We present new major, trace, rare earth element, and oxygen isotope analyses of a well-dated section of the Independence dike swarm (IDS) and associated plutonic host rocks in order to constrain the origin of the dioritic and granitic lithologies comprising the IDS. Despite the apparent lack of intermediate dike lithologies, the whole-rock geochemical data are consistent with the interpretation that the dikes form a comagmatic suite interrelated by hornblende ± pyroxene and plagioclase fractionation from a mafic parent magma. The oxygen isotope systematics of rare, mineralogically-unaltered dikes corroborate this interpretation; the possibility of limited crustal assimilation cannot, however, be excluded. Generation of the bimodal suite solely by mixing between magmas of widely disparate origins, such as partial melts of mantle and metasedimentary rocks, without crystal fractionation is precluded by the presence of characteristic reversals in geochemical trends and by the relatively low $\delta^{18}O$ of an unaltered granitic dike (+6.8%). Whole-rock geochemical compositions of the volumetrically-dominant biotite granitoid hosts plot near or within the lithologic gap defined by the IDS suite. Zircon geochronology (Chen and Moore, 1979) suggests that the intermediate hosts are only 1 to 6 m.y. older than the cross-cutting dikes. The age relationships thus permit the possibility that the apparent bimodal character of the IDS resulted not from differentiation processes but from rheological constraints that restricted the dikes to mafic and felsic compositions.

Hydrothermal alteration produced minor geochemical and significant mineralogical and isotopic changes in the majority of the samples. Variable degrees of low-temperature alteration are recorded by replacement of magmatic hornblende and biotite by chlorite, by saussuritization and albitization of feldspars, and by elevated whole-rock $\delta^{18}O$ values. Weakly constrained alteration temperatures of 250 to 400°C and increases in dike $\delta^{18}O$ by as much as 3.5‰ from presumed magmatic values together require involvement of high-$^{18}O$ water. As the most geologically reasonable water source is sea water and a likely heat source is the dikes themselves, the position of the Late Jurassic marine shoreline is constrained to lie somewhat south of the field area. 

INTRODUCTION

In this paper we present new geochemical and isotopic analyses made with the intent of investigating the petrogenesis of the Independence dike swarm (IDS). The IDS occupies an area approximately 40 km in width and 500 km in length, oriented NW-NNW across eastern California (James, 1989). Special geochronologic and tectonic significance has long been attributed to this regional feature. Moore and Hopson (1961) initially recognized the IDS as a structural marker useful for distinguishing between older and younger cycles of magma emplacement within the Sierra Nevada batholith. Geochronologic evidence led Chen & Moore (1979) to propose that dike intrusion occurred at 148 ± 2 Ma during a relative hiatus in batholith emplacement. This age has been confirmed for felsic dikes throughout the length of the swarm (James, 1989; Lahren et al., 1990; Stephens et al., 1993), but the abundance of broadly coeval plutons and volcanic rocks in the central Mojave desert and the western Basin and Range indicates that Late Jurassic magmatism was more widespread than previously thought (Hopson, 1988; Schermer and Busby, 1994; Dunne et al., 1994). Emplacement of the IDS and structurally different but broadly coeval igneous rocks is ascribed to a regime characterized by both extensional and contractional tectonic components resulting from sinistral-sense oblique subduction (Wolf and Saleeby, 1992; Schermer and Busby, 1994). Little is known, however, concerning the origin of the IDS magmas: specifically, whether or not the apparently unique tectonic event during which the IDS was emplaced coincided with a magmatic event distinct from pre- and post-148-Ma continental margin arc magmatism.

The IDS is composed of a wide variety of hypabyssal dike rocks dominated by mafic and felsic endmembers with mafic rocks being more abundant than felsic rocks (Moore and Hopson, 1961; Smith, 1962; Chen and Moore, 1979). The apparent bimodal