Assessing stress levels on faults using clumped isotope thermometry of gouges and vein arrays

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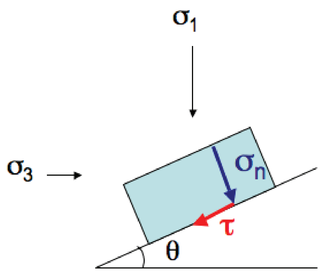
Stress on low-angle normal faults



At failure,
shear stress $\tau=\mu\sigma_n$

Where μ is the coefficient of friction and σ_n is the normal stress

Shear heating

Shear stress is related to heat produced along a fault by:

$$q=\tau \cdot v$$

where q is heat flux, τ is shear stress, and v is long-term velocity along a fault

Clumped Isotope Thermometry

Reaction:

$Ca^{13}C^{16}O_3 + Ca^{12}C^{18}O^{16}O_2 \leftrightarrow Ca^{13}C^{18}O^{16}O_2 + Ca^{12}C^{16}O_3$

The forward reaction causes "clumping" of the heavy isotopes. This is more favorable at low temperatures.

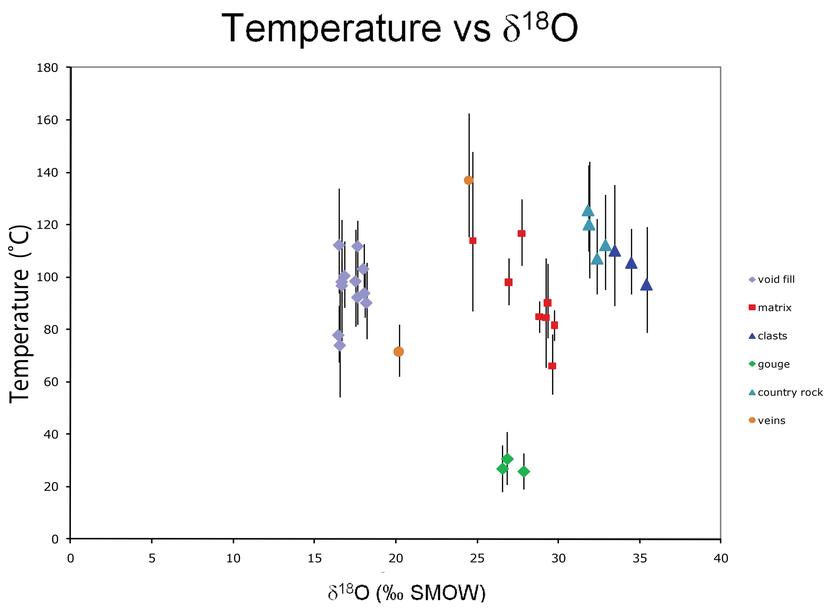
The sample is dissolved in acid to release CO_2 gas, which is measured for masses 44-48.

Mass 47 (the clumped molecules) is related to temperature by:

$$\Delta_{47} = 45870/T^2 + 0.129$$

Where Δ_{47} is the difference between the measured mass 47 and that expected from random distribution

Slip surface gouge and breccia sampled for clumped isotope analysis



Void-filling calcite sampled for clumped isotope analysis

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