The Sierra Nevada batholith, CA: What have we learned?

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The Mesozoic Sierra Nevada batholith accumulated during subduction beneath the western margin of the North American plate. Exposure of the batholith is dominated by Cretaceous tonalite and granodiorite with subordinate exposures of Cretaceous granite and diorite, and Jurassic and sparse Triassic plutons. Neoproterozoic to Paleozoic metasedimentary and Mesozoic metavolcanic rocks comprise the wall rocks of the batholith. Independent of age, rocks exposed in the batholith are dominated by tonalite and granodiorite compositions; however, there is a bias toward more mafic compositions among analyzed samples. Seismic data suggest that rocks exposed at the surface are typical of rock exposed all the way to the Moho with P-wave velocities 6.0 ± 0.2 km/sec persisting from the surface to ~ 35 km depth, above a discrete increase to velocities greater than 7.0 km/sec. The interpretation that upper crustal rocks are comparable to deeper batholithic rocks is corroborated by the observation that there is no systematic variation in the composition of plutonic rocks through greater than 20 km of crustal section exposed in a north-to-south cross-section from ~ 0.2 to 0.9 GPa. Zircon U/Pb data indicate that assembly of the batholith occurred in three distinct pulses in the Triassic (210 ±10 Ma), Jurassic (160 ± 15 Ma) and Cretaceous (100 ± 20 Ma).

There are no obvious spatial patterns in the age of the batholith – recent high-precision geochronology suggests that the steady west-to-east migration of the locus of Cretaceous plutonism is not as well defined as previously thought. Geochronologic data also demonstrate that the batholith accumulated via addition of small increments and that even apparently homogeneous map units may integrate millions of years of assembly. Numerous estimates of magma flux in the batholith suggest that accumulation rates on the order of ~0.001 km^3a^{-1} were typical throughout at least the Cretaceous. Detailed mapping, geochronology and geochemistry suggest that upper crustal differentiation of magmas was extremely localized and played little role in determining the composition of volcanic rocks erupted in this portion of the Sierran arc. Instead, the data suggest that the geochemical trends defined by plutonic and volcanic rocks are inherited from their source, inferred to be the lower crust. There is little noise added to the data by shallow assimilation and crystal/liquid separation. Thus, the plutonic rocks do not represent biased samples (crystal cumulates) of the magmas feeding the arc, but are thoroughly recrystallized samples of primary magma compositions. In combination with isotopic data that suggest an origin in the lithospheric mantle for the mafic rocks exposed in the Sierra Nevada batholith, this suggests rapid distillation of the crustal rocks exposed in the batholith via a series of partial melting events.