Fluid evolution and transport during metamorphism: evidence from the Llano Uplift, Texas

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Abstract. A field, petrologic and stable isotopic investigation of the marbles and calc-silicates of the 1.15 b.y. Valley Spring Gneiss documents the dilution of internally evolved CO_2-rich fluids by externally derived aqueous fluids introduced along channelways. Reaction textures within calc-silicates record the evolution through time of initially CO_2-rich fluids toward increasingly more aqueous compositions. Assemblage zonations within calc-silicates require equilibration within local gradients of the mole fraction of CO_2 in the fluid, and suggest that the infiltration of aqueous fluids was largely channelized along more permeable lithologies. Localized depletions in ^{13}C and ^{18}O corroborate petrologic evidence for channelized infiltration. Isotopic compositions reflect both devolatilization and the introduction of low-$\delta^{18}O$ fluids; estimated minimum oxygen-equivalent fluid-to-rock ratios are near unity. Both mineralogical and stable isotopic systematics document the essential role of infiltration in driving decarbonation reactions during calc-silicate formation. The calc-silicate assemblages which equilibrated with fluids of the lowest mole fraction of CO_2 record isotopic exchange equilibrium with fluids of $\delta^{18}O$ typical of those derived from "normal granites", as do the granitic aplites and pegmatites which transect most calc-silicate occurrences. Thus the infiltrating fluids are believed to be genetically linked to the intrusion of a suite of granitic plutons emplaced after the peak of regional metamorphism.