Radiocarbon in Dinosaur and Other Fossils

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Abstract

Measurable amounts of radiocarbon have been consistently detected within carbonaceous materials across Phanerozoic strata. Under uniformitarian assumptions, these should no longer contain measurable amounts of radiocarbon. Secularists have asserted that these challenging finds originate from systematic contamination, but the hypothesis of endogenous radiocarbon should be considered. Assuming these strata were largely deposited by the Noahic Flood occurring within the time range of radiocarbon's detectability with modern equipment under uniformitarian assumptions, we hypothesized that fossils from all three erathems, including dinosaur fossils, should also contain measurable amounts of radiocarbon. Consistent with this hypothesis, we report detectable amounts of radiocarbon in all 16 of our samples. Attempts to falsify our hypothesis failed, including a comparison of our data with previously published carbon-dated fossils. We conclude that fossils and other carbonaceous materials found throughout Phanerozoic strata contain measurable amounts of radiocarbon that is most probably endogenous.

Introduction

The consistent failure of carbon dating facilities to find carbon-dead samples to serve as baselines highlights the regularity with which they have detected measurable amounts of radiocarbon in samples from Phanerozoic settings (Nadeau et al., 2001). Simply put, carbonaceous materials from any portion of the geologic column deposited millions of years ago should, with the exception of rare instances of contamination, contain zero ^{14}C atoms. This reasonable assumption follows from the half-life of ^{14}C, which places a time limit on its duration of about 100,000 years until the number of ^{14}C atoms become too few to detect with accelerator mass spectrometry (AMS) (Hebert, 2013). Preliminary results from undocumented dinosaur bones, where the bones were genuine but not curated into a repository, presented at the 1990 International Conference on Creationism (ICC) indicated measurable radiocarbon, but contamination could not be ruled out (Dahmer et al., 1990). At the 2003 ICC, the RATE team (a research effort sponsored by the Institute for Creation Research and the Creation Research Society and an acronym for "Radioisotopes and the Age of The Earth") argued that since Pennsylvanian coals used to gener-

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ate a baseline prior to dating a sample typically register amounts of radiocarbon well in excess of AMS detection limits, the radiocarbon must be endogenous to the coal, and not a contaminant (Baumgardner et al., 2003).

Consistent with this hypothesis, they found radiocarbon in ten carefully extracted coal samples and even in ten diamonds (Baumgardner, 2005). In addition, Snelling published a series of articles over a number of years describing individual carbon dates for fossils, including wood and shell samples (Snelling, 1998, 1999, 2000a, 2000b, 2008a, 2008b). These data confirm the expectation that endogenous radiocarbon might occur in dinosaur and other fossils. They also suggest a test of the Creation-Flood model. If it were possible to calibrate radiocarbon "ages" to calendar ages, date-specific amounts of ^{14}C within fossils could be compared to the expected age of Noah's Flood at 4300 or so years ago. However, until future studies establish such a calibration, a more generalized test presents itself. Namely, if Phanerozoic strata were not deposited hundreds or tens of millions of years ago, but by Noah's Flood fewer than 10,000 years ago, they should still contain detectable amounts of ^{14}C. We tested this possibility by obtaining and analyzing carbon dates for dinosaur bones, other fossil bones, and fossil wood.

Sample Preparation

A single lab used the following standard radiocarbon dating procedures in performing their AMS tests and calculating radiocarbon ages for all 16 of our samples. Preparation protocols for radiocarbon isotope analyses of bone apatite were performed according to Cherkinsky (2009). First, extraneous materials were removed by physical scraping. Then, samples were soaked overnight in 1N acetic acid. This removes carbon compounds that contaminate samples by sediment infilling or carbonate crystallization post-deposition. After rinsing and drying, approximately 2 grams of bone are crushed and retreated with 1N acetic acid with periodic evacuations until CO_2 and other gases cease forming. This acid treatment does not exceed 72 hours, after which time original bioapatite begins dissolving, not just secondary surface carbonaceous materials. After drying again, several hundred mg of partially treated bone are added to 1N HCl for fewer than 20 min, and CO_2 from the reaction is collected. If the mass of captured carbon exceeds expected amounts, contaminating contributions are suspected and additional acid treatments ensue. Finally, the cleaned carbon dioxide is catalytically converted to graphite for accelerator mass spectrometer analysis of the $^{13}C/^{14}C$ ratio that is immediately compared to the $^{13}C/^{14}C$ ratio in the absolute radiocarbon standard sample OXI (NBS 4990).

"Uncalibrated" radiocarbon dates in radiocarbon years "Before Present," defining "present" as AD 1950, a date that honors the publication of the first use of carbon date calculations (Arnold and Libby, 1949) are reported. These uncalibrated dates were calculated using the traditional, older, and less accurate Libby ^{14}C half-life of 5,568 years, and the error margins represent one standard deviation (1σ). This error expression incorporates both experimental and statistical errors. Further, the lab corrected each of our dates for isotope fractionation, which assumes an original ratio of stable ^{13}C. Although for the sake of completion it is important to disclose these standards, they have no bearing on the main findings of this present investigation. We are not attempting to use carbon dating to determine ages of artifacts but merely to test for the presence of measurable amounts of ^{14}C in fossils bearing conventional age assignments that should preclude ^{14}C. These radiocarbon results are summarized in Table 1 and described below.

Specimen Collection and Analysis

A Miocene Plant Specimen

We describe 14 recently carbon dated fossils that span all three erathems. Our *Tectocarya rhenana* specimen was obtained from the Braunkohle Lignite seam in Adendorf, Germany. The Alberta Dinosaur Museum (ADM) had procured a number of samples from secular geologic contacts from within the open fossil trading market, including this one. We could smell fruitlike odors emitting from these fossils. We submitted the fossil for chemical analysis, testing for the esters that confer fruity odors, and we plan to present those results elsewhere.

Our sample of the darkened fossil fruit was naturally mummified. We hypothesized, on the basis of the assumption that the lignite was deposited by a local catastrophe after Noah's Flood and was thus only several thousand years old, that it had not yet lost all of its radiocarbon atoms. According to the 2014 International Chronostratigraphic Chart, Middle Miocene fossils are assigned ages exceeding eleven million years. The sample was photographed and a portion packaged and mailed to a nationally recognized radiocarbon facility. We obtained 10.84 pMC for the fossil fruit, which corresponds to the age shown in Figure 1 of 17,850 ± 40 BP, where "BP" means "uncalibrated radiocarbon years Before Present." While the procedure for converting the uncalibrated years that radiocarbon dating facilities typically supply into calibrated years has been simplified using the free software OxCal, and whereas ^{14}C "ages" are most often calibrated to years BC, we saw no need to perform this step in the current analysis. The standard calibration procedure incorporates more uniformitarian assumptions than those already used in generating raw radiocarbon years and usually ends up adding a few thousand "years" to the number of reported raw radiocarbon years for ages as great as we

Taxon	Radio-carbon Years BP	pmc	δ13	Stratigraphy	Sample date	Note
Tectocarya rhenana	17850 ± 40	10.84	-25.4	Braunkohle Lignite	6/1/2011	mummified fruit
hadrosaur vert (ICR)	20850 ± 90	7.46	-24.51	Hell Creek Fm.	3/20/2013	Medullary bone
Edmontosaurus sp.	25550 ± 60	4.15	-0.5	Lance Fm.	5/30/2014	vertebra
Phareodus sp.	26,110 ± 60	3.87	-0.4	Green River Fm.	5/30/2014	skull bones & scales
ceratopsian	26300 ± 60	3.78	-3.6	Horseshoe Canyon Fm.	7/14/2014	metacarpal V
hadrosaur vert (ICR)	28790 ± 100	2.78	-20.11	Hell Creek Fm.	3/20/2013	cortical bone
Edmontosaurus sp.	32420 ± 160	1.77	-6.1	Lance Fm.	2/26/2013	phalanx
hadrosaur (ADM)	32770 ± 100	1.69	-3.5	Horseshoe Canyon Fm.	7/14/2014	caudal vertebra
Crossopholis magnicaudatus	33530 ± 170	1.54	-26.18	Green River Fm.	3/20/2013	Paddlefish "cartilage"
Triceratops horridus	33570 ± 120	1.53	-17.1	Hell Creek Fm.	8/14/2012	horn core bulk bone
ceratopsian	36760 ± 130	1.03	-1.7	Horseshoe Canyon Fm.	7/14/2014	caudal vertebra
Axel wood	39720 ± 270	0.71	-22.2	Buchanan Lake Fm.	5/5/2014	unmineralized
Drumheller wood	40040 ± 160	0.68	-24.1	Horseshoe Canyon Fm.		peat-like
Triceratops horridus	41010 ± 220	0.61	-4.3	Hell Creek Fm.	8/14/2012	horn core bioapatite
Czech wood	48160 ± 330	0.25	-22.7	Boskovice Furrow	2/26/2013	carbonized wood
Captorhinus aguti	49470 ± 510	0.21	-29.7	Admiral Fm.	8/5/2014	vert, jaw, leg

Table 1. Carbon isotope data used to plot Figures 1 and 6 are shown from 14 fossils. Radiocarbon ages were copied from referenced sources without calibration or other normalization. Plus/minus value represents 1σ confidence error margins. Pmc refers to percent modern carbon, a ratio of the fraction of ^{14}C to ^{12}C in the sample to the fraction of ^{14}C to ^{12}C in the international standard (where "modern" means AD 1950, and the absolute radiocarbon standard is a sample of wood from a tree that died in AD 1890). Radiocarbon years in "Before Present" are calculated based on pmc. Radiocarbon analyses also supply ^{13}C isotope results, shown as δ13, which represents the parts of ^{13}C in the sample per thousand parts ^{13}C in an international standard. Negative values, below the standard zero value, are typical for samples of great antiquity.

report herein. These relatively minute differences do not impact the thrust of this present investigation, which targets the three orders of magnitude difference between radiocarbon years (either uncalibrated or calibrated) and conventional "ages."

Fish Fossil Specimens

A fossil osteichthyan of genus *Phareodus* (ADM 0112, Alberta Dinosaur Museum) was obtained in 2011 directly from the Green River Formation (GRF) near Kemmerer, Wyoming. The outcrop on private property where the fish fossil was obtained bears a conventional age assignment of approximately 49 million years. The specimen, seen in Figure 2, had not been prepared after its removal from the "split fish layer," and thus provided a pristine sample for carbon isotope analysis, untouched with any glues, preservatives, or other commercial contaminants. This and similar sites in the GRF have supplied a wide variety of reptilian, avian, and mammalian lagerstatte, famous worldwide for preservation of even soft body parts (Whitmore, 2006), including original vertebrate proteins (Edwards et al., 2011). Portions of the skull, jaw with teeth, and scales were carefully extracted from the shale matrix using clean stainless steel tools directly onto tin foil. The sample was sent to a commercial U.S. radiocarbon facility, which returned 3.87 pMC, or 26,110 ± 60 BP as plotted on Figure 1.

Our chondrichthyan *Crossopholis magnicaudatus* fossil was purchased by the Institute for Creation Research (ICR) at a 2009 Heritage Auction event that supplied original fossils to museums and private parties. Lot number 41304 at auction 6012 is being accessioned by the Institute provisionally as ICR 0111.

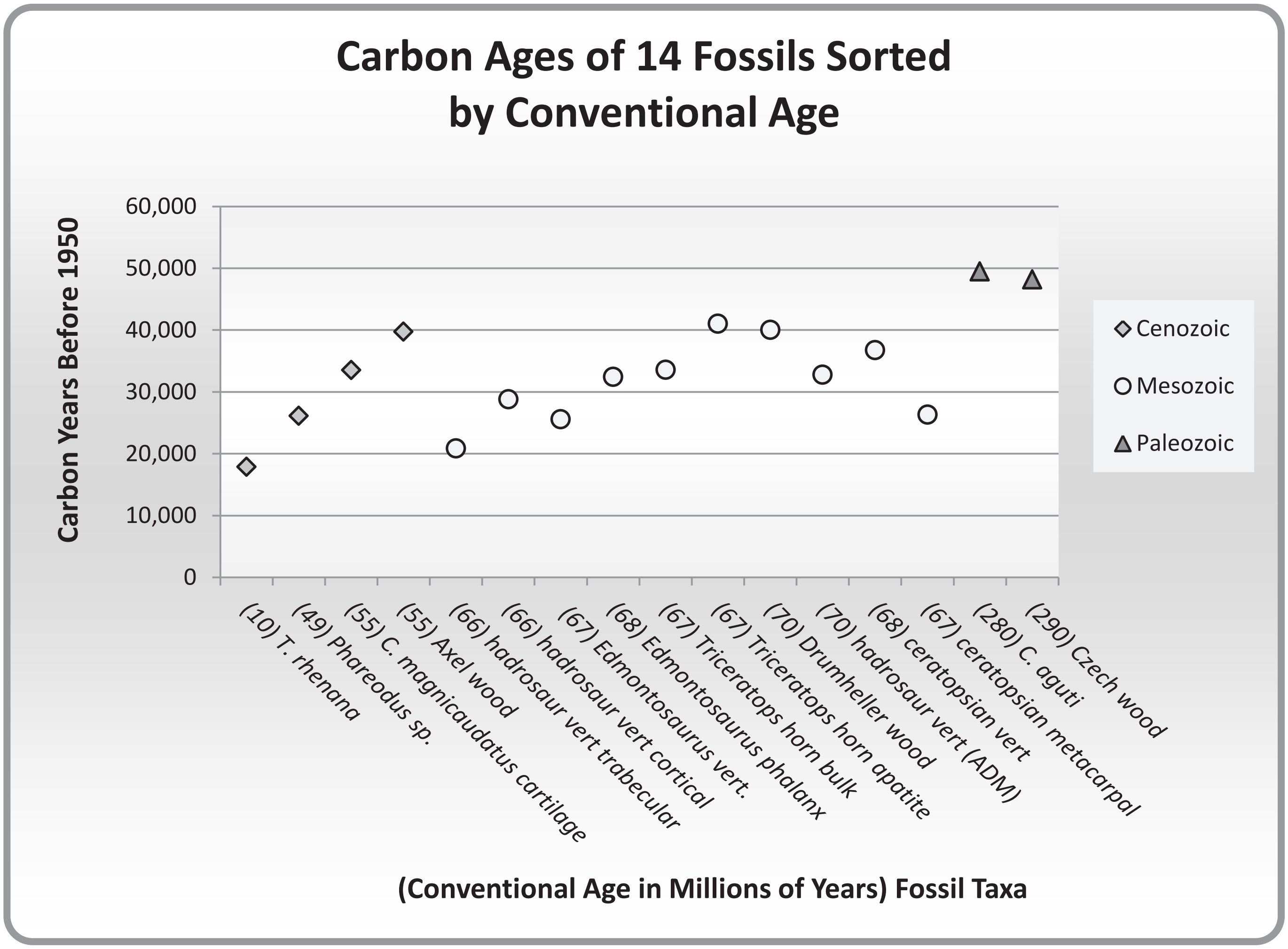

Figure 1. Carbon dates measured by AMS for 14 fossils including seven dinosaur bones lie within approximately 17,850 and 49,470 radiocarbon years. All fossils so far tested returned a carbon age. These carbon ages starkly contrast the approximate conventional ages shown in parentheses for each fossil. "Hadrosaur vert cortical" marks the carbon date for the exterior bone, adjacent to rock matrix, and "hadrosaur vert trabecular" indicates the carbon date for the interior of the same bone (ICR 021). Error bars lie within the graphic markers.

Also exhumed from the famous Fossil Lake region of GRF, this rare, whole paddlefish fossil is 42-¾ inches long and includes darkened, sinewy material that may contain original cartilage. We reasoned that endogenous, little-altered cartilage might retain collagen, the main protein constituent of cartilage. This could preserve ^{14}C if the fossil was deposited fewer than 100,000 years ago. However, the auction description noted, "Where the fine structure of the fins has been lost, sympathetic restoration completes this superb specimen," and we suspected that "sympathetic restoration" may have included modern pigments or coatings as potential contaminants. Thus, we removed a shard from one of the thickest skeletal portions, near the head, with a sterile blade. The shard measured approximately 12 X 3 X 4.5 mm. We indicated on the radiocarbon sample submission form the possibility of bacteria, fungus or oil contamination so that the lab would exercise appropriate decontamination protocols, including an organic solvent and acid-base-acid prewash. The result presented 1.54 pMC, which corresponds to 33,530 ± 170 BP as shown in Figure 1. We note the large disparity between this fossil's carbon age and its standard assigned age of approximately 50 million years.

Wood and Dinosaur Specimens

We obtained a portion of fossil wood of unidentified taxon from a secular 1986 paleontological expedition to Axel Heiberg Island. It came from an upper lignitic coal-bearing member of the Buchanan Lake Formation, Nunavut, Canada. This upper member, assigned an Eocene conventional age, is known for naturally mummified leaf tissues (Shoenhut, 2005), leaf mats, stumps, cones, and seeds (LePage et al., 1991). The fossil wood still had a fresh-looking appearance, was partially pliable, and easily ignited at standard temperature and pressure with a common butane fuel source. These features clearly indicated a lack of mineralization and thus the potential for endogenous woody compounds containing carbon. A core sample of still-brown-colored wood (ADM 0113) was submitted for radiocarbon dating, which reported 0.71 pMC. This corresponds to 39,720 ± 270 BP as Figure 1 indicates.

Next, a whole hadrosaur caudal vertebra (ICR 021, Institute for Creation Research), minus its spinous process, was donated by Mr. Paul Koepp of Dallas, Texas. He acquired it from Stuart Schmidt of Grand River Museum near Lemmon, South Dakota. GRM houses a sizeable collection of dinosaur fossils collected by summer dig groups that Mr. Russ McGlenn of Adventure Safaris and the Twin Cities Creation Science Association organizes on Stuart Ranch property, located approximately 40 miles from Lemmon near Keldron, SD. Abundant disarticulated hadrosaur and ceratopsian fossils occur on the Schmidt ranch, as at other Hell Creek Formation sites, mostly across Montana. Our cylindrical bone was collected by one of McGlenn's groups circa 2006 and retained at Grand River Museum until transfer to ICR in 2012. The interior trabecular bone was plainly not infilled with sediment, and retains its *in vivo* spongy structure, albeit colored almost black, as shown in Figure 3a. This fossil also yielded radiocarbon in amounts well within the detection threshold of the AMS technique at 20,850 ± 90 BP for the interior trabecular portion, and 28,790 ± 100 BP, as shown in Figure 1.

Figure 2. *Phareodus* fossil fish fragments from the Green River Formation, supposedly more than 40 million years old, returned an approximate age of 26,110 radiocarbon years. Jaw and teeth are visible on the right, and the dark oval structure is its operculum. Scale bar equals 10mm.

In 2013 we acquired two hadrosaurid bones from the Lance Formation from a professional fossil dealer in the U.S. with a large personal network of fossil excavators. These bones were observed to be in pristine condition, exactly as found, with no glue present or preservative applied. One hadrosaur caudal vertebra from an *Edmontosaurus* had a very similar color, condition, and lithologic context to the ICR 021 vertebra, and both are pictured in Figure 3. As a kind of sister to the Hell Creek Formation, the Lance Formation is assigned a conventional age of late Cretaceous. The other hadrosaurid bone procured was also from an *Edmontosaurus*, but is a foot phalanx. To provide the purest samples possible for carbon dating, both of these whole bones were split open and material was removed from the center of each using clean stainless steel instruments. The samples were collected directly onto tin foil. No silt or other material was observed within the center of these bones. Furthermore, the bones were not mineralized to any noticeable degree, as seen in Figure 3. The trabecular cavities were still open as in a modern bone of a similar kind, though the fossils exhibited a more brownish color in their interiors. We plotted in Figure 1 the reported carbon ages of these *Edmontosaurus* bone fossils at 25,550 ± 60 for the vertebra, and 32,420 ± 160 BP for the phalanx.

A *Triceratops horridus* horn core (HCTH 00), excavated by Armitage and Anderson as part of the Creation Research Society's iDINO effort, yielded a spectacular whole sheet of soft, fibrillar tissue. The bone's geographic and geologic settings were described in Armitage and Anderson's *Acta Histochemica* paper (Armitage and Anderson, 2013). We reasoned that a fossil containing original fibrillar material must preserve proteinaceous connective tissue and thus possibly endogenous ^{14}C. We note that Armitage and Anderson (2013) expressed surprise over their discovery

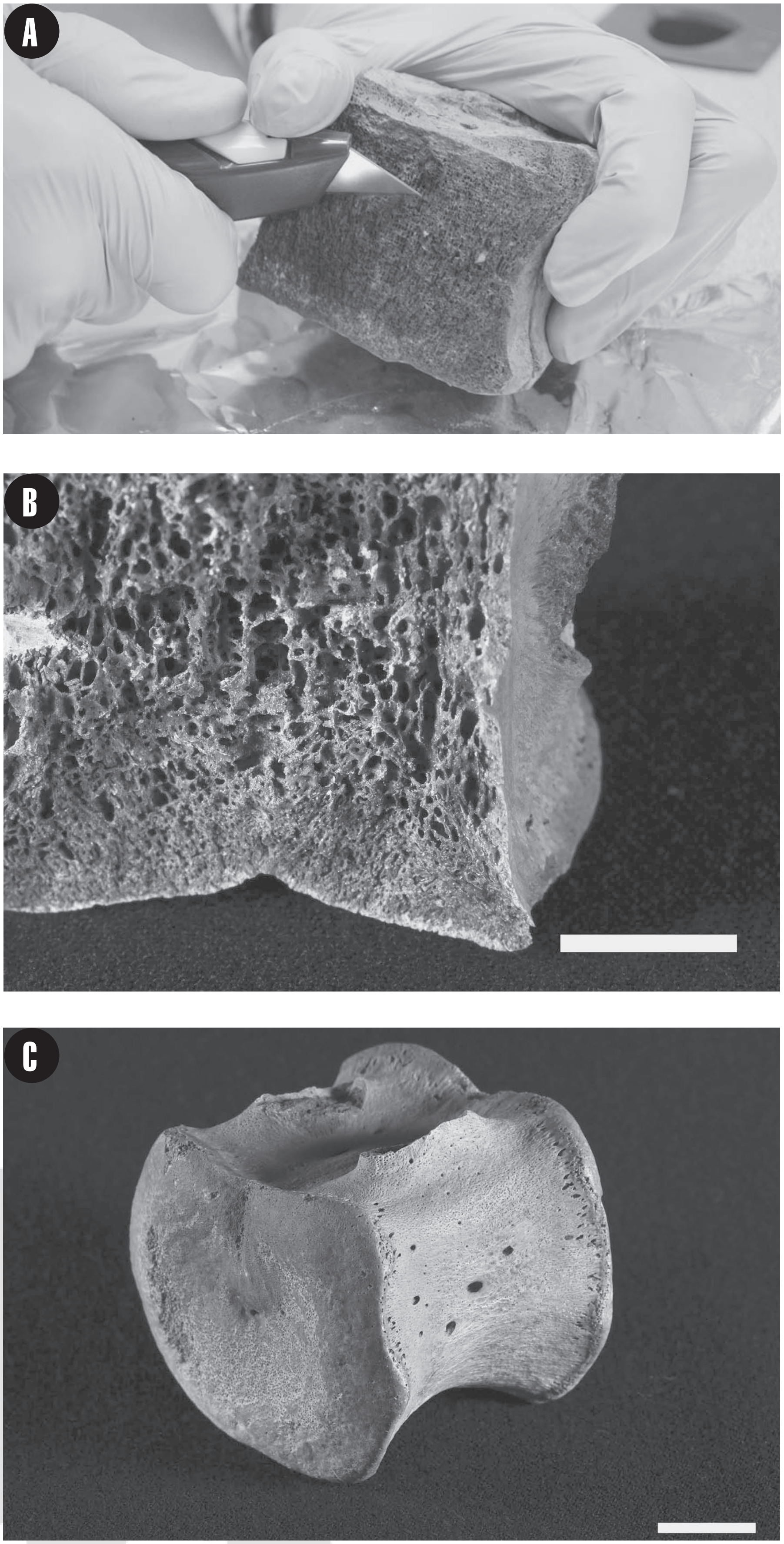

Figure 3 ***(left).*** **Trabecular bone spaces of these hadrosaur vertebrae are clean and vacant, showing no sedimentary or any other infilling. (a) Darkened core bony material from the center of a freshly split caudal vertebra (ICR 021) from North Dakota Cretaceous Hell Creek Formation yielded approximately 20,850 radiocarbon years. The exterior of this bone dated to approximately 28,790 radiocarbon years. (b) Darkened core bony material from the center of freshly split caudal vertebra from Cretaceous Lance Formation returned an age of approximately 25,550 carbon years. (c) Whole** ***Edmontosaurus*** **vertebra (except for spinous processes that are only rarely preserved) prior to fracturing reveals original bone color, indicating no mineralization. Scale bars equal 10mm.**

of still-stretchy tissue within this horn bone core given that it "actually had a muddy matrix deeply embedded within it, which became evident when the horn fractured." In this case, the presence of soft tissue contradicted an intuition-based suggestion that recurring hydration accelerates tissue decay. In a similar way, could endogenous radiocarbon persist within a seasonally damp bone sample? See our discussion below for indications that the answer could be affirmative.

A portion of this horn core was submitted to the AMS dating facility. At the suggestion of Mr. Hugh Miller, we requested that the lab separate the bioapatite fraction of the bone for one carbon date test and separately obtain a bulk bone (bioapatite plus any organics including proteins) test result. The bulk bone yielded a uniformitarian carbon age of 33,570 ± 120 BP, and 41,010 ± 220 BP for the bioapatite fraction. The results are shown in Figure 1 as "*Triceratops* horn bulk" and "*Triceratops* horn apatite," respectively. The greater age for our bioapatite fraction resembles the pMC proportions in modern bone fractions. The odds that modern radiocarbon could contaminate fractions of a fossil bone by adding the same proportions of all three carbon isotopes that occur in modern bone should be exceedingly small. However, given that the variation between carbon dates taken from very nearby samples (and as described below, other authors found a range of carbon dates from within the same sample) overlaps the variation between these two horn core fractions, there may be other explanations for these results. We are currently gathering more carbon dates from bone fractions to further test the hypothesis that the pMC difference between fossil bone fractions resembles the pMC difference between modern bone fractions.

Figure 4 shows an exposure of the Late (Upper) Cretaceous Horseshoe Canyon Formation in Alberta, near Drumheller, a site that typifies its badlands topology. We see here exposed layers of shaley sandstone, thin coal seams, carbonaceous shale, and mudstones. Like the Hell Creek and Lance Formations, we associate the deposition of Horseshoe Canyon Formation's layers with the middle-Flood months, when Rising Rocky Mountain terrains temporarily trapped Floodwaters perhaps near the apex of water coverage (Clarey, 2015). Late Flood or residual Flood catastrophism may have eroded then-soft sediments to generate the badlands topology found across northwestern North America. A fresh-looking, semisoft, peat-like sample of wood was discovered in the Horseshoe Canyon Formation by Author Nelson on October 14, 2013. Official disposition was granted on May 5, 2014 by the government of Alberta. The sample for carbon dating was then obtained by removing outer layers of the wood to obtain core portions, which were sent to the radiocarbon facility for dating. Our wood specimen of unknown taxon (ADM 0116) appears as "Drumheller wood" in Figures 1 and 6. Its carbon age was reported as 40,040 ± 160 BP.

Figure 4. The badlands of Alberta's Horseshoe Canyon Formation contain many dinosaur and other fossils, including our hadrosaurian caudal vertebra, a ceratopsian caudal vertebra, a ceratopsian metacarpal V and a wood sample. Their uniformitarian carbon ages were approximately 32,770; 36,760; 26,300; and 40,040 radiocarbon years, respectively.

We also acquired a hadrosaurian caudal vertebra (ADM 0117), a ceratopsian caudal vertebra (ADM 0118), and a ceratopsian metacarpal V (ADM 0119) directly from their discoverer, who indicated that the bones had never been prepared, glued, or sealed but were exactly as found within the Horseshoe Canyon Formation, from which our wood (ADM 0116) was also obtained. Figure 1 also shows their uniformitarian radiocarbon ages of 32,770 ± 100, 36,760 ± 130, and 26,300 ± 60 BP, respectively.

Lizard and Wood Specimens

We acquired *Captorhinus aguti* fossils to test for the presence of radiocarbon in the Paleozoic erathem. Because of the persistent failure of AMS facilities to consistently find carbon-dead samples—even from Paleozoic sources—for use as machine blanks (see introduction), and based on the assumption that Paleozoic strata represent Flood deposits, radiocarbon is expected. The extinct nondinosaurian reptile *C. aguti* indexes Permian strata and retains a conventional age range of between 280 and 270 million years. We obtained through a professional paleontologist high quality original specimens, including complete foot bones, jaw fragments with teeth, skull fragments, and vertebrae, shown in Figure 5. Its provenance describes an extension into Oklahoma of the Admiral Formation, with most of the Formation's footprint found in Texas. The lab detected 0.21 pMC, corresponding to 49,470 ± 510 BP, shown in Figure 1.

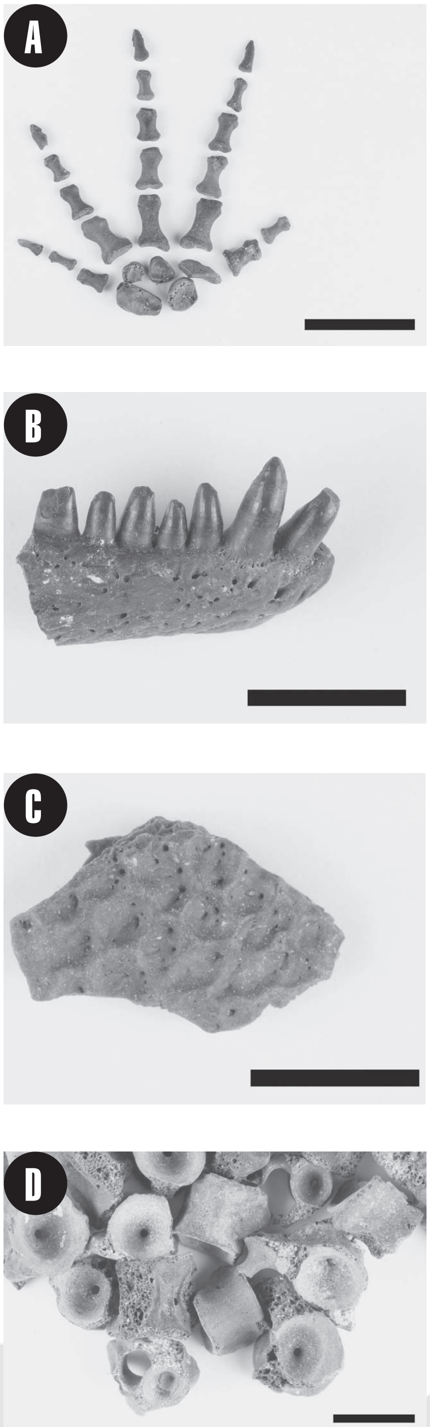

Figure 5. Fragments of *Captorhinus aguti*, an extinct lizard index fossil for the Permian System collectively yielded an age of approximately 49,470 radiocarbon years. (a) Complete foot bones; (b) mandible fragment with teeth; (c) skull fragment; (d) vertebrae. Scale bar in 5a equals 10mm, and 5mm in all others.

The final fossil on our list, and the one holding the oldest conventional age assignment in our collection, is a wood sample obtained from the Boskovice Furrow in the Czech Republic. This wood was carbonized and almost black. It was procured from a professional fossil dealer in the U.S. It had been found ensconced within a small shaley slab that also contains an exquisitely preserved fossil branch of genus *Walchia* (a conifer). Under 60X magnification, it was apparent that the wood had not been glued or sealed with any contaminating substance. Using stainless steel instruments, the wood was carefully extracted directly onto tin foil. Its conventional age at 290 million years stands in stark contrast to its uniformitarian carbon age of 48,160 ± 330 BP. We list this fossil in Figures 1 and 6 as "Czech wood."

Results and Discussion

Consistent Radiocarbon in Fossils

Unexpectedly, all 16 samples submitted for measurement contained C-14. We found measurable amounts of ^{14}C in all 14 of our dinosaur and other fossils. Moreover, we found surprising consistency in these data, which range from approximately 17,850 to 49,470 radiocarbon years as indicated in Figure 1.

Comparison with Published Ages

One way to falsify the hypothesis that our 14 fossils contain endogenous radiocarbon is to compare their pMC measurements to those supplied by other workers who also demonstrated each of their artifacts' provenances. We reasoned that a higher average pMC, indicating a lower average number of carbon years, in our data compared to previously published Phanerozoic fossil carbon dates would implicate ^{14}C contributions from contaminants in our samples. We therefore plotted our ^{14}C data along with ^{14}C ages for mostly Mesozoic fossils in Figure 6.

The single secularly published Cretaceous carbon date came from the early Maastrichtian Ciply Phosphatic Chalk of Southwest Belgium. The mosasaur fossil humerus (IRSNB 1624; Institut Royal des Sciences Naturelles de Belgique) yielded direct evidence of endogenous bone proteins as well as radiocarbon, shown in Figure 6 as "mosasaur." The study authors suggested, but did not show convincing evidence, that bacterial contamination caused their result. In any case, at 24,600 carbon years, it fits well within the range of carbon dates assembled in this report (Lindgren et al, 2011).

A remarkable carbon isotope analysis of a Cambrian fossil from the Burgess Shale of the Canadian Rockies, accompanied by a half dozen techniques used to verify chitin endogenous to the genus *Vauxia* sea sponge, revealed a calibrated carbon age of 43,000 years BC (Ehrlich et al, 2013). The study authors wrote in their paper's supplement that their result, coming as it did from a 505-million-year-old source, "has to be seen as [a] minimum age resulting from contaminations." Similar to Lindgren et al's analysis of a mosasaur, they proposed sources of contamination (bacteria, topsoil, and siderite minerals) but did not test these. Our results can be compared to this data point, shown on Figure 6 as "Burgess Sponge."

Igneous petrologist Andrew Snelling carbon dated fossil wood extracted from the middle Triassic Hawkesbury Sandstone of Queensland (Snelling, 1998). The seed-fern *Dicroidium* is common in the Hawkesbury Sandstone near Sydney at Bunadoon, Australia. Snelling acquired it from quarry workers and tentatively identified it as *Dicroidium*, "probably the wood from the stem of a frond" (Snelling, 1999). Geochron Laboratories near Boston detected radiocarbon in the partly petrified wood. Its corresponding carbon age of 33,720 ± 430 years BP is shown in Figure 6.

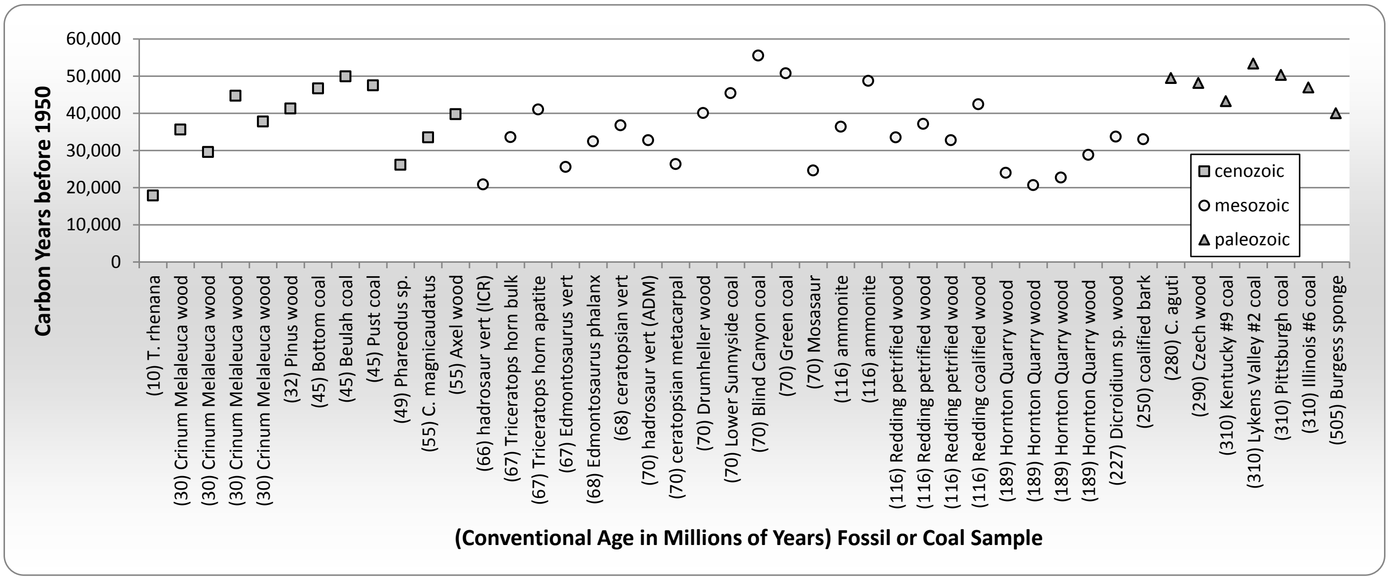

Figure 6. Our 16 dinosaur and other fossil carbon dates mingled with already published AMS carbon dates for fossils plus coal samples are listed in order of conventional age. These 43 results lie within a range of approximately 17,850 and 53,381 radiocarbon years. These data indicate that fossils may systematically exhibit endogenous radiocarbon. As discoveries of radiocarbon in fossil materials increase, arguments of contamination become less plausible. Indeed, if these carbon dates are illegitimate, then the whole carbon dating industry would be held suspect. Error bars lie within the graphic markers.

Snelling also carbon dated wood samples from Australia's Crinum mines (Snelling, 2000a). He carefully documented the provenance, tentatively identifying the fossils as incompletely petrified *Melaleuca* entombed in olivine basalt conventionally aged at 30 Ma. Figure 6 includes all four carbon dates presented in this paper by Snelling, obtained by two different laboratories. He presented carbon dates for wood from a ventilation shaft and one, dated twice, from a drill core. These four samples appear in Figure 6 as "Crinum Melaleuca wood" and derive from the same tertiary basalt flow in Bowen Basin that overlies a Permian sandstone and siltstone.

The upper nine feet of the Marlstone Rock Bed, with outcrops across southern England, contains *Dactylioceras tenuicostatum* ammonite and genus Acrocoelite belemnite fossils that index the sometimes sandy limestone to the early Jurassic System. Nevertheless, Snelling collected and dated four wood samples from this rock at Hornton Quarries, shown in Figure 6 under "Hornton Quarry wood" (Snelling, 2000b). The samples he sent to Geochron yielded 24,005 ± 600, 22,730 ± 170, and 28,820 ± 350 carbon years, and one he sent to a separate lab, ANSTO, yielded 20,700 ± 1,200 carbon years. ANSTO used different standards in reporting error margins, as Snelling describes in his various reports.

Snelling later reported another carbon-dated wood sample to 41,260 ± 540 carbon years. Found near Cripple Creek, Colorado, it was described as having been embedded in lava conventionally dated by the Ar-Ar method at 32 million years old. He wrote, "It can only be concluded, therefore, that the radiocarbon measured by the laboratory must be real *in situ* radiocarbon intrinsic to the original wood, and not contamination of any sort" (Snelling, 2008a). Here we summarize four rationales Snelling used to support his conclusion and then apply his rationales to our results.

1. Laboratory handling could not have introduced nearly enough modern ^{14}C to produce these results because they carefully and rigorously exclude contaminants using procedures such as acid pretreatments and regular calibrations of the accelerator mass spectrometer.
2. Similarly, laboratory treatment in acid removes surface contaminants that may have been introduced by handling in the field. Our fossil bone samples were pretreated with an acid-base-acid prewash procedure that has proven its reliability in many prior experiments and has thus formed the basis of the industry of carbon dating archaeological bone (Aitken, 1990, pp. 86–89).
3. Contamination could have occurred in his wood via post-burial alteration

facilitated by hydrothermal fluid transport of modern radiocarbon sources. However, rigorous demineralization during sample preparation at the carbon dating facility removes these potential contaminants.

4. Contamination of his carbon-dated wood sample might have occurred in the intervening millennia through groundwater percolation. However, the fossil, found deep in a mine, had been located over 3,000 feet below the surface, where groundwater mixing to the extent required to produce the measured amounts of ^{14}C after millions of years would have been very unlikely. Also, the soluble forms of carbon dissolved in groundwater would not interact with the insoluble forms of carbon in the fossil.

In considering our 16 samples, we note that groundwater interaction should have been much more likely since our fossils were not taken from such great depths. Does this falsify our results? In response we note that the soluble versus insoluble forms of carbon remain incompatible regardless of depth or hydration levels. For example, carbon-containing collagen protein is insoluble in water and has not been shown to readily react with dissolved carbonates.

Interestingly, the moisture surrounding the iDINO *Triceratops* horn core fossil showed it had been exposed to ground water when it was first uncovered—indeed, the base of the horn was exposed at the surface prior to excavation (K. Anderson, personal communication). Our hadrosaur vertebra was also removed from very near the ground surface when discovered, our other fossils came from sites better protected from groundwater, and yet the carbon dates from all fossils fell within a similar range, as shown in figures 1 and 6. Also, we have a preliminary indication that the most sequestered sections of our fossils, for example interior trabecular bone scrapings from the hadrosaur vertebra (ICR 021), and the exposed exterior portions ("hadrosaur vert cortical" in Figure 1) both present consistent radiocarbon ages. If percolation contaminated these fossils, their exteriors should show lower carbon ages than their interiors, but we did not find this. Plus, as noted above, studies comparing the ratios of ^{14}C to those in modern bone will further test the effects of groundwater.

Last, Snelling described in detail the geologic setting for a fossil ammonite collected near Redding, California, the shell of which yielded two additional carbon dates: 36,400 and 48,710 carbon years (Snelling, 2008b).

Overall we find that our 16 carbon dates fall within a range that closely approximates that of similar data already published, consistent with the hypothesis that our dinosaur bone and other fossil materials contain endogenous ^{14}C. In sum, we note that Snelling's same four reasons point to a similar conclusion for our 16 carbon-dated dinosaur and other fossils.

We also included in our Figure 6 the ten carbon dates for carefully extracted coal samples that the RATE team published (Baumgardner, 2005). The coals did show higher carbon ages on average than fossil carbon ages from comparable erathems, but those coal carbon ages did overlap with some fossil carbon ages, which in turn overlapped other carbon ages. These overlaps seem to suggest natural, endogenous fluctuations in radiocarbon amounts per sample instead of a systematic bias arising from contamination. Future research could explore possible reasons for higher average carbon ages in coals as compared to fossils.

After comparing these data in attempts to falsify the hypothesis of authigenic radiocarbon, we noticed that we had compiled carbon dates for fossils from all three erathems, enabling us to compare carbon dates to a broad range of conventional age assignments. The pMC averages and ranges from our combined data set are displayed according to erathems in Figure 7. We find that although pMC in fossils does not significantly differ between erathems, they infer carbon ages that are orders of magnitude younger than conventional age assignments for these fossils. This result is consistent with the hypothesis that even geologic strata described as Paleozoic, and including the Mesozoic, were deposited in one year only thousands of years ago during Noah's Flood.

Comparing Laboratories

We considered the possibility that error could arise from a given carbon-dating facility, for example by operator error on a given day. Our 16 results from a carbon isotope facility that specializes in bone tissue combine with similar detections of radiocarbon in Phanerozoic fossils from Geochron Laboratories in Massachusetts, the IsoTrace Radiocarbon Laboratory at the University of Toronto in Ontario, the Australia Nuclear Science and Technology Organisation (ANSTO), and the Jena AMS system at the Max-Planck Institut für Biogeochemie. The most parsimonious explanation for five different laboratories detecting radiocarbon in ancient fossils seems to be that these fossils contain endogenous ^{14}C.

Comparing Localities

According to the Creation-Flood model, water covered the whole globe recently, enabling us to interpret the global occurrences of fossils largely as resulting from this cataclysm. Given such universally recent deposition, ^{14}C might be detected worldwide, and our results confirm this. The geographical settings of radiocarbon-containing fossils and coals from Figure 6 include:

> Adendorf, Germany; Alberta, Canada; Arizona; Czech Republic; Mons, Belgium; California; Colorado; Illinois; Kentucky; Montana; North Dakota; Nunavut, Canada; Oklahoma; Pennsylvania; Ratley, England; Sydney, Australia; Queensland, Australia; Texas; Utah; and Wyoming.

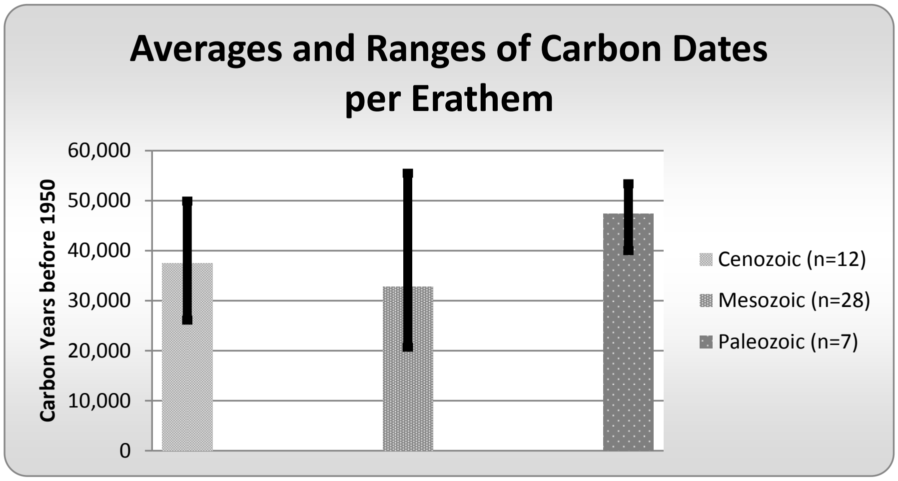

Figure 7. Histogram bar heights represent average carbon dates of Figure 6 samples from each erathem. Solid black lines represent carbon date ranges for each erathem. Mesozoic samples show the widest range probably because they include the highest number of samples. Although our youngest conventionally aged fossil also showed the youngest carbon age, and our oldest conventionally aged fossils showed the oldest carbon ages, these are not enough data to resolve a relative time trend across erathems. Future research, including additional carbon dates and statistical analyses might reveal new trends in fossil carbon dates.

This wide distribution makes it difficult to assert that radiocarbon in fossils arises from a local source of contamination, and suggests that ^{14}C might be found at any location worldwide where a fossil occurs. More data from additional sites will help generate an accurate picture of the distribution of ^{14}C, but thus far these data are consistent with the Creation-Flood model.

Conclusions

On the basis of repeated observations of original tissues found in dinosaur and other bones, and on the basis of prior researchers' difficulties in finding a reliable source of carbon-dead earth material to calibrate highly sensitive AMS systems, we tested 16 fossil samples for the presence of ^{14}C. Our fossils came from seven dinosaurs, including two dates from the iDINO project's *Triceratops* horn core, which had a spectacular whole sheet of soft, fibrillar tissue, and two dates from a hadrosaur vertebra, a fruit, one cartilaginous fish, one bony fish, three wood samples, and one extinct lizard. We sought to falsify the hypothesis that this radiocarbon originated from our fossil material first by comparing our amounts of measured radiocarbon to those already published, finding general concordance between our data and already published data. Second, all samples, regardless of geographic and even stratigraphic provenance, showed detectable ^{14}C within a total age range spanning orders of magnitude smaller than the conventional age range for these fossils. In addition, some of our fossil material was not extracted from as great a depth as were certain previously published carbon-dated fossils like wood from Californian and Australian mine shafts, and yet both settings revealed very comparable age averages and ranges. Third, five different laboratories all detected radiocarbon in fossils from locations worldwide, arguing against contamination by poor lab practice or by any local anomaly. These observations are not consistent with contamination. Finally, similar levels of radiocarbon were recovered from all three erathems, consistent with the hypothesis that all three erathems contain fossils deposited during Noah's year-long Flood only thousands of years ago. Additional tests of more material would add more data for further analyses. In particular, we plan to extend our single comparison of the ^{14}C ratio between bioapatite and bulk bone fractions to investigate whether or not dinosaur material trends toward mimicking similar carbon isotope ratios as found in modern bone. Additional carbon dates could also reveal relative age trends across erathems.

References

Aitken, M.J. 1990. *Science-based Dating in Archaeology*. Longman, London, UK.

Armitage, M.H., and K.L. Anderson. 2013. Soft sheets of fibrillary bone from a fossil of the supraorbital horn of the dinosaur *Triceratops horridus*. *Acta Histochemica* 116(6): 603–608.

Arnold, J.R., and W.F. Libby. 1949. Age determinations by radiocarbon content: checks with samples of known age. *Science* 110(2869): 678–680.

Baumgardner, J., A.A. Snelling, D.R. Humphreys, and S.A. Austin. 2003. Measurable ^{14}C in fossilized organic materials: confirming the young earth Creation-Flood model. In Ivey, H. (editor), *Proceedings of the Fifth International Conference on Creationism*, pp. 127–142. Creation Science Fellowship, Pittsburgh, PA. (http://www.icr.org/article/young-earth-creation-flood-14c/)

Baumgardner, J. 2005. ^{14}C evidence for a recent global flood and a young earth. In Vardiman, L., A.A. Snelling, and E.F. Chaffin (editors), *Radioisotopes and the*

Age of the Earth: Results of a Young-Earth Creationist Research Initiative, pp. 587–630. Institute for Creation Research, El Cajon, CA, and Creation Research Society, Chino Valley, AZ. (http://www.icr.org/article/carbon-14-evidence-for-recent-global/)

Cherkinsky, A. 2009. Can we get a good radiocarbon age from "bad bone"? Determining the reliability of radiocarbon age from bioapatite. *Radiocarbon* 51(2): 647–655.

Clarey, T. 2015. The Hell Creek Formation: the last gasp of the pre-Flood dinosaurs. *Creation Research Society Quarterly* 51:286–298.

Dahmer, L., D. Kouznetsov, A. Ivenov, J. Hall, J. Whitmore, G. Detwiler, and H. Miller. 1990. Report on chemical analysis and further dating of dinosaur bones and dinosaur petroglyphs. In Walsh, R.E., and C.L. Brooks (editors), *Proceedings of the Second International Conference on Creationism, Vol. II*, pp. 371–374. Creation Science Fellowship, Pittsburgh, PA.

Edwards, N.P., H.E. Barden, B.E. van Dongen, P.L. Manning, P.L. Larson, U. Bergmann, W.I. Sellers, and R.A. Wogelius. 2011. Infrared mapping resolves soft tissue preservation in 50 million year-old reptile skin. *Proceedings of the Royal Society B* 7:3209–3218.

Ehrlich, H., J.K. Rigby, J.P. Botting, M.V. Tsurkan, C. Werner, P. Schwille, Z. Petrášek, A. Pisera, P. Simon, V.N. Sivkov, D.V. Vyalikh, S.L. Molodtsov, D. Kurek, M. Kammer, S. Hunoldt, R. Born, D. Stawski, A. Steinhof, V.V. Bazhenov, and T. Geisler. 2013. Discovery of 505-million-year old chitin in the basal demosponge *Vauxia gracilenta*. *Scientific Reports* 3:3497.

Hebert, J. 2013. Rethinking carbon-14 dating: what does it really tell us about the age of the earth? *Acts & Facts* 42(4): 12–14.

International Chronostratigraphic Chart. 2014. International Commission on Stratigraphy. http://www.stratigraphy.org/index.php/ics-chart-timescale

LePage, B.A., and J.F. Basinger. 1991. Early Tertiary Larix from the Buchanan Lake Formation, Canadian Arctic Archipelago, and a consideration of the phytogeography of the genus. In Christie, R.L., and N.J. McMillan (editors), *Tertiary Fossil Forests of the Geodetic Hills, Axel Heiberg Island, Arctic Archipelago*, GSC Bulletin 403, pp. 67–82. Geological Survey of Canada, Ottawa, ON.

Lindgren, J, P.Uvdal, A. Engdahl, A.H. Lee, C. Alwmark, K-E. Bergquist, E. Nilsson, P. Ekström, M. Rasmussen, D.A. Douglas, M.J. Polcyn, and L.L. Jacobs. 2011. Microspectroscopic evidence of Cretaceous bone proteins. *PLoS ONE* 6(4): e19445. (http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0019445)

Lot 41304; Rare fossil paddlefish. 2009. Heritage Auction. http://fineart.ha.com/itm/fossils/fish/rare-fossil-paddlefish/a/6012–41304.s (accessed November 2014).

Nadeau, M.-J., P.M. Grootes, A. Voelker, F. Bruhn, A. Duhr, and A. Oriwall. 2001. Carbonate ^{14}C background: does it have multiple personalities? *Radiocarbon* 43:2A, 169–176.

Shoenhut, K. 2005. Ultrastructural preservation in Middle Eocene Metasequoia leaf tissues from the Buchanan Lake Formation. In LePage, B.A., C.J. Williams, and H. Yang (editors), *Topics in Geobiology: The Geology and Biology of Metasequoia, Part II* 22:219–252. Springer, Dordrecht, Netherlands.

Snelling, A.A. 1998. Stumping old-age dogma: radiocarbon in an 'ancient' fossil tree stump casts doubt on traditional rock/fossil dating. *Creation* 20(4): 48–51. (http://creation.com/stumping-old-age-dogma)

Snelling, A.A. 1999. Dating dilemma: fossil wood in 'ancient' sandstone. Creation.com. http://creation.com/dating-dilemma-fossil-wood-in-ancient-sandstone (accessed February 16, 2015).

Snelling, A.A. 2000a. Conflicting 'ages' of Tertiary basalt and contained fossilised wood, Crinum, Central Queensland, Australia. *Journal of Creation* (*CENTJ*) 14(2): 99–122. (http://creation.com/images/pdfs/tj/j14_2/j14_2_99–122.pdf)

Snelling, A.A. 2000b. Geological conflict: young radiocarbon date for ancient fossil wood challenges fossil dating. *Creation*. 22(2): 44–47. (http://creation.com/geological-conflict)

Snelling, A.A. 2008a. Radiocarbon in "ancient" fossil wood. *Acts & Facts* 37(1): 10. (http://www.icr.org/article/radiocarbon-ancient-fossil-wood/)

Snelling, A.A. 2008b. Radiocarbon ages for fossil ammonites and wood in Cretaceous strata near Redding, California. *Answers Research Journal* 1 (2008): 123–144. (https://answersingenesis.org/geology/carbon-14/radiocarbon-ages-fossils-cretaceous-strata-redding-california/)

Whitmore, J. 2006. The geologic setting of the Green River Formation. *Journal of Creation* 20(1): 72–78. (http://creation.com/the-geologic-setting-of-the-green-river-formation)

Addendum

More background surrounding the longstanding debate over the usefulness for secular archaeology of ^{14}C dates from bone apatite has come to the authors' attention since we submitted this paper. Zazzo (2014) showed evidence that apatite suffers from isotopic exchange of modern carbonates in the presence of groundwater, leading to younger radiocarbon ages for apatite than expected. He and Cherkinsky (2009) noted that ^{14}C introduced in this manner cannot be removed with pretreatments. However, Cherkinsky and Chataigner (2010) showed that some apatite fractions yielded carbon ages older than those of collagen fractions from the same bone. Even so, we calculate that discordance between collagen/charcoal/eggshell radiocarbon dates and their corresponding apatite dates from material older than 10,900 RCY in Zazzo (2014) averages 19.75%, implying that even in samples where isotope exchange may have rejuvenated apatite carbonates, most of the measured ^{14}C is endogenous. These considerations do not appear to significantly impact our major conclusions, but provide direction for future research.

References

Cherkinsky, A. 2009. Can We Get a Good Radiocarbon Age from “Bad Bone?” Determining the Reliability of Radiocarbon Age from Bioapatite. *Radiocarbon* 51(2): 647–655.

Cherkinsky, A., and Chataigner, C. 2010. ^{14}C Ages of Bone Fractions from Prehistoric Armenian Sites. *Radiocarbon* 52(2–3): 569–577.

Zazzo, A. 2014. Bone and enamel carbonate diagenesis: A radiocarbon prospective. *Palaeogeography, Palaeoclimatology, Palaeoecology* 416 (2014) 168–178.

Letters to the Editor

The policy of the editorial staff of CRSQ *is to allow letters to the editor to express a variety of views. As such, the content of all letters is solely the opinion of the author, and does not necessarily reflect the opinion of the* CRSQ *editorial staff or the Creation Research Society.*

Snowmass Fossils

I want to commend young Andrew St. Marie for his interesting and informative article, “Evidence for the Recent Existence of Mammoths and Mastodons,” in the Fall 2014 edition of *CRSQ*. While I have never met Andrew, we share a fondness for fossils and creationist paleontology and are acquainted via e-mail.

I’m honored that Andrew quoted me in his paper about the Snowmass Fossil Site. However, I’d like to make one correction. In citing my (unpublished) article, “Fresh Look (and Smell) of Snowmass Fossils Astonish Evolutionists,” Andrew mentioned that a date of 50,000–150,000 years was assigned to the fossils because they contained no measurable C-14. In reality, the carbon-14 dates obtained were *dismissed* by the scientists involved as “dead” or “unreliable.” This likely occurred for a couple of reasons: (1) Despite C-14 testing results of 43,000–58,000 ya—most near C-14’s commonly accepted accuracy limit of 50,000 years—the age range was probably considered too recent and too narrow for the geological setting. (2) Some of the *older* dates came from fossils in the *upper* layers, while some of the *younger* dates came from those in *lower* strata.[1] Thus, the search was on for “better dates,” using other testing methods, including Optically Stimulated Luminescence and Uranium-Series Dating. And (surprise!) they indeed confirmed the preassigned age range of 50,000–150,000 years.

The Snowmastodon Project, as it was named, was originally touted as “one of the most significant fossil discoveries ever made in Colorado,” by the Denver Museum of Nature & Science (DMNS). Interestingly, however, the final reports from its “international team of scientists” were released without fanfare in the November 2014 issue of *Quaternary Research*. Maybe this is because the findings continue to provide conflicting data about the Snowmass fossil site that don’t match up with evolutionary expectations, much less aid our understanding of “global climate change,” one of the project’s stated goals.

Terry P. Beh

[1] These data are from a February 16, 2011, meeting of the Colorado Scientific Society at the Colorado School of Mines, where an initial public report on *The Snowmass Fossil Discoveries* was given by paleontologist Dr. Kirk Johnson, Chief Curator at DMNS, and USGS geologist Dr. Jeff Pigati.