Thermal springs of the Cordillera Blanca, Peru: Evidence for mantle-crust fluid connections

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The Cordillera Blanca is a ~200 km long NNW trending mountain range hosting peaks 5-6.7 km in elevation. This range is located in a currently amagmatic reach of the Andes above a flat-slab segment of the subducting Nazca Plate. The last period of magmatic activity was the Miocene (~8 Ma) emplacement of the Cordillera Blanca batholith, which forms the core of the mountain range. Bounding the entire western edge of the range is a NNW trending and WSW dipping normal fault (Cordillera Blanca detachment), recording a progression of top to the west ductile shear to brittle faulting since ~5 Ma [1].

Hot springs ranging in temperature from 20–79°C are found along the trace of this detachment fault and steeply dipping normal faults cutting the hanging wall. These are CO_2-rich, near-neutral, alkaline-chloride to alkaline-carbonate waters, with elevate trace metal contents including arsenic (≤ 11 ppm). Water $\delta^{18}O$ and δD, trends in elemental chemistry, and cation geothermometry indicate mixing of hot (200–260°C) geothermal brine with cold meteoric recharge along the fault zone. Helium isotope ratios ($^3He/^4He$) for dissolved gases in the hot springs range from 0.6 to 2.0 R_c/R_A, indicating the presence of up to 25% mantle–derived helium. $CO_2/^3He$ ratios and $\delta^{13}C$ of CO_2 provide evidence of degassing during fluid ascent and record mixing between mantle-derived and crustal volatiles. Mantle volatiles may originate at or near the subducting slab-continental lithosphere interface, given the long duration since active magmatism in the region.

[1] Giovanni, M., Horton, B., Garzione, C., McNulty, B., Grove (2010), *Tectonics* ***29***, TC6007.