GEOLOGY AND GEOCHRONOLOGY OF THE PINE FOREST RANGE, NORTHWEST NEVADA: STRATIGRAPHIC, STRUCTURAL AND MAGMATIC HISTORY, AND REGIONAL IMPLICATIONS

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ABSTRACT

The Pine Forest Range, located in the Black Rock Desert region of northwest Nevada, exposes a section of Paleozoic and Mesozoic strata that were multiply deformed and metamorphosed and widely intruded by plutons in Mesozoic time. Older Paleozoic strata comprise early(?) Paleozoic to Devonian(?) quartzo-feldspathic clastic sedimentary rocks and mafic volcanic and volcaniclastic rocks overlain by a thick sequence (3-4 km) of Devonian(?) to Upper Mississippian chert-rich clastic sedimentary rocks, limestone and silicic tuffs. These rocks are overlain unconformably by a thin sequence (<1 km) of Permian and Permian(?) limestones, clastic sedimentary rocks and chert. Mesozoic strata are late Middle or early Late Triassic to latest Triassic and are separated from Paleozoic rocks by an unconformity that reflects uplift, tilting and weak folding during the latest(?) Permian to Middle or Late Triassic. The Triassic section is over 3.5 km thick and consists of basaltic to andesitic lavas and associated volcaniclastic rocks, limestones and siliciclastic sedimentary rocks. Geochemical analyses indicate that Triassic lavas are arc-derived. Facies analysis indicates that all of the Triassic strata were deposited in a relatively deep marine, slope to base-of-slope environment and there is no evidence of progradational facies trends despite the thickness of the section. This relation, coupled with deposition of the deep marine Triassic strata above the Permo-Triassic unconformity, suggests that the Black Rock Desert region was characterized by active subsidence during Middle(?) and Late Triassic time.

Paleozoic strata in the Pine Forest Range exhibit strong lithologic and stratigraphic similarities to those in other volcanic arc sequences of the western U. S. Cordillera, supporting an interpretation of paleogeographic and tectonic ties between all of these sequences in Paleozoic time. In addition, the presence of a Permo-Triassic unconformity in the Pine Forest Range represents new evidence that these arc sequences

experienced uplift, erosion and some deformation during the Late Permian-Early Triassic Sonoma orogeny, and supports an interpretation that this orogenic event was related to arc-continent accretion. Preservation of a thick early Mesozoic section in the Pine Forest Range, coupled with evidence suggesting active subsidence during the accumulation of this section, is inferred to reflect development of the early Mesozoic arc in an extensional to neutral tectonic regime, possibly in response to changes in plate motion following the Sonoma orogeny.

Two main periods of deformation and metamorphism affected the Pine Forest Range. The first was regional in extent, producing a strain and metamorphic gradient that increases with stratigraphic depth such that the youngest rocks are at subgreenschist to greenschist grade, folded by relatively open folds and deformed by a weak to moderate penetrative fabric, whereas bedding in the older rocks has been completely transposed into a well-developed amphibolite grade schistosity. Structural relations suggest that this deformation occurred in the hanging wall of a top-to-the-NW bedding-parallel shear zone and $^{40}Ar/^{39}Ar$ and U/Pb dating indicate that deformation was broadly synchronous with intrusion of Middle Jurassic (~190-180 Ma) plutons. Heat from these plutons is inferred to be responsible for elevating temperatures during deformation and thereby generating the observed high metamorphic gradient. A second deformation and metamorphism is spatially restricted, affecting rocks only in the aureoles of Cretaceous plutons. This deformation increases in strain and metamorphic grade towards the margins of the Cretaceous plutons such that greenschist grade metamorphism and relatively open folding of the Jurassic fabric characterizes the outer pluton aureoles, whereas the Jurassic fabric has been transposed into a pervasive amphibolite grade second foliation in the inner pluton aureoles. The second deformation represents a combined response to regional NE-SW shortening and forceful pluton emplacementt. $^{40}Ar/^{39}Ar$ and U/Pb dating confirm that the second deformation and metamorphism were synchronous with pluton emplacement at ~108-100 Ma.

The Middle Jurassic age of deformation in the Pine Forest Range argues against collisional tectonic models for Jurassic orogenesis in the Cordillera as these models require deformation to postdate accretion of a Late Jurassic volcanic arc to the continental margin. A model involving compressional strain in the upper plate of a single convergent margin, in response to changing plate boundary conditions, is thus preferred. The timing of Cretaceous deformation indicates that the Cretaceous magmatic arc of the Cordillera was deformed prior to the main phase of shortening in the Sevier fold and thrust belt further east (middle to Late Cretaceous). Cretaceous shortening in the arc also appears to be more limited, at current levels of exposure, than shortening in the Sevier belt. Structural relations in the Pine Forest Range indicate that Mesozoic deformation and

metamorphism along the magmatic axis of the western U. S. Cordillera was localized and facilitated by syntectonic intrusive activity, particularly during Cretaceous time.