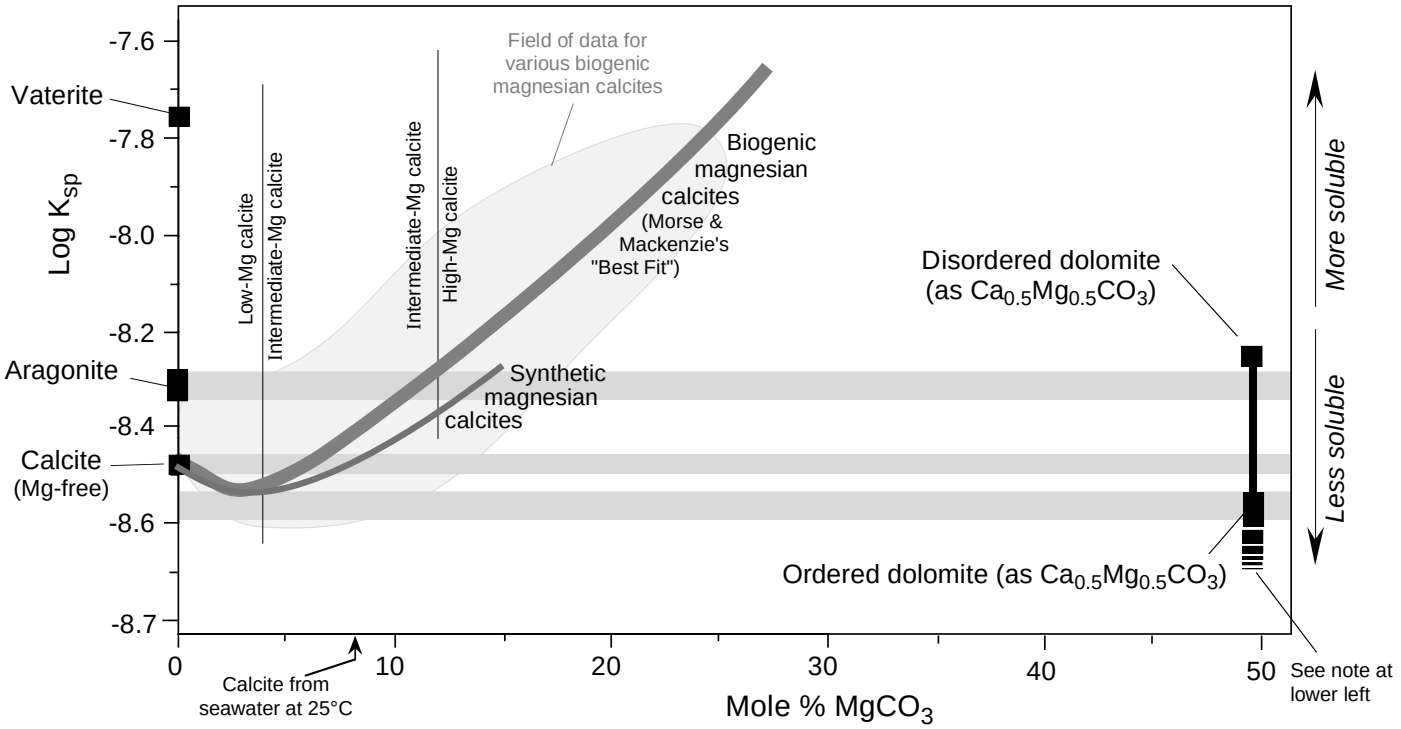
Solubility of common carbonate minerals

$CaCO_3$ exists in nature as three minerals, the common minerals calcite and aragonite and the rare mineral vaterite. Calcite's structure accomodates substitution of Mg^{2+} for Ca^{2+}, so that there are magnesian calcites with a range of Mg^{2+} contents. Calcite is thus described as "Low-Mg calcite" or "High-Mg calcite", and at least some workers also speak of an "Intermediate-Mg calcite" in between.

In calcite, including high-Mg calcite, Mg^{2+} substitutes randomly for Ca^{2+}. Dolomite, on the other hand, is a mineral in which Mg^{2+} and Ca^{2+} are segregrated into separate planes of the crystal structure. A high-Mg calcite and a Mg-poor dolomite thus might have the same chemical composition, but they would be different minerals because of the difference in their crystal structure. They would also be different in their solubility, as shown below.



Sources:

Data for calcite and aragonite are from Table 2.3 of Morse and Mackenzie (1990) and near those reported in Table 6.1 of Langmuir (1997). Data for magnesian calcites are from Figure 3.7 of Morse and Mackenzie (1990). Division of calcites by Mg content is from Veizer (1992).

Log Ksp for ordered dolomite is from Table 6.1 of Langmuir (1997) and similar to result calculated from data in Robie et al. (1979), whereas data from Garrels (1960) give a much lower value near -9.8. Uncertainty in determination of Ksp for dolomite is to be expected, because the well-known kinetic inhibition of precipitation of dolomite at low temperature makes the experimental work needed to determine Ksp problematic.

Synthetic magnesian calcites presumably have fewer defects and irregularities than biogenic calcites and so are less soluble, as shown. However, most of the magnesian calcites of interest in the earth sciences are biogenic calcites.

The data at left show that solubility of magnesian calcites varies with Mg^{2+} content. Data from biogenic magnesian calcites vary widely, presumably because different organisms produce calcites differing subtly in chemistry and microstructure. The "best fit" curve here thus may be the best estimate of variation in solubility of biogenic calcites, but it masks a large variance in the original data.

The "best fit" curve for solubility of magnesian calcites provides a rationale for the terms used to delimit Mg-content of calcites. Low-Mg calcites are those with solubilites as lower or lower than that of pure calcite, intermediate-Mg calcites are those with solubilities between that of pure calcite and aragonite, and high-Mg calcites are those with solubilities greater than that of aragonite.