

RESPONSE TO CRITIQUE BY LUCAS ET AL. (2009) OF PAPER BY FASSETT (2009) DOCUMENTING PALEOCENE DINOSAURS IN THE SAN JUAN BASIN

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ABSTRACT

In this issue of *Palaeontologia Electronica* Lucas, et al. (2009) question the validity of the Fassett (2009) paper that presented evidence for Paleocene dinosaurs in the San Juan Basin of New Mexico and Colorado. Their challenges focus primarily on the lithostratigraphy, palynology, and paleomagnetism of the dinosaur-bearing Ojo Alamo Sandstone, shown by Fassett to be of Paleocene age. The lithostratigraphy of the Ojo Alamo is addressed by Lucas et al. (2009) based on detailed studies of outcrops of this formation in two relatively small areas in the southern San Juan Basin where Ojo Alamo dinosaur fossils have been found. When viewed over its 13,000 km² extent, the Ojo Alamo is seen to be a much more complex formation than these authors recognize, thus their perception and description of the lithostratigraphy of this rock unit is limited and provincial. Fassett (2009) presented a detailed discussion of the palynology of the rocks adjacent to the Cretaceous-Tertiary (K-T) interface in the San Juan Basin, including a 67-page appendix and 25 tables listing the 244 palynomorph species identified from these strata. The Ojo Alamo Sandstone produced 103 palynomorphs from five principal localities including one especially prolific sample set from drill core through K-T strata. Without exception, all samples collected from the Ojo Alamo Sandstone for palynologic analysis were found to contain Paleocene palynomorph assemblages. Lucas et al. challenge only one Ojo Alamo palynomorph assemblage from one of the five areas studied, stating that they were unable to find palynomorph-productive samples at that locality. They submit no new palynologic data that refutes the Paleocene palynologic age of the Ojo Alamo Sandstone. In addressing the paleomagnetism of the Ojo Alamo, these authors dismiss the presence of a critical normal-polarity magnetochron discovered in the lower part of the Ojo Alamo – magnetochron C29n.2n of Fassett (2009) with no evidence to justify this dismissal. This magnetochron has been identified at five localities in the basin, thus its existence seems unquestionable. At the Mesa Portales locality, this normal chron was found in Ojo Alamo strata containing Paleocene palynomorph assemblages verifying its identification as chron C29n. Other minor arguments of Lucas et al. (2009) are also addressed in this paper. In sum, Lucas et al. (2009) present no new data to contradict the data presented in Fassett (2009).

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INTRODUCTION

William James (American Philosopher) wrote that "A new idea is first condemned as ridiculous and then dismissed as trivial, until finally, it becomes what everybody knows." It would appear that the "new idea" of Paleocene dinosaurs is now somewhere between phases one and two of the above quotation. The nearly instantaneous response by Lucas et al. (2009) to my recent paper in *Palaeontologia Electronica* (Fassett, 2009) documenting the presence of in-place Paleocene dinosaur fossils was not unexpected because the belief that all dinosaurs became extinct at the end of the Cretaceous has become a matter of faith among vertebrate paleontologists, thus my heresy had to be quickly challenged. The rather strident words "No definitive evidence" in the title of the critique by these authors smacks of a clear attempt to challenge my paper primarily by use of a declarative title rather than by an even-handed evaluation of the data at hand.

Fassett (2009) presented new data that confirmed the Paleocene age of the dinosaur-bearing Ojo Alamo Sandstone throughout the San Juan Basin based on paleomagnetic and palynologic evidence. This paper amplified recent publications by Fassett and Lucas (2000), Fassett et al. (2000), and Fassett et al. (2002) that also concluded that Paleocene dinosaurs had been documented in the San Juan Basin. In addition, Fassett (2009) presented data attesting to the presence of dinosaur fossils in the Paleocene Animas Formation in the northern part of the San Juan Basin. And new geochemical data were presented that buttressed earlier findings that the many dinosaur-bone specimens present in the Ojo Alamo Sandstone could not have been reworked from underlying Cretaceous strata.

The Lucas et al. (2009) paper consists essentially of the same rhetorical arguments against the presence of Paleocene dinosaurs in the San Juan Basin presented in Sullivan et al. (2005). There is an ironic circularity to this process because Fassett (2009) addressed and refuted these same arguments, and again does so in this paper. The Lucas

et al. (2009) critique addresses the lithostratigraphy, palynology, and magnetostratigraphy of the Ojo Alamo Sandstone and includes a discussion of the geochemistry of bone samples from the Ojo Alamo Sandstone vs. samples from underlying Cretaceous strata. These authors also discuss the value of vertebrate fossils as geochronologic tools generally throughout the Western Interior of North America and include a short discussion of the dinosaurs of the Animas Formation. The following remarks respond to the Lucas et al. (2009) paper by these major topics.

LITHOSTRATIGRAPHY

As discussed in Fassett (2009) and in Fassett et al. (2002), the Ojo Alamo Sandstone is present throughout much of the ~13,000 km² area of the New Mexico part of the San Juan Basin. Those authors of the Lucas et al. paper who have studied the Ojo Alamo Sandstone in the basin have done so at only a relatively few limited outcrop areas in the southern part of the basin. Being vertebrate paleontologists, they have naturally focused on the few places on the Ojo Alamo Sandstone outcrop – a few square km - where dinosaur fossils have been found (the locations of these areas are shown on Figure 1). The Ojo Alamo, is a multi-storied, high energy, fluvial, conglomeratic-sandstone deposit thus it is extremely variable in its lithologic make up and thickness throughout the basin (Figure 1). This figure shows the lithologic diversity of the Ojo Alamo in a northeast-trending, geophysical-log cross section. Geophysical log 1 at the southwest end of this cross section is only about 3 km down dip from the outcropping Ojo Alamo Sandstone in the Ojo Alamo Sandstone type area. In this outcrop area the Ojo Alamo is about 25 m thick and consists of upper and lower ledge-forming sandstone beds with interbeds of less well cemented sandstone beds and overbank mudstone beds (see photographs of Ojo Alamo Sandstone exposures at several localities in Fassett (2009). The Ojo Alamo on log 1 is about the same thickness as at the outcrop in the type area, however on the log, the uppermost part of the forma-

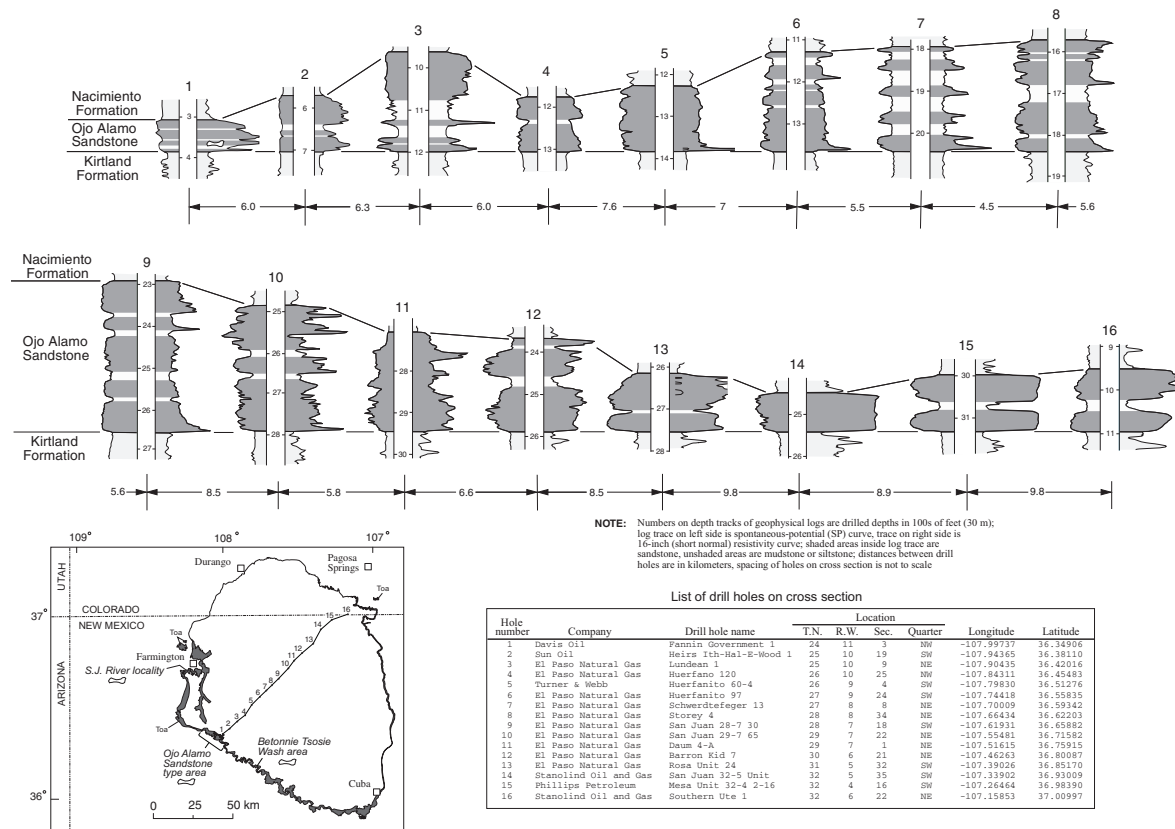


FIGURE 1. Northeast-trending geophysical-log cross section across San Juan Basin showing variability of Ojo Alamo Sandstone in subsurface of San Juan Basin. Geophysical log traces of Ojo Alamo from stratigraphic cross section A-A' of Fassett (2000, Plate 1). Shaded areas inside log traces are sandstone, white areas represent mudstone interbeds; lithologies are based on geophysical log interpretation by the author. Bone symbol on log 1 indicates level of multiple-bone set; the “articulated” bones of Lucas et al. (2009). Modified from figure 5 of Fassett et al. (2002).

tion consists of three massive sandstone beds separated by two thin (~1-m thick) mudstone layers. The lowermost sandstone bed of the Ojo Alamo on log 1 is about 2 m thick, slightly thicker than the average thickness of the lowermost conglomeratic sandstone bed in the Ojo Alamo type area.

Figure 1 shows that the Ojo Alamo is thinnest – 25 m – in log 1 and ranges up to 110 m thick in log 9; the numbers of sandstone beds and mudstone interbeds included in the formation can be seen to vary greatly across this line of cross section. The same variations in the lithologic components of the Ojo Alamo are also seen along its outcrop where the formation ranges in thickness from one bed a few meters thick in the southeast part of the basin to four massive beds aggregating

120 m thick at the San Juan River locality (Figure 1).

Lucas et al. (2009) divide the Ojo Alamo into a lower Naashoibito Member and an upper Kimbeto Member in the type area of the Ojo Alamo Sandstone, whereas in Fassett (2009) it is shown that there are no lithostratigraphic criteria for such a subdivision. The cross section of Figure 1 speaks for itself in showing that there is no such simple, two-part, lithostratigraphic subdivision of the Ojo Alamo throughout the basin. Lucas et al. state that their Kimbeto Member is Paleocene and their Naashoibito Member in the type area is Cretaceous and on their figure 1 they show that an unconformity separates these two members. These authors present no physical or biochronologic evidence for the presence of such an unconformity within the Ojo Alamo either in their current

paper or in any previous publications, thus this unconformity appears to be no more than a mental construct.

Lucas et al. (2009) state that Fassett (2009) “combined all fossils from the Ojo Alamo into one fossil assemblage” of Paleocene age. This statement is somewhat misleading. Fassett (2009) listed 103 palynomorph species from Ojo Alamo Sandstone samples collected at numerous localities throughout the basin; these palynomorphs came from samples throughout the formation; from its base to its top. Without exception, all such samples were found to represent Paleocene palynomorph assemblages. All of the unequivocally in-place vertebrate remains identified from the Ojo Alamo are from the lowermost 15 m of this formation at the three principal Ojo Alamo bone areas shown on Figure 1. Because the palynomorph assemblages from the Ojo Alamo are unequivocally all Paleocene, the inevitable conclusion is that the vertebrate remains found in the Ojo Alamo Sandstone are Paleocene as well.

One might argue that dinosaur bones, traditionally thought to be Cretaceous index fossils, should have equal weight with pollen and spores as biochronologic age indicators in assigning an age to the Ojo Alamo Sandstone. However, the end-Cretaceous, asteroid-impact, fall-out layer has been discovered in the nearby Raton Basin (and at many other localities in the northern part of the Western Interior of North America) precisely coincident with the palynologically defined K-T boundary, and as discussed in Fassett (2009) this validates palynology as the sharper tool to define the K-T boundary in the Western Interior of North America.

Lucas et al. (2009) end their discussion of the lithostratigraphy of the Ojo Alamo Sandstone by stating that this formation “has long been recognized” to encompass “two distinct lithosomes that yield fossils of different ages.” These authors offer no citations to substantiate this claim because there are none, other than perhaps Baltz et al. (1966) and some of their own recent publications. It is true that many authors, including Reeside (1924) and Anderson (1960), recognized that plant fossils and vertebrate fossils offered conflicting evidence for the age of the Ojo Alamo Sandstone, but these authors never suggested that these fossils represented “two distinct lithosomes.” In addressing these conflicting age-data Reeside (1924) concluded that the plant fossils were the best biochronologic indicator and thus classified the Ojo Alamo as “Tertiary (?)” and Anderson (1960) concluded that because his palynologic studies indi-

cated that the Ojo Alamo was Paleocene, this formation’s contained dinosaur fossils must also be Paleocene, if not reworked. Both of these authors thus suggested decades ago that the dinosaurs of the Ojo Alamo Sandstone were Paleocene in age.

PALYNOLOGY

Lucas et al. argue that Paleocene palynomorphs have only been recorded physically beneath dinosaur bone at two localities in the San Juan Basin. This is correct; however, dinosaur bone has only been observed in the Ojo Alamo in the three areas shown on Figure 1, thus Paleocene pollen has been found beneath dinosaur bone in the Ojo Alamo at two of the three areas where this formation is known to contain dinosaur fossils. (The arguments of these authors criticizing the value of palynomorphs in determining the age of the Ojo Alamo and its contained dinosaur fossils at these two localities are addressed in detail in Fassett (2009) and are briefly summarized below.)

San Juan River Locality

A large (length 1310 mm, maximum proximal width 370 mm, maximum distal width 330 mm) pristine hadrosaur femur was found embedded in conglomeratic sandstone of the Ojo Alamo Sandstone, 15 m above its base, at the San Juan River locality (Fassett and Lucas, 2000). Subsequent to the collection of this bone, samples collected from a coaly layer 3.5 m below it yielded Paleocene index palynomorphs. Lucas et al. concede that these palynomorphs confirm the Paleocene age of the Ojo Alamo at this locality, but argue that this bone is reworked. It is particularly ironic that Lucas now makes that claim because in a paper coauthored with me (Fassett and Lucas, 2000) he described this femur in detail and stated that (p. 228): “The bone (Figs. 4B, 5) has a pristine outer surface with no abrasions or scratches, and all of its delicate features are intact; there is thus no evidence of transport of this bone.” At the time we coauthored this paper, Lucas (pers. commun., 2000) assured me that no vertebrate paleontologist examining this specimen would conclude that it had been reworked. In a second paper published that same year (Fassett, et al., 2009) titled: “Compelling new evidence for Paleocene dinosaurs in the Ojo Alamo Sandstone, San Juan Basin, New Mexico and Colorado, USA” Lucas’s name again appeared as a coauthor. Rather than reiterate the detailed discussion of this bone found in Fassett (2009), or Fassett and Lucas (2000) readers can make their own observations and draw their own

conclusions from the photographs of this bone in those publications or by examining the specimen itself (on display at the University of New Mexico Geology Department in Albuquerque). Lucas has obviously now changed his mind about this bone, however he and his coauthors offered no evidence to support a revised opinion that this bone was reworked.

Lucas et al. (2009) further stated that “the well preserved nature” of the San Juan River bone “does not preclude reworking” and they go on to compare this fossil with Paleozoic brachiopod shells with preserved shell morphology that have been found embedded in limestone pebbles in the Ojo Alamo Sandstone. Indeed, such fossiliferous limestone pebbles and cobbles are commonly found today in recent river-terrace deposits along the San Juan and Animas rivers in the northern part of the San Juan Basin, but to date, no meter-long dinosaur fossils have been found therein. To compare the reworking of fossils weighing a few tens of grams embedded in limestone pebbles with a pristine hadrosaur femur weighing upwards of 100 kg seems hardly apt, to say the least.

Barrel Spring Locality

The Barrel Spring locality is in the eastern part of the Ojo Alamo Sandstone type area of Figure 1. At that locality Fassett (2009) reported that a sample collected from a carbonaceous mudstone less than 1 m below the base of the Ojo Alamo Sandstone had yielded a Paleocene palynomorph assemblage. Dinosaur bone is abundant in the Ojo Alamo Sandstone in this area. Lucas et al. (2009) and Sullivan et al. (2005) discount the value of this Paleocene palynomorph assemblage because they stated that they were unable to find identifiable palynomorphs in their samples that they claim were collected from this same stratigraphic level. However, these authors do not document their sample collection sites in their publications, thus it is impossible to fully evaluate those claims. Moreover, as stated in detail in Fassett (2009), samples containing identifiable palynomorphs in K-T strata in the San Juan Basin have been notoriously difficult to find, and the 244 palynomorph species identified from Cretaceous and Paleocene (K-T) strata in the San Juan Basin and listed in Appendix 1 of Fassett (2009) are the product of decades of sample collection. Thus, the Paleocene palynomorph assemblage from the Barrel Spring locality remains unchallenged. A true challenge to the palynologic data presented in Fassett (2009) showing that the Ojo Alamo Sandstone is Paleocene in age would

consist of the finding of Cretaceous palynomorph assemblages anywhere in the Ojo Alamo Sandstone. To reiterate, all the palynomorph assemblages from rock samples from the Ojo Alamo Sandstone were found to be Paleocene in age.

In Fassett (2009) the palynology of the Ojo Alamo Sandstone is discussed in detail based on sample collections from three other localities in the basin where palynomorph-productive samples were found; at all of those localities, palynomorph assemblages throughout the Ojo Alamo were found to be Paleocene in age. Lucas et al. (2009) fail to address the importance of these data nor do they attempt to challenge them. As these authors correctly point out, palynology is the keystone to the Fassett (2009) paper as evidenced by a 67-page appendix containing 25 tables listing palynomorph species from K-T boundary strata throughout the San Juan Basin. It is suggested that the challenge to the Paleocene palynologic age of the Ojo Alamo Sandstone in the San Juan Basin by Lucas et al. (2009) is trivial when compared to the massive palynologic data set presented in Fassett (2009).

MAGNETOSTRATIGRAPHY

Lucas et al. (2009) stated that Fassett (2009) resurrected the short normal polarity intervals of the lower Ojo Alamo Sandstone first espoused by Lindsay et al. (1981), reaffirmed by Lindsay et al. (1982), and later rejected by Butler and Lindsay (1985). (This “resurrection” is discussed in great detail in Fassett, 2009.) This is literally true for three of the four localities of Lindsay et al. (1981), however Lucas et al. (2009) fail to mention that this same normal interval was not rejected at one of the Lindsay et al. (1981) localities, and more importantly, that a short normal polarity interval was independently found in the lower part of the Ojo Alamo in the western part of the Ojo Alamo Sandstone type area by Fassett and Steiner (1997) and at Mesa Portales (documented in Fassett, 2009). (The Mesa Portales paleomagnetic section, published for the first time in Fassett (2009), represents important new data – thus the title of Fassett (2009) – confirming the Paleocene age of the Ojo Alamo Sandstone.) The Mesa Portales data set is especially important because at that locality, Paleocene pollen assemblages are present at multiple levels within the lower Ojo Alamo normal zone and in the underlying reversed polarity zone in the lower Ojo Alamo. Lucas et al. (2009) agreed that palynology is an unequivocal age determinant for K-T boundary strata in the Western Interior (as

they so indicate for the San Juan River locality). They must then also agree that the presence of Paleocene palynomorphs in the normal and reversed polarity intervals in the lower Ojo Alamo at Mesa Portales uniquely identify these intervals as magnetochrons C29n and C29r, respectively. It thus follows that these same polarity intervals identified at the other localities along the Ojo Alamo Sandstone outcrop northwest of Mesa Portales are also C29n and C29r and are thus Paleocene in age.

In this part of their paper, Lucas et al. (2009) stated that a four- to six-m.y. hiatus is present at the base of the Ojo Alamo and that a two to 4 m.y. hiatus is present somewhere above all of the dinosaur fossils in the lower Ojo Alamo that they consider to be in place. However, as stated above, both palynologic and paleomagnetic data indicate that the Ojo Alamo Sandstone is Paleocene throughout the San Juan Basin, thus the presence of a multi-million year unconformity within the Ojo Alamo Sandstone is not supported by the data in hand.

GEOCHEMISTRY

Lucas et al. (2009) stated that they wanted to “emphasize” that the differing geochemistry of dinosaur-bone samples from the Cretaceous Kirtland Formation and the Paleocene Ojo Alamo Sandstone only demonstrates their provenance of mineralization and does not prove that the Ojo Alamo is Paleocene. This statement is in full agreement with Fassett (2009), thus it is puzzling why this emphasis was deemed necessary. These authors discuss the chemistry of the large hadrosaur femur from the Ojo Alamo Sandstone at the San Juan River locality, stating that it had “values that overlap the values of Kirtland Formation bone.” It is true that the U content of this bone is quite low and thus comparable to U levels for Cretaceous bone, and that problem is addressed in Fassett (2009). It is not true, however, that the REE data for this bone are not indicative of a Paleocene age. As shown on table 2 of Fassett (2009), the San Juan River bone had a La/Yb(n) ratio of 3.2 and a Sum REE value of 1004. The mean of these values for the Ojo Alamo is 6.6 and 1624, respectively, whereas for the Kirtland Formation the mean of these values is 13.7 and 2650. It is thus clear that the REE values for the San Juan River femur fall well below the mean of Ojo Alamo Sandstone bones as is stated in Fassett (2009).

VERTEBRATE BIOCHRONOLOGY

Lucas et al. (2009) clearly take offense at the statement in Fassett (2009) that “vertebrate paleontology has had limited biochronologic value in determining the age of strata adjacent to the K-T interface in the San Juan Basin.” In my opinion, this statement is essentially true, if restricted to uppermost Cretaceous strata in the basin. A detailed discussion of the differing ages assigned to vertebrate fossils over time in uppermost Cretaceous strata in the San Juan Basin is beyond the scope of this response; (see discussion of this topic in Fassett, 2009 and in references therein). Very recent papers (cited in Fassett, 2009) have stated that the vertebrate fossils from the Ojo Alamo Sandstone are Lancian – very latest Cretaceous in age; whereas other very recent papers have declared that the age of this same fossil assemblage is near the Campanian-Maastrichtian boundary. According to the Gradstein et al. (2004) time scale, these placements are as much as 5 m.y. apart. On this basis, I do not find it unreasonable to conclude that “vertebrate paleontology has had limited value” for age determination in Cretaceous strata in the San Juan Basin. Paleocene vertebrates have a much better record for age determinations, thus I confess that my use of “K-T” in the above quote was ill-advised and I should have restricted this comment to Cretaceous strata.

Lucas et al. (2009) thought it “extraordinary” that Fassett (2009) only found Paleocene dinosaurs in the San Juan Basin. The San Juan Basin was my area of study, thus my data had no relevance to ages of vertebrates in other parts of the Western Interior. These authors stated that Fassett (2009) ignored the mammalian fossils from K-T strata in the basin, but that is not true. These fossils are discussed on pages 60-65 of Fassett (2009) and it is concluded therein that the mammals (and dinosaurs) identified from the Paleocene Ojo Alamo are Paleocene in age. As for the value of mammalian fossils as age indicators for K-T rock strata in the Western Interior of North America, Fassett (2009, p. 62) referred to the pointed warning in Clemens and Williamson (2005) that stated that the ages assigned to mammalian fossils from strata adjacent to the K-T boundary were in a state of flux due to limited numbers of collection sites, biogeographic diversity of taxa, and limited knowledge of the evolution and radiation of mammals across the K-T interface. If Lucas et al. disagree with the opinions of Clemens and Williamson (2005) in this regard, they may wish to air those dif-

ferences in the proper scientific forum; perhaps in *Palaeontologia Electronica*?

ANIMAS FORMATION DINOSAURS

Lucas et al. stated that because the Paleocene fossil leaves and palynomorphs of the Animas Formation were from levels stratigraphically above reported dinosaur fossils, these dinosaurs may not be Paleocene in age. The Animas Formation was first described in detail by Reeside (1924) and was originally assigned a Paleocene age based on fossil leaves (Knowlton, 1924); this age was later confirmed based on palynomorphs (Newman, 1987). Newman not only stated that his studies indicated that the Animas was Paleocene; he further stated that palynologic evidence indicated that the lowermost Paleocene was missing from the Animas Formation. The Animas is a lithologically consistent and distinct unit containing diagnostic volcanoclastic rock fragments that clearly distinguish it from the underlying Cretaceous Kirtland Formation strata. Reeside (1924) stated that the basal Animas Formation of the northern San Juan Basin was equivalent in age to the "Tertiary (?)" Ojo Alamo Sandstone of the southern part of the basin. With no evidence to refute the Paleocene age of the entire Animas Formation, the dinosaurs of the Animas can only be assumed to be Paleocene.

FIGURE 1 OF LUCAS ET AL. (2009)

There are several serious errors and omissions in figure 1 of Lucas et al. (2009). The asterisks to the right of the stratigraphic column are said to indicate levels of "Ar/Ar dated ash beds." The Cretaceous $^{40}\text{Ar}/^{39}\text{Ar}$ ages at the levels shown were first reported in Fassett and Steiner (1997) and the $^{40}\text{Ar}/^{39}\text{Ar}$ age for the Paleocene Nacimiento Formation ash bed was reported in Fassett (2009). Why Lucas et al. (2009) did not show these ages on their figure 1 and cite their origin is puzzling. The age of the Nacimiento Formation ash bed was reported to be 64.4 Ma in Fassett (2009), yet Lucas and others show it to be 64.0 Ma; the placement of this ash-bed level should be the equivalent of 0.4 m.y. below the 64.0 Ma level on this figure. Two dated ash beds are shown just below the 74.0 Ma age on figure 1. The ages of these beds are 74.55 Ma and 74.56 Ma (Fassett and Steiner, 1997) and thus should be placed much lower in the section than where they are shown. The age scale on the left side of the stratigraphic column is inconsistent with 0.5 m.y. inter-

vals being the same width as a 1.0 m.y. interval. The lithology of the Ojo Alamo Sandstone is incorrectly shown on figure 1 because the interval between the upper and lower conglomeratic sandstone beds in the Ojo Alamo Sandstone type area always contains multiple sandstone beds and never consists entirely of mudstone as figure 1 shows.

More importantly, the **base** of magnetochron C29n of "This paper" on figure 1 of Lucas et al. (2009) is shown to be 64.0 Ma. Gradstein et al. (2004), however, stated that the **top** of chron C29n is 64.432 Ma and its **base** 65.118 Ma. Clearly the position of C29n on figure 1 is badly misplaced. In the column labeled "Fassett (2009)", the Ojo Alamo polarity chrons should be labeled as follows: the upper normal chron is C29n.1n, the underlying reversed-polarity chron is C29n.1r, and the lower normal chron is C29n.2n per Fassett (2009). In addition, the lower paleomagnetic normal chron is incorrectly placed and sized on figure 1. The base of this chron in Fassett (2009) is located very close to the base of the Ojo Alamo in the type area and is stated to average 11 m thick, thus if the thickness of chron C29n.2n were correctly scaled on figure 1 of Lucas et al., it would be much thicker than it is shown. It is assumed that these errors resulted from undue haste in preparing this paper rather than any other intent. It is especially surprising that the many errors on figure 1 of Lucas et al. (2009) could have survived the scrutiny of all eight authors of this report.

CONCLUSION

The rhetorical statements of Lucas et al. (2009) do not refute the findings of Fassett (2009) that the Ojo Alamo Sandstone and the Animas Formation and their contained dinosaurs and other vertebrate fossils are Paleocene in age. Lucas et al. (2009) offer no data with which to refute the detailed data set presented in Fassett (2009), thus that data remains unchallenged, in any meaningful way, by the Lucas et al. critique.

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