Introduction:
Although shield-stage lavas of Hawaiian volcanoes are derived from the Hawaiian hotspot, commonly inferred to be a mantle plume, many Hawaiian shields are distinct in major and trace element abundances, as well as isotopic ratios. Some of these geochemical differences may be related to melting processes, but there is no doubt that the mantle source for Hawaiian shield lavas is geochemically heterogeneous. Compositions of lavas collected from subaxial exposures of the Koolau shield on Oahu (hereafter referenced as Koolau lavas) (Fig. 1) define an extreme endmember. Hawaiian shield lavas are characterized by relatively high Sr isotopes, Sr207/Sr206, Sr206/Sr208, Sr208/Sr206, Nd isotopes, Nd143/Nd144, Th isotopes, Th208/Th230, and low total iron and Co contents, 142Nd/144Nd, 176Hf/177Hf, Th/La, and Th/La ratios (e.g., Fig. 2; Frey et al., 1994; Roden et al., 1999; Lasister and Hauri, 1998; Blichter-Teff et al., 1999).

These geochemical characteristics have provided evidence for recycled oceanic crust, including sediments, in the source of Koolau lavas.

Important Questions:
1. Does the entire Koolau shield have the end-member geochemical characteristics manifested by the subaxially exposed Makapuu-stage of Koolau lavas?
2. What is the origin of Makapuu-stage of Koolau lavas?

Koolau Scientific Drilling Project (KSDP)
A deeper sampling of the Koolau shield was obtained by deepening and coring a ~350 m water well to a depth of ~678 m (Haskins and Garcia, 2004). The core includes ~103 m of flows from the lowestmost ~28% of the hole. Based on petrography and compositions of whole-rocks and glasses, Haskins and Garcia (2004) conclude that the distinct geochemical features of uppermost Koolau lavas (Makapuu-stage) form a tenner only 175 to 200 m thick at the drill site (Fig. 3). This project reports ICPS-MG data for 26 trace elements in 95 KSDP samples and 15 Makapuu-stage samples. We use these data, in conjunction with major element compositions and Nd-Hf isotopic ratios (Haskins and Garcia, 2004; Feiakova et al., in prep., Salters et al., in prep.), to understand the temporal evolution of Koolau shield lavas.

Are KSDP lavas Similar to Makapuu-Stage of Koolau Lavas? - No!

Summary
Geochemical and petrographic studies of surface lavas erupted on the Koolau shield and drill core from the Koolau Scientific Drilling Project show that the shield lavas changed markedly near the end of shield-building (Frey et al., 1994; Roden et al., 1994; Jackson et al., 1999; Haskins and Garcia, 2004). Specifically, as shield building ended, tholeiitic shield basalt changed gradually from a Mauna Loa-like composition (Koolau-stage of Haskins and Garcia, 2004) to the well known geochemical endmember that characterizes exposed Koolau lavas (Koolau-stage of Haskins and Garcia, 2004). The transition from typical Koolau-stage composition to Koolau-stage composition occurred over at least 175% which is about three times longer than the estimate of Haskins and Garcia (2004).

The transition from Koolau-stage to Makapuu-stage lavas reflects changes in source material that presumably occurred as Koolau volcano migrated away from the hot spot.

1. The presence at age a garnet pyroxene component was increasingly important in generating Koolau shield lavas. The relatively high Sr isotopes and Sr208/Sr206 (Figs 5 and 6) in Makapuu-stage lavas is consistent with the increasing amount of melt (dacies) derived from partial melting of garnet pyroxene.
2. Makapuu-stage lavas also have relatively high La/Nb, Sm/Nb and low Th/La which are correlated with ~143Nd/144Nd, 176Hf/177Hf and 206Pb/204Pb (Fig. 4). These reflect a small amount of ancient recycled pelagic carbonate and upwelling sediment in the source of Makapuu-stage lavas. Such sediments occur in the Central America trench (DSDP Site 495, Plank and Langmuir, 1998).