**Supplemental Materials**

*Carbonate Clumped-Isotope Thermometry*

 The carbonate δ18O value was calculated using a 90°C acid digestion fractionation factor for calcite from Swart et al., (1991) and for dolomite from Rosenbaum and Sheppard, (1986). Carbonate δ13C and δ18O values were drift-corrected using a 10 standard moving window to NBS-19 and NBS-19 calibrated internal Carrara Marble standards (HCM and CIT). We corrected all of the ∆47 data using a 10 standard moving window using heated gases, equilibrated gases (when available) and carbonate standards for both the linearity correction and empirical transfer function into the “absolute reference frame” or “carbon dioxide equilibrated scale” (CDES) as defined by Dennis et al. (2011).

 To build an empirical function to transfer our data into the CDES reference frame in Easotope, we first calculated ∆47CDES values for five in-house standards from periods when both 1000°C heated and 25°C equilibrated gases were analyzed (HCM (n = 44), CIT CM (n = 38), TV01 (n = 60), TV03 (n = 32), 102-GC-AZ-01 (n = 30). We then used a 10 standard moving window of a combination of at least two carbonate standards (HCM/CIT CM, TV01/TV03, 102-GC-AZ-01) and two compositions of 1000°C heated and 25°C equilibrated gases (when available) to calculate ∆47CDES values for the entire time period. We did exactly the same approach twice, first using the 17O correction parameters from following Schauer et al. (2016) and Daëron et al. (2016), as outlined in Brand et al. (2010), and then using the 17O correction parameters outlined in Huntington et al., (2009). The standard values are consistently more depleted using the parameters from Brand et al., (2010). In the long run as calibration lines are transferred into the CDES space using the 17O parameters as outlined in Brand et al., (2010) this issue will be corrected for. However, here we opt to present both results in our tables and supplemental materials and use the same correction process as the calibration dataset from Bonifacie et al., (2017), their Eq. 1 to calculate our ∆47 temperatures used in the main text. This calibration includes data garnered at Caltech during the same time interval as our analyses using the same methods outlined here. The Bonifacie et al., (2017) Δ47CDES90 calibration Eq.1 agrees well with Bonifacie et al., (2017), their Eq. 3, which is a composite of both synthetic and biogenic calcite, aragonite, and dolomite minerals analyzed at 70–90°C in eight laboratories (Fernandez et al., 2014; Henkes et al., 2013; Tang et al., 2014; Wacker et al., 2014; Defliese et al., 2015; Kele et al., 2015; Bonifacie et al., 2017). Temperatures using other recent calibrations (Kele et al., 2015; Kelson et al., 2017) are compared in the Supplemental Materials using both 0.082 and 0.092 acid fractionation factors (Henkes et al., 2013; Defliese et al., 2015). There is agreement among all studies that 90°C reactions of calcite and dolomite can be treated using the same acid fractionation factor (Murray et al., 2016; Müller et al., 2017b; Defliese et al., 2015; Lloyd et al., 2017).

 Fluid compositions were calculated using the measured clumped–isotope temperatures and an equilibrium fractionation equation for calcite–water (Kim and O’Neil, 1997). To calculate fluid compositions for dolomite samples, we compared published equilibrium fractionation equations for dolomite–water (and proto-dolomite–water) and found little difference (± 1‰; Supplemental Materials; Matthews and Katz, 1977; Vasconcelos et al., 2005; Horita, 2014). We present water δ18OVSMOW values for dolomite in the main text using the equation from Horita (2014).

Fig. SM1.—Average crystal size of each component (grains, matrix, cement) versus calculated water δ18OVSMOW. % of each component (grains, matrix, cement) versus calculated water δ18OVSMOW.

Fig. SM2.—SEM images of A) Eocene sample from Fig. 4A (HM1). Scale bar is 100 µm. B) SEM image of Eocene sample from Fig. 4A (HM1) with an inset elemental map showing small rhombohedral dolomite crystals in green. Scale bar is 20 µm. C) Cretaceous sample from Fig. 4C (HM4). Scale bar is 40 µm. D) Jurassic sample from Fig. 5C (HM12). Scale bar is 40 µm. E) Permian dolomite from Fig. 5F (HM15). Scale bar is 40 µm. F) Cambrian sample from Fig. 5K (HM20). Scale bar is 200 µm.

Fig. SM3 - Fig. SM6.—Images of polished slabs, thin-section billets, and thin sections. HM samples have blue-stained epoxy. All other samples do not. Drill area is shown as a green circle. Other drill holes are for other analyses. Scale bar is 500 µm.

Fig. SM7 - Fig. SM14.—SEM images of various samples to compare crystal size results from the petrographic images.