Degassing in the near surface produces $^{13}$C enriched hot springs

Topography driven meteoric water circulation

Mixed meteoric and crustal fluids

"High-temperature" silicate weathering reactions consume metamorphic CO$_2$ and produce alkalinity

$$\text{CaSiO}_3 + 2\text{CO}_2 + 3\text{H}_2\text{O} \rightarrow \text{Ca}^{++} + 2\text{HCO}_3^- + \text{Si(OH)}_4$$

Decarbonation and dehydration produce crustal fluids with variable $^{13}$C

$$\text{CaCO}_3 + \text{SiO}_2 \rightarrow \text{CaSiO}_3 + \text{CO}_2$$

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**Figure a.** Map of Tibet and Nepal with the MHT, MHT, and STDS lines.

**Figure b.** Cross-section of the Himalayan region showing the MHT, MHT, and STDS lines.

**Figure c.** Depth profile showing the LH and HHC regions with the MHT, MHT, and STDS lines.
Himalayan hot spring near MCT
Champagne bubbler, Marsyandi
pCO₂ > 1 bar, T = 55°C

Narayani central Nepal 200 km along strike
Heat: 1760 MW => 228 mW m⁻²
CO₂: 1.4x10¹⁰ mol a⁻¹

Scaled to Himalayan arc (??!!!!)
CO₂ flux ≈ 2x10¹¹ mol a⁻¹

Metamorphic degassing 3-4x weathering uptake for CO₂
- Himalayan system net CO₂ source, not sink
Geothermal circulation is ubiquitous along Himalayan front at steep topographic gradients.

Swath topo.

Incision rate

Geothermal zone

Advection of rock to surface

Continental subduction of Indian plate, including ancient margin sediments

Fluvial Incision (mm/yr)

Elevation (km)

Depth (km)

N18E Distance from MFT (km)
c Deformed grid with tectonic interpretation (V:H=1:1)

d Thermal structure and particle paths