MEASURABLE ^{14}C IN FOSSILIZED ORGANIC MATERIALS: CONFIRMING THE YOUNG EARTH CREATION-FLOOD MODEL

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ABSTRACT

Given the short ^{14}C half-life of 5730 years, organic materials purportedly older than 250,000 years, corresponding to 43.6 half-lives, should contain absolutely no detectable ^{14}C. (One gram of modern carbon contains about 6 x 10^{10} ^{14}C atoms, and 43.6 half-lives should reduce that number by a factor of 7.3 x 10^{-14}.) An astonishing discovery made over the past twenty years is that, almost without exception, when tested by highly sensitive accelerator mass spectrometer (AMS) methods, organic samples from every portion of the Phanerozoic record show detectable amounts of ^{14}C! ^{14}C/C ratios from all but the youngest Phanerozoic samples appear to be clustered in the range 0.1-0.5 pmc (percent modern carbon), regardless of geological 'age.' A straightforward conclusion that can be drawn from these observations is that all but the very youngest Phanerozoic organic material was buried contemporaneously much less than 250,000 years ago. This is consistent with the Biblical account of a global Flood that destroyed most of the air-breathing life on the planet in a single brief cataclysm only a few thousand years ago.

INTRODUCTION

Giem [18] reviewed the literature and tabulated about seventy reported AMS measurements of ^{14}C in organic materials from the geologic record that, according to the conventional geologic time-scale, should be ^{14}C 'dead.' The surprising result is that organic samples from every portion of the Phanerozoic record show detectable amounts of ^{14}C. For the measurements considered most reliable, the ^{14}C/C ratios appear to fall in the range 0.1-0.5 percent of the modern ^{14}C/C ratio (percent modern carbon, or pmc). Giem demonstrates instrument error can be eliminated as an explanation on experimental grounds. He shows contamination of the ^{14}C-bearing fossil material *in situ* is unlikely but theoretically possible and is a testable hypothesis, while contamination during sample preparation is a genuine problem but largely solved by two decades of improvement in laboratory procedures. He concludes the ^{14}C detected in these samples most likely is from the organisms from which the samples

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**The statements the authors make and the conclusions they reach do not necessarily represent the positions or viewpoints of the institutions for which they work nor does a listing of the institutions' names imply that they support this research.*

are derived. Moreover, because most fossil carbon seems to have roughly the same ^{14}C/C ratio, Giem deems it plausible that all these organisms resided on earth at the same time.

Anomalous ^{14}C in fossil material actually has been reported from the earliest days of radiocarbon dating. Whitelaw [46], for example, surveyed all the dates reported in the journal Radiocarbon up to 1970, and he commented that for all of the over 15,000 specimens reported, "All such matter is found datable within 50,000 years as published." The specimens included coal, oil, natural gas, and other allegedly ancient material. The reason these anomalies were not taken seriously is because the older beta-decay counting technique had difficulty distinguishing genuine low levels of ^{14}C in the samples from background counts due to cosmic rays. The AMS method, besides its inherently greater sensitivity, does not have this complication of spurious counts due to cosmic rays. In retrospect, it is likely that many of the beta-counting analyses were indeed truly detecting intrinsic ^{14}C.

Measurable ^{14}C in pre-Flood organic materials fossilized in Flood strata therefore appears to represent a powerful and testable confirmation of the young earth Creation-Flood model. It was on this basis that Snelling [37-41] analyzed the ^{14}C content of fossilized wood conventionally regarded as ^{14}C 'dead' because it was derived from Tertiary, Mesozoic, and upper Paleozoic strata having conventional radioisotope ages of 40 to 250 million years. All samples were analyzed using AMS technology by a reputable commercial laboratory with some duplicate samples also tested by a specialist laboratory in a major research institute. Measurable ^{14}C was obtained in all cases. Values ranged from 7.58 ± 1.11 pmc for a lower Jurassic sample to 0.38 ± 0.04 pmc for a middle Tertiary sample (corresponding to ^{14}C 'ages' of $20{,}700 \pm 1200$ to $44{,}700 \pm 950$ years BP, respectively). The δ^{13}C values for the samples clustered around –25‰, as expected for organic carbon in plants and wood. The ^{14}C measured in these fossilized wood samples does not conform to a simple pattern, however, such as constant or decreasing with increasing depth in the geologic record (increasing conventional age). On the contrary, the middle Tertiary sample yielded the least ^{14}C, while the Mesozoic and upper Paleozoic samples did not contain similar ^{14}C levels as might be expected if these represent pre-Flood trees. The issue then of how uniformly the ^{14}C may have been distributed in the pre-Flood world we concluded would likely be an important one. Therefore, our RATE team decided to undertake further ^{14}C analyses on a new set of samples to address this issue as well as to confirm the remarkable ^{14}C levels reported in the radiocarbon literature for Phanerozoic material.

^{14}C MEASURED IN SAMPLES CONVENTIONALLY DATED OLDER THAN 100,000 YEARS

Giem [18] compiled a long list of AMS measurements made on samples that, based on their conventional geological age, should be ^{14}C 'dead.' These measurements were performed in many different laboratories around the world and reported in the standard peer-reviewed literature, mostly in the journals Radiocarbon and Nuclear Instruments and Methods in Physics Research B. Despite the fact that the conventional uniformitarian age for these samples is well beyond 100,000 years (in most cases it is tens to hundreds of millions of years), it is helpful nonetheless to be able to translate ^{14}C/C ratios into the equivalent uniformitarian ^{14}C age under the standard uniformitarian assumptions of an approximately constant ^{14}C production rate and an approximately constant biospheric carbon inventory, extrapolated into the indefinite past. This conversion is given by the simple formula, pmc = 100 x $2^{-t/5730}$, where t is the time in years. Applying this formula, one obtains values of 0.79 pmc for t = 40,000 years, 0.24 for t = 50,000 years, 0.070 pmc for 60,000 years, 0.011 pmc for 75,000 years, and .001 pmc for 95,000 years, as shown in graphical form in Figure 1.

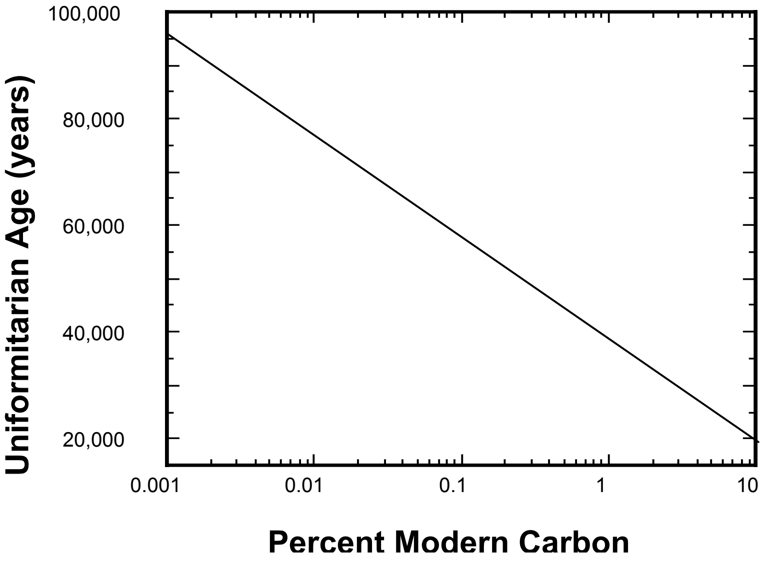

Figure 1. *Uniformitarian age as a function of ^{14}C/C ratio in percent modern carbon. The uniformitarian approach for interpreting the ^{14}C data assumes a constant ^{14}C production rate and a constant biospheric carbon inventory extrapolated into the indefinite past. It does not account for the possibility of a recent global catastrophe that removed a large quantity of carbon from the biospheric inventory.*

Table 1 below contains most of Giem's [18] data plus data from some more recent papers. Included in the list are a number of samples from Precambrian, that is, what we consider non-organic pre-Flood settings. Most of the graphite samples with ^{14}C/C values below 0.05 pmc are in this category.

TABLE 1. AMS Measurements on Samples Conventionally Deemed ^{14}C 'Dead'

Item	^{14}C/C (pmc) (±1 S.D.)	Material	Reference
1	0.71±?*	Marble	Aerts-Bijma *et al.* [1]
2	0.65±0.04	Shell	Beukens [8]
3	0.61±0.12	Foraminifera	Arnold *et al.* [2]
4	0.60±0.04	Commercial graphite	Schmidt *et al.* [36]
5	0.58±0.09	Foraminifera (*Pyrgo murrhina*)	Nadeau *et al.* [30]
6	0.54±0.04	Calcite	Beukens [8]
7	0.52±0.20	Shell (*Spisula subtruncata*)	Nadeau *et al.* [30]
8	0.52±0.04	Whale bone	Jull *et al.* [24]
9	0.51±0.08	Marble	Gulliksen & Thomsen [21]
10	0.5±0.1	Wood, 60 Ka	Gillespie & Hedges [19]
11	0.46±0.03	Wood	Beukens [8]
12	0.46±0.03	Wood	Vogel *et al.* [45]
13	0.44±0.13	Anthracite	Vogel *et al.* [45]
14	0.42±0.03	Anthracite	Grootes *et al.* [20]
15	0.401±0.084	Foraminifera (untreated)	Schleicher *et al.* [35]
16	0.40±0.07	Shell (*Turitella communis*)	Nadeau *et al.* [30]
17	0.383±0.045	Wood (charred)	Snelling [37]
18	0.358±0.033	Anthracite	Beukens *et al.* [9]
19	0.35±0.03	Shell (*Varicorbula gibba*)	Nadeau *et al.* [30]
20	0.342±0.037	Wood	Beukens *et al.* [9]
21	0.34±0.11	Recycled graphite	Arnold *et al.* [2]
22	0.32±0.06	Foraminifera	Gulliksen & Thomsen [21]
23	0.3±?	Coke	Terrasi *et al.* [43]
24	0.3±?	Coal	Schleicher *et al.* [35]
25	0.26±0.02	Marble	Schmidt *et al.* [36]
26	0.2334±0.061	Carbon powder	McNichol *et al.* [29]
27	0.23±0.04	Foraminifera (mixed species avg.)	Nadeau *et al.* [30]
28	0.211±0.018	Fossil wood	Beukens [8]
29	0.21±0.02	Marble	Schmidt *et al.* [36]
30	0.21±0.06	CO_2	Grootes *et al.* [20]
31	0.20–0.35* (range)	Anthracite	Aerts-Bijma *et al.* [1]
32	0.20±0.04	Shell (*Ostrea edulis*)	Nadeau *et al.* [30]
33	0.20±0.04	Shell (*Pecten opercularis*)	Nadeau *et al.* [30]
34	0.2±0.1*	Calcite	Donahue *et al.* [15]
35	0.198±0.060	Carbon powder	McNichol *et al.* [29]
36	0.18±0.05 (range?)	Marble	Van der Borg *et al.* [44]
37	0.18±0.03	Whale bone	Gulliksen & Thomsen [21]
38	0.18±0.03	Calcite	Gulliksen & Thomsen [21]
39	0.18±0.01**	Anthracite	Nelson *et al.* [32]
40	0.18±?	Recycled graphite	Van der Borg *et al.* [44]
41	0.17±0.03	Natural gas	Gulliksen & Thomsen [21]
42	0.166±0.008	Foraminifera (treated)	Schleicher *et al.* [35]
43	0.162±?	Wood	Kirner *et al.* [26]
44	0.16±0.03	Wood	Gulliksen & Thomsen [21]
45	0.154±?**	Anthracite coal	Schmidt *et al.* [36]

46	0.152±0.025	Wood	Beukens [8]
47	0.142±0.023	Anthracite	Vogel *et al.* [45]
48	0.142±0.028	CaC_2 from coal	Gurfinkel [22]
49	0.14±0.02	Marble	Schleicher *et al.* [35]
50	0.13±0.03	Shell (*Mytilus edulis*)	Nadeau *et al.* [30]
51	0.130±0.009	Graphite	Gurfinkel [22]
52	0.128±0.056	Graphite	Vogel *et al.* [45]
53	0.125±0.060	Calcite	Vogel *et al.* [45]
54	0.12±0.03	Foraminifera (*N. pachyderma*)	Nadeau *et al.* [30]
55	0.112±0.057	Bituminous coal	Kitagawa *et al.* [27]
56	0.1±0.01	Graphite (NBS)	Donahue *et al.* [15]
57	0.1±0.05	Petroleum, cracked	Gillespie & Hedges [19]
58	0.098±0.009*	Marble	Schleicher *et al.* [35]
59	0.092±0.006	Wood	Kirner *et al.* [25]
60	0.09–0.18* (range)	Graphite powder	Aerts-Bijma *et al.* [1]
61	0.09–0.13* (range)	Fossil CO_2 gas	Aerts-Bijma *et al.* [1]
62	0.089±0.017	Graphite	Arnold *et al.* [2]
63	0.081±0.019	Anthracite	Beukens [9]
64	0.08±?	Natural Graphite	Donahue *et al.* [15]
65	0.080±0.028	Cararra marble	Nadeau *et al.* [30]
66	0.077±0.005	Natural Gas	Beukens [9]
67	0.076±0.009	Marble	Beukens [9]
68	0.074±0.014	Graphite powder	Kirner *et al.* [25]
69	0.07±?	Graphite	Kretschmer *et al.* [29]
70	0.068±0.028	Calcite (Icelandic double spar)	Nadeau *et al.* [30]
71	0.068±0.009	Graphite (fresh surface)	Schmidt *et al.* [36]
72	0.06–0.11 (range)	Graphite (200 Ma)	Nakai *et al.* [31]
73	0.056±?	Wood (selected data)	Kirner *et al.* [26]
74	0.05±0.01	Carbon	Wild *et al.* [47]
75	0.05±?	Carbon-12 (mass sp.)	Schmidt, *et al.* [36]
76	0.045–0.012 (m0.06)	Graphite	Grootes *et al.* [20]
77	0.04±?*	Graphite rod	Aerts-Bijma *et al.* [1]
78	0.04±0.01	Graphite (Finland)	Bonani *et al.* [14]
79	0.04±0.02	Graphite	Van der Borg et al. [44]
80	0.04±0.02	Graphite (Ceylon)	Bird *et al.* [12]
81	0.036±0.005	Graphite (air)	Schmidt *et al.* [36]
82	0.033±0.013	Graphite	Kirner *et al.* [25]
83	0.03±0.015	Carbon powder	Schleicher *et al.* [35]
84	0.030±0.007	Graphite (air redone)	Schmidt *et al.* [36]
85	0.029±0.006	Graphite (argon redone)	Schmidt *et al.* [36]
86	0.029±0.010	Graphite (fresh surface)	Schmidt *et al.* [36]
87	0.02±?	Carbon powder	Pearson *et al.* [33]
88	0.019±0.009	Graphite	Nadeau *et al.* [30]
89	0.019±0.004	Graphite (argon)	Schmidt *et al.* [36]
90	0.014±0.010	CaC_2 (technical grade)	Beukens [10]

*Estimated from graph
**Lowest value of multiple dates

We display the published AMS values of Table 1 in histogram format in Figure 2 below. We have separated the source material into three categories, (1) those (mostly graphites) that are likely from Precambrian geological settings and unlikely to contain biological carbon, (2) those that are clearly of biological affinity, and (3) those (mostly marbles) whose biological connection is uncertain. We show categories (1) and (2) in Figure 2(a) and 2(b), respectively, and ignore for these purposes samples in category (3). Some caution is in order with respect to the sort of comparison implicit in Table 1 and Figure 2. In some cases the reported values have a 'background' correction, typically on the order of 0.07 pmc, subtracted from the raw measured values, while in other cases such a correction has not been made. In most cases, the graphite results do not include such 'background' corrections since they are usually intended themselves to serve as procedural blanks. Therefore, Figure 2 is to be understood only as a low precision means for comparing these AMS results.

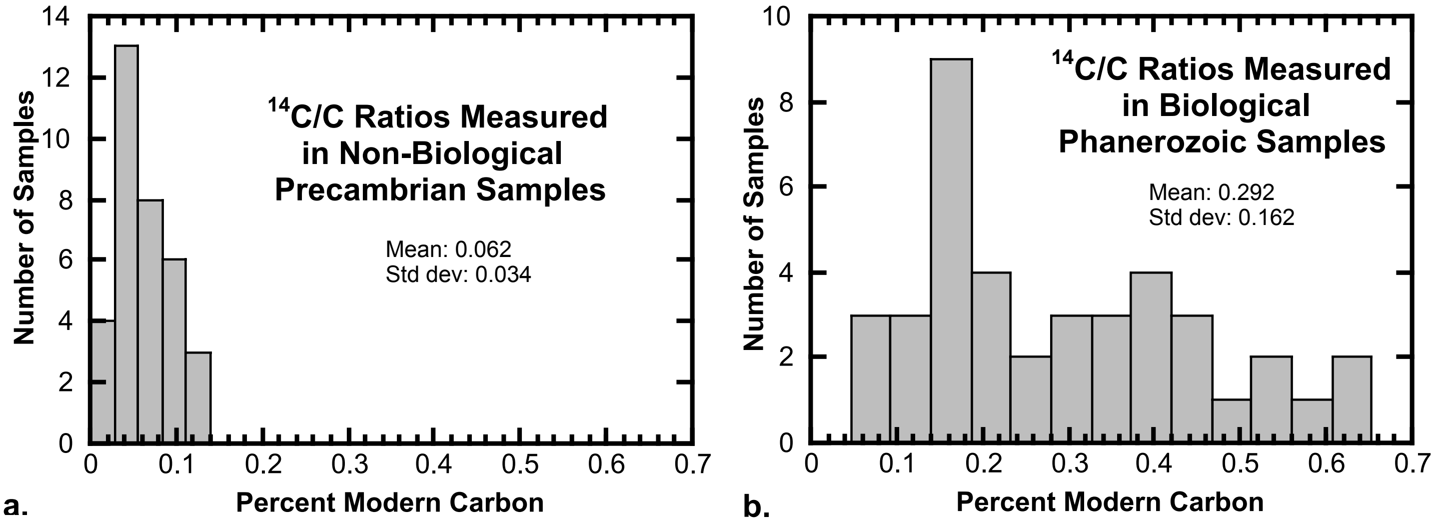

Figure 2. *Distribution of ^{14}C values for (a) non-biogenic samples and (b) biogenic samples from Table 1. Given their position in the geological record, all these samples should contain no detectable ^{14}C according to the standard geological time scale.*

We draw several observations from this comparison, imprecise as it may be. First, the set of samples with biological affinity display a mean value significantly different from those without such affinity. In terms of the standard geological time scale, all these samples should be equally ^{14}C dead. The samples with biological affinity display an unambiguously higher mean than those without such affinity, 0.29 versus 0.06 pmc. A second observation is that the variation in ^{14}C content for the biological samples is large. Although a peak in the distribution occurs at about 0.2 pmc, the mean value is near 0.3 pmc with a standard deviation of 0.16 pmc. This large spread in ^{14}C content invites an explanation. A third observation, although weaker that the first two, is that the distribution of values for non-biogenic material displays a peak offset from zero. This may provide a hint that carbon never cycled through living organisms—in most cases locked away in Precambrian geological settings—may actually contain a low level of intrinsic ^{14}C.

COPING WITH PARADIGM CONFLICT

How do the various ^{14}C laboratories around the world deal with the reality that they measure significant amounts of ^{14}C, far above the detection threshold of their instruments, in samples that should be ^{14}C dead according to the standard geological time scale? A good example can be found in a recent paper by Nadeau *et al.* [30] entitled, "Carbonate ^{14}C background: Does it have multiple personalities?" The authors are with the Leibnitz Laboratory at Christian-Albrechts University in Kiel, Germany. Many of the samples they analyze are shells and foraminifera tests from sediment cores. It would very useful to them if they could extend the range for which they could date such biological carbonate material from roughly 40,000 years ago (according to their uniformitarian assumptions), corresponding to about 1 pmc, toward the 0.002 pmc limit of their AMS instrument, corresponding to about 90,000 years in terms of uniformitarian assumptions. The reason they are presently stuck at this 40,000-year barrier is that they consistently and reproducibly measure ^{14}C levels approaching 1 pmc in shells and foraminifera from depths in the record where, according to the standard geological time scale, there should be no detectable ^{14}C.

Their paper reports detailed studies they have carried out to attempt to understand the source of this ^{14}C. They investigated shells from a late Pleistocene coring site in northwestern Germany dated by U/Th methods at 120,000 years. The mean ^{14}C levels measured in the shells of six different species of mussels and snails varied from 0.1 to 0.5 pmc. In the case of one species, *Spisula subtruncata*, measurements were made on both the outside and inside of the shell of a single individual specimen. The average ^{14}C value for the outside of the shell was 0.3 pmc, while for the inside it was 0.67. At face value, this suggests the $^{14}C/C$ ratio more than doubled during the lifetime of this organism. Most of their foraminifera were from a Pleistocene core from the tropical Atlantic off the northwest coast of Africa dated at 455,000 years. The foraminifera from this core showed a range of ^{14}C values from 0.16 to 0.4 pmc with an average, taken over 115 separate measurements, of 0.23 pmc. A benthic species of foraminifera from another core, chosen because of its thick shell and smooth surface in the hope its 'contamination' would be lower, actually had a higher average ^{14}C level of 0.58 pmc!

The authors then performed a number of experiments involving more aggressive pre-treatment of the samples to attempt to remove contamination. These included progressive stepwise acid hydrolization of the carbonate samples to CO_2 gas and ^{14}C measurement of each of four separate gas fractions. They found a detectable amount of surface contamination was present in the first fraction collected, but it was not large enough to make the result from the final gas fraction significantly different from the average value. They also leached samples in hydrochloric acid for two hours and cracked open the foraminifera shells to remove secondary carbonate from inside, but these procedures did not significantly alter the measured ^{14}C values.

The authors summarize their findings in the abstract of their paper as follows, "The results…show a species-specific contamination that reproduces over several individual shells and foraminifera from several sediment cores. Different cleaning attempts have proven ineffective, and even stronger measures such as progressive hydrolization or leaching of the samples prior to routine preparation, did not give any indication of the source of contamination." In their conclusion they state, "The apparent ages of biogenic samples seem species related and can be reproduced measuring different individuals for larger shells or even different sediment cores for foraminifera. Although tests showed some surface contamination, it was not possible to reach lower ^{14}C levels through cleaning, indicating the contamination to be intrinsic to the sample." They continue, "So far, no theory explaining the results has survived all the tests. No connection between surface structure and apparent ages could be established."

The measurements reported in this paper obviously represent serious anomalies relative to what should be expected in the uniformitarian framework. There is a clear conflict between the measured levels of ^{14}C in these samples and the dates assigned to the geological setting by other radioisotope methods. The measured ^{14}C levels, however, are far above instrument threshold and also appear to be far above contamination levels arising from sample processing. Moreover, the huge difference in ^{14}C levels among species co-existing in the same physical sample violates the assumption that organisms living together in the same environment should share a common $^{14}C/C$ ratio. The position the authors take in the face of these conflicts is that this ^{14}C, which should not be present according to their framework, represents 'contamination' for which they currently have no explanation. On the other hand, in terms of the framework of a young earth and a recent global Flood, these measurements provide important clues these organisms are much younger than the standard geological time scale would lead one to suspect.

This same approach of treating measurable and reproducible ^{14}C values in samples that ought to be ^{14}C dead, given their position in the geological record, as 'contamination' is found throughout the current literature. Bird *et al.* [12], for example, freely acknowledge 'contamination' in old samples leads to a 'radiocarbon barrier': "Detecting sample contamination and verifying the reliability of the ages produced also becomes more difficult as the age of the sample increases. In practice this means that many laboratories will only quote ^{14}C ages to about 40 ka BP (thousands of ^{14}C years before present), with ages greater than this generally considered to be 'infinite', or indistinguishable from procedural blanks. The so-called 'radiocarbon barrier' and the difficulty of ensuring that ages are reliable at <1% modern carbon levels has limited research in many disciplines." This statement is in the context of a high precision AMS facility the authors use, capable of measuring ^{14}C levels in the range of <<0.01 pmc.

In their paper they describe a strategy for eliminating various types of genuine contamination commonly associated with charcoal samples. A main component of this strategy is a stepped combustion procedure in which the sample is oxidized to CO_2 in a stepwise manner, at temperatures of 330°C, 630°C, and 850°C, with the resulting CO_2 fractions analyzed separately using AMS. Oxidation of most of any surficial contamination generally occurs at the lowest temperature, and the ^{14}C level of the highest temperature fraction is generally considered the one representing the least contaminated portion of the sample. The variation among the three fractions is considered a general indicator of the overall degree of contamination. They apply this approach to analysis of charcoal from one of the early sites of human occupation in Australia.

Included in their paper is considerable discussion of what is known as a 'procedural blank,' or a sample that represents effectively infinite ^{14}C age. For this they use what they refer to as 'radiocarbon-dead' graphite from Ceylon. They apply their stepped combustion procedure, using only the highest temperature fraction, on 14 such graphite samples to get a composite value of 0.04±0.02 pmc for this background material. They note that a special pre-treatment they use for charcoal samples applied to 4 of the 14 samples yielded results indistinguishable from the other 10 graphite samples that had no pre-treatment. They further note that sample size variation between 0.1 and 2.2 mg among the 14 samples also made no difference in the results. From this they acknowledge, "the few ^{14}C atoms observed may already be present in the Ceylon graphite itself." Indeed, they offer no explanation for the fact that this graphite displays ^{14}C levels well above the detection threshold of their AMS system other than it might be inherent to the graphite itself.

Measuring notable levels of ^{14}C in samples intended as procedural blanks or 'background' samples is a phenomenon that has persisted from the earliest days of AMS down to the present time. For example, Vogel *et al.* [45] describe their thorough investigation of the potential sources and their various contributions to the ^{14}C background in their AMS system. The material they used for the blank in their study was anthracite coal from a deep mine in Pennsylvania. An important part of their investigation was variation of the sample size of the blank by a factor of 2000, from 10 μg to 20 mg. They found that samples 500 μg and larger displayed a ^{14}C concentration of 0.44±0.13 pmc, independent of sample size, implying this ^{14}C was intrinsic to the anthracite material itself. For samples smaller than 500 μg, the measured ^{14}C could be explained in terms of this intrinsic ^{14}C, plus contamination by a constant amount of modern carbon that seemed to be present regardless of sample size. After many careful experiments, the authors concluded that the main source of this latter contamination was atmospheric CO_2 adsorbed within the porous Vicor glass used to encapsulate the coal sample in its combustion to CO_2 at 900 °C. Another source of smaller magnitude was CO_2 and CO adsorbed on the walls of the graphitization apparatus retained from reduction of earlier samples. It was found that filling the apparatus with water vapor at low pressure and then evacuating the apparatus before the next graphitization mostly eliminated this memory effect. Relative to these two sources, measurements showed that storage and handling of the samples, contamination of the copper oxide used in combustion, and contamination of the iron oxide powder used in the graphitization were effectively negligible. And when the sample size was greater than 500 μg, the intrinsic ^{14}C in the coal swamped all the sources of real ^{14}C contamination. Rather than deal with the issue of the nature of the ^{14}C intrinsic to the anthracite itself, the authors merely refer to it as "contamination of the sample *in situ*", "not [to be] discussed further."

As it became widely appreciated that many high carbon samples, which ought to be ^{14}C 'dead' given their position in the geological record, had in fact ^{14}C levels far above AMS machine thresholds, the approach was simply to search for specific materials that had as low a ^{14}C background level as possible. For example, Beukens [8], at the IsoTrace Laboratory at the University of Toronto, describes measurements on two samples that, from his experience at that time, displayed exceptionally low background ^{14}C levels. He reports 0.077±0.005 pmc from a sample of industrial CO_2 obtained by combustion of natural gas and 0.076±0.009 pmc from Italian Carrara marble. Previously for his blank material he had used an optical grade calcite (Iceland spar) for which he measured a ^{14}C level of 0.15 to 0.13 pmc. He emphasizes that the pre-treatment, combustion, and hydrolysis techniques applied to these new samples were identical to those normally applied to samples submitted for analysis to his laboratory and these techniques had not changed appreciably in the previous five years. He states, "The lower ^{14}C levels in these [more recent] measurements should therefore be attributed entirely to the lower intrinsic ^{14}C contamination of these samples and not to changes in sample preparation or analysis techniques." Note that he indeed considers the ^{14}C in all these materials to be 'intrinsic', but he has to call it 'contamination.' In his search for even better procedural blanks, he tested two standard blank materials, a calcite and an anthracite coal, used by the Geological Survey of Canada in their beta decay counting ^{14}C laboratory. These yielded ^{14}C levels of 0.54±0.04 pmc for the calcite and 0.36±0.03 pmc for the coal. Beukens noted with moderate alarm that the background corrections being made by many decay-counting radiocarbon dating facilities that had not checked the intrinsic ^{14}C content of their procedural blanks by AMS methods were probably quoting ages systematically older than the actual ages. His AMS analysis of the samples from the Geological Survey of Canada "clearly shows these samples are not ^{14}C-free" since these levels were markedly higher than those from his own natural gas and marble blanks.

AMS analyses reveal carbon from fossil remains of living organisms, regardless of their position in the geological record, consistently contains ^{14}C levels far in excess of the AMS machine threshold, even when extreme pre-treatment methods are applied. Experiments in which the sample size is varied argue compellingly that the ^{14}C is intrinsic to the fossil material and not a result of handling or pre-treatment. These conclusions continue to be confirmed in the very latest peer-reviewed papers. Moreover, even non-organic carbon samples appear consistently to yield ^{14}C levels well above machine threshold. Graphite samples formed under metamorphic and reducing conditions in Precambrian limestone environments commonly display ^{14}C values on the order of 0.05 pmc. Most AMS laboratories are now using such Precambrian graphite for their procedural blanks. A good question is what possibly could be the source of the ^{14}C in this material? We conclude that the possibility this ^{14}C is primordial is a reasonable one. Finding ^{14}C in diamond formed in the earth's mantle would provide support for such a conclusion. Establishing that non-organic carbon from the mantle and from Precambrian crustal settings consistently contains inherent ^{14}C well above the AMS detection threshold would, of course, argue the earth itself is less than 100,000 years old, which is orders of magnitude younger than the 4.56 Ga currently believed by the uniformitarian community.

RESULTS OF RATE ^{14}C AMS ANALYSES

Table 2 summarizes the results from ten coal samples prepared by our RATE team and analyzed by one of the foremost AMS laboratories in the world. These measurements were performed using the laboratory's 'high precision' procedures which involved four runs on each sample, the results of which were combined as a weighted average and then reduced by 0.077±0.005 pmc to account for a 'standard background' of contamination believed to be introduced by sample processing. This standard background value is obtained by measuring the ^{14}C in a purified natural gas. Subtraction of this background value is justified by the assumption that it must represent contamination. Figure 3 displays these AMS analysis results in histogram format.

Table 2. Results of AMS ^{14}C analysis of 10 RATE coal samples.

Sample	Coal Seam Name	State	County	Geological Interval	$^{14}C/C$ (pmc)
DECS-1	Bottom	Texas	Freestone	Eocene	0.30±0.03
DECS-11	Beulah	North Dakota	Mercer	Eocene	0.20±0.02
DECS-25	Pust	Montana	Richland	Eocene	0.27±0.02
DECS-15	Lower Sunnyside	Utah	Carbon	Cretaceous	0.35±0.03
DECS-16	Blind Canyon	Utah	Emery	Cretaceous	0.10±0.03
DECS-28	Green	Arizona	Navajo	Cretaceous	0.18±0.02
DECS-18	Kentucky #9	Kentucky	Union	Pennsylvanian	0.46±0.03
DECS-21	Lykens Valley #2	Pennsylvania	Columbia	Pennsylvanian	0.13±0.02
DECS-23	Pittsburgh	Pennsylvania	Washington	Pennsylvanian	0.19±0.02
DECS-24	Illinois #6	Illinois	Macoupin	Pennsylvanian	0.29±0.03

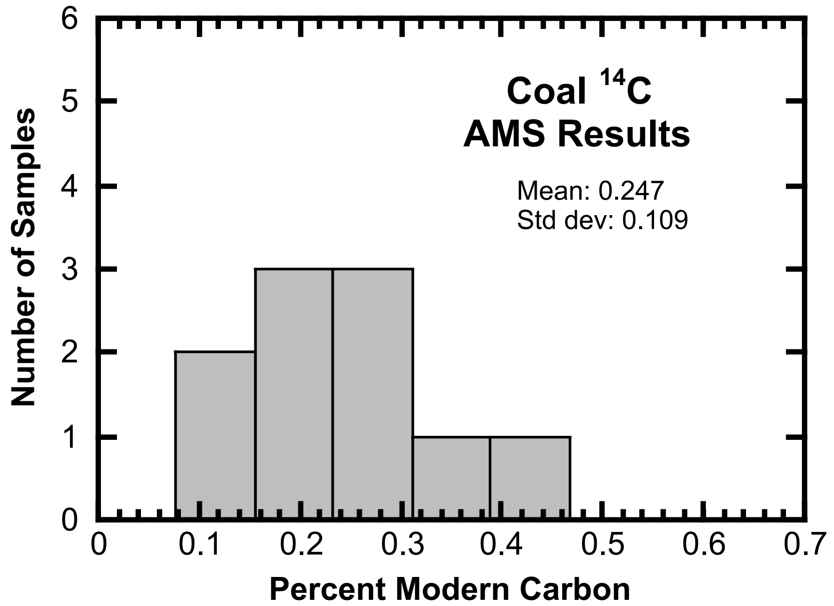

Figure 3. *Histogram representation of AMS ^{14}C analysis of ten coal samples undertaken by RATE ^{14}C research project.*

DETAILS OF RATE SAMPLE SELECTION AND ANALYSIS

The ten samples in Table 2 were obtained from the U. S. Department of Energy Coal Sample Bank maintained at Penn State University. The coals in this bank are intended to be representative of the economically important coalfields of the United States. The original samples were collected in 400-pound quantities from recently exposed areas of active mines, where they were placed in 30-gallon steel drums with high-density gaskets and purged with argon. As soon as feasible after collection, these large samples were processed to obtain representative 300 g samples with 0.85 mm particle size (20 mesh). These smaller 300 g samples were sealed under argon in foil multilaminate bags and have since been kept in refrigerated storage at 3°C. We selected ten of the 33 coals available with an effort to obtain good representation geographically as well as with respect to depth in the geological record. Our ten samples include three Eocene, three Cretaceous, and four Pennsylvanian coals.

The ^{14}C analysis at the AMS laboratory we selected involves first processing the coal samples to make graphite targets and then counting the relative numbers of atoms from the different carbon isotopes in the accelerator mass spectrometer system. The accelerator generates an intense ion beam that ionizes the graphite on the target, while the mass spectrometer uses electric and magnetic fields to separate different atomic species by mass and charge and counts the numbers of triply ionized ^{14}C, ^{13}C, and ^{12}C atoms. The sample processing consists of three steps: combustion, acetylene synthesis, and graphitization. The coal samples are first combusted to CO_2 and then converted to acetylene using a lithium carbide synthesis process. The acetylene is then dissociated in a high voltage AC electrical discharge to produce a circular disk of graphite on spherical aluminum pellets that represent the targets for the AMS system. Four separate targets are produced for each sample. Every target is analyzed in a separate AMS run with two modern carbon standards (NBS I oxalic acid). Each target is then analyzed on 16 different spots (organized on two concentric circles). The advantage of this procedure over a single high precision measurement is that a variance check (typically a T-test) can be performed for the 16 spots on each target. If an individual target fails this variance test, it is rejected. While this has advantages for any kind of sample, it is particularly useful for samples with very low ^{14}C levels because they are especially sensitive to contamination. While great care is taken to prevent target contamination after the graphitization step, it nevertheless can happen. Any contaminated spot or any contaminated target would bias the average. This variance test attempts to identify and eliminate this source of error.

Table 3 below gives the measurements in pmc from the four separate targets for our ten coal samples. The numbers in parentheses are the percent errors, calculated from the ^{14}C count rate of the sample and the two NBS standards and from the transmission of errors in the ^{12}C and ^{13}C current measurements of the sample and two standards. The composite results in Table 2 represent the weighted averages of these numbers in Table 3 and the subtraction of a standard background of 0.077±0.005 pmc.

Table 3. Detailed AMS ^{14}C measurements for 10 RATE coal samples in pmc.

Sample	Target 1	Target 2	Target 3	Target 4
DECS-1	0.398 (12.0%)	0.355 (13.2%)	0.346 (15.1%)	0.346 (15.1%)
DECS-11	0.237 (18.2%)	0.303 (14.8%)	0.292 (17.8%)	0.294 (17.2%)
DECS-25	0.342 (13.3%)	0.359 (15.3%)	0.352 (14.2%)	0.328 (14.8%)
DECS-15	0.416 (13.1%)	0.465 (12.2%)	0.467 (12.2%)	0.377 (13.6%)
DECS-16	0.184 (25.0%)	0.233 (21.8%)	0.141 (38.4%)	0.163 (34.0%)
DECS-28	0.203 (18.3%)	0.379 (14.5%)	0.204 (21.2%)	0.204 (21.2%)
DECS-18	0.533 (11.8%)	0.539 (11.4%)	0.492 (11.6%)	0.589 (10.0%)
DECS-21	0.183 (22.0%)	0.194 (20.0%)	0.230 (18.2%)	0.250 (18.0%)
DECS-23	0.225 (18.1%)	0.266 (13.8%)	0.246 (18.7%)	0.349 (13.2%)
DECS-24	0.334 (19.7%)	0.462 (17.5%)	0.444 (13.4%)	0.252 (25.8%)

The background standard of this AMS laboratory is CO_2 from purified natural gas that provides their background level of 0.077±0.005 pmc. This same laboratory obtains values of 0.076±0.009 pmc and 0.071±0.009 pmc, respectively, for Carrara Marble (IAEA Standard Radiocarbon Reference Material C1) and optical-grade calcite from Island spar. They claim this is one of the lowest background levels quoted among AMS labs, and they attribute this low background to their special graphitization technique. They emphasize backgrounds this low cannot be realized with any statistical significance through only one or two measurements, but many measurements are required to obtain a robust determination.

The laboratory has carefully studied the sources of error within its AMS hardware, and regular tests are performed to ensure these remain small. According to these studies, errors in the spectrometer are very low and usually below the detection limit since the spectrometer is energy dispersive and identifies the ion species by energy loss. The detector electronic noise, the mass spectrometric inferences (the E/q and mE/q^2 ambiguities), and the cross contamination all contribute less than 0.0004 pmc to the background. Ion source contamination as a result of previous samples (ion source memory) is a finite contribution because 50-80% of all sputtered carbon atoms are not extracted as carbon ions and are therefore dumped into the ion source region. To limit this ion source memory effect, the ion source is cleaned every two weeks and critical parts are thrown away. This keeps the ion source contamination at approximately 0.0025 pmc for the duration of a two-week run. Regular spot checks of these contributions are performed with a zone-refined, reactor-grade graphite sample (measuring $^{14}C/^{12}C$ ratios) and blank aluminum target pellets (measuring ^{14}C only).

The laboratory claims most of their quoted system background arises from sample processing. This processing involves combustion (or hydrolysis in the case of carbonate samples), acetylene synthesis, and graphitization. Yet careful and repeated analysis of their methods over more than fifteen years have convinced them that very little contamination is associated with the combustion or hydrolysis procedures and almost none with their electrical dissociation graphitization process. By elimination they conclude that the acetylene synthesis must contribute almost all of the system background. But they can provide little tangible evidence it actually does. Our assessment from the information we have is that the system background arises primarily from ^{14}C intrinsic to the background standards themselves. The values we report in Table 2 and Figure 3 nevertheless include the subtraction of the laboratory's standard background. In any case, the measured $^{14}C/C$ values are notably above their background value.

MAKING SENSE OF THE ^{14}C DATA

How does one make sense of these ^{14}C measurements that yield a uniformitarian ages of 40,000-60,000 years for organic samples, such as our coal samples, that have uniformitarian ages of 40-350 million years based on long half-life isotope methods applied to surrounding host rocks? Clearly there is an inconsistency. Our hypothesis is that the source of the discrepancy is the interpretational framework that underlies these methods. Could the proposition, articulated 180 years ago by Charles Lyell, that "the present is the key to the past" be suspect? Could the standard practice employed all these years by earth scientists and others of extrapolating the processes and rates observed in today's world into the indefinite past not be reliable after all? As authors of this paper we are convinced that there is abundant observational evidence in the geological record that the earth has experienced a global tectonic catastrophe of immense magnitude that is responsible for most of the Phanerozoic geological record. We are persuaded it is impossible any longer to claim that geological processes and rates observable today can account for the majority of the Phanerozoic sedimentary record. To us the evidence is overwhelming that global scale processes operating at rates much higher than any observable on earth today are responsible for this geological change [3, 4, 5, 6]. Not only are the ^{14}C data at odds with the standard geological time scale, but the general character of the sedimentary and tectonic record is as well. We realize for many such a view of the geological data is new, or at least controversial. For those new to this possibility we urge reading of some of our papers on this topic [e.g., 3, 4, 5, 6]. We are convinced that not only do the observations strongly support this interpretation of the geological record, but the theoretical framework also now exists to explain it [4, 5, 6]. Our approach for making sense of these ^{14}C data, therefore, is to do so in the light of a major discontinuity in earth history in its not so distant past, an event we correlate with the Flood described in the Bible as well as in many other ancient documents.

WHAT WAS THE PRE-FLOOD ^{14}C LEVEL?

What sorts of $^{14}C/C$ ratios might we expect to find today in organic remains of plants and animals buried in a single global cataclysm correlated with all but the latter part of the Phanerozoic geological record (i.e., Cambrian to middle-upper Cenozoic)? Such a cataclysm would have buried a huge amount of carbon from living organisms to form today's coal, oil, and oil shale, probably most of the natural gas, and some fraction of today's fossiliferous limestone. Estimates for the amount of carbon in this inventory are at least a factor of 100 greater than what currently resides in the biosphere [14, 18, 34]. This implies the biosphere just prior to the cataclysm would have had at least 100 times the total carbon relative to our world today. Living plants and animals would have contained most of this biospheric carbon, with only a tiny fraction of the total in the atmosphere. The vast majority of this carbon would have been ^{12}C, since even today only about one carbon atom in a trillion is ^{14}C.

To estimate the pre-cataclysm ^{14}C/C ratio we of course require an estimate for the amount of ^{14}C. As a starting point we might assume the total amount was similar to what exists in today's world. If that were the case, and this ^{14}C were distributed uniformly, the resulting ^{14}C/C ratio would be about 1/100 of today's level, or about 1 pmc. This follows from the fact that 100 times more carbon in the biosphere would dilute the available ^{14}C and cause the biospheric ^{14}C/C ratio to be 100 times smaller than today. But this value of 1 pmc is probably an upper limit because there are reasons to suspect the total amount of ^{14}C just prior to the cataclysm was less, possibly much less, than exists today. Two important issues come into play here in regard to the amount of pre-Flood ^{14}C -- namely, the initial amount of ^{14}C after creation and the ^{14}C production rate in the span of time between creation and the Flood catastrophe. We have seen already there are hints of primordial ^{14}C in non-biogenic Precambrian materials at levels on the order of 0.05 pmc. This provides a clue that the ^{14}C/C ratio in everything containing carbon just after creation might have been on the order of 0.1 pmc. But it is also likely ^{14}C was added to the biosphere between creation and the Flood. The origin of ^{14}C in today's world is by cosmic ray particles in the upper atmosphere changing a proton in the nucleus of a ^{14}N atom into a neutron to yield a ^{14}C atom. Just what the ^{14}C production rate prior to the cataclysm might have been is not easily constrained. It could well have been lower than today if the earth's magnetic field strength were higher and resulting cosmic ray flux lower. But perhaps it was not. In any case, given the 5730-year half-life of ^{14}C, it is almost certain the less than 2000 year interval between creation and the Flood was insufficient for ^{14}C to have reached an equilibrium level in the biosphere. If the ^{14}C production rate itself was roughly constant, then the ^{14}C/C ratio in the atmosphere would have been a steadily increasing function of time across this interval. Hence, we conclude the pre-Flood ^{14}C/C ratios were likely no greater than 1 pmc but also highly variable, especially in the case of plants, depending on when during the interval they generated their biomass.

In addition to the preceding considerations, we must also account for the ^{14}C decay that has occurred since the cataclysm. Assuming a constant ^{14}C half-life of 5730 years, the ^{14}C/C ratio in organic material buried, say, 5000 years ago would be reduced by an additional factor of 0.55. When we combine all these factors, we conclude it is not at all surprising organic materials buried in the cataclysm should display the roughly 0.05-0.5 pmc we actually observe. We note that when these considerations are included, especially the larger pre-cataclysm carbon inventory, a ^{14}C/C value of 0.24 pmc, for example, is consistent with an actual age of 5000 years. By contrast, when these considerations are not taken into account, the uniformitarian formula, pmc = $100 \times 2^{-t/5730}$, displayed in graphical form in Figure 1, yields an age of 50,000 years. Yet in *either* case, the ^{14}C ages are still typically orders of magnitude less than those provided by the long half-life radioisotope methods.

In this context it is useful to note that ^{14}C/C levels must have increased dramatically and rapidly just after the cataclysm, assuming near modern rates of ^{14}C production in the upper atmosphere, due to the roughly hundredfold reduction in the amount of carbon in the biospheric inventory. The large variation in ^{14}C levels between species as well as from the outside to the inside of a single shell as reported by Nadeau *et al.* [30] indeed seems to suggest significant spatial and temporal variations in this dynamic period during which the planet was recovering from the cataclysm.

EFFECT OF ACCELERATED DECAY ON PRE-FLOOD ^{14}C

Other RATE projects are building a compelling case that episodes of accelerated nuclear decay must have accompanied the creation of the earth as well as the Genesis Flood [7, 23, 42]. We believe several billions of years worth of cumulative decay at today's rates must have occurred for isotopes such as ^{238}U during the creation of the physical earth, and we now suspect a significant amount of such decay likely also occurred during the Flood cataclysm. An important issue then arises as to how an episode of accelerated decay during the Flood might have affected a short half-life isotope like ^{14}C. The fact that significant amounts of ^{14}C are measured routinely in fossil material from organisms alive before the cataclysm argues persuasively that only a modest amount of accelerated ^{14}C decay occurred during the cataclysm itself. This suggests the possibility that the fraction of unstable atoms that decayed during the acceleration episode for all of the unstable isotopes might have been roughly the same. If the fraction were exactly the same, this would mean that the acceleration in years for each isotope was proportional to the isotope's half-life. In this case, if ^{40}K, for example, underwent 400 Ma of decay during the Flood relative to a present half-life of 1250 Ma, then ^{14}C would have undergone (400/1250)*5730 years = 1834 years of decay during the Flood. This amount of decay represents $1 - 2^{-(1834/5730)}$ = 20% reduction in ^{14}C as a result of accelerated decay. This is well within the uncertainty of the level of ^{14}C in the pre-Flood world so it has little impact on the larger issues discussed in this paper.

DISCUSSION

The initial vision that high precision AMS methods should make it possible to extend ^{14}C dating of organic materials back as far as 90,000 years has not been realized. The reason seems to be clear. Few, if any, organic samples can be found containing so little ^{14}C! This includes samples uniformitarians presume to be millions, even hundreds of millions, of years old. At face value, this ought to indicate immediately, entirely apart from any consideration of a Flood catastrophe, that life has existed on earth for less than 90,000 years. Although repeated analyses over the years have continued to confirm the ^{14}C is an intrinsic component of the sample material being tested, such ^{14}C is still referred to as 'contamination' if it is derived from any part of the geological record deemed older than about 100,000 years. To admit otherwise would fatally undermine the uniformitarian framework. For the creationist, however, this body of data represents obvious support for the recent creation of life on earth. Significantly, the research and data underpinning the conclusion that ^{14}C exists in fossil material from all portions of the Phanerozoic record are already established in the standard peer-reviewed literature. And the work has been performed largely by uniformitarians who hold no bias whatever in favor of this outcome. The evidence is now so compelling that additional AMS determinations by creationists on samples from deep within the Phanerozoic record can only make the case marginally stronger than it already is.

Indeed, the AMS results for our ten coal samples, as summarized in Table 2 and Figure 3, fall nicely within the range for similar analyses reported in the radiocarbon literature, as presented in Table 1 and Figure 2(b). Not only are the mean values of the two data sets almost the same, but the variances are also similar. Moreover, when we average the results from our coal samples over geological interval, we obtain mean values of 0.26 pmc for Eocene, 0.21 for Cretaceous, and 0.27 for Pennsylvanian that are remarkably similar to one another. These results, limited as they are, indicate little difference in ^{14}C level as a function of position in the geological record. This is consistent with the young-earth view that the entire fossil record up to somewhere within the middle-upper Cenozoic is the product of a single recent global catastrophe. On the other hand, an explanation for the notable variation in ^{14}C level among the ten samples is not obvious. One possibility is that the ^{14}C production rate between creation and the Flood was sufficiently high that the ^{14}C levels in the pre-Flood biosphere increased from, say, 0.1 pmc at creation to perhaps as much as 1 pmc just prior to the Flood. Plant material that grew early during this period and survived until the Flood would then contain low levels of ^{14}C, while plant material produced by photosynthetic processes just prior to the cataclysm would contain much higher values. This situation would prevail across all ecological zones on the planet, and so the large variations in ^{14}C levels would appear within all stratigraphic zones that were a product of the Flood.

Moreover, in contrast to the uniformitarian outlook that ^{14}C in samples older than late Pleistocene must be contamination and therefore is of little or no scientific interest, such ^{14}C for the creationist potentially contains vitally important clues to the character of the pre-Flood world. The potential scientific value of these ^{14}C data in our opinion merits a serious creationist research effort to measure the ^{14}C content in fossil organic material from a wide variety of pre-Flood environments, both marine and terrestrial. Systematic variations in ^{14}C levels, should they be discovered, conceivably could provide important constraints on the time history of ^{14}C levels and ^{14}C production, the pattern of atmospheric circulation, the pattern of oceanic circulation, and the carbon cycle in general in the pre-Flood world.

Furthermore, a careful study of the ^{14}C content of carbon that has not been cycled through living organisms, especially carbonates, graphites, and diamonds from environments believed to pre-date life on earth, could potentially place very strong constraints on the age of the earth itself. The data already present in the peer-reviewed radiocarbon literature suggests there is indeed intrinsic ^{14}C in such materials that cannot be attributed to contamination. If this conclusion proves robust, these reported ^{14}C levels then place a hard limit on the age of the earth of less than 100,000 years, even when viewed from a uniformitarian perspective. We believe a creationist research initiative focused on this issue deserves urgent support.

CONCLUSION

The careful investigations performed by scores of researchers in more than a dozen AMS facilities in several countries over the past twenty years to attempt to identify and eliminate sources of contamination in AMS ^{14}C analyses have, as a by-product, served to establish beyond any reasonable doubt the existence of intrinsic ^{14}C in remains of living organisms from all portions of the Phanerozoic record. Such samples, with 'ages' from 1-500 Ma as determined by other radioisotope methods applied to their geological context, consistently display ^{14}C levels that are far above the AMS machine threshold, reliably reproducible, and typically in the range of 0.1-0.5 pmc. But such levels of intrinsic ^{14}C represent a momentous difficulty for uniformitarianism. A mere 250,000 years corresponds to 43.6 half-lives for ^{14}C. One gram of modern carbon contains about 6×10^{10} ^{14}C atoms, and 43.6 half-lives worth of decay reduces that number by a factor of 7×10^{-14}. Not a single atom of ^{14}C should remain in a carbon sample of this size after 250,000 years (not to mention one million or 50 million or 250 million years). A glaring (thousand-fold) inconsistency that can no longer be ignored in the scientific world exists between the AMS-determined ^{14}C levels and the corresponding rock ages provided by ^{238}U, ^{87}Rb, and ^{40}K techniques. We believe the chief source for this inconsistency to be the uniformitarian assumption of time-invariant decay rates. Other research reported by our RATE group also supports this conclusion [7, 23, 42]. Regardless of the source of the inconsistency, the fact that ^{14}C, with a half-life of only 5730 years, is readily detected throughout the Phanerozoic part of the geological record argues the half billion years of time uniformitarians assign to this portion of earth history is likely incorrect. The relatively narrow range of $^{14}C/C$ ratios further suggests the Phanerozoic organisms may all have been contemporaries and that they perished simultaneously in the not so distant past. Finally, we note there are hints that ^{14}C currently exists in carbon from environments sealed from biospheric interchange since very early in the earth history. We therefore conclude the ^{14}C evidence provides significant support for a model of earth's past involving a recent global Flood cataclysm and possibly also for a young age for the earth itself.

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