Comparing $^{40}Ar/^{39}Ar$ ash dates to U-Pb sedimentary carbonate dates from the middle Miocene: Implications for timing climate change and chronometer cross-calibration

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Introduction: The Miocene is a particularly interesting part of Earth's history because of the change from relatively warm conditions during the Mid-Miocene Climatic Optimum to the onset of glaciation associated with the formation of the East Antarctic Ice-Sheet (Fig. 1; Flowers and Kennett, 1994). These climatic shifts have been recorded as changes in the oxygen isotope composition of marine organisms (Zachos et al., 2001), atmospheric CO_2 concentrations (Royer et al., 2001), and mammalian evolution and distribution (Opdyke, 1990).

The precise and accurate understanding of time is essential for studies of past climate change. For geologic time beyond the realm of radiocarbon and uranium-series, there is a paucity of techniques available for dating the sedimentary sequences that record these changes in climate. Dating intercalated volcanic deposits with $^{40}Ar/^{39}Ar$ of sanidines or U-Pb of zircon can only be applied when suitable materials are present and extrapolations must be made to the sedimentary event of interest. When only one dateable ash can be identified, the determination of rates can be impossible. I have recently completed extensive development work on U-Pb dating of sedimentary carbonates from the middle Miocene Barstow Formation (Cole, 2003; Cole et al., 2004; Cole et al., in press). This technique has the advantage of directly dating the sedimentary record and provides precise ages. Improvements in both $^{40}Ar/^{39}Ar$ and U-Pb dating techniques have increased the analytical precision such that calibration between the systems is now necessary (Villeneuve et al., 2000).