d) 10 elements with atomic number <27 are most abundant: H, He, C,N,O, Ne,Mg,Si,S,Fe

Nucleii with even N + even Z most abundant

Nucleii with odd N-even Z & even N-odd Z are equally abundant

Nucleii with odd N and odd Z least abundant-exception N(14)

Why Fe is relatively more abundant?

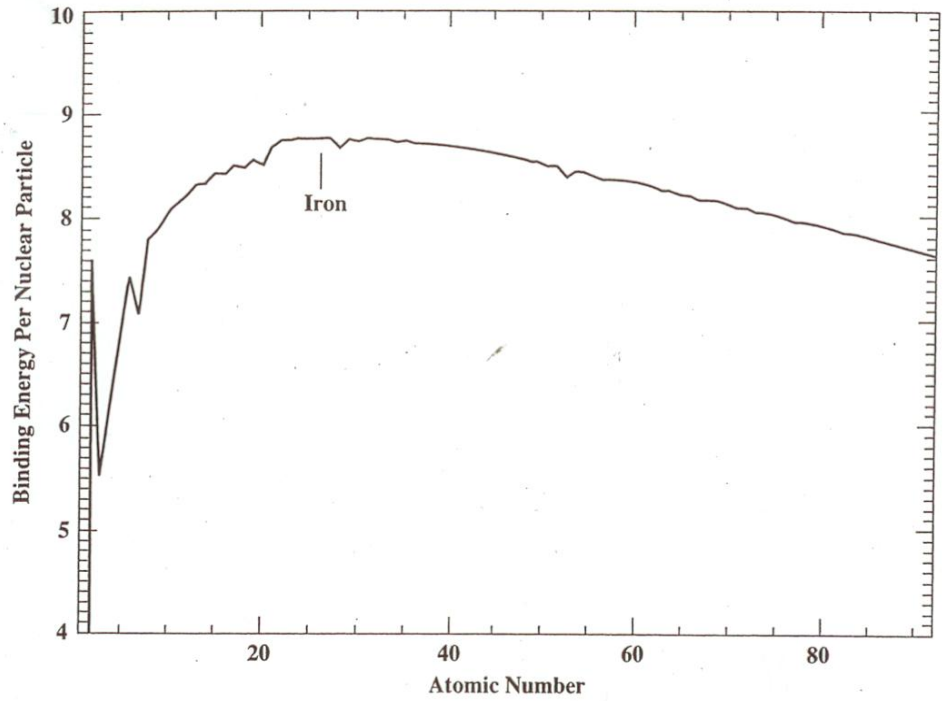


Figure 4.1. Binding energy of the nucleus as a function of atomic number. The higher the energy, the more stable is the nucleus against fragmentation or other decay. Note that stability is highest around the atomic number corresponding to iron. The binding energy is expressed relative to the number of protons and neutrons in the nucleus, and the units are millions of *electron volts*. One electron volt is 1.6×10^{-19} joules, and is a convenient unit for energies on the small scale of atoms. The curve was computed from a model that roughly fits the measured value for most elements, but there are small deviations from the experimental values.

Meteorites

Meteoroid (Asteroid) enters the atmosphere and burns to produce meteor.

Meteor falling on the Earth is Meteorite

Classification of Meteorites

Basis of classification: Chemistry, Mineralogy, Microstructure

IRONS (6%), STONY IRONS (2%) and STONES (92%)

STONES are further divided into Chondrite (84%) and Achondrite (8%)

IRONS: Fe-Ni Alloy + FeS (very similar to the core of the Earth)

STONY IRONS: Fe-Ni Alloy + Fe-Mg silicates

STONES: Basically Fe-Mg silicates;

Chondrites are with **Chondrules***

A special type of chondrite is Carbonaceous Chondrite with C, minerals with water and other volatiles

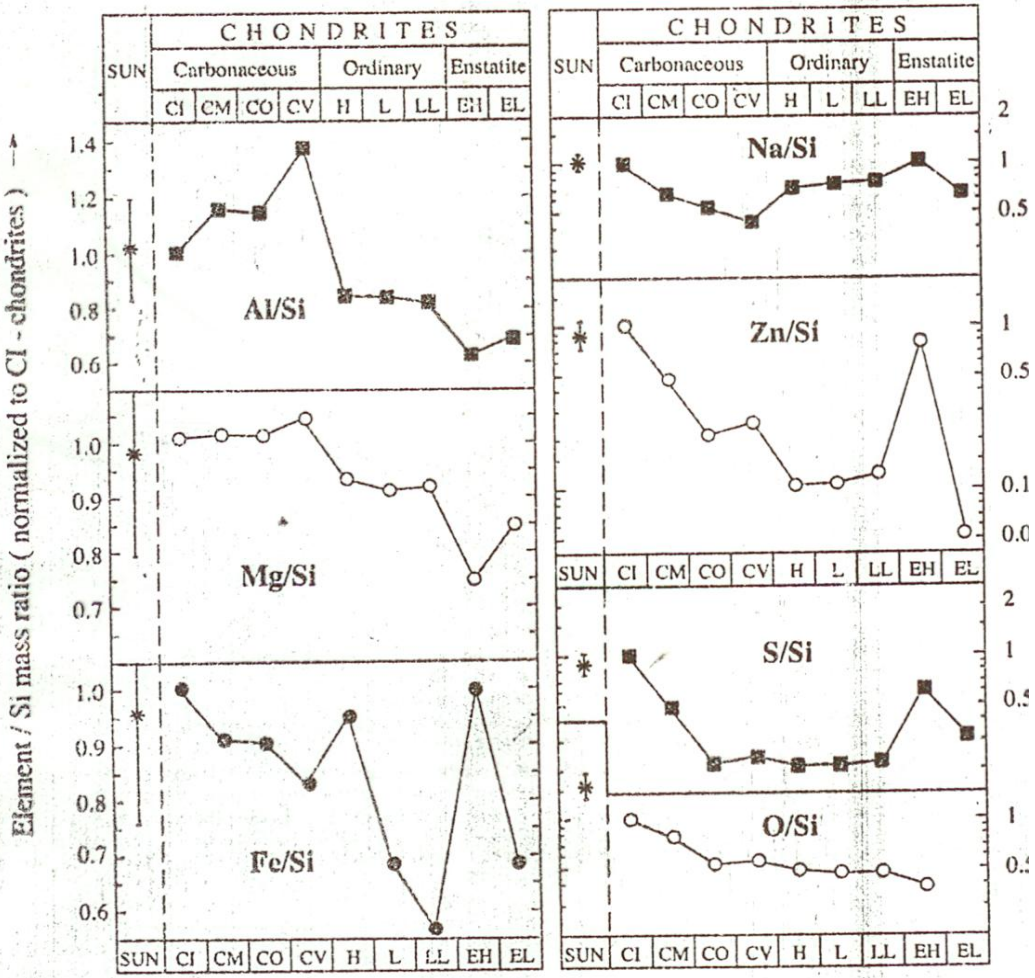
Carbonaceous chondrites are further subdivided, but Type I is considered to be most primitive as it contains maximum volatile matter.

Hundreds of research papers, principally by biologists, discuss about the origin of carbon in meteorites, searching for extraterrestrial origin of life

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2829962/

Element / Si ratios in Different types of meteorites

Fig. 1



Element abundance Solar Vs, C1 chondrite

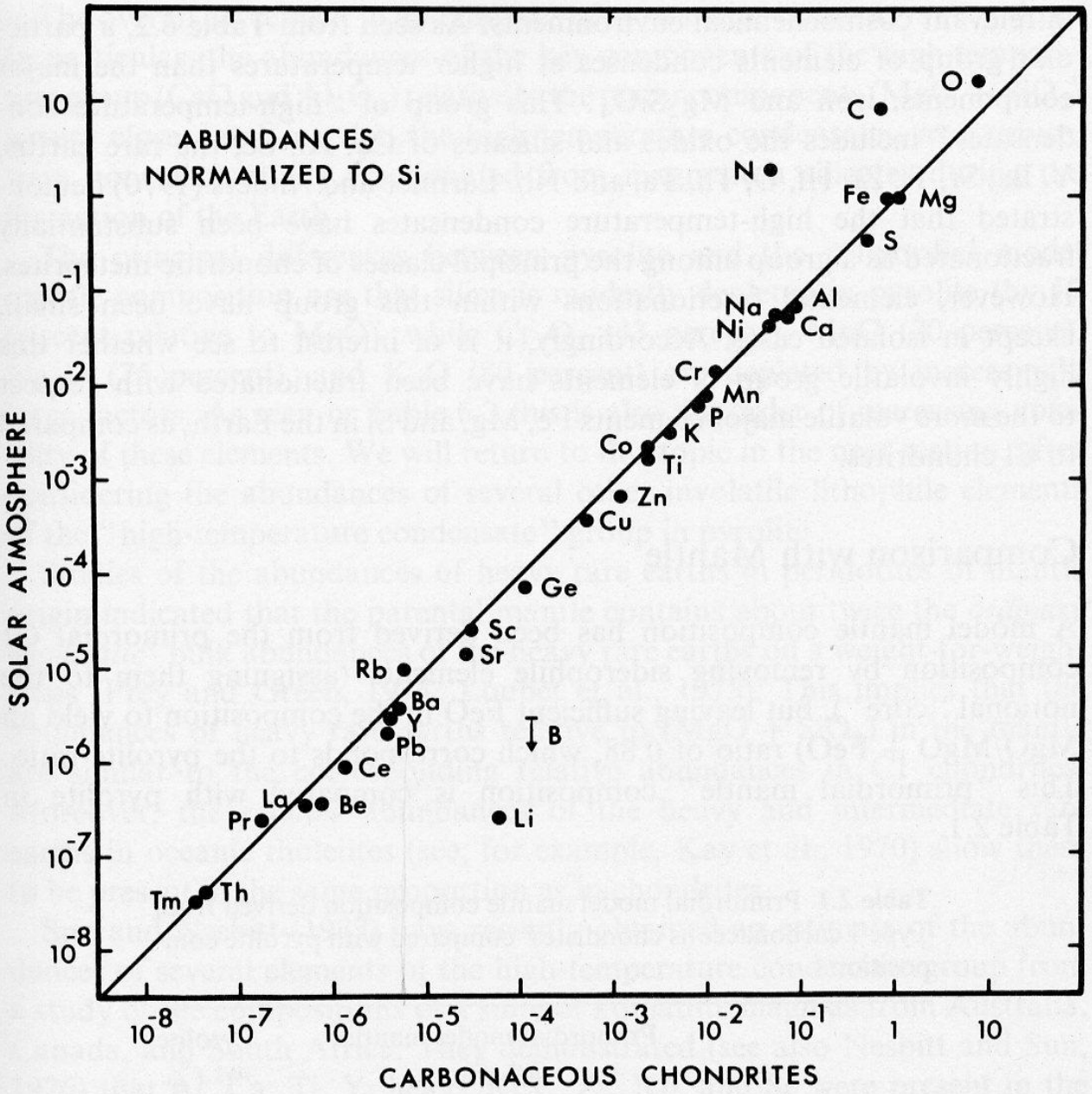
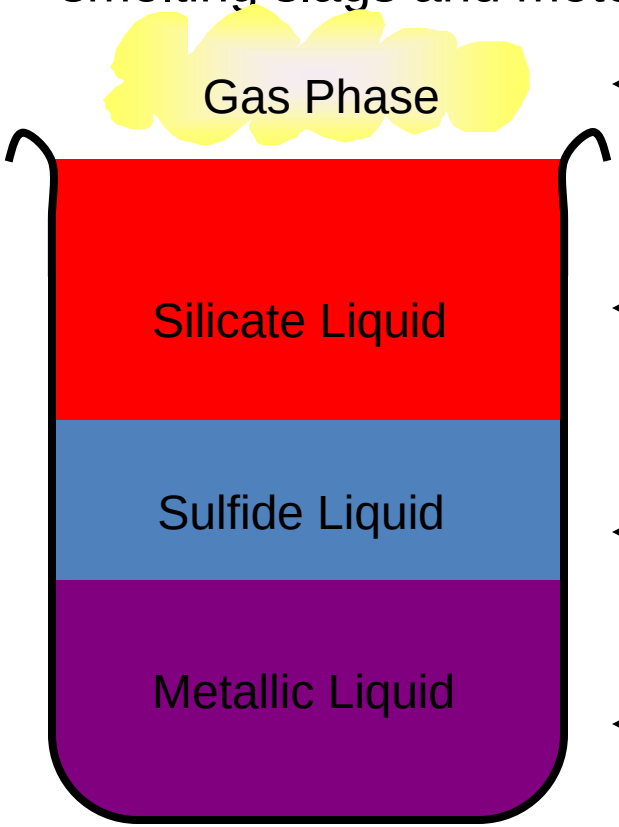


Figure 2.2 Comparison of elemental abundances in Type 1 carbonaceous chondrites with those in the solar photosphere. All abundances are normalized on the basis of Si = 10^6. (From J. E. Ross and Aller, 1976.)

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…defined by examining ore smelting slags and meteorites



← Atmophile	H, He, N, Noble gases
← Lithophile	Alkalis, Alkaline Earths, Halogens, B, O, Al, Si, Sc, Ti, V, Cr, Mn, Y, Zr, Nb, Lanthanides, Hf, Ta, Th, U
← Chalcophile	Cu, Zn, Ga, Ag, Cd, In, Hg, Tl, As, S, Sb, Se, Pb, Bi, Te
← Siderophile	Fe, Co, Ni, Ru, Rh, Pd, Os, Ir, Pt, Mo, Re, Au, C, P, Ge, Sn

Atmophile elements: Covalently bonded gases with weak van der Waals forces

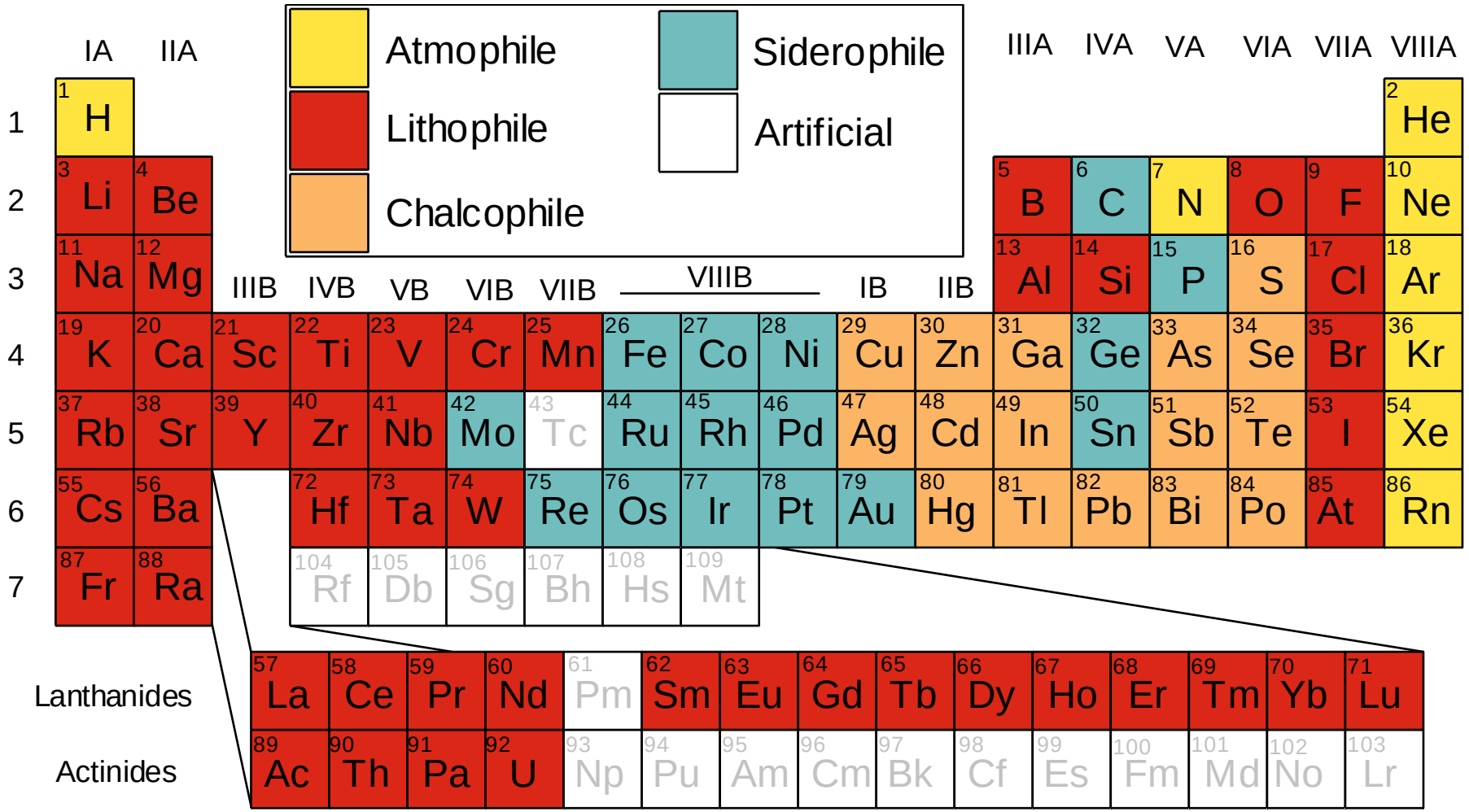
Siderophile elements: Transition metals , Metallic bonding

Chalcophile elements: Covalent bonding

Lithophile elements: Ionic bonding

Geochemical classification of elements

What makes an element siderophile or lithophile? Notably, the Goldschmidt categories are well-grouped in the **periodic table of the elements**:



Cosmochemical classification of elements

Basis: Condensation temperature

Tc is calculated at 10x-4 bars

Refractory: Al, Ti, REE, U, Pb… 1400-1850K
Main Component: Mg,Cr,Si….1250-1350K
Moderately volatile: Mn,P, Rb,K…640-1230K
Highly volatile: Cl,Br,H,C,O….<640K

Cosmochemical classification of elements