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Supracrustal input to magmas in the deep crust of Sierra Nevada batholith: Evidence from high-$\delta^{18}O$ zircon

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Abstract

Oxygen isotope ratios of zircon (Zc) from intrusives exposed in the Tehachapi Mountains, southern California, reveal large inputs of high-$\delta^{18}O$ supracrustal contaminant into gabbroic and tonalitic magmas deep (>30 km) in the Cretaceous Sierra Nevada batholith. High $\delta^{18}O$(Zc) values (7.8 ± 0.7‰) predominate in the deep parts of the batholith, but lower values (6.1 ± 0.9‰) occur in shallower parts. This indicates a larger gradient in $\delta^{18}O$ with depth in the batholith than occurs from west to east across it. Oxygen, Sr, and Nd isotope data show that the supracrustal contaminant was likely young (Paleozoic or Mesozoic), hydrothermally altered upper oceanic crust or volcanic arc sediments. Such rocks were subducted or underthrust beneath the Sierran arc during accretion of oceanic terranes onto North America. This component yielded high-$\delta^{18}O$ magmas that were added to the base of the batholith. On average, gabbros in the southern Sierra contain at least 18% of the subducted supracrustal component. Some tonalite and granodiorite magmas were additionally contaminated by Kings Sequence metasedimentary rocks, as evidenced by $\delta^{18}O$(Zc) and initial $^{87}Sr/^{86}Sr$ that trend toward values measured for the Kings Sequence. Besides high $\delta^{18}O$ values in the southern Sierra, xenoliths in the central Sierra also have elevated $\delta^{18}O$, which confirms the widespread abundance of supracrustal material in the sub-arc lithospheric mantle. In contrast to $\delta^{18}O$(Zc), whole rock $\delta^{18}O$ values of many samples have undergone post-magmatic alteration that obscures the magmatic contamination history of those rocks. Such alteration previously prevented confident determination of the mass of young, hydrothermally altered mantle rocks that contributed to Sierran granitoids.

Keywords: oxygen isotopes; zircon; granitoids; alteration; Sierra Nevada; Tehachapi Mountains

1. Introduction

Understanding convergent margin magmatism is essential to unraveling processes of crustal growth and maturation. Granitic batholiths at continental con-

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vergent margins are thought to represent crust generated by interaction of mantle-derived magmas and pre-existing continental crust. Studies of continental margin batholiths have sought to understand how mantle and crustal components interact at different depths, and how much material is added versus recycled (e.g., [1–3]). A particularly important but elusive parameter of magma generation at convergent

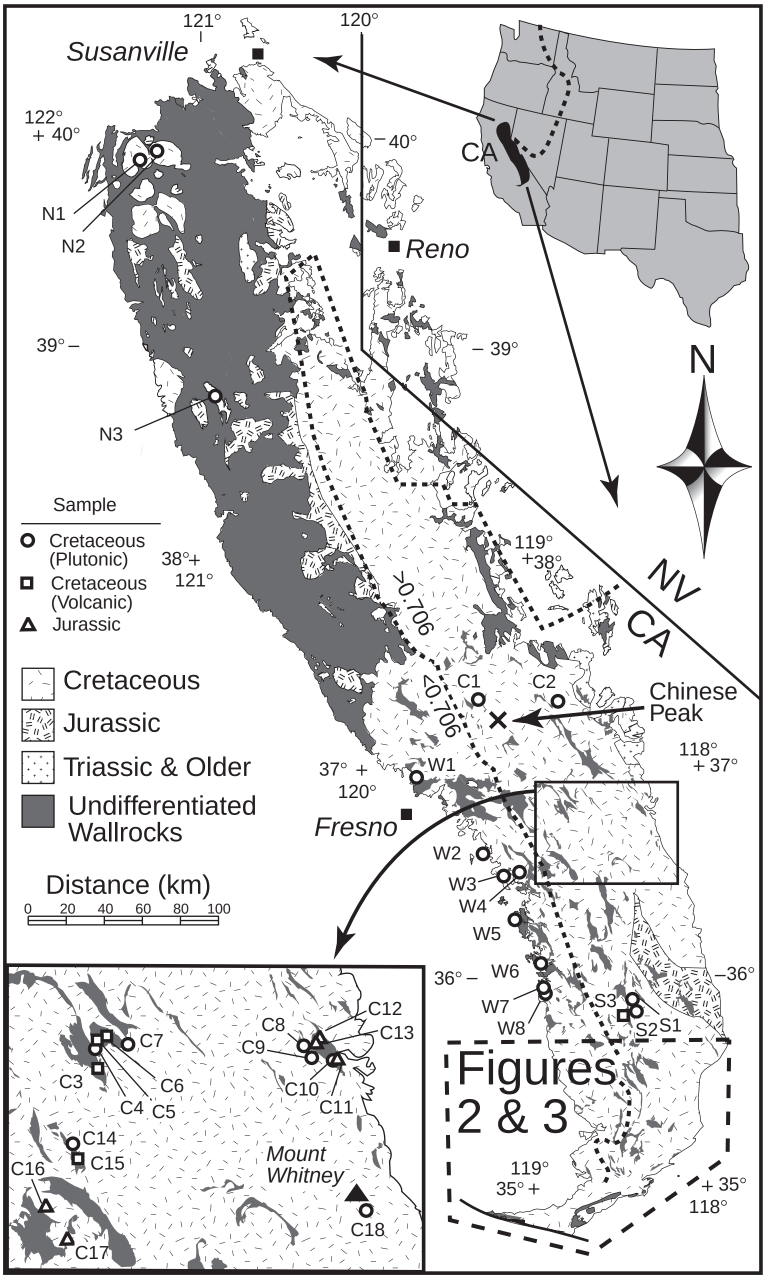

Fig. 1. Generalized geologic map of the Sierra Nevada batholith. Sample locations are indicated for rocks studied in the northern, western and central Sierra Nevada. $Sr_i = 0.706$ isopleth [4] is shown for reference. Map after Jennings et al. [5] and Moore and Sisson [6].