COMPELLING NEW EVIDENCE FOR PALEOCENE DINOSAURS IN THE OJO ALAMO SANDSTONE, SAN JUAN BASIN, NEW MEXICO AND COLORADO, USA.

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The San Juan Basin is in the Western United States in the states of New Mexico and Colorado (fig. 1). A hiatus of about 8 m.y. separates Late Cretaceous from Tertiary rocks in the Basin. Most of the missing strata are from the Maastrichtian Stage. The unconformity is overlain by the Ojo Alamo Sandstone in the south and underlain by the Kirtland or Fruitland Formation at most other places in the basin. Isopach lines on figure 1 show that the pre-Ojo Alamo unconformity beveled underlying Upper Cretaceous rocks southeastward by more than 640 m. (2,100 ft., fig. 1).

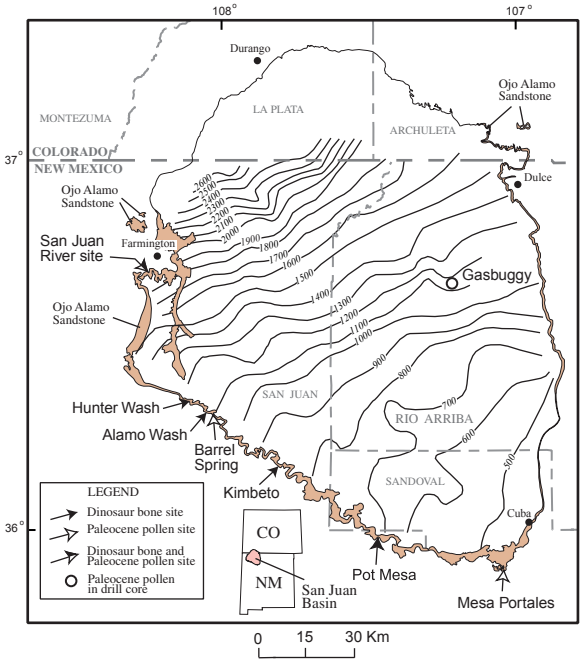

Figure 1 – Index map of San Juan Basin showing outcrop of Tertiary, Ojo Alamo Sandstone and locations of dinosaur-bone and (or) pollen collection sites. Isopached interval is from the Huerfanito Bentonite Bed of the Lewis Shale to the base of the Ojo Alamo Sandstone. Line delimiting northern part of basin is base of Tertiary Animas or Nacimiento Formation. Modified from Fassett et al [1].

The Ojo Alamo Sandstone was defined at Alamo Wash (fig. 1) as two conglomeratic sandstone beds separated by a medial, sandy-shale unit and was assigned a Cretaceous age because of its abundant dinosaur fauna [2]. Elsewhere in the basin, the Ojo Alamo consists of a series of lensing, overlapping, multistoried channel sandstone bodies, conglomeratic in the north and west and non-conglomeratic in the south and east. Paleocurrent studies [3, 4] show that the Ojo Alamo was deposited by high-energy, braided streams with a north to northwest source. Numerous papers [2] have suggested new member names for parts of the Ojo Alamo and the upper part of the Kirtland Shale. In this report, the name Ojo Alamo is used as first formally applied but is considered to be entirely Paleocene in age.

Two publications [5, 1] focused on the contradictory evidence of Paleocene pollen and dinosaur bone within the Ojo Alamo in the basin. These reports tentatively concluded that pollen was the more accurate age indicator and therefore the Ojo Alamo dinosaurs were Paleocene in age. The conclusion was tentative because Paleocene pollen nowhere occurred at exactly the same locality as dinosaur bone. Paleocene pollen is present, however, in the Ojo Alamo near Barrel Spring, within one mile of the Alamo Wash bone locality (fig. 1). Fassett et al [1] discussed the recent discovery of a large hadrosaur femur in the Ojo Alamo at the San Juan River site (fig. 1) and showed a photograph of this bone, in place (fig. 2A). Subsequently, the bone was excavated, cleaned, and mounted for display at the Department of Earth and Planetary Science, at the University of New Mexico, Albuquerque, N.M. (fig. 2B).

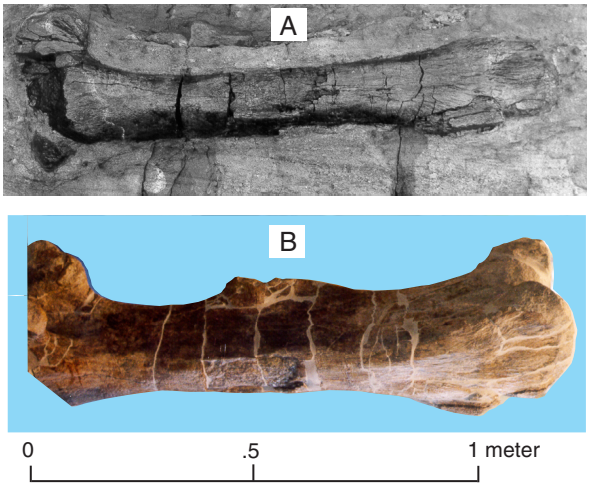

Figure 2 – Right femur of a hadrosaurian dinosaur from the San Juan River site (fig. 1). A -- bone in place in the Tertiary Ojo Alamo Sandstone, west-central San Juan Basin, New Mexico; photograph from Fassett et al [1]. B -- bone after excavation, preparation, and mounting. Bone in B is rotated on its long axis about 180 degrees from view in A.

Following the excavation of the hadrosaur femur from the San Juan River site, a coaly, carbonaceous shale bed was discovered about 160 m west of the dinosaur-bone locality and 3 m stratigraphically below the level from which the bone had been excavated. Samples of this coaly bed were collected and analyzed for their pollen and spore content and were found to contain a diverse assemblage, including *Momipites tenuipolis*, indicating a Paleocene age for these rocks.

Figure 3 is a composite stratigraphic column showing the stratigraphy of the lower part of the Ojo Alamo Sandstone at the San Juan River site.

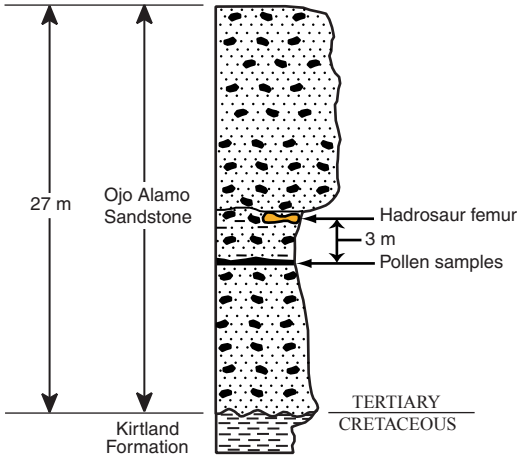

Figure 3 – Stratigraphic column of the lower part of the Ojo Alamo Sandstone at the San Juan River site (fig. 1). Modified From Fassett et al [1].

The data from the San Juan River site demonstrate that the large hadrosaur femur found there was preserved in rocks of Paleocene age. Because this is a single bone, however, the question of possible reworking from the underlying Kirtland Formation of Cretaceous age must be addressed. We find that possibility unlikely to impossible, for the following reasons: 1) The base of the Ojo Alamo Sandstone is a planar surface in this area with no local topographic highs in the underlying Cretaceous strata extending 15 m upward into the Ojo Alamo to the level of the bone; the isopach lines of figure 1 also indicate a very flat surface at the base of the Ojo Alamo in the vicinity of the San Juan River site, 2) Uppermost Kirtland strata were certainly at the same level as the San Juan River site bone a few miles to the northwest, but given the size of this bone and its silicified weight of more than 150 Kg, it would have been practically impossible for this bone to have been transported even a few meters, not to mention a few miles southward to the San Juan River site, and 3) The bone, (fig. 2B) has a pristine outer surface with no abrasions or scratches and with all of its delicate outer processes intact. There is thus no evidence of transport of this bone.

We suggest that this animal lived in Tertiary time and died near the place where this silicified femur was found. As the corpse decayed, river currents disarticulated the skeleton, dispersing the lighter elements, and leaving this large massive bone behind to be quickly buried and silicified.

The fully documented Paleocene dinosaur bone from the Ojo Alamo Sandstone at the San Juan River site, bolsters conclusions [5, 1] that the dinosaur-bone assemblage from the Ojo Alamo Sandstone in the vicinity of Alamo Wash is also of Paleocene age, even though vertebrate paleontologists have assigned a Lancian age to that assemblage.

We have initiated trace-element analyses of dinosaur bone from the Ojo Alamo to further resolve the reworking question. Instrumental neutron activation analysis of 14 bone samples from the southern San Juan Basin, seven from the Kirtland and seven from the Ojo Alamo, indicate distinct differences in the concentration of rare earth elements (REE) and uranium (U) in the two populations. Chondrite-normalized REE abundances in Kirtland bone indicate a markedly steeper slope ($La/Yb=16.1\pm7.8$) compared to Ojo Alamo bone ($La/Yb=5.7\pm3.9$). Kirtland samples also have markedly lower concentrations of U (2.1 to 38.3 ppm) compared to Ojo Alamo samples (166 to 834 ppm). Uptake of REE and U by apatite is believed to occur rapidly during early diagenesis and to reflect differences in pore-water environments [6, 7]. REE abundances preserved in fossil bone have been used to identify reworked bone in other settings [6]. The distinctive REE pattern and U content of Ojo Alamo bones suggests that they are not reworked Cretaceous bones. Fission-track radiography will be used to determine if the distribution of uranium in Ojo Alamo bone is consistent with early diagenetic uptake in apatite or with secondary introduction of U. An unexpected finding is that iridium concentrations in these bone samples are high, ranging from 0.1-2.77 ppb.

References:

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