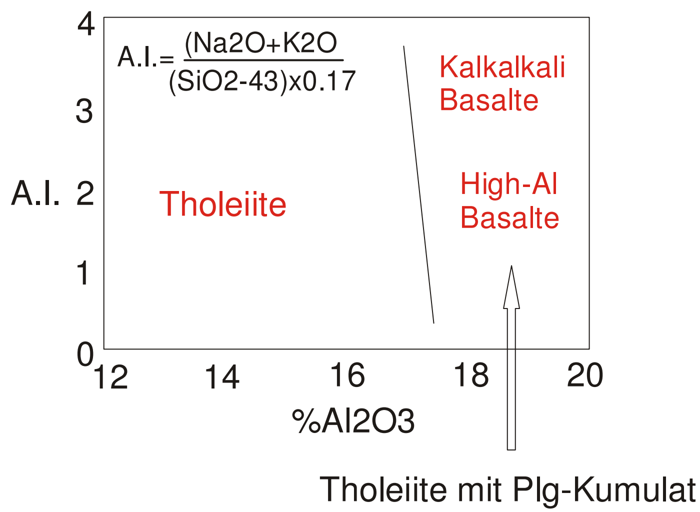
The major element chemistry of MORBs

A "typical" MORB is an olivine tholeiite with low K_2O (< 0.2%) and low TiO_2 (< 2.0%)



Glass samples are very important chemically, because they represent *liquid* compositions, whereas the chemistry of phyric samples can be modified by crystal accumulation

Average Analyses and CIPW Norms of MORBs (BVTP Table 1.2.5.2)

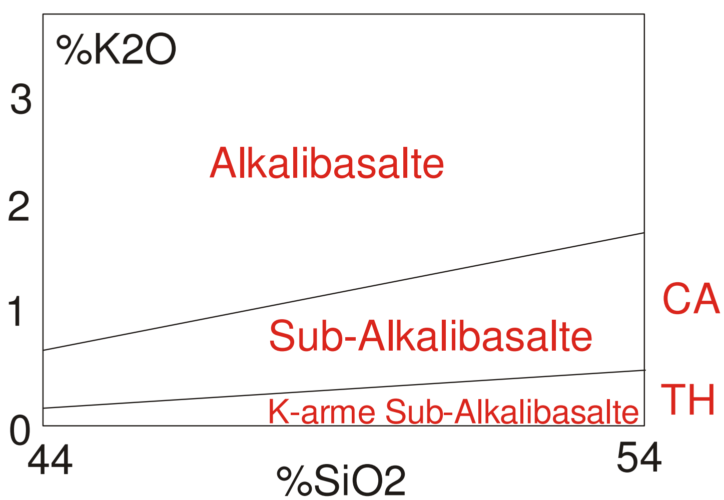
Oxide (wt%)	All	MAR	EPR	IOR
SiO_2	50.5	50.7	50.2	50.9
TiO_2	1.56	1.49	1.77	1.19
Al_2O_3	15.3	15.6	14.9	15.2
FeO*	10.5	9.85	11.3	10.3
MgO	7.47	7.69	7.10	7.69
CaO	11.5	11.4	11.4	11.8
Na_2O	2.62	2.66	2.66	2.32
K_2O	0.16	0.17	0.16	0.14
P_2O_5	0.13	0.12	0.14	0.10
Total	99.74	99.68	99.63	99.64
Norm				
q	0.94	0.76	0.93	1.60
or	0.95	1.0	0.95	0.83
ab	22.17	22.51	22.51	19.64
an	29.44	30.13	28.14	30.53
di	21.62	20.84	22.5	22.38
hy	17.19	17.32	16.53	18.62
ol	0.0	0.0	0.0	0.0
mt	4.44	4.34	4.74	3.90
il	2.96	2.83	3.36	2.26
ap	0.30	0.28	0.32	0.23

All: Ave of glasses from Atlantic, Pacific and Indian Ocean ridges.
MAR: Ave. of MAR glasses. EPR: Ave. of EPR glasses.
IOR: Ave. of Indian Ocean ridge glasses.

The major element chemistry of MORBs

MORBs were originally considered to be extremely uniform – interpreted as a simple petrogenesis

More extensive sampling has shown that they display a (restricted) range of compositions



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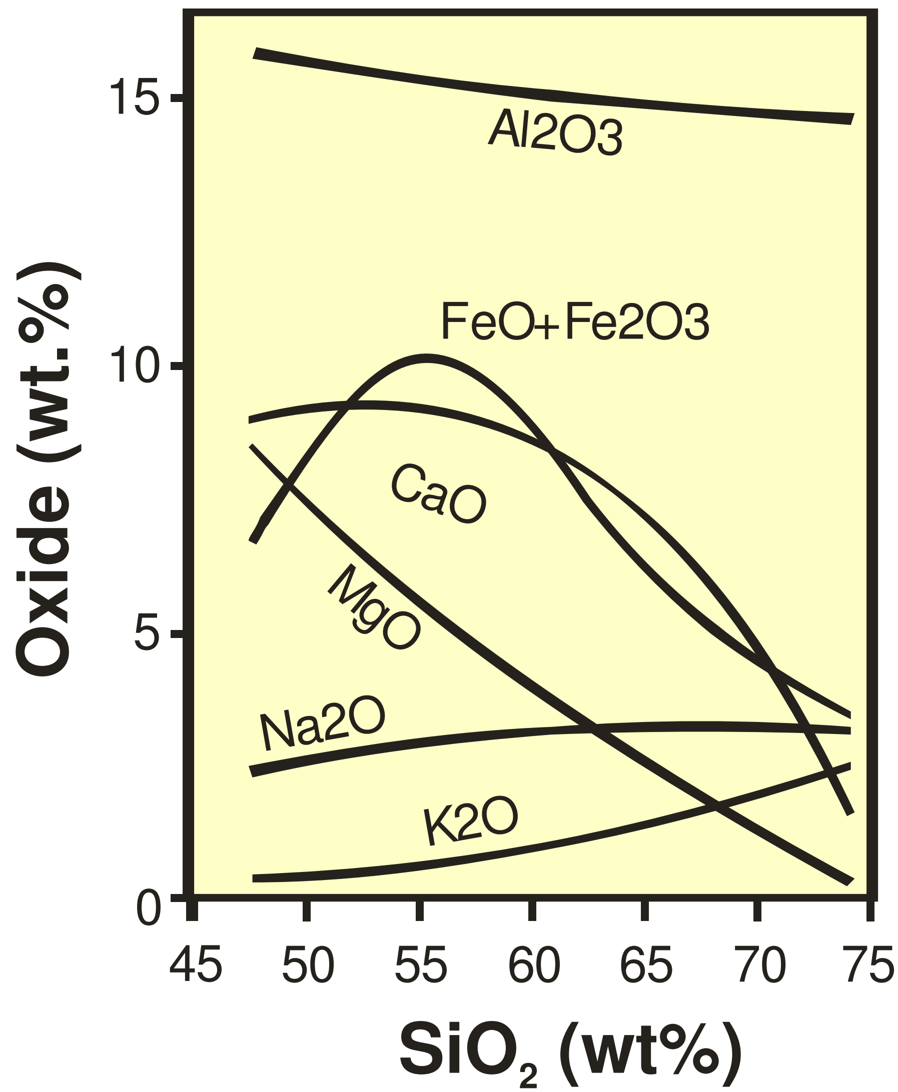
“Harker-type” variation diagrams for MORB



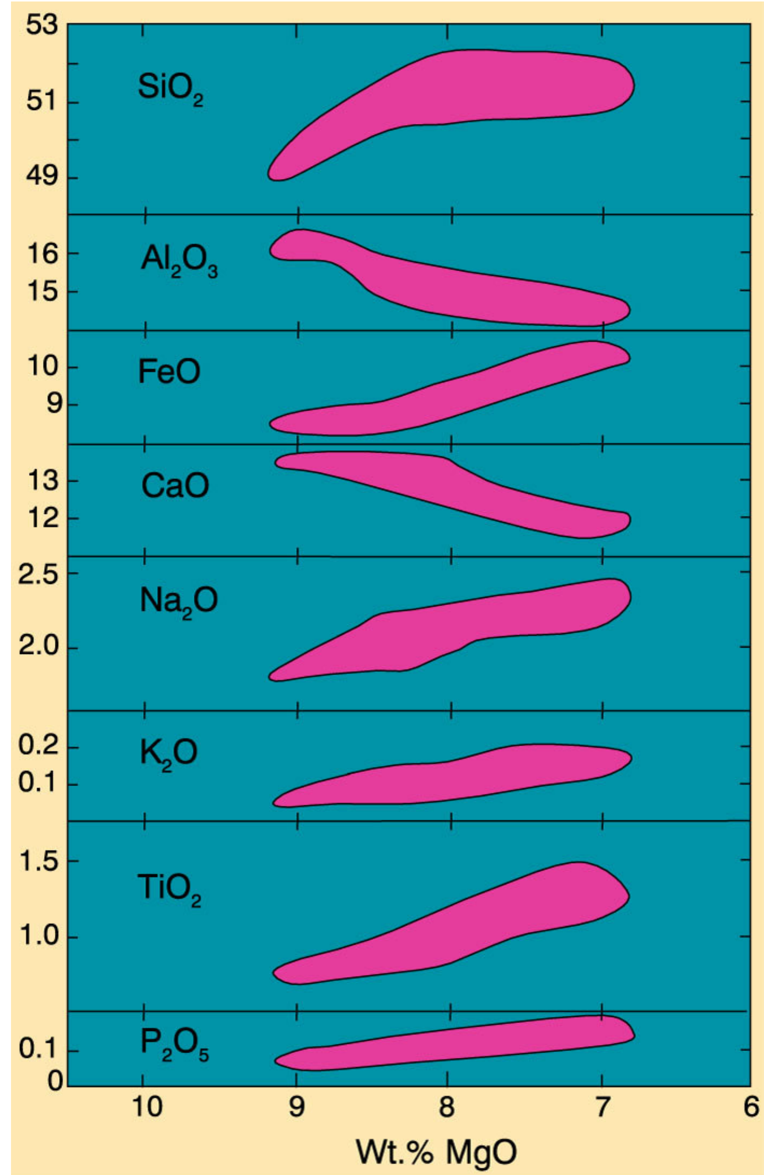
SiO_2 is a ~ poor fractionation index for MORB

"Fenner-type" variation diagrams for MORB

Decrease in MgO and relative increase in FeO → early differentiation trend of tholeiites

Patterns are compatible with crystal fractionation of the observed phenocryst phases

Separation of a calcic plagioclase can cause Al_2O_3 and CaO to decrease



Stakes et al. (1984)

Conclusions about MORBs, and the processes beneath mid-ocean ridges

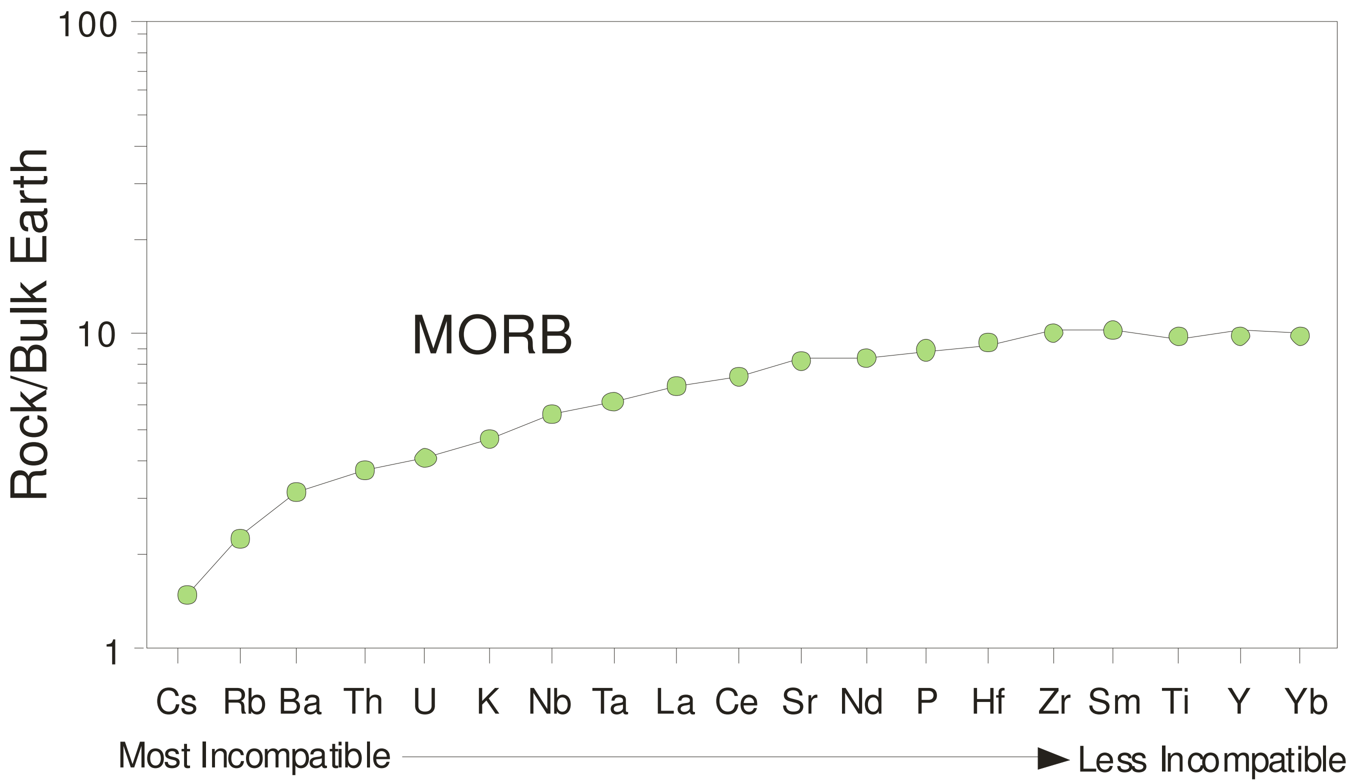
MORBs are not the completely uniform magmas that they were once considered to be

They show chemical trends consistent with fractional crystallization of olivine, plagioclase, and clinopyroxene

MORBs cannot be primary magmas, but are derivative magmas resulting from fractional crystallization (~ 60%)

Trace Elements

Multi element diagram for MORBs



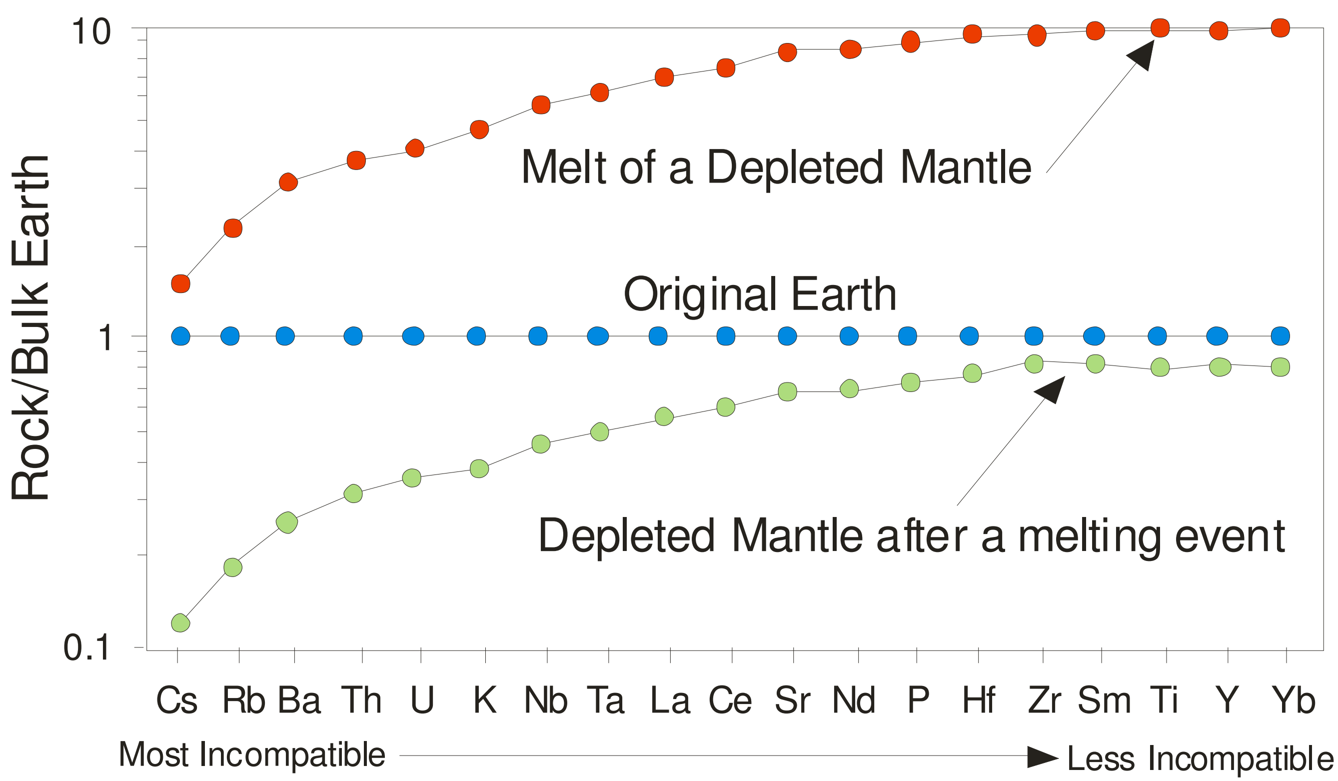
Trace Elements

Petrogenesis of MORBs

Melting of the mantle:

Incompatible: K, Rb, Cs, Ta, Nb, U, Th, Y, Hf, Zr, LREEs

Compatible: Ni, Cr, Co, V, Sc



Concentration of incompatible elements in the melt decreases with increasing degree of melting

Conclusions about MORBs, and the processes beneath mid-ocean ridges

MORBs which show a depletion in most incompatible elements likely formed by melting of a depleted mantle (i.e. a mantle that had suffered a melting event sometime in the past).

Because the MORB pattern is nearly parallel to the depleted mantle, the degree of melting required to produce such MORBs must have been high (20-40%).