$^{40}Ar/^{39}Ar$ geochronology at Sheephead Mountain, California, with implications for the long-term slip rate of the right-lateral Sheephead fault

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40Ar/39Ar geochronology of volcanic flows and tuffs at Sheephead Mountain provides new constraints on the timing of faulting and tilting of blocks in the southeastern Black Mountains on the east flank of Death Valley, California. Provisional ages for the kilometer-thick succession range from ~10.5 Ma to 9.48 ± 0.05 Ma, indicating that much of the eastward tilting and hence faulting took place after ~9.5 Ma. Thickening of the Rhodes Tuff (10.34 ± 0.05 Ma; 10.48 ± 0.05 Ma) and an underlying porphyritic dacite (~10.5 Ma) towards the right-lateral Sheephead fault, which bounds Sheephead Mountain to the south, suggests that faulting initiated during the emplacement of those units (at ~10.5-10.3 Ma). All but one of the quoted ages are based on isochrons calculated from single-step laser fusions of 9 individual biotite crystals. The age of the dacite (step heating isochron for feldspar) is currently least well constrained; additional analysis is under way. Movement on the Sheephead fault is inferred to have been co-ordinated with normal faulting, and to have ceased in the early Pliocene (by ~3 Ma or earlier), based on the lack of deformation of Lake Tecopa sediments (Wright et al., 1991, Geol. Soc. America Guidebook, 93-127).

The Sheephead fault—which strikes WNW, and is exposed intermittently from the Black Mountains to the Amargosa Valley—is one of the major structures accommodating dextral motion in the Death Valley area. However, its contribution has been left out of slip budgets for the Eastern California Shear Zone because its offset and timing were largely unknown. Recent estimates for displacement along the Sheephead fault, based on its bookshelf style of deformation and some very tentative piercing point offsets, range from ~12 to 18.5 km, with an uncertainty of up to several kilometers greater and smaller than those figures. Combining those offset estimates with our new dating of volcanic rocks suggests an average long-term slip rate of ~1.6-2.5 mm/yr. This rate, though tentative, is comparable to that of other right-lateral faults in the region. Displacement along the Sheephead fault is thus consistent with the interpretation of Guest et al. (2007, Geol. Soc. America Bull., 119, 1337-1346) that the Eastern California Shear Zone extends farther east than previously thought.