Absolute plate reference frames are a means of describing the motion of plates on the surface of the Earth over time, relative to a fixed point or "frame." Multiple reference frames have been proposed for the Cretaceous-Tertiary period. Estimating the robustness and limitations of each model remains a significant limitation for refining both regional and global models of plate motion as well as fully integrated and time dependent geodynamic models. Here, we use a novel approach to compare each absolute reference frame in terms of their consequences for deep mantle structure. We show that the use of hotspots, either fixed or moving, or palaeomagnetics, with or without corrections for true-polar wander leads to significant differences in the location of palaeo-plate boundaries of up to 30 degrees longitude and latitude. We use the fully spherical 3D finite element mantle convection code TERRA, coupled with the interactive plate-tectonic reconstruction software GPlates to forward model mantle heterogeneity since at least 140Ma. We present a global comparison of the absolute reference frames, which we have pseudo-seismically filtered, to the seismic tomography model s20rts. At very long wavelengths (spherical harmonic degrees 1-3) hotspot models best reproduce the mantle structure. However, when geometry and the match of smaller-scale subducted slab volumes are compared, hybrid models based on moving hotspots after 100 Ma and palaeomagnetic data before, best reproduce the overall mantle structure of slab burial grounds, even though no single model fits best at all mantle depths.