The Rattlesnake Valley and Oriflamme Canyon plutons: key temporal markers in the Jurassic and Cretaceous development of the transition zone of the Peninsular Ranges batholith

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Abstract

Along ~33^{o}N latitude we have mapped at a 1:12000 scale a segment of the Cuyamaca-Laguna Mountain Shear zone (CLMSZ) lying within the transition zone of the Peninsular Ranges batholith (PRB). Based on structural fabric we subdivided the mapped area into western and eastern domains. The western domain consists of (1) the Late Triassic – Early Jurassic Julian Schist, (2) the Jurassic Harper Creek and Cuyamaca Reservoir gneisses, and (3) the Jurassic – Early Cretaceous East Mesa pluton. It is characterized by EW and NE striking vertical to sub-vertical faults and shear zones. These faults form boundaries to zones containing an older foliation that we refer to as S_1. Within the Julian Schist, S_1 is defined by aligned alternating lenses of biotite ± andalusite ± sillimanite ± cordierite, and quartz + plagioclase ± K-feldspar. S_1 is a transposed, NS to NW trending, coarsely to finely crystalline, spaced to continuous cleavage. It is folded about upright tight to isoclinal moderately plunging F_1 macro and mesoscopic folds that are truncated by the ~130 Ma granitic to granodioritic Rattlesnake Valley pluton. Geochemical data suggest that the Rattlesnake Valley pluton is weakly peraluminous, calcic, and calc alkaline in character.

The faults and S_1 characteristic of the western domain are truncated by the Sunrise Highway-Oriflamme Canyon shear zone. The western most fault of the shear zone is referred to as the Sunrise Highway fault. This fault defines the eastern limit of the western domain, and is represented by a thin (~1-3 m) protomylonitic rind along the margin of the Rattlesnake Valley pluton.

The eastern domain is composed of phyllonitic Julian Schist, and is intruded by the ~116 Ma protomylonitic Oriflamme Canyon pluton. The protolith of the Oriflamme Canyon pluton was a granodiorite with a metaluminous to weakly peraluminous, calcic, and calc alkaline character.

The Julian Schist in the eastern domain generally lacks macro and mesoscopic folds, and, is instead, characterized by S_2, a pervasive and penetrative, platy NW striking steeply NE dipping phyllonitic cleavage. S_2 can be traced eastward into the Oriflamme Canyon pluton where it is represented by mylonitic foliation and west verging shear bands dipping ~30^{o} - 40^{o} eastward. The S_2 fabric in the Oriflamme Canyon pluton is interpreted to be the result of a magmatic foliation that with decreasing temperature passed progressively into a solid-state

protomylonitic state. Hence, it is syntectonic with respect to the formation of the Sunrise Highway-Oriflamme Canyon shear zone.

The final Mesozoic event to affect the transition zone within our mapped area involved the Chariot Canyon fault. This fault is characterized by a cataclastic fabric that overprints S_2. Sometime between ~94 Ma and ~80 Ma a large segment of the Harper Creek gneiss lying along the eastern part of Sunrise Highway – Oriflamme Canyon shear zone was thrust westward along the Chariot Canyon fault.

Within our study area, we interpret the structural history of the transition zone to reflect the changing plate boundary configuration of the Farallon and North American plates. For example, during the Late Jurassic to Early Cretaceous, the Farallon and North American plates were converging in an oblique sinistral fashion. However, sometime between ~140 Ma and ~125 Ma convergence between the two plates became nearly orthogonal, and this period of normal convergence continued until about 115 Ma. Work by J. Dewey and L. Royden suggests that when the convergence of two plates is orthogonal and the overall convergence is greater than the rate of subduction, deformation in the adjacent magmatic arc will be by horizontal contraction. We speculate that (1) based on timing of formation of the tight to isoclinal upright folds and S_1 cleavage characteristic of the western domain that the transition from oblique sinistral convergence to orthogonal convergence occurred prior to ~130 Ma, (2) during and following emplacement of the Rattlesnake Valley pluton the strain field became weaker and that portion of the transition zone that we studied was at about ~13 - ~16 km depth, and (3) the formation of the Sunrise Highway – Oriflamme Canyon shear zone some 14 million years after emplacement of the Rattlesnake Valley pluton is the result of heat and fluids softening the immediately adjacent areas to the intruding Oriflamme Canyon pluton, and thus weakening them to the point that they yielded to the horizontal contraction imposed by normal convergence. Finally, M. Grove and colleagues argue that brittle movement along the Chairot Canyon fault some 22 to 36 million years following the development of the Sunrise Highway – Oriflamme Canyon shear zone may have been generated by the removal of the lithospheric mantle during Laramide shallow subduction. Apparently, this process destabilized the overlying crust and triggered erosion localizing brittle shortening along the Chariot Canyon fault. In short, the area underlain by the Sunrise Highway – Oriflamme Canyon shear zone and the Chariot Canyon fault has been a zone of weakness that has responded to various plate boundary configurations beginning as early as 130 Ma. These relationships support the general idea that structures within magmatic arcs may faithfully reflect the plate boundary configurations in which they develop.