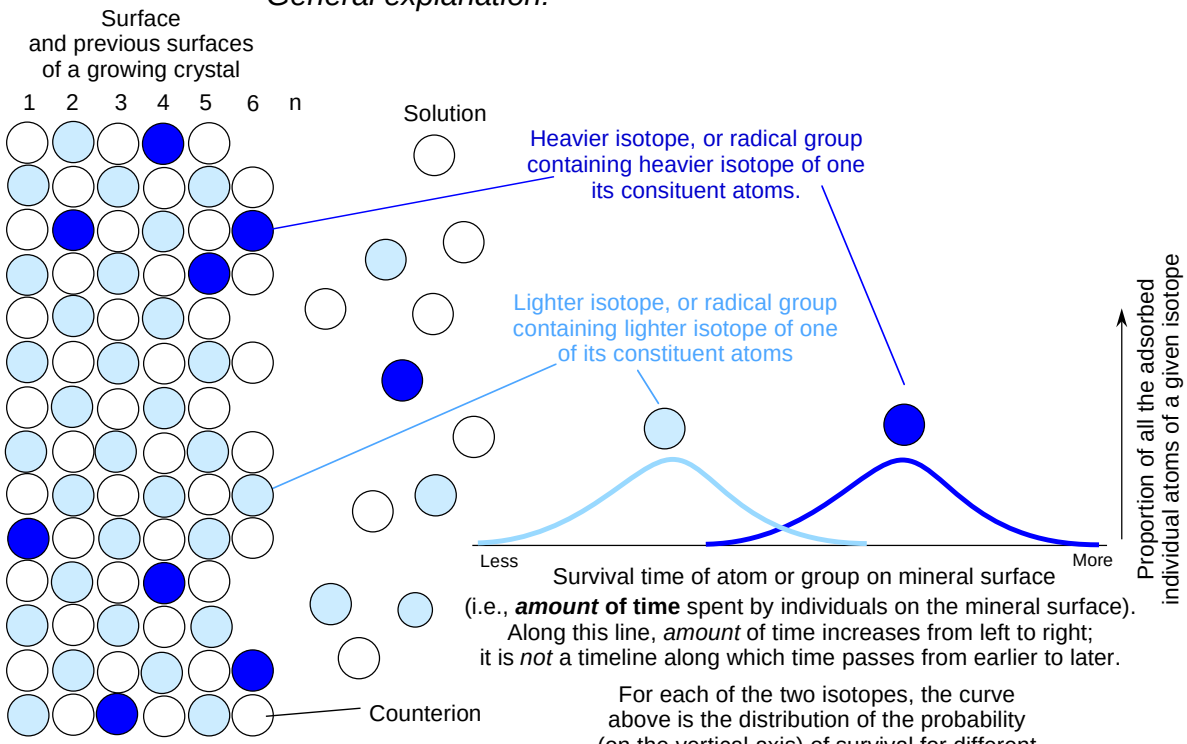
An explanation of why isotopic fractionation varies with precipitation rate and temperature

Isotopic fractionation is the separation of two isotopes of a given element during some process. In the Earth Sciences, one process commonly of interest is precipitation of a mineral from an aqueous solution. For at least the stable isotopes of oxygen and carbon, the extent of fractionation depends on rate of precipitation and on temperature (much more so for O than C). This document attempts to explain why.

General explanation:



Surface 6 will after some lifetime bury Surface 5, which buried Surface 4, etc.

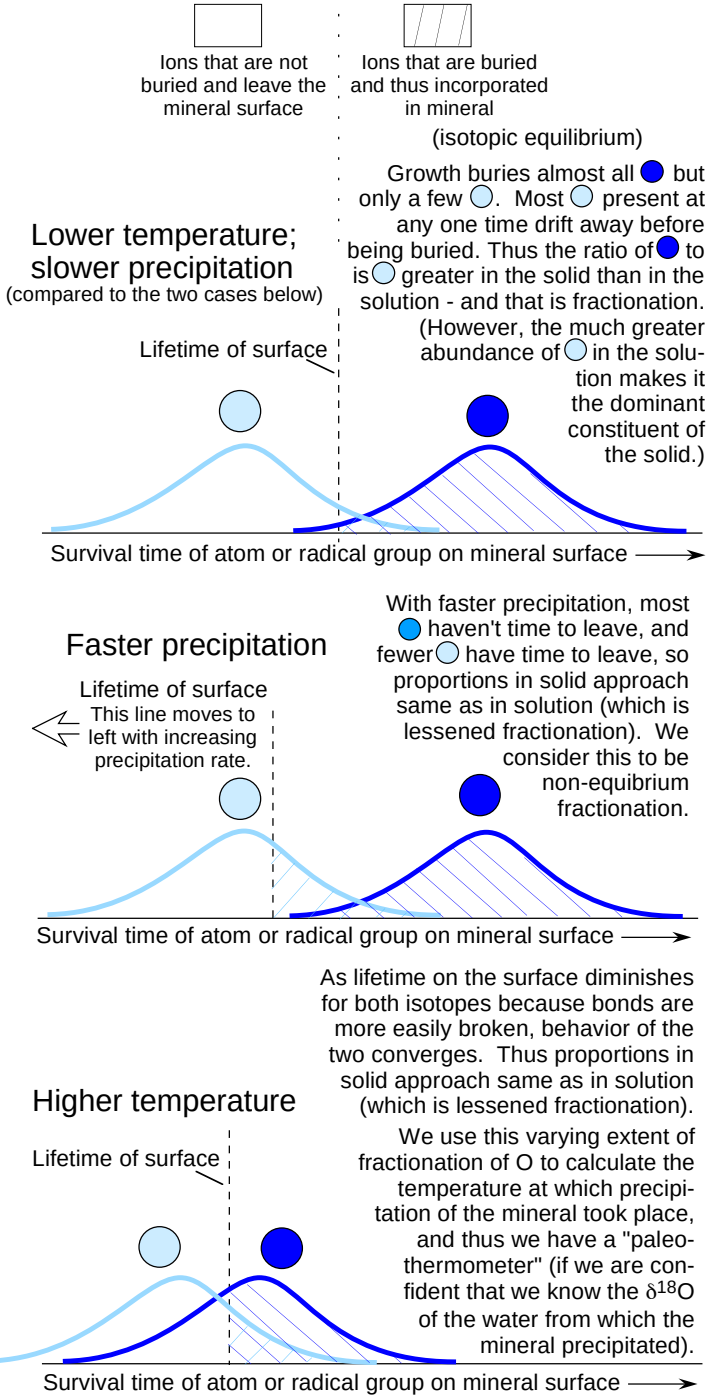
In the sketch above, relative size of white-filled cicles and blue-filled circles is arbitrary and irrelevant.

For each of the two isotopes, the curve above is the distribution of the probability (on the vertical axis) of survival for different lengths of time (on the horizontal axis).

The distributions are *assumed* here to be normal (i.e., symmetrical around coincident mean, median, and mode).

This concept of survival times of atoms or radical groups on the mineral surface lets us then consider the different diagrams at right as explanations of why fractionation varies with precipitation rate and temperature.

Three specific cases:



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SFMGIsotopeFraxnScheme04,
adapted from 8150 DistribnCoefficients 09L
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