Provenance and Tectonic Implications of Greenstone Clasts in Eocene(?) Gravels, Picacho State Recreation Area, SE California

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A. Yin proposed that the Chocolate Mountain anticlinorium formed ~65-50 Ma as a fault-bend fold lying above the low angle trajectory of the subducting Farallon plate. In contrast, C. Jacobson and colleagues based on thermochronological data have argued that the anticlinorium can be no older than about 24 Ma. This latter interpretation is supported by recent provenance studies by G.H. Girty and students at San Diego State University that indicate that the Chocolate Mountain anticlinorium was growing during the early to middle Miocene. However, little work has been undertaken regarding probable Eocene (?) gravels unconformably overlying the Jurassic Winterhaven Formation and stratigraphically underlying the Oligocene Quechan volcanics. These gravels contain abundant rounded pebble- and cobble-sized clasts of metavolcanic rock that superficially resemble rocks in the Winterhaven Formation.

The purpose of this thesis is to assess whether or not the Eocene (?) gravels were deposited during initial growth of the Chocolate Mountains anticlinorium or alternatively were derived from a more distant source. In order to build a geochemical data base of possible metavolcanic source rocks in the Winterhaven Formation, I first collected and chemically analyzed a suite of 14 representative samples from the Winterhaven Formation, and then collected and analyzed a suite of 8 volcanic (greenstone) clasts from the Eocene (?) gravels.

All samples were analyzed for major and trace elements using standard XRF procedures. Thin section study revealed that all samples have been metamorphosed to the greenschist facies. Hence, the TiO_2/Zr versus Nb/Y magma series discrimination diagram was used to classify each analyzed specimen. The results of this phase of my work indicated that the metavolcanic rocks in the Winterhaven Formation vary from basalt to basalt-andesite to trachyte. On a bivariate plot of [Fe_2O_3 + MgO] versus Sc analyzed samples from the Winterhaven Formation form a crude linear array with basaltic specimens consistently having the highest Sc and [Fe_2O_3 + MgO] values and trachytes the lowest while samples of basalt-andesite form an intermediate variety. Such trends suggest that the suite of analyzed samples from the Winterhaven Formation may represent a related series derived from a common magma through crystal fractionation of a mafic phase such as amphibole and/or pyroxene.

In contrast to samples from the Winterhaven Formation, the 7 greenstone clasts plot about the boundary separating basalt and andesite on the TiO_2/Zr versus Nb/Y magma series discrimination diagram, and 1 sample plots well within the basalt-andesite field. For a given Sc value, the greenstone clasts display higher [Fe_2O_3 + MgO] values than do samples analyzed form the Winterhaven Formation. These data suggest that the greenstone clasts in the Eocene (?) gravels were not derived from the Winterhaven Formation, and imply further that they may have been derived from a

distant source. In short, the Chocolate Mountains anticlinorium was not a significant feature at the Earth's surface during their deposition.