

Architecture of the Franciscan Subduction Complex, California and Implications for Tectonic Processes

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Many studies characterize the Franciscan complex as a mega mélangé, implying that internal details follow a random or chaotic nature that renders detailed field assessment comparatively unimportant. Field studies show a far from random structure. The Franciscan comprises a stack of thrust nappes, accreted sporadically over a time span of over 100 million years, and each nappe commonly has both coherent and mélangé components. Out-of-sequence low-angle faults locally reorder the nappe stack, and the stack is folded by regional-scale overturned to open upright folds with subhorizontal fold axes. Erosion of these structures gives the characteristic elongate map pattern to Franciscan rock units. Post-subduction strike-slip faulting, related folding, and dip-slip faulting overprints earlier structures. Horizons between accreted thrust nappes represent paleo megathrust locations, and should collectively accommodate ~10000 km of subduction. This slip appears to be accommodated primarily in narrow (tens of meters) wide zones between mélanges and coherent units, rather than by mélanges themselves. Most mélanges with exotic blocks, including blocks of higher metamorphic grade than the matrix, have sedimentary origins as shown by gradational contacts between little deformed sedimentary conglomerate and breccia with exotic blocks/clasts, and more deformed equivalents that appear to be typical “tectonic” mélanges. HP (high-pressure) metamorphic exotic blocks were thus emplaced into lower grade matrix by submarine sedimentary sliding rather than being tectonic mixing in a subduction channel. Both mélanges and coherent clastic sedimentary records have abundant recycled Franciscan detritus, including HP clasts/blocks. Tectonically-generated mélanges lack exotic blocks, and appear to have formed by progressively greater deformation from coherent rocks, including ocean plate stratigraphy (basalt-chert-sandstone). Metamorphic and deformation events are discrete within units accreted at different times. The oldest HP metamorphic rocks were metamorphosed at least 80 million years before the protoliths of some of the younger HP rocks formed. A similar history should apply to deformational episodes within a given accreted nappe.