Table 3
Kennar Valley drift ages.

Deposit	Height[a] (m)	Mean exposure age[b] (ka)	Preferred age model[c] (ka)
K1	0	19	20
K2	55	160	290
K3	70	260	320
K4	95	550	590
K5	85	720	1000
K6	95	490	560
K7	90	1800	1800
K8	205	3100	3100
UD[d]	n/a	3700	3900

[a] Maximum elevation of deposit/moraine above current elevation of the base of Taylor Glacier.
[b] Average of all clast exposure ages for each moraine/drift, in which a constant erosion rate of 10 cm Myr^{-1} is assumed for each sample.
[c] Preferred age model using oldest dated clast from each moraine/drift, assuming a constant erosion rate of 10 cm Myr^{-1}.
[d] Undifferentiated drift dated ~20 m distal to moraine K7. Drift is stratigraphically below K7 drift.

dates on a series of moraines in Vernier Valley (~25 km southeast of Kennar Valley) indicate gradual lowering of Ferrar Glacier (a second outlet glacier draining Taylor Dome) since the mid-Pliocene (Staiger et al., 2006; Johnson and Staiger, 2007) (Fig. 1). Although these records share similar first-order trends, they differ in the precise number and age of individual moraines and drifts; individual drifts cannot be correlated with certainty from valley to valley. The variation likely arises from stochastic factors associated with spatially variable and intermittent rockfall. In addition, temporal and spatial changes in rates of ice ablation, and resulting ice flow, might also influence moraine deposition. The unusually large number of moraines in Arena Valley most likely reflects extensive and persistent rockfall from exposed dolerite cliffs at the base of Finger Mountain and/or potentially persistent higher-than-average ablation rates along the surface of Taylor Glacier ice at the mouth of Arena Valley (which may drive increased ice flow into the valley and result in more frequent moraine formation).

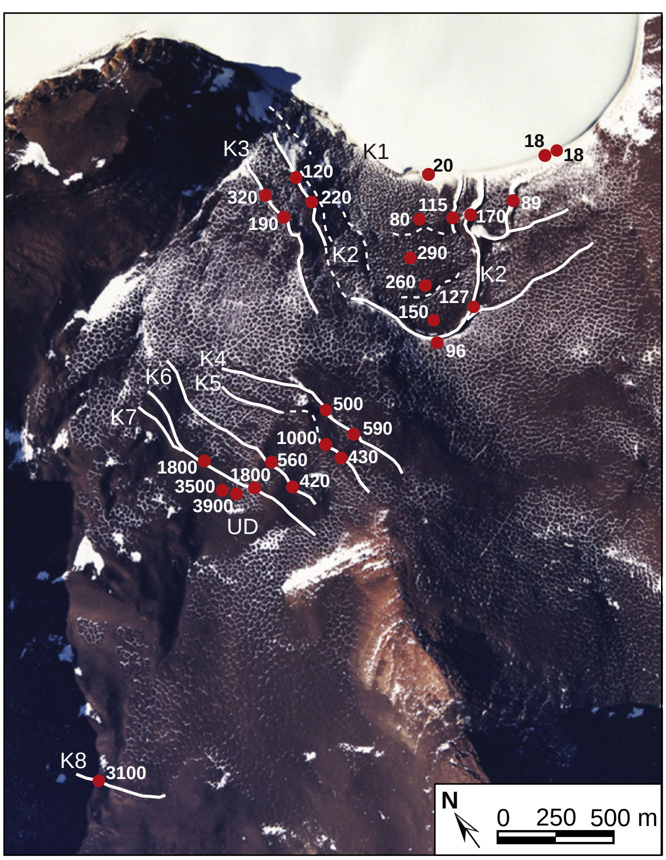

Fig. 7. Results from our preferred-age model (assuming 10 cm Myr^{-1} of erosion) for all 27 exposure samples in Kennar Valley. Ages are listed in thousands of years (ka).

5.3. Response of Taylor Dome to warmer-than-present conditions and the mid-Pleistocene transition

The 3.1 million-year glacial record from Kennar Valley (as well as from Arena and Vernier valleys) implies overall ice recession for outlet glaciers draining Taylor Dome since mid- to late-Pliocene time. In detail, the Kennar Valley record indicates that the ice-surface elevation of Taylor Glacier, and hence of Taylor Dome, stood at higher-than-present levels during significant, globally warm intervals: the mid-Pliocene climatic optimum (~3.0–3.1 Ma) and MIS 31 (~1.07 Ma). However, these findings contrast with recent reports for significant reductions in the volume of grounded, marine-based ice from the WAIS in the Ross Embayment (Scherer et al., 2008; Naish et al., 2009; Pollard and DeConto, 2009; see also Miller et al., 2005). The findings call for considerable variability in the response of Antarctic ice to global climate change.

In addition, the combined glacier records from Kennar, Arena, and Vernier valleys suggest that the rate of change accelerated at the mid-Pleistocene transition (or just shortly after), with both Taylor and Ferrar glaciers experiencing most (50–80%) of their total vertical recession after ~0.9 Ma (Table 3). One possible explanation calls on reduction in snowfall at Taylor Dome, which could reflect overall cooling of atmospheric temperatures throughout the late Pleistocene (Lisiecki and Raymo, 2005) and/or northward displacement of open water in the Ross Embayment associated with expanding sea ice and/or increasing frequency of WAIS expansion (Denton and Marchant, 2000; Steig et al., 2000; Grootes et al., 2001; Naish et al., 2009).

5.4. Implications for paleoclimate

The mapped drifts in Kennar Valley (as well as in nearby Arena and Vernier valleys) were deposited from cold-based ice (Brook et al., 1993; Marchant et al., 1994; Staiger et al., 2006). Had wet-based conditions occurred, clasts within the Kennar Valley drifts would show evidence for glacial abrasion, including striations, polish, and faceting, which is not the case (see also Marchant et al., 1994; Staiger et al., 2006). Also, had the ice surface experienced significant melting, outwash and/or stratified sediments would be commonplace (e.g., Denton et al., 1993). Instead, all moraines are texturally and morphologically identical to those found today alongside cold-based margins of outlet and alpine glaciers that pass across the central and southern Transantarctic Mountains (Denton et al., 1989; Marchant et al., 1994; Staiger et al., 2006; Kowalewski et al., 2011). The implication is that climate conditions during moraine deposition were similar to present-day conditions, and not as warm as those inferred for the central Ross Embayment (Scherer et al., 2008; Naish et al., 2009). In addition, the presence of in-situ moraine ridges at the base of steep valley walls in all mapped valleys (K8 drift in Kennar Valley, for example) imply limited slope development for the last ~3.1 Myr. To be sure, a record of morphologic change does exist, and is most notably expressed in the overall reduction in clast size on drifts K2 to K8 and a gradual lowering of moraine heights with increasing exposure age (e.g., Morgan et al., 2011).

6. Conclusions

The areal distribution of drifts in lower Kennar Valley, along with a relative and numerical chronology afforded by surface-weathering characteristics and ^3He exposure ages, call for overall thinning of upper Taylor Glacier over the last 3.1 Myr, although subtle readvances cannot be precluded. At ~3.1 Ma, the margin of upper Taylor Glacier in Kennar Valley stood at ~1610 m elevation (~205 m higher than at present).