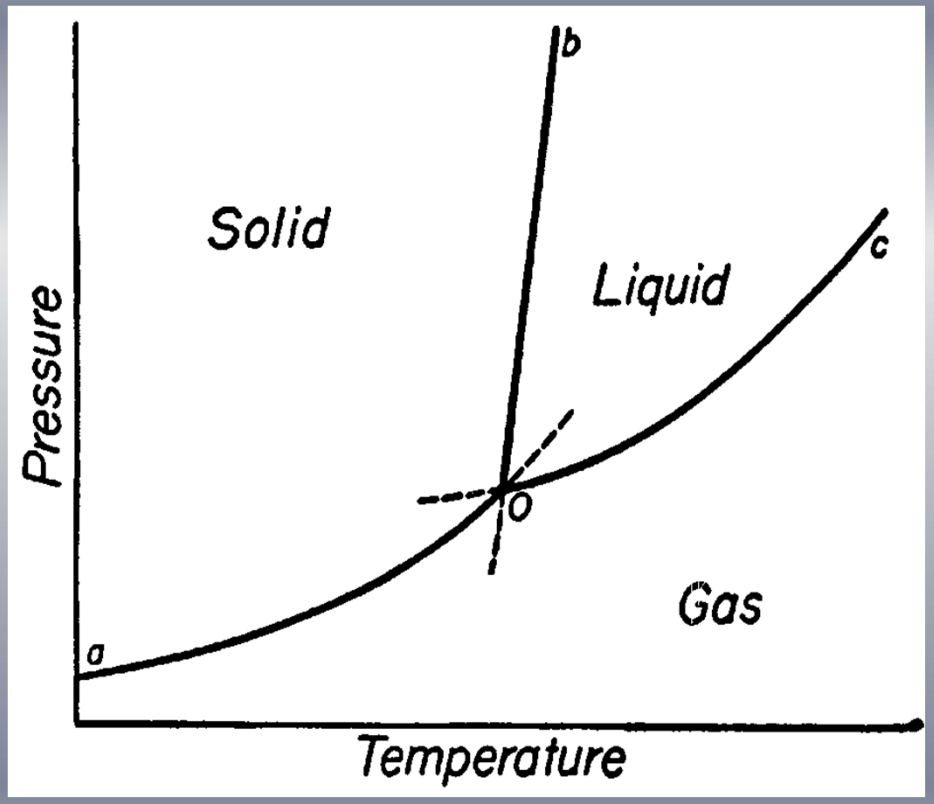
Sistemas Unários

1 componente → **Variáveis: *P* e *T***



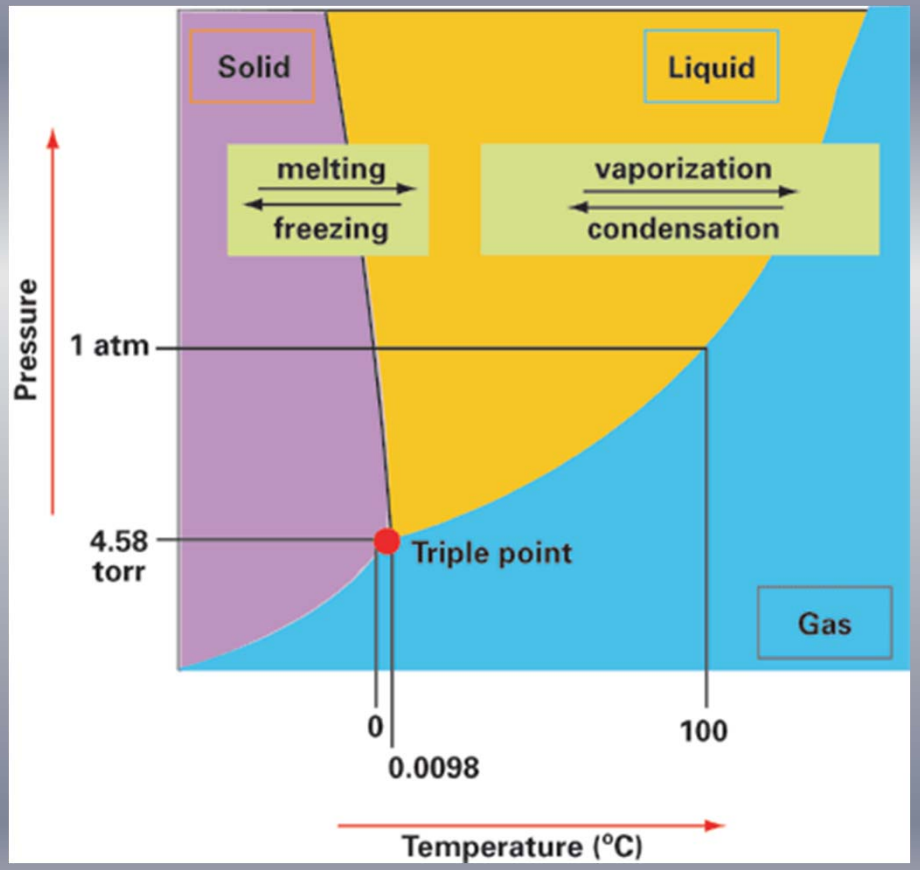


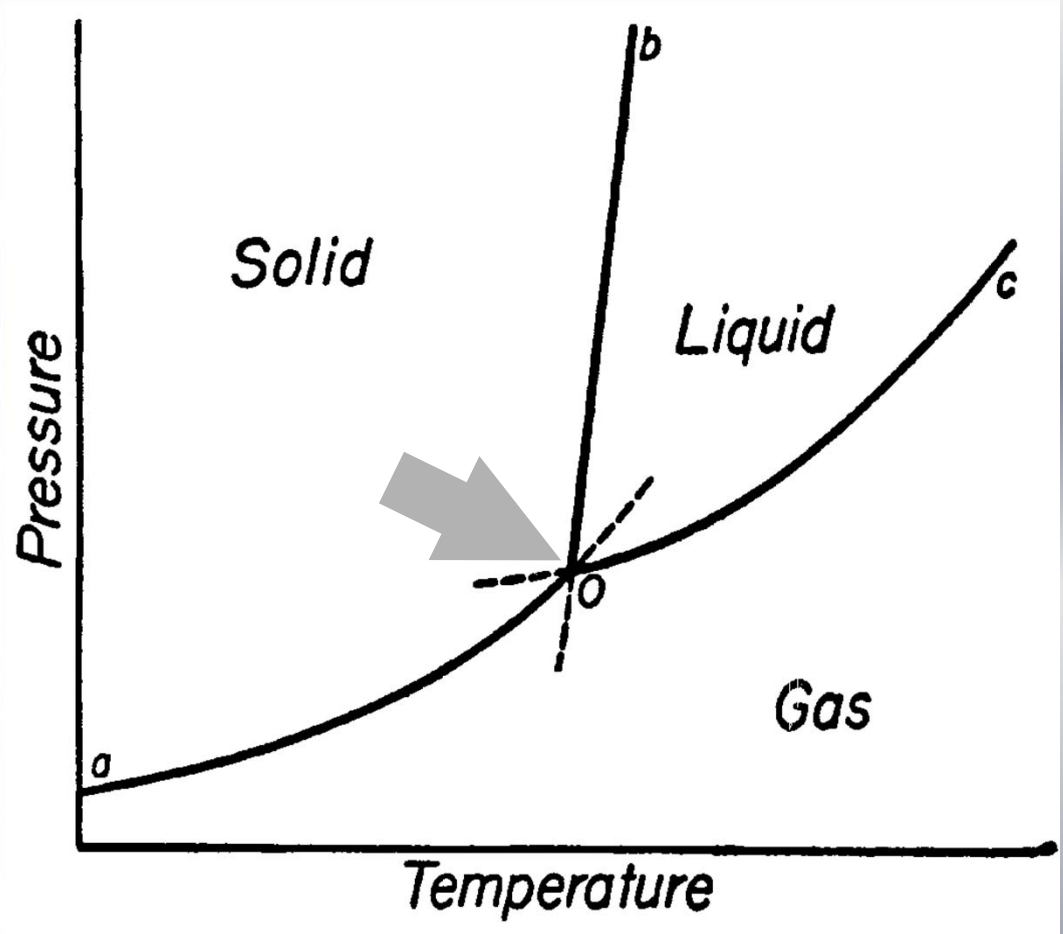
Diagrama de fases da água

Equilíbrio Invariante ($F = 0$)

$F = 0$ e $C = 1$

$P + 0 = 1 + 2$

$P = 3$



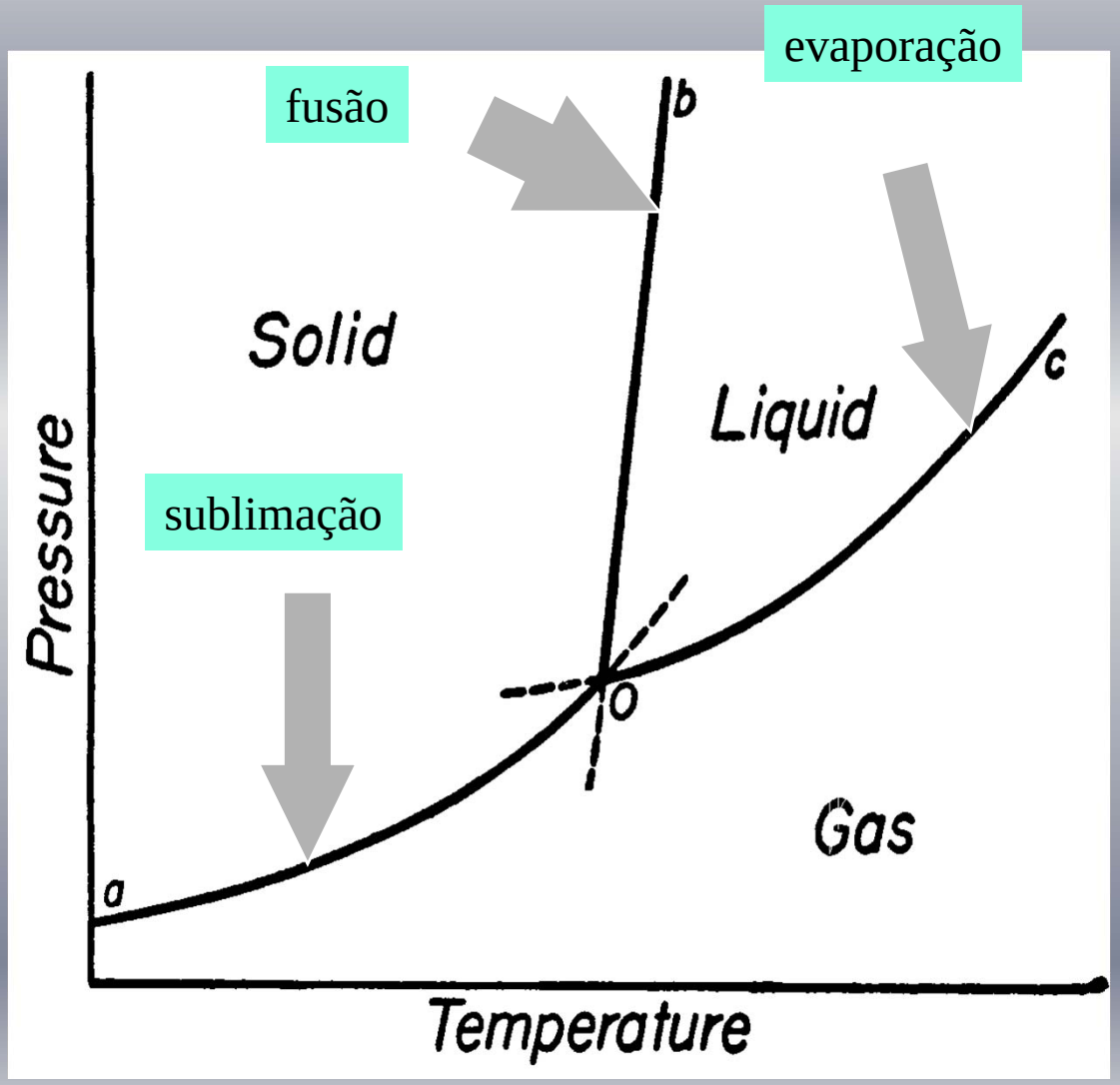
Geral: a regra das fases não está relacionada com as quantidades das fases presentes ou com suas propriedades, mas somente com o número de fases presentes no equilíbrio e com suas composições, temperatura e pressão.

Equilíbrio Monovariante ($F = 1$)

$F = 1$ e $C = 1$

$P + 1 = 1 + 2$

$P = 2$

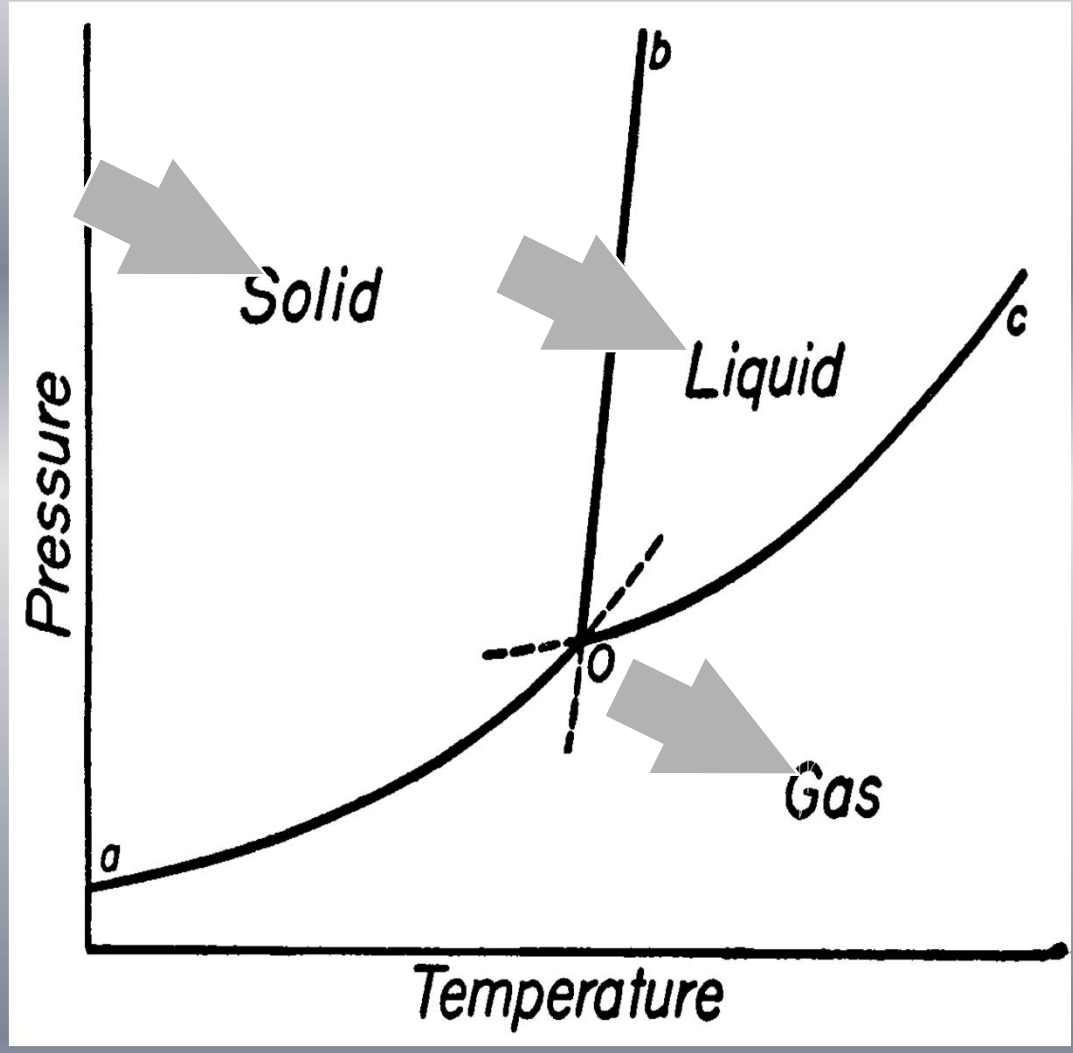


Equilíbrio Bivariante ($F = 2$)

$F = 2$ e $C = 1$

$P + 2 = 1 + 2$

$P = 1$

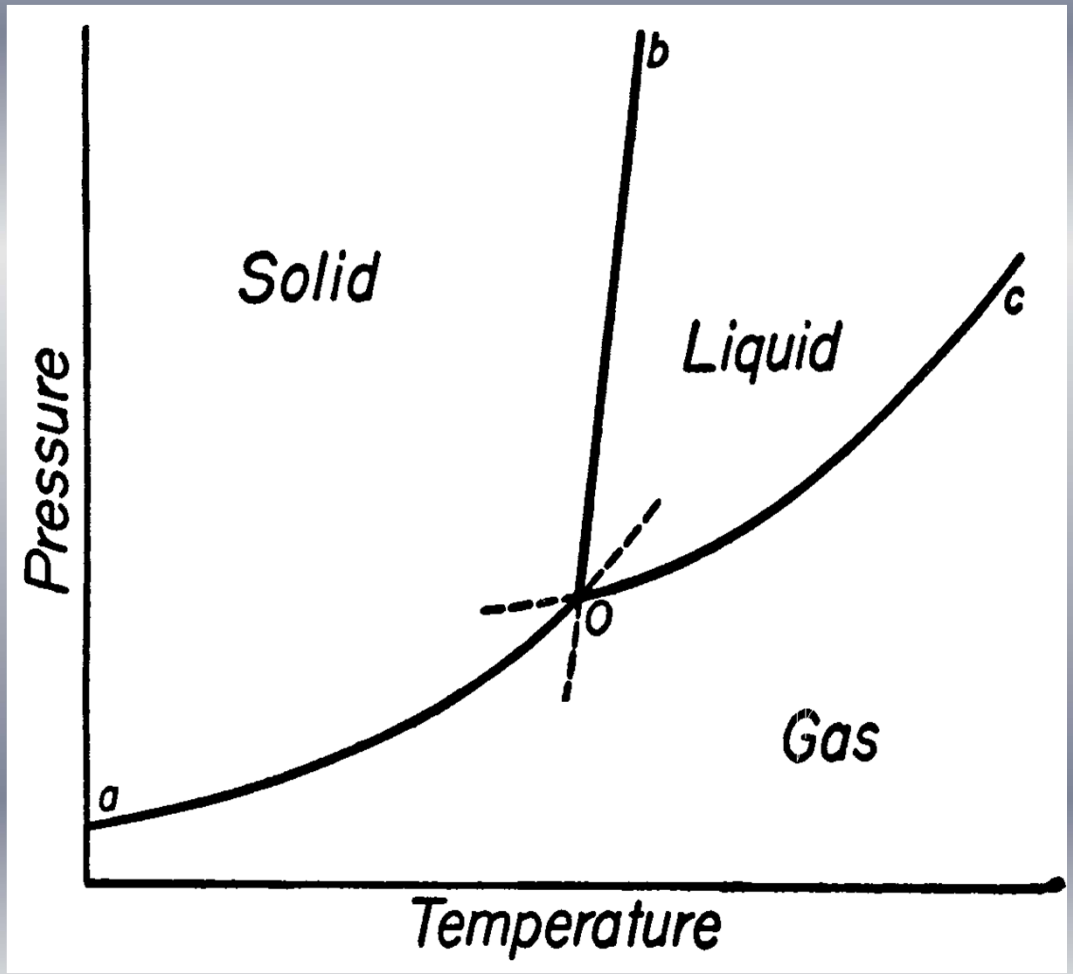


Forma das curvas

Le Chatelier (qualitativo) : Quando uma ação é exercida sobre o sistema, este varia de forma a anular os efeitos desta ação.

Clausius-Clapeyron (quantitativo)

$$\frac{dP}{dT} = \frac{\Delta H_{tr}}{T \Delta V_{tr}}$$

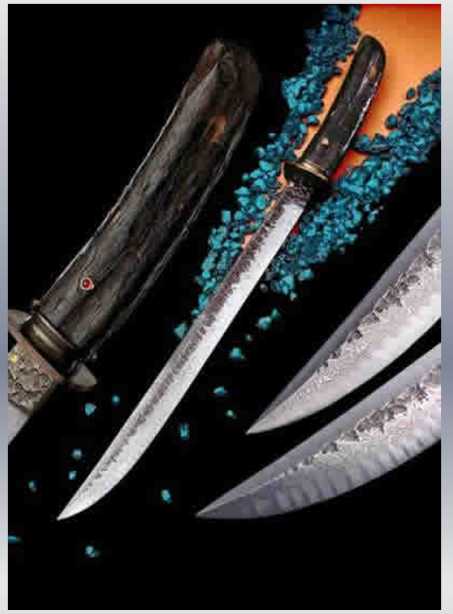


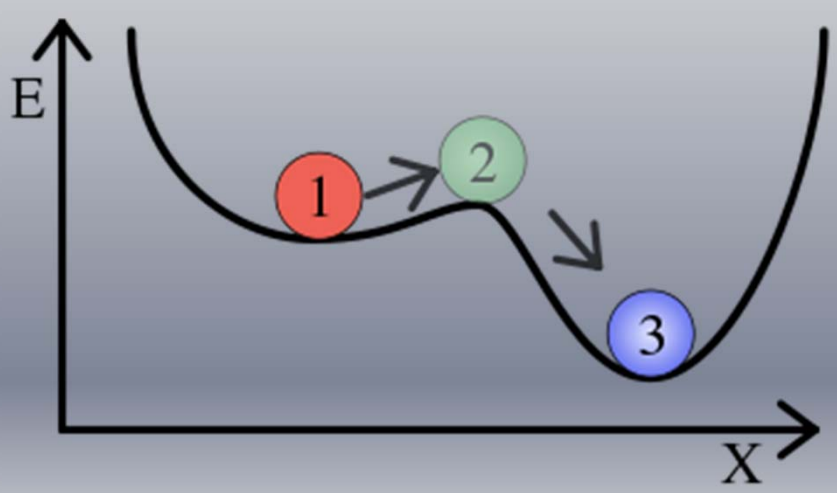
Equilíbrio univariante metaestável

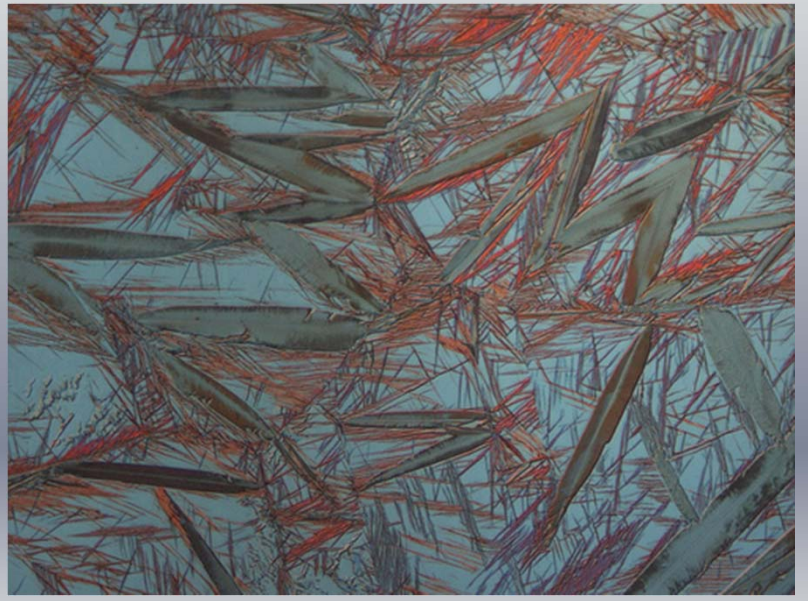
Exemplo: subresfriamento do equilíbrio L+G

A extensão de uma curva de equilíbrio bifásico para além do equilíbrio trifásico que a limita ocorre para dentro do campo de estabilidade da terceira fase não presente no equilíbrio bifásico.

Metaestabilidade







Pressão de vapor de elementos puros

TABLE 12-1. VAPOR PRESSURE OF THE ELEMENTS*.
(Temperature in degrees Kelvin for various partial pressures in atmospheres)

Species	10^{-6} atm	10^{-5} atm	10^{-4} atm	10^{-3} atm	10^{-2} atm	1 atm
A	.....	.....	.....	.....	.....	87.3(l)
Ag	1200(s)	1305	1442	1607	1816	2485
Al	1290(l)	1405	1545	1725	1940	2600
As_4	477(s)	517	563	622	708	895
At_2	.....	270(s)	320	350	390	500
Au	1570(l)	1720	1896	2112	2388	3239
B	1500(s)	1600	1750	1900	2150	2800(l)
Ba	810(s)	890	985(l)	1116	1293	1911
Be	1390(s)	1505	1655(l)	1830	2070	2780
Bi	873(l)	960	1060	1190	1360	1900
Br_2	173(s)	186	203	222	245	331(l)
C	2720(s)	2920	3170	3450	3800	4775
Ca	790(s)	867	961	1075	1231(l)	1755
Cb	2820(l)	3050	3340	3700	4120	5400
Cd	485(s)	530	585(l)	657	744	1038
Ce	1450(l)	1550	1700	1850	2100	2800
Cl_2	114(s)	123	139	153	169	239(l)
Co	1750(s)	1900(l)	2100	2300	2600	3370
Cr	1350(s)	1465	1600	1755	1960	2495(l)
Cs	383(l)	425	476	544	634	963
Cu	1400(l)	1530	1685	1875	2117	2868
F_2	.....	.....	.....	.....	58(l)	85
Fr(87)	.....	.....	490(l)	.....	.....	950
Fe	1550(s)	1680	1837(l)	2033	2277	3008
Ga	1225(l)	1350	1500	1690	1920	2700
Ge	1370(l)	1500	1670	1880	2150	2980
H_2	.....	.....	.....	.....	.....	20.39(l)
He	.....	.....	.....	.....	.....	4.22(l)
Hf	2850(l)	3100	3350	3750	4150	5500
Hg	287(l)	316	351	394	449	634
I_2	241(s)	260	282	308	341	456(l)
In	1100(l)	1210	1350	1510	1730	2440
Ir	2580(s)	2800(l)	3040	3350	3700	4800
K	429(l)	475	534	605	702	1052
Kr	.....	.....	.....	.....	.....	119.9(l)
La	1500(l)	1650	1800	2000	2250	3000
Li	705(l)	775	865	980	1130	1640
Mg	653(s)	715	789	881	1000(l)	1399
Mn	1140(s)	1240	1360	1570(l)	1750	2370
Mo	2530(s)	2740	3000(l)	3330	3750	5077
N_2	.....	.....	.....	.....	.....	77.4(l)
Na	510(l)	558	623	705	813	1187
Ne	.....	.....	.....	.....	.....	27.3(l)
Ni	1630(s)	1765(l)	1930	2130	2380	3110

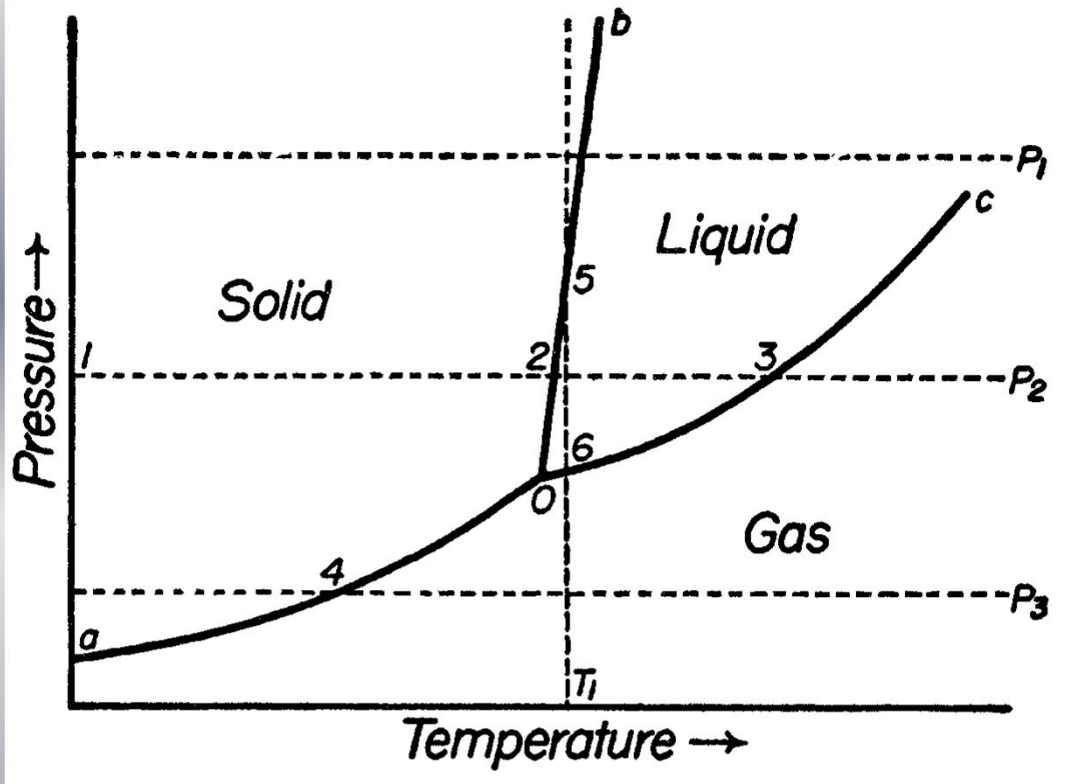
Pressão de vapor de elementos puros

TABLE 12-1. VAPOR PRESSURE OF THE ELEMENTS.*—(*Continued*)

Species	10^{-6} atm	10^{-5} atm	10^{-4} atm	10^{-3} atm	10^{-2} atm	1 atm
O_2	.....	.....	.....	.....	.....	90.2(l)
Os	2700(s)	2900	3160(l)	3470	3850	4900
P_4(yellow)	244(s)	268	296	334(l)	382	553
Pa	2250(l)	2450	2700	2950	3300	4500
Pb	887(l)	975	1088	1226	1408	2010
Pd	1660(s)	1800	2000(l)	2240	2530	3440
Po_2	.....	660(s)	750	835(l)	945	1300
Pt	2160(l)	2340	2550	2820	3140	4100
Ra	650(s)	700	770	850	965	1410(l)
Rb	403(l)	445	496	561	650	952
Re	2900(s)	3150	3450(l)	3850	4300	5800
Rh	2200(s)	2400(l)	2600	2850	3200	4150
Rn	.....	.....	.....	.....	.....	211(l)
Ru	2480(s)	2670	2900(l)	3180	3500	4500
S_2	.....	.....	500(l)			
Sb_2	860(s)	940(l)	1025	1160	1340	1890
Sc	1540(s)	1680(l)	1850	2050	2300	3000
Se_2	525(l)	568	620	679	755	1000
	(2 atm Se_6 and 10^{-4} atm Se at 1000°K)					
Si	1480(s)	1600	1740(l)	1920	2140	2750
Sn	1300(l)	1450	1600	1850	2150	3000
Sr	740(s)	810	900	1010	1150(l)	1657
Ta	3300(l)	3600	3900	4300	4800	6300
Tc(43)	2550(l)	2750	3000	3300	3700	5000
Te_2	655(s)	700	758(l)	825	907	1130
Th	2250(l)	2450	2700	2950	3300	4500
Ti	1640(s)	1800	1990	2210(l)	2500	3400
Tl	795(l)	870	965	1082	1235	1730
U	2000(l)	2150	2350	2580	2900	3800
V	1970(l)	2140	2340	2550	2900	3800
W	3230(s)	3490	3780(l)	4150	4625	5950
Xe	.....	.....	.....	.....	.....	165.1(l)
Y	1750(s)	1900(l)	2100	2300	2700	3500
Zn	560(s)	610	672	750(l)	852	1180
Zr	2070(s)	2250	2450(l)	2700	3000	3850

* Taken from Leo Brewer, Report for the Manhattan Project, MDDC-438C, 1946.

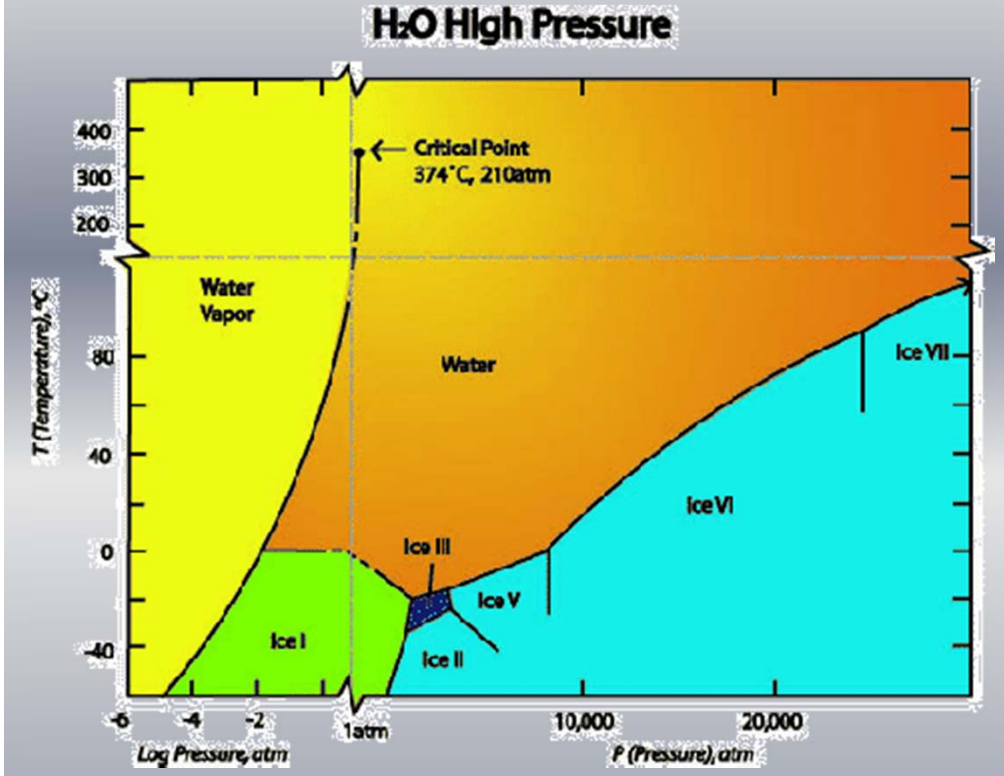
2.4 - Interpretação de diagramas unários

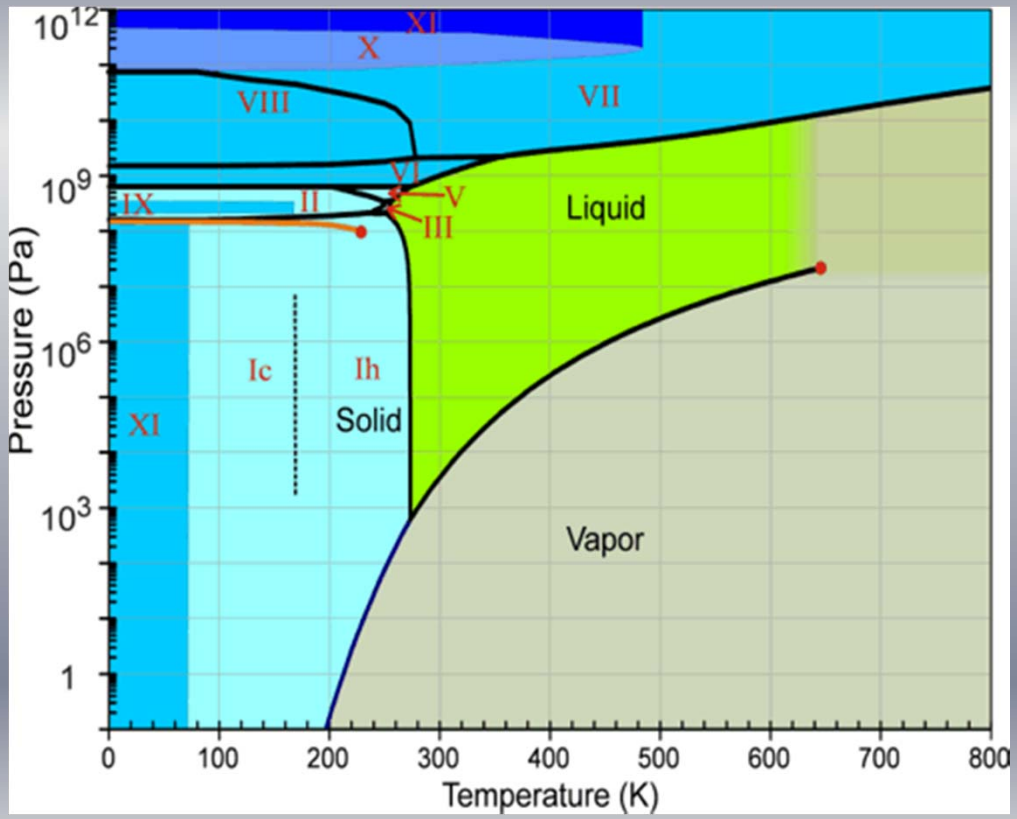


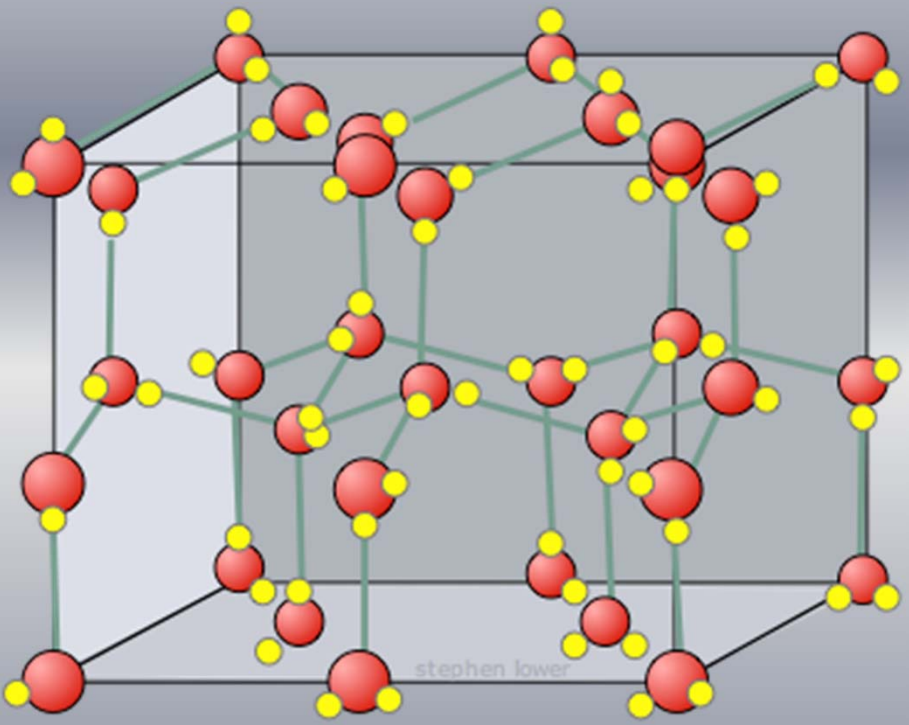
Metal	As	Ba	Ca	Cu	Fe	Pb
T (^oC)	**814**	**704**	**850**	**1083**	**1535**	**327**
P (atm)	**36**	**1.10^{-3}**	**1.10^{-4}**	**8.10^{-7}**	**5.10^{-5}**	**1.10^{-7}**

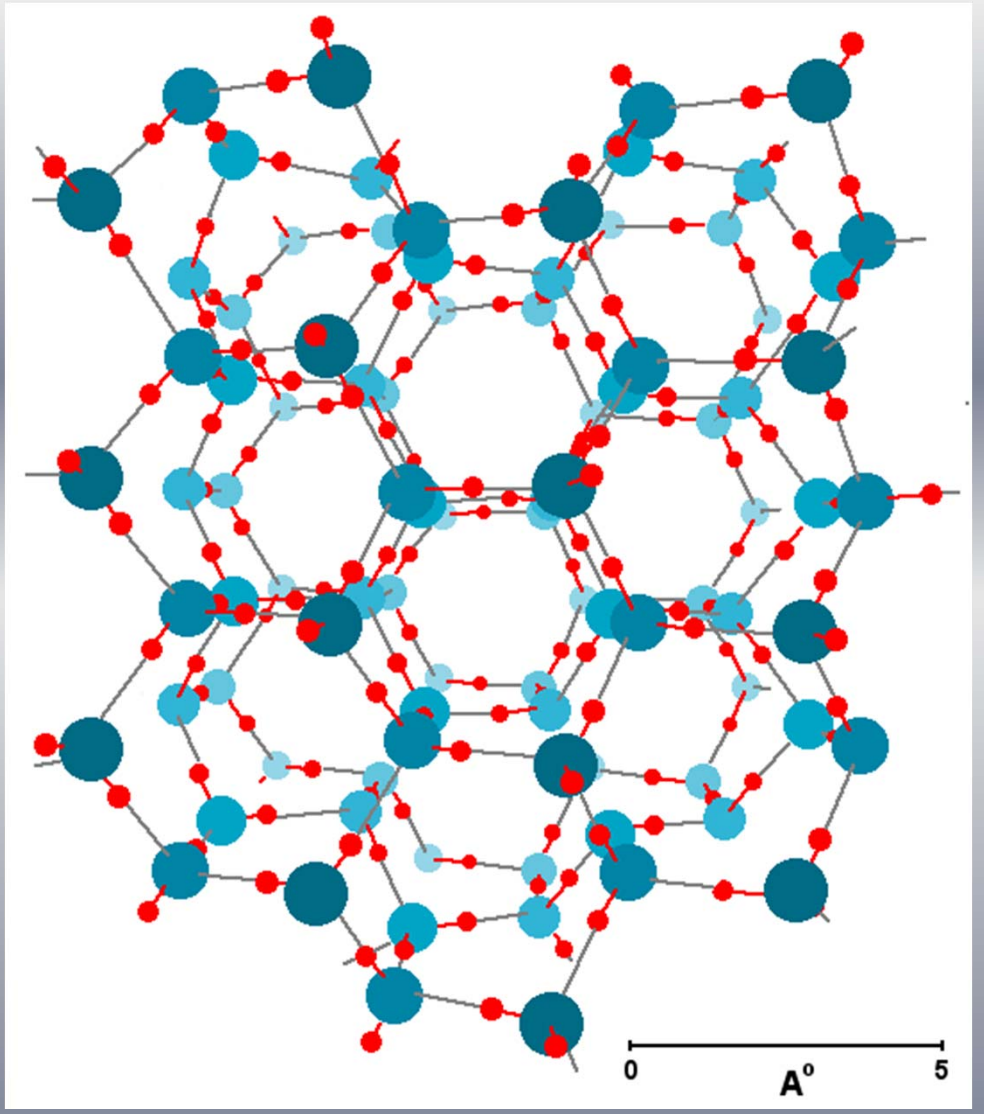
Metal	Mn	Hg	Ni	Pt	Ag	Zn
T (^oC)	**1240**	**-38,87**	**1455**	**1773**	**960**	**419**
P (atm)	**1.10^{-3}**	**1.10^{-9}**	**1.10^{-4}**	**1.10^{-6}**	**1.10^{-4}**	**5.10^{-2}**

2.5 - Alotropia









Gelo: diferente estruturas cristalinas

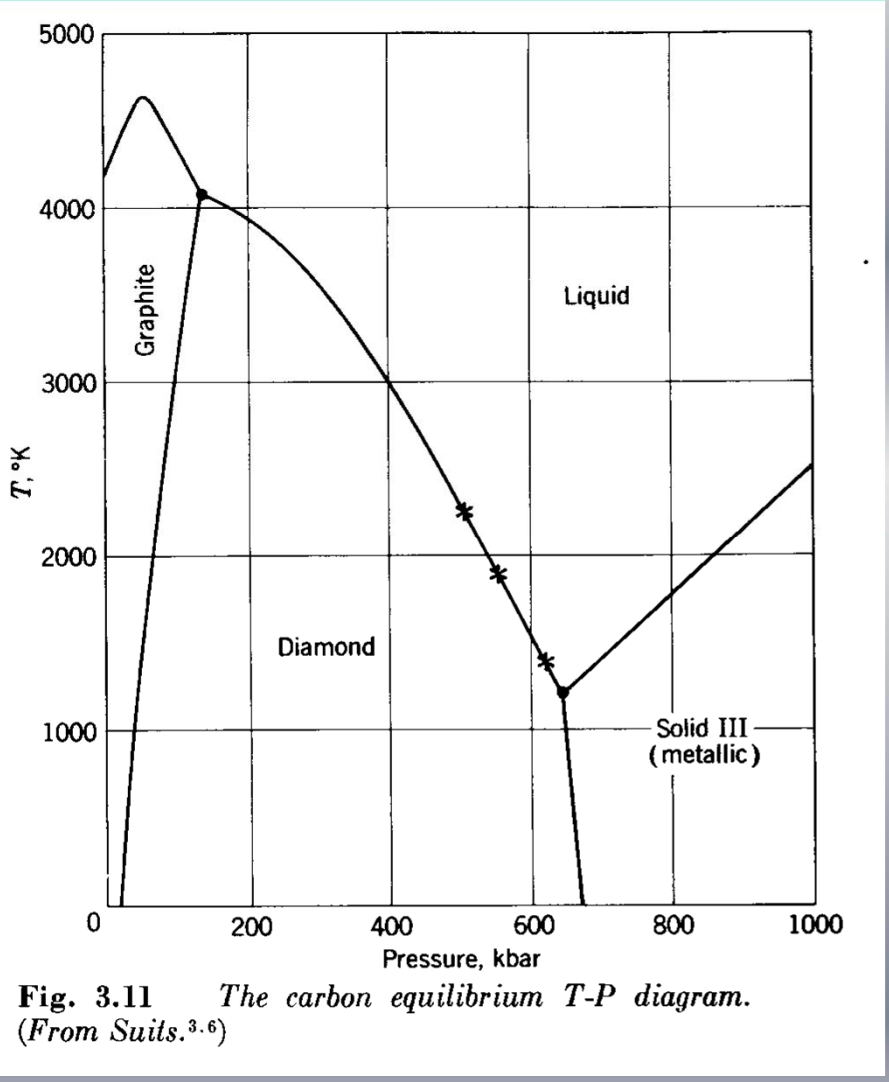
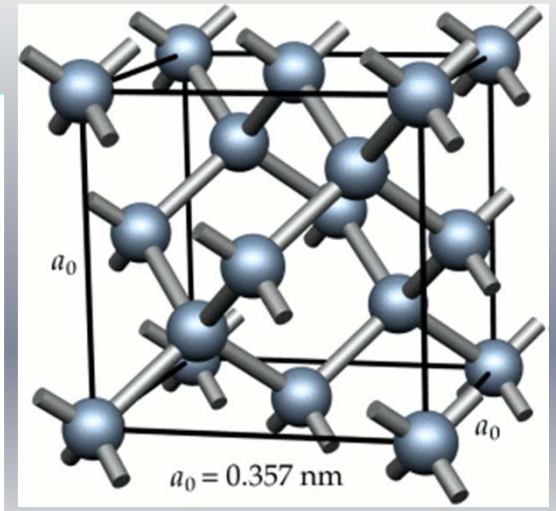
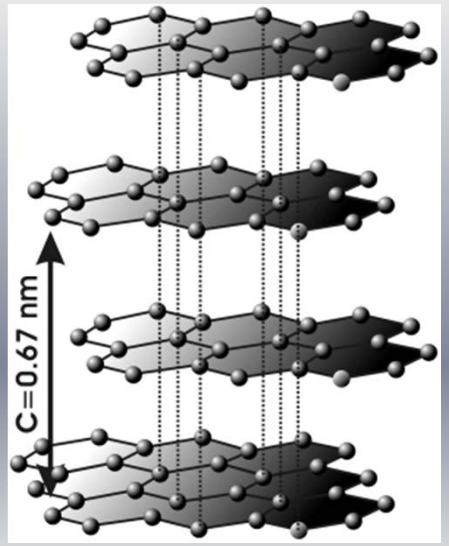


Fig. 3.11 *The carbon equilibrium T-P diagram.* (*From Suits.*[3.6])

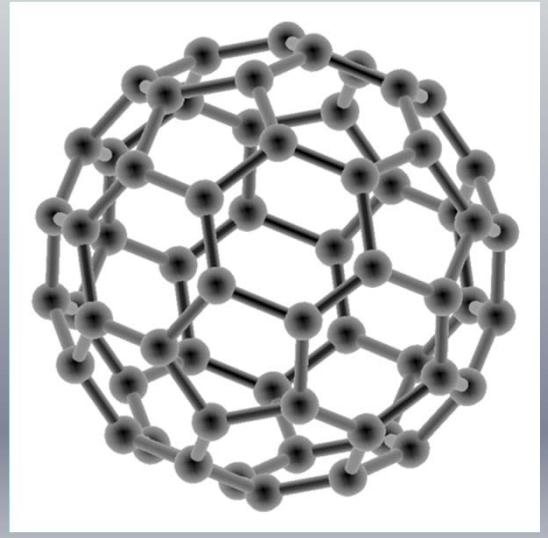
Diagrama de fases do carbono

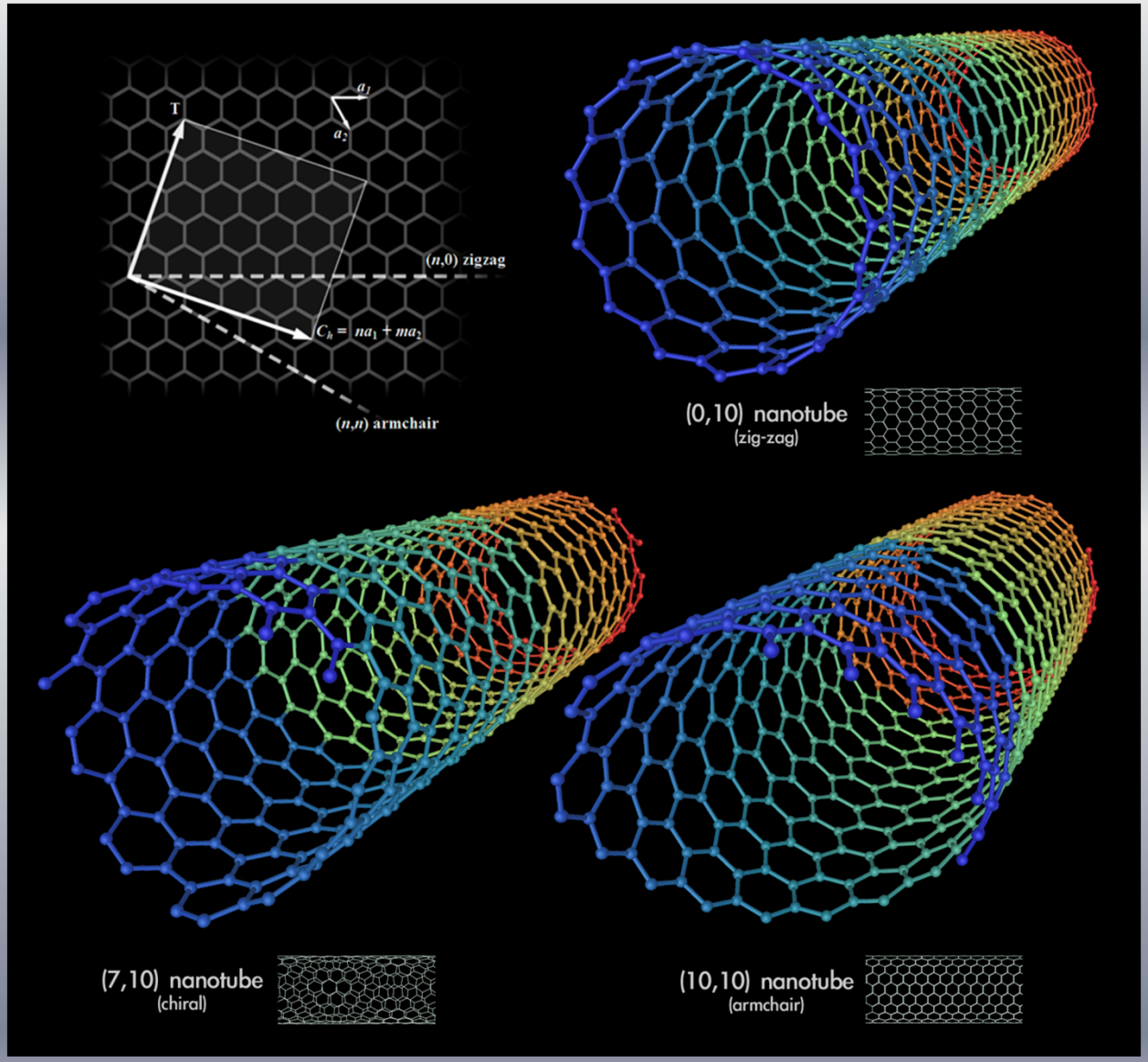


Diamante



Grafite





Nanotubos de carbono

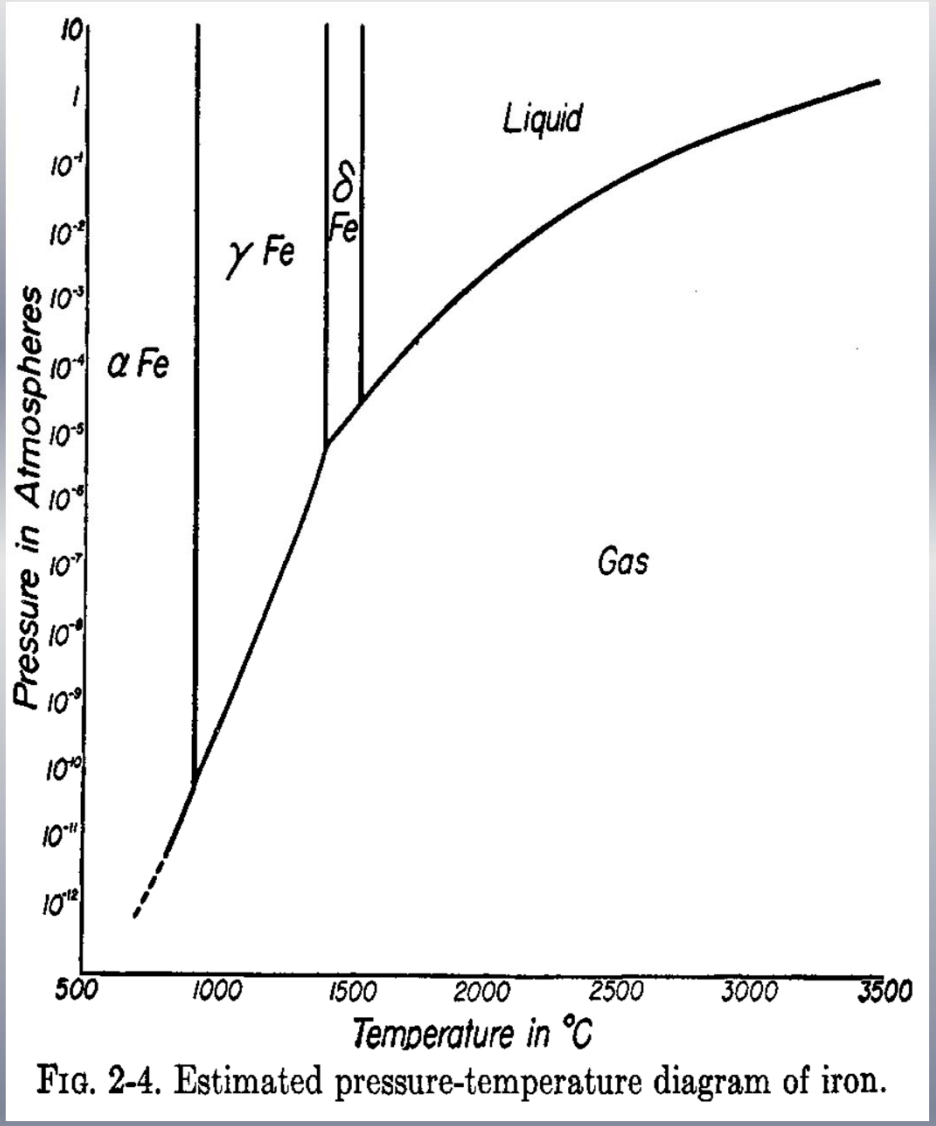


FIG. 2-4. Estimated pressure-temperature diagram of iron.

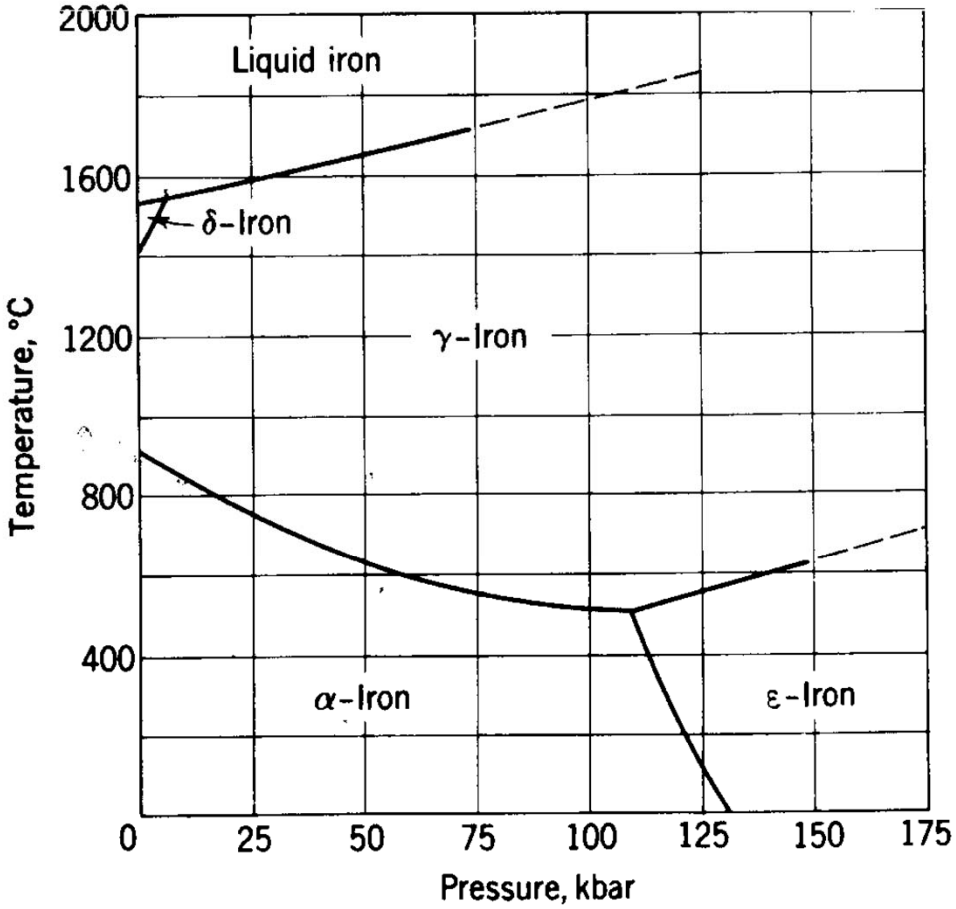
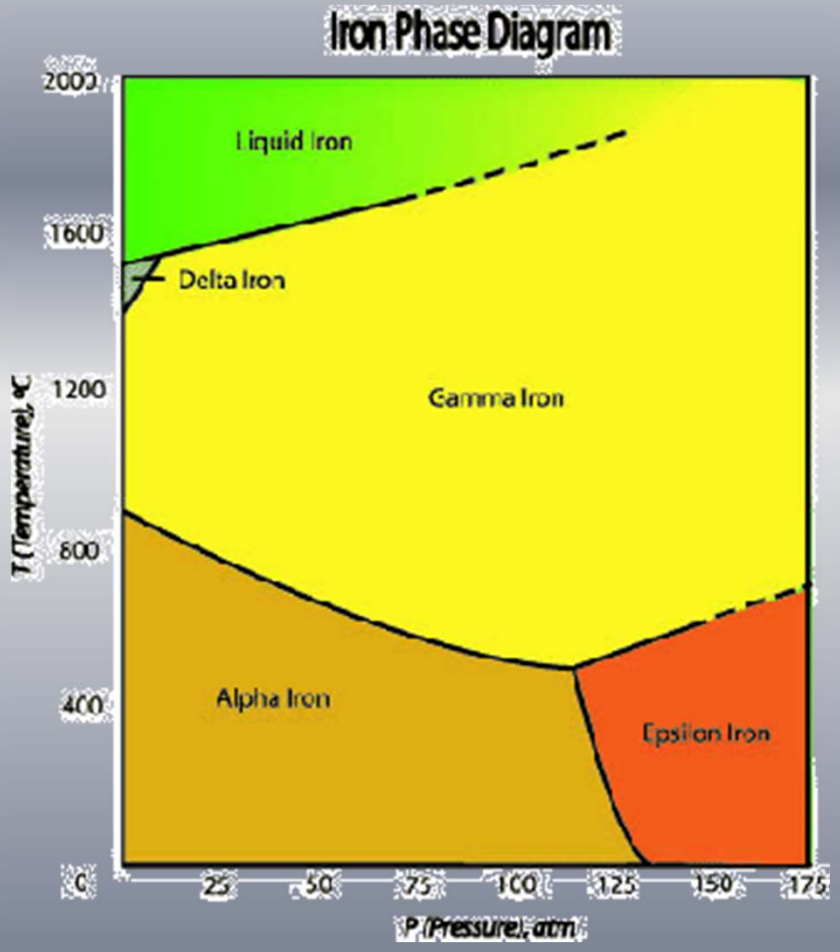
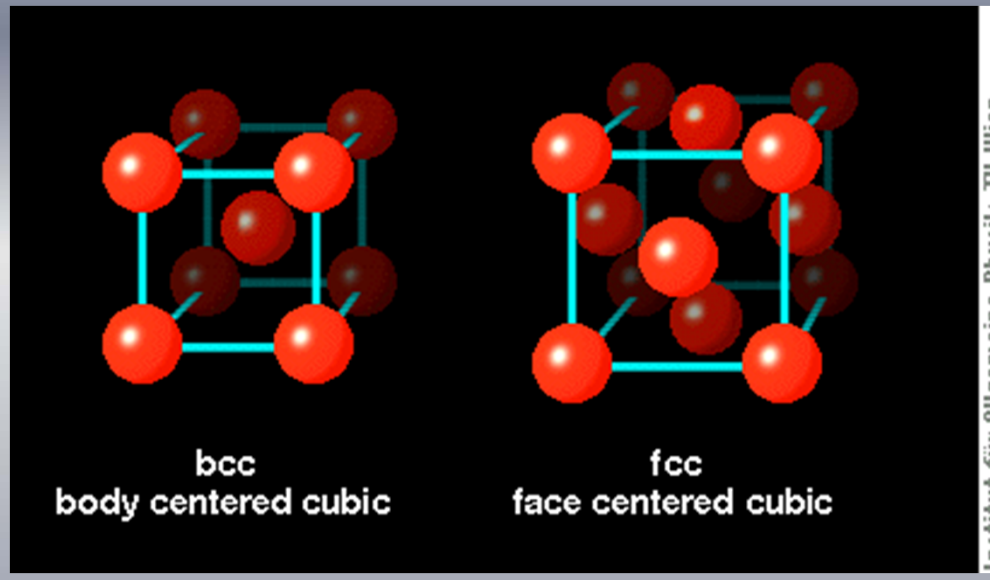
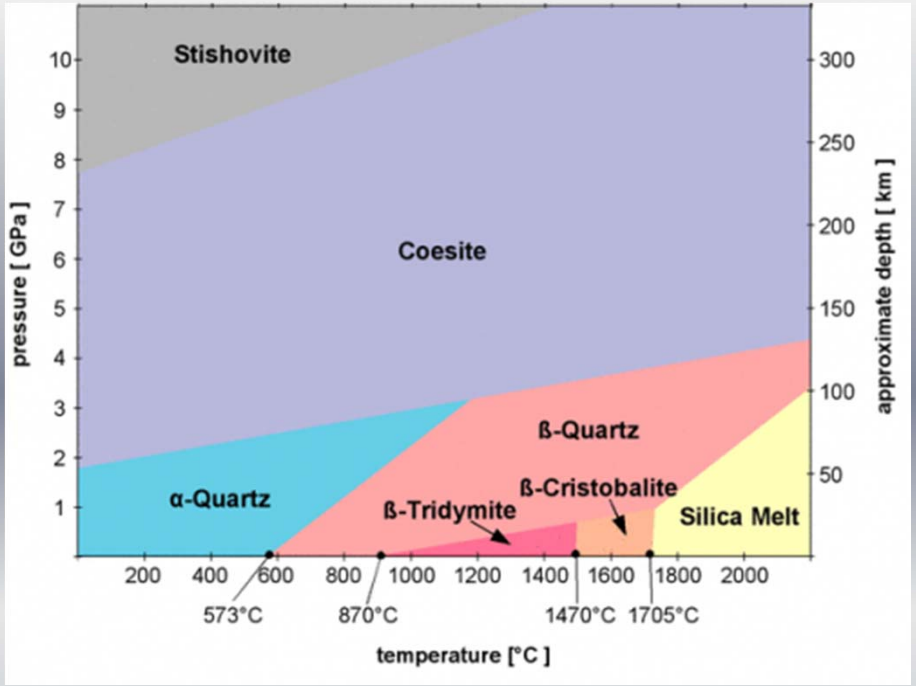


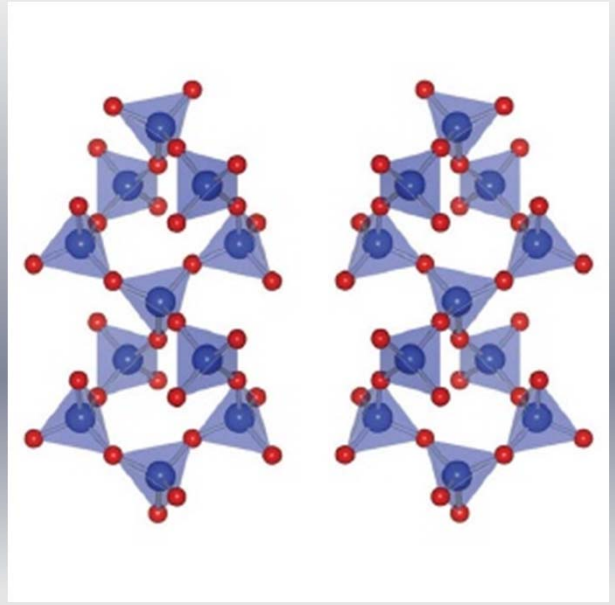
Fig. 3.5 *The iron T-P equilibrium phase diagram. (From Takahashi and Bassett, The Composition of the Earth's Interior. Copyright © 1965 by Scientific American, Inc. All rights reserved.)*

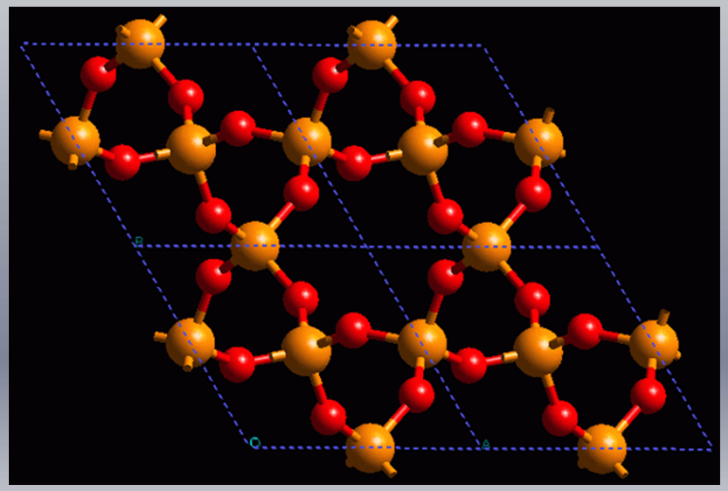
Diagrama de fases do ferro

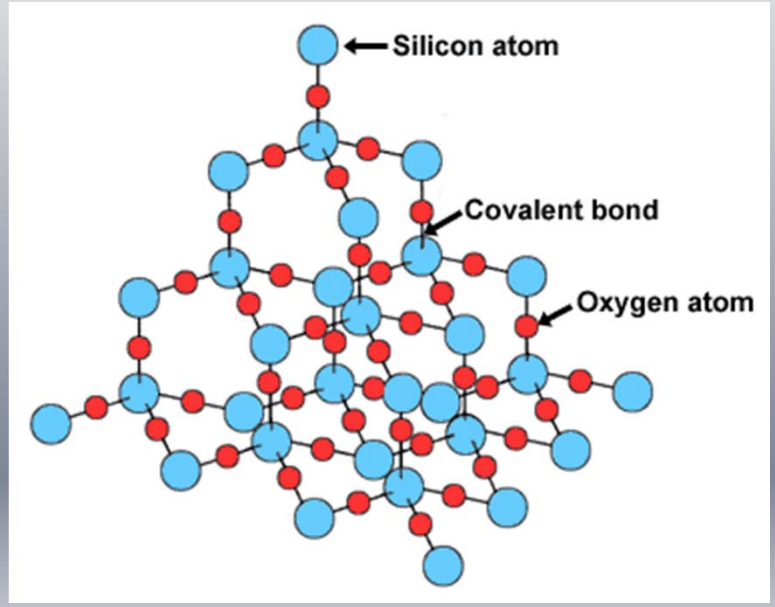

Iron Phase Diagram
2000
1600
1200
800
400
0
T (Temperature), °C
Liquid Iron
Delta Iron
Gamma Iron
Alpha Iron
Epsilon Iron
25
50
75
100
125
150
175
P (Pressure), atm

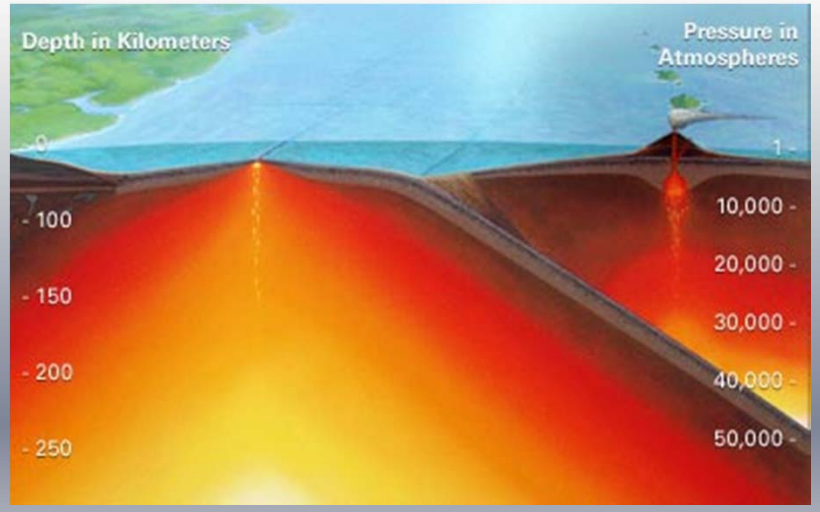

bcc
body centered cubic
fcc
face centered cubic
Institut für Allgemeine Physik, TU Wien

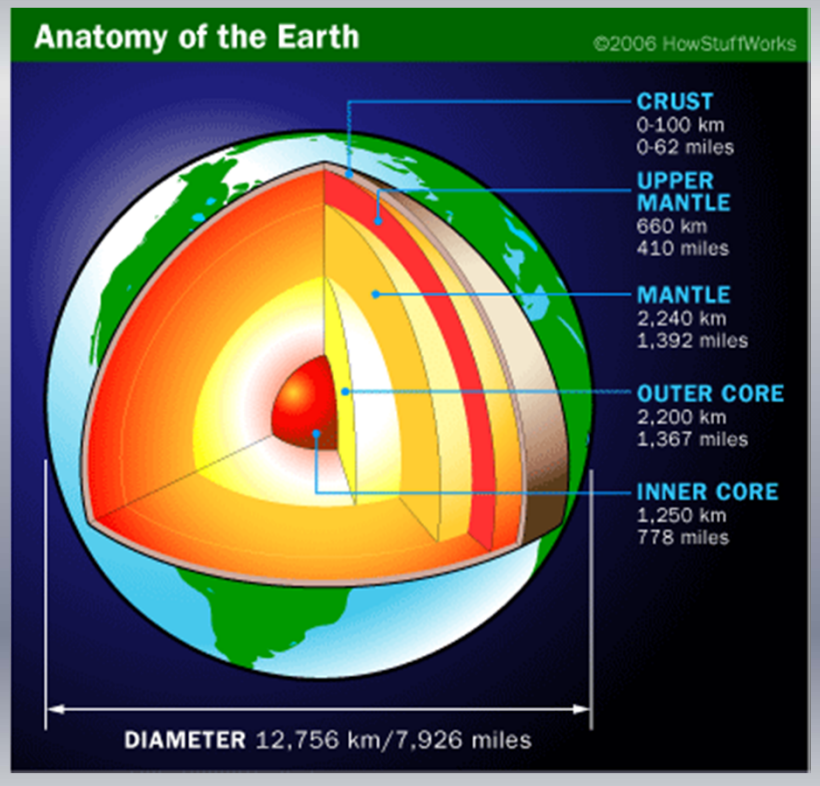

Stishovite
Coesite
ß-Quartz
α-Quartz
ß-Tridymite
ß-Cristobalite
Silica Melt
pressure [GPa]
approximate depth [km]
temperature [°C]
573°C
870°C
1470°C
1705°C



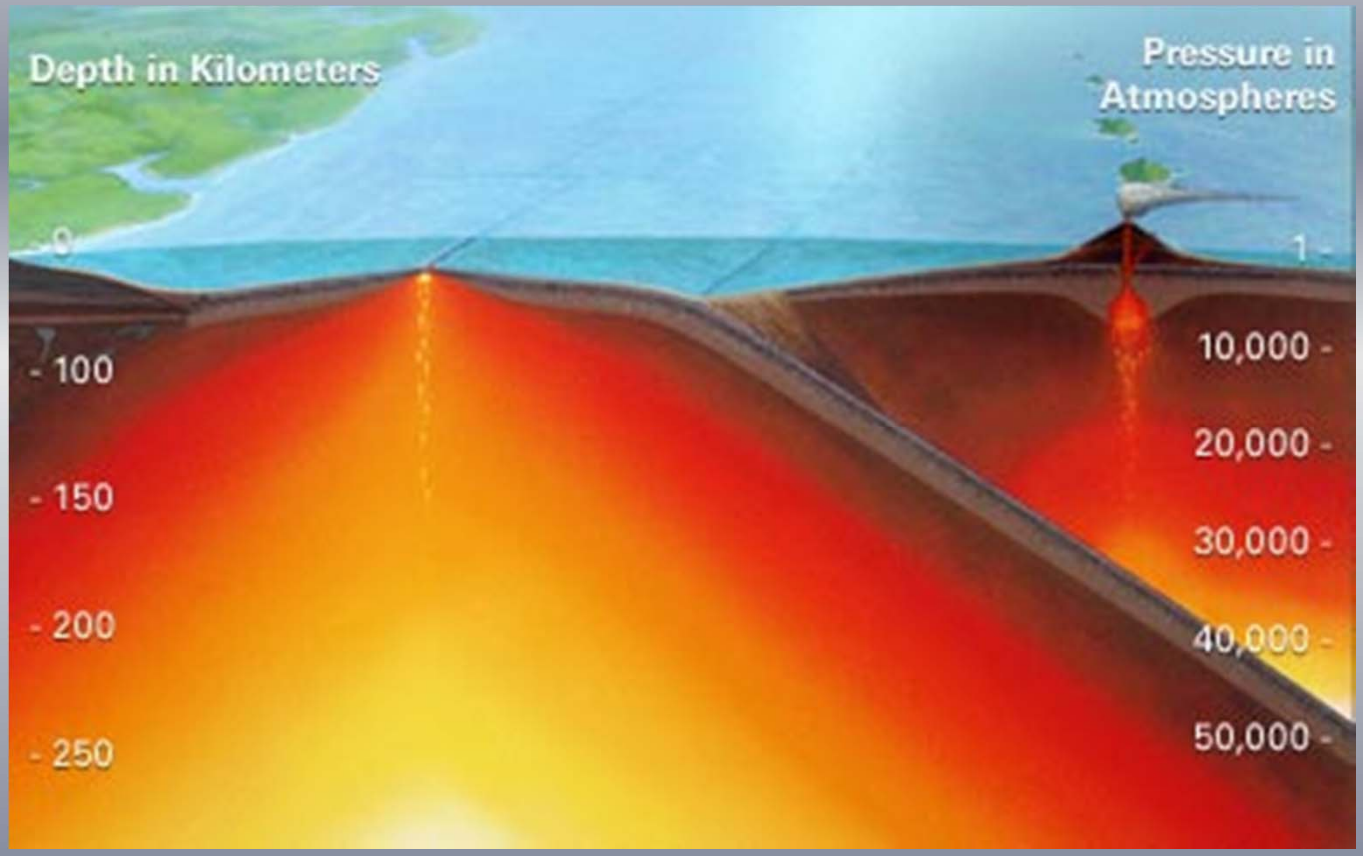



Silicon atom
Covalent bond
Oxygen atom





The deeper a rock is within the Earth, the hotter and denser it is. Both temperature and pressure increase with depth. With every kilometer in depth the temperature increases by about 25 C, and the pressure increases by about 250 atm. (One atmosphere = 14.7 lb/sq in, the average pressure of the atmosphere at sea level.


Depth in Kilometers
Pressure in Atmospheres
0
- 100
- 150
- 200
- 250
1
10,000
20,000
30,000
40,000
50,000