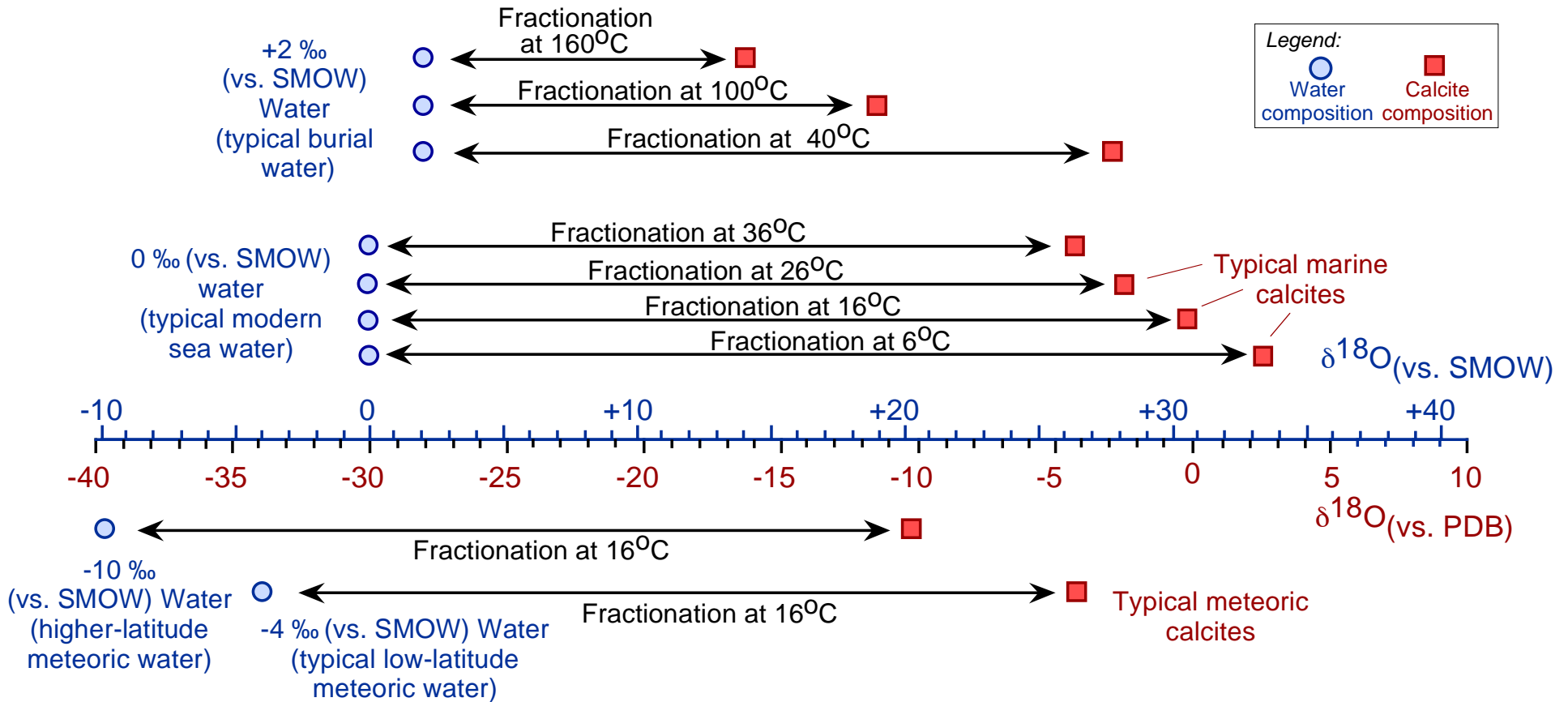


## A graphic explanation of fractionation of oxygen isotopes between water and calcite



Some key thoughts:

1. When calcite is precipitated in isotopic equilibrium with water, the calcite is enriched in  $^{18}\text{O}$  relative to the water, but the extent of that enrichment or fractionation diminishes with increasing temperature.
2.  $\delta^{18}\text{O}$  values of waters and (non-carbonate minerals) are commonly expressed relative to SMOW (Standard Mean Ocean Water) or, in modern usage, VSMOW.  $\delta^{18}\text{O}$  values of carbonate minerals are commonly expressed relative to PDB (the PeeDee Belemnite, a Cretaceous calcitic marine fossil) or, in modern usage, VPDB. The "V" in the modern usage stands for Vienna,

home of the International Atomic Energy Agency and thus the source for modern standards.

3. At  $\sim 15^\circ\text{C}$ , the  $\delta^{18}\text{O}$  of a calcite relative to PDB is the same as the  $\delta^{18}\text{O}$  of the precipitating water relative to SMOW. (This temperature is  $15.7^\circ\text{C}$  if one uses the equation of Friedman and O'Neil (1977), but it is  $13.7^\circ\text{C}$  if one uses the equation of Kim and O'Neil (1997)).
4. At temperatures of more than  $\sim 15^\circ\text{C}$ , a calcite's  $\delta^{18}\text{O}$  relative to PDB is less than the precipitating water's  $\delta^{18}\text{O}$  relative to SMOW. However, at **all** temperatures the calcite is inevitably enriched in  $^{18}\text{O}$  relative to the precipitating water.