ABSTRACT

Late Cretaceous tectonic evolution of the Deep Creek-Kern Mountains, eastern Nevada and western Utah: Magmatically induced large-scale folding, dynamothermal metamorphism and ductile strain at mid- to upper-crustal levels in the Sevier hinterland

by

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Deformation and metamorphism in the hinterland of the Cretaceous Sevier Orogeny in western North America has often been attributed to be a result of the same retroarc shortening that caused deformation in the fold-and-thrust belt to the east. However, new data presented in this dissertation from the Kern Mountains and Deep Creek Range of western Utah and eastern Nevada suggests that, at least in this area, much of the deformation and metamorphism can be attributed to the emplacement of Late Cretaceous leucogranite plutons. The third and final chapter of this dissertation focuses on a different topic: a series of virtual field trips that were made for upper division Structural Geology and Physical Volcanology classes.

Chapter 1 focuses on the Trout Creek Intrusive Complex (TCIC) on the eastern flank of the Deep Creek Range, which forms the center of a Late Cretaceous granite cored gneiss dome. The TCIC is composed of several leucogranite stocks and numerous dikes and sills exposed over an area of ~2 km^2 and is surrounded by a structural dome with a diameter of ≥5 km and ~1-1.5 km of structural relief. Within a few hundred meters of the TCIC, rocks exhibit an intensification of penetrative strain and increase in metamorphic grade from

greenschist to amphibolite facies. Integrated geologic mapping, structural analysis and U-Pb geochronology of igneous zircon from the granite and metamorphic monazite from surrounding country rock indicates that peak metamorphism, doming of the country rock, and penetrative deformation occurred approximately synchronously with, and were a direct result of emplacement of the 80 ± 2 Ma TCIC. A regional foliation (S_1) developed prior to emplacement and was passively rotated during doming, while a younger more localized cleavage (S_2) was actively developing and upgraded during emplacement, ultimately resulting in a penetrative transposition foliation along the immediate margins.

Chapter 2 focuses on the southern flank Deep Creek Range and Kern Mountains and proposes that the Water Canyon Anticline, a major recumbent fold that has been previously interpreted to reflect Sevier-age tectonic shortening, formed in response to the emplacement of the Tungstonia Granite, a large highly peraluminous Late Cretaceous pluton that underlies most of the Kern Mountains. The Tungstonia Granite is surrounded by a deformational aureole with a well-developed foliation along its margins that parallels intrusive contact and decreases in intensity and dies out completely within a few hundred meters both outward into the country rock and inward towards to core of the pluton. This deformational aureole coincides with deflections of bedding into parallelism with the intrusive contact, the largest of which is the Water Canyon Anticline, where stratigraphy in the overturned limb is highly attenuated and parallels the northeastern margin of the pluton. U-Pb zircon geochronology from the Tungstonia suggests it was emplaced at ~70 Ma but that its upper and outer margins crystallized prior to its interior and deeper portions. Zircon ages show a continuous spectrum of ages from ~70 Ma to 80-90 Ma, suggesting a period of protracted crustal

anatexis and crystallization prior to final emplacement. U-Pb geochronology of monazite from two amphibolite facies metamorphic aureoles in the southern Deep Creek Range indicates a prolonged period of monazite crystallization from ~80-90 Ma followed by another episode of crystallization at 70 ± 2 Ma. We interpret the earlier period to reflect a protracted prograde metamorphism, anatexis, and fluid flow that is also reflect in the zircon ages from the Tungstonia, with the 70 ± 2 Ma peak possibly reflecting final ascent of the Tungstonia magma/crystal mush. We propose that the area now occupied by the southern Deep Creek Range and Kern Mountains served as a long lived "channel" during the Late Cretaceous, where leucogranite melts and fluids were funneled upward, resulting in localized metamorphism and culminating in the emplacement of the largest Late Cretaceous pluton in eastern Nevada—the Tungstonia Granite.

The third chapter discusses eight virtual field trips were produced for upper division Structural Geology and Volcanology classes that integrate high-quality videos taken at classic field sites with focused assignments requiring data analysis and interpretation. Virtual field trips help alleviate the logistical, financial, and accessibility issues associated with in-person trips, and allow students to work at their own pace, view annotations that clarify geologic relationships, and can provide superior audio and outcrop viewing experiences. Major drawbacks of virtual field exercises are that students don't get the same hands-on experiences observing rocks and collecting data, deciphering ambiguous relationships, and group bonding. We believe these virtual field trips are best used in conjunction with in-person trips in order to reinforce the material, provide more opportunities for field-experiences, and provide an alternative for students who can't attend a trip in-person.