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# Supplemental Material

**Supplemental File 1.** Assessing stratigraphic uncertainties between published dates and dates from CPCP 1A

**Table S1.** U-Pb zircon geochronology and depositional age models for the Upper Triassic Chinle Formation (Petrified Forest National Park, Arizona, USA): implications for Late Triassic paleoecological and paleoenvironmental change.

**Table S2.** U-Pb zircon geochronology and depositional age models for the Upper Triassic Chinle Formation (Petrified Forest National Park, Arizona, USA): implications for Late Triassic paleoecological and paleoenvironmental change

U-Pb zircon geochronology and depositional age models for the Upper Triassic Chinle Formation (Petrified Forest National Park, Arizona, USA): implications for Late Triassic paleoecological and paleoenvironmental change

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## Supplemental File 1

### Assessing stratigraphic uncertainties between published dates and dates from CPCP 1A

One of the driving motivations for coring at Petrified Forest was the uncertainty in placing outcrop data in a quantitatively accurate stratigraphic sequence (Olsen et al. 2018) when there was no reference section, a situation remedied by the CPCP core 1A. However, correlation of outcrop data to the core has uncertainties as well and are difficult to quantify. This is particularly true for the previously published zircon U-Pb data (Atchley et al. 2013; Ramezani et al. 2011, 2014; Nordt et al. 2015). Because if these uncertainties, it is difficult to assess the meaning of the differences between these dates and our own. A large part of the uncertainty arises from questionable identification of marker beds shared between sections selected to produce composite sections especially between widely spaced outcrops; traditionally these marker beds are entirely fluvial sandstones which are very difficult to justify in a sedimentological processes sense. We can get some idea of the uncertainties by using linear correlation to project the outcrop locations of samples in published composites of different authors to the CPCP 1A core (Figure S1).

Kent et al. (2019), used linear regression between Atchley et al. (2013) [Appendix Fig 1; incorporating the dates of Ramezani et al. (2011)] and the CPCP 1A core, using unit boundaries as depicted by Atchley et al. (2013) and Olsen et al. (2018) as correlative tie points.

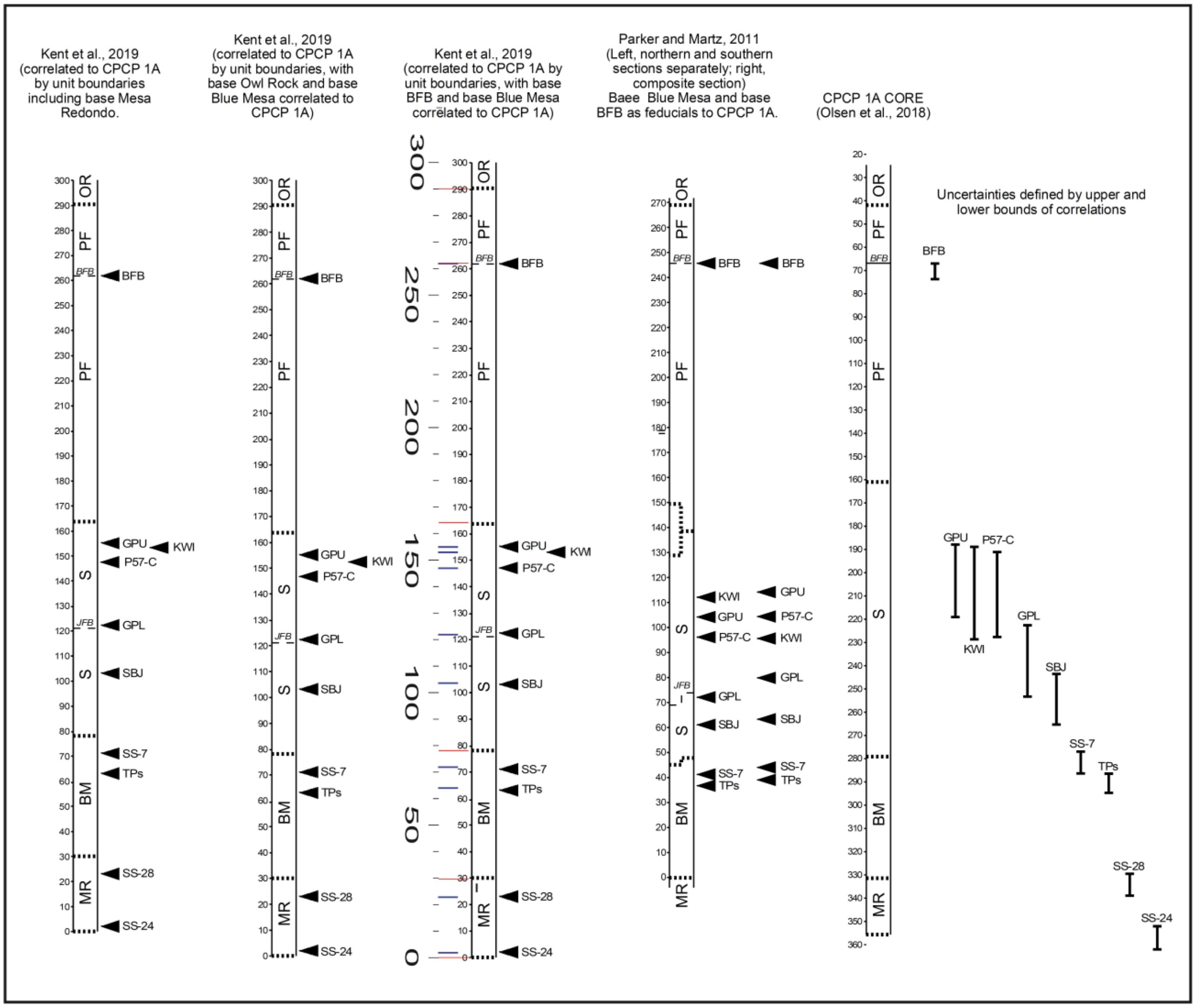


Figure S1: Outcrop sections of different authors with placement of samples that produced the dates in Ramezani et al. (2011), Atchley et al. (2013), and Nordt et al. (2015) correlated to the CPCP 1A core showing the uncertainties among the stratigraphic placement of outcrop samples relative to the core depending on the author of the sections and correlation fiducials employed.

However, the Atchley et al. (2013) column is a composite of three sections (northern park, southern park and Hunt Valley) each more than 20 km apart from the stratigraphically adjacent section. If instead, the base of the Blue Mesa Member is used as a datum, and the section are re-correlated it results in a shift of nearly ten meters down section of TPs, and SS-7 and smaller amounts for SBJ and GPL. A smaller adjustment occurs if the base of the Black Forest Bed is used to correlate as opposed to the base of the Owl Rock Member. Much larger changes in apparent position occur if the locations for Ramezani's (2011) samples are correlated to the Parker and

Martz (2011) northern and southern sections individually or in their composite section, using the base Blue Mesa and Black Forest Bed as fiducials. The largest discrepancy is generated by a difference of about 25 m in the stratigraphic position of the Jasper Forest Bed between Parker and Martz (2011) and Atchley et al. (2013). The Jasper Forest Bed produce sample GPL, resulting in a total stratigraphic uncertainty of more than 30 m, the provenance of which we have been able to conform. The entire section overlying Jasper Forest Bed the and all of its samples in the southern park section are correspondingly shifted down in Parker and Martz (2011) relative to Atchley, et al. (2013), resulting in similar large uncertainties. Furthermore, depending on how the northern and southern park sections are correlated, even the relative order of samples GPU, KWI, and P57-C change.

If these different linear projection of the outcrop samples are used as uncertainly limits, the apparent discrepancies between the Ramezani et al. (2011) dates and our new dates (Main Text Figure 3) disappear or nearly disappear into the stratigraphic uncertainty (Figure S1) (Main Text Figure 3). Only TPs remains irreconcilably too old compared to our data, including our oldest samples, and dating of recycled older grains is the only plausible explanation.

As already discussed in Olsen et al. (2018), the stratigraphic thickness of the members of the Chinle Formation in the CPCP core 1A are very similar to their inferred thickness in outcrop based on composites of individual correlated sections. Though the thickness of the lowest unit, the Mesa Redondo Member, cannot be compared because the base of the member does not crop out in the park, the overlying Blue Mesa Member in core CPCP 1A has a thickness of ~52 m, which matches well with the thicknesses of ~47-50 m reported by Atchley et al. (2013) and Martz et al. (2012). The Sonsela Member in CPCP 1A has a stratigraphic thickness of ~119 m, which is thicker than the ~88-90 m estimated from outcrop (Atchley et al., 2013; Martz et al. 2012). However, this difference is not surprising because this unit requires a long lateral traverse of ~5-10 km (e.g., Martz & Parker 2010: figs. 6-9) to estimate the complete Sonsela Member thickness from outcrop, resulting in increased uncertainty from sighting error. Additionally, there could be some true variation in unit thickness, as these outcrop estimates are from the southern portion of PFNP, whereas the core was drilled in the north, where the base of the Sonsela Member is not exposed (Parker and Martz, 2011: fig. 5; Martz et al., 2012; Martz and Parker, 2017: fig. 10). The discrepancy could also arise from the presence of an addition bed of sandstone in the core included by Olsen et al. (2018) in the Sonsela equivalent to more mudstone-dominated section in outcrop that would otherwise be part of the Petrified Forest Member. Finally, the overlying Petrified Forest Member again matches closely with outcrop estimates, with a stratigraphic thickness of ~119 m from core, and estimates of ~125-130 m from outcrop (Atchley et al., 2013; Martz et al., 2012). Even individual bed-level units are within error; the Black Forest bed is ~11 m thick in core CPCP 1A, and has been estimated at ~9-13 m thick in outcrop (Ash, 1992; Atchley et al., 2013; Martz et al., 2012). Therefore, the stratigraphic thicknesses of members as defined in the CPCP 1A core closely approximate the stratigraphic thicknesses estimated in outcrop; hence, it seems very unlikely that core-outcrop lithostratigraphic miscorrelation is responsible for the discrepancy we observe between core and outcrop U-Pb ages in the lower half of the Chinle Formation.

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