

## Chapter 8

# **<sup>14</sup>C Evidence for a Recent Global Flood and a Young Earth**

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*Abstract.* A remarkable discovery made over the past twenty-five years is that organic samples from every level in the Phanerozoic portion of the geological record, when tested by highly sensitive accelerator mass spectrometer (AMS) methods, display significant and reproducible amounts of <sup>14</sup>C. Because the lifetime of <sup>14</sup>C is so brief, these AMS measurements pose an obvious challenge to the standard geological timescale that assigns millions to hundreds of million of years to this part of the rock record. With a half-life of 5730 years, <sup>14</sup>C decays to levels undetectable by any currently available technique after only 100,000 years (17.5 half-lives). After one million years (175 half-lives), the amount of <sup>14</sup>C remaining is only  $3 \times 10^{-53}$  of the initial <sup>14</sup>C concentration—so vanishingly small as to exclude even a single <sup>14</sup>C atom in a beginning mass of <sup>14</sup>C equal to the mass of the earth itself. However, in samples with uniformitarian ages between one and 500 million years, the peer-reviewed radiocarbon literature documents scores of examples of <sup>14</sup>C/C ratios in the range 0.1–0.5 percent of the modern <sup>14</sup>C/C ratio. The lower limit of this range is a factor of ten above the detection threshold of most AMS laboratories in the world. Another noteworthy observation is that the <sup>14</sup>C/C ratio of these samples appears to be uncorrelated with their position in the geological record. RATE's own measurement of <sup>14</sup>C levels in ten coal samples using one of the world's best AMS laboratories strongly confirms both this reported range in <sup>14</sup>C/C ratio and the lack of dependence of this ratio on position in the rock record. In terms of <sup>14</sup>C age, if one makes the assumption, as is normally done, that the

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$^{14}\text{C}/\text{C}$  ratio in these fossilized organisms when they died was close to that of today's atmosphere, the range in  $^{14}\text{C}/\text{C}$  ratio of 0.1–0.5 percent of the modern value corresponds to  $^{14}\text{C}$  ages between 44,000 and 57,000 years. A straightforward but startling inference from these AMS data is that all but the very youngest fossil material in the geological record was buried contemporaneously only thousands of years ago in what must have been a major global cataclysm. The simultaneous destruction of so much life implies, however, that dramatically more total carbon (now in the form of coal, oil, and oil shale) had to be present in the earth's biosphere prior to this cataclysmic event. In this case using today's atmospheric  $^{14}\text{C}/\text{C}$  ratio as the initial  $^{14}\text{C}/\text{C}$  ratio for this fossil material almost certainly would not be a proper assumption. Using a lower, more realistic estimate for the biospheric  $^{14}\text{C}/\text{C}$  ratio prior to this cataclysm reduces the actual  $^{14}\text{C}$  age by roughly a factor of ten from about 50,000 years to a value of about 5000 years. This latter age estimate, of course, is consistent with the Biblical account of a global Flood that destroyed most of the life on the planet, both plants and animals, in a single brief cataclysm some four to five millennia ago. Finally, our  $^{14}\text{C}$  RATE project has measured  $^{14}\text{C}/\text{C}$  ratios above the AMS threshold in diamonds from a variety of locations. Although more confirmation is needed to justify a strong claim in this regard, these measurements appear to limit the age of the physical earth itself to the range of thousands (as opposed to billions) of years.

## 1. Introduction

The presence of detectable  $^{14}\text{C}$  in fossils that, according to the uniformitarian timescale, should be entirely  $^{14}\text{C}$ -dead has been reported from the earliest days of radiocarbon dating. *Whitelaw* [1970], for example, surveyed all the dates reported in the journal *Radiocarbon* up to 1970 and commented that for the more than 15,000 samples reported, "All such matter is found datable within 50,000 years as published." The samples included coal, oil, natural gas, and other allegedly very ancient material. The reason these anomalies were not taken seriously is because the earlier  $\beta$ -decay counting technique that counted actual  $^{14}\text{C}$  decay events had difficulty distinguishing genuine low intrinsic levels

of <sup>14</sup>C in the samples from background counts due to cosmic rays. The low <sup>14</sup>C levels measured in samples that, according to their location in the geological record, ought to have been <sup>14</sup>C-dead were therefore simply attributed to the cosmic ray background. This β-counting method was used exclusively until the advent of the accelerator mass spectrometer (AMS) method in the early 1980s. The AMS method, because it counts <sup>14</sup>C atoms directly instead of counting <sup>14</sup>C decay events, does not have this complication of spurious counts due to cosmic rays. In retrospect, in light of the presence of <sup>14</sup>C in AMS measurements at levels significantly above the AMS detection threshold in samples from throughout the Phanerozoic record, it is almost certain that many of the β-counting analyses were indeed recording intrinsic <sup>14</sup>C.

In the late 1990s *Snelling* [1997, 1998, 1999, 2000a, b] applied the highly sensitive AMS technology to fossilized wood derived from Tertiary, Mesozoic, and upper Paleozoic strata having conventional uniformitarian ages ranging from 40 to 250 million years. A reputable commercial laboratory analyzed all the samples, while a specialist laboratory at a major research institute ran several duplicates. In all cases these labs obtained <sup>14</sup>C levels notably above the AMS detection threshold. Values ranged from 7.58±1.11 percent of the modern atmospheric <sup>14</sup>C/C ratio (commonly referred to as *percent modern carbon*, or pMC) for a lower Jurassic sample to 0.38±0.04 pMC for a middle Tertiary sample. This range in <sup>14</sup>C/C ratio implies radiocarbon ages of between 20,700±1200 and 44,700±950 years, respectively, provided one assumes the modern atmospheric <sup>14</sup>C/C ratio existed when these trees were alive. Given the short <sup>14</sup>C half-life, the presence of *any* intrinsic <sup>14</sup>C in these wood samples represents, of course, a profound challenge to the uniformitarian timescale. Such <sup>14</sup>C limits the age of this wood to mere thousands of years, whereas the conventional timescale posits ages from tens to hundreds of millions of years.

*Giem* [2001] published an article in which he tabulated about seventy AMS measurements published between 1984 and 1998 in the standard radiocarbon literature reporting significant levels of <sup>14</sup>C in organic material that, according to the conventional uniformitarian timescale, should be entirely <sup>14</sup>C dead. *Giem* documented that organic samples

from every portion of the Phanerozoic record display detectable amounts of  $^{14}\text{C}$  well above the AMS threshold. For the measurements considered most reliable, these  $^{14}\text{C}/\text{C}$  ratios appear to fall in the range 0.1–0.5 percent of the modern  $^{14}\text{C}/\text{C}$  ratio (pMC). He argued that instrument error could be eliminated as an explanation on experimental grounds. He further showed contamination of the  $^{14}\text{C}$ -bearing fossil material *in situ* was unlikely, but theoretically possible, and was a testable hypothesis. While contamination during sample preparation was a genuine problem, the literature showed it could be reduced to low levels by proper laboratory procedures. He concluded the  $^{14}\text{C}$  detected in these samples most likely originates from the organisms themselves from which the samples are derived. Moreover, because most fossil carbon seems to have roughly the same  $^{14}\text{C}/\text{C}$  ratio, he deemed it a clear logical possibility that all these fossil organisms had lived together on earth at the same time.

Although all the projects originally identified as part of the RATE initiative involved long half-life radioisotopes, because of the mounting evidence for genuine intrinsic  $^{14}\text{C}$  in organic samples throughout the Phanerozoic record (that is, the part of the geological record containing evidence for multicellular life), the RATE group decided in 2001 to add a project to investigate  $^{14}\text{C}$  in materials from the portion of the rock record conventionally dated Tertiary and older. One of the priorities of this new project was to undertake AMS analyses on a carefully selected set of samples to attempt to verify the  $^{14}\text{C}$  levels reported in the radiocarbon literature for samples that should be  $^{14}\text{C}$ -dead according to the uniformitarian timescale. We decided that coal samples from the U.S. Department of Energy Coal Sample Bank maintained at Pennsylvania State University would be an excellent choice for this study, particularly because of the rigorous and uniform quality control involved with their collection, processing, and storage. As will be described in more detail later, the AMS analyses of these samples confirmed both the range of  $^{14}\text{C}$  levels that had been reported for Phanerozoic fossil material and the uniformity of this range with respect to depth in the geological record [*Baumgardner et al.*, 2003].

## 2. Description of the AMS Method

Before we discuss the AMS measurements, let us first review some of the basic features of the AMS technique itself. Briefly, the first step in the AMS method is conversion of the carbon in the sample to CO<sub>2</sub>, either by combustion with oxygen or, in the case of carbonates, dissolution in acid. The CO<sub>2</sub> is then reduced to graphite as a spot on an aluminum target that in turn is placed inside the vacuum environment of the AMS system. Within the AMS system, a beam of high-energy cesium ions converts some of the graphite on the target to C<sup>-</sup> ions, which in turn are formed into a tight beam at kilovolt energies. This beam of C<sup>-</sup> ions is then accelerated to MeV energies and in the process converted to mostly C<sup>3+</sup> ions. These C<sup>3+</sup> ions are in turn separated by mass in a strong 90° bending magnet, with the lighter <sup>12</sup>C atoms bent more than the <sup>13</sup>C atoms, and the <sup>13</sup>C atoms more than the <sup>14</sup>C atoms. The <sup>14</sup>C atoms, the only ones with the proper angular trajectory, are counted in a special detector chamber. The objective is to measure the ratio of <sup>14</sup>C to <sup>12</sup>C atoms in as precise a fashion as possible. Figure 1 shows the principal components in the Vienna Environmental Research Accelerator, a typical modern AMS facility.

The detection limit for the best modern AMS facilities is about one <sup>14</sup>C atom for every 10<sup>17</sup> C atoms, or an absolute <sup>14</sup>C/C ratio of 10<sup>-17</sup>. A more representative limit is a factor of ten larger, or an absolute <sup>14</sup>C/C ratio of 10<sup>-16</sup>. Since the modern <sup>14</sup>C/C ratio in living things is about 10<sup>-12</sup>, the current AMS technology can reliably measure ratios as low as about 10<sup>-4</sup> times (0.01%) the modern ratio (0.01 pMC). If one makes the uniformitarian assumption that the modern atmospheric <sup>14</sup>C/C ratio has prevailed more or less unchanged into the indefinite past, 0.01 pMC implies an age of 75,000 years.

## 3. AMS <sup>14</sup>C Levels in Samples Conventionally Dated as Older than 100,000 Years

Over the past 20 years the primary radiocarbon journals, *Radiocarbon* and *Nuclear Instruments and Methods in Physics Research B*, have



published a significant number of articles reporting AMS measurements made on samples that, based on their conventional geological age, should be <sup>14</sup>C dead. These measurements were performed in several different laboratories around the world. Many were made in an attempt to understand and isolate the source or sources of the unexpected <sup>14</sup>C that always seemed to be present.

Despite the fact that the conventional uniformitarian age for the samples in question was well beyond 100,000 years (in most cases it was tens to hundreds of millions of years), it is helpful nonetheless to be able to translate the results presented in these papers back and forth between a measured <sup>14</sup>C/C ratio and the corresponding <sup>14</sup>C “age.” This translation is simple when one makes the usual uniformitarian assumption of a nearly constant <sup>14</sup>C/C level in the atmosphere as one goes backward in time. The conversion is then given by the formula,  $pMC = 100 \times 2^{-t/5730}$ , where  $t$  is the time in years. Applying this formula, one obtains values of 0.79 pMC for  $t=40,000$  years, 0.24 pMC 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 2.

However, as we will show later, if all the organisms represented in the fossil record were alive simultaneously prior to a massive catastrophe that generated the portion of the geological record that now contains their remains, then the amount of total carbon in the biosphere interacting with the atmosphere was dramatically larger prior to the cataclysm. If the source of the <sup>14</sup>C in the system was the same as today, namely, conversion of <sup>14</sup>N atoms to <sup>14</sup>C atoms by cosmic ray generated neutrons in the atmosphere, it is reasonable that the total amount of <sup>14</sup>C in the biosphere could be similar to what it is today. In that case the biospheric <sup>14</sup>C/C ratio would have been much different (that is, smaller), and the simple formula given above would no longer apply. If applied, it would yield ages that were much larger than actual.

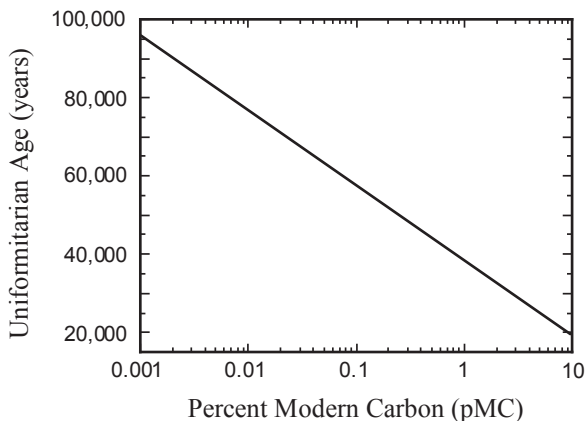
Let us now consider the AMS measurements that have been reported over the past 20 years for organic samples that, given their position in the geological record, should have absolutely no intrinsic <sup>14</sup>C. Table 1 contains most of *Giem's* [2001] data, plus data from several more

recent papers. Included in the list are a number of samples from the Precambrian, that is, what we consider non-organic pre-Flood settings. Most of the graphite samples with  $^{14}\text{C}/\text{C}$  values below 0.05 pMC are in this category. Note that  $^{14}\text{C}$  levels are reported as  $^{14}\text{C}/\text{C}$  ratios in percent modern carbon (pMC). Figure 2 can be applied to translate  $^{14}\text{C}/\text{C}$  ratios into corresponding conventional radiocarbon ages.

To provide a more visual picture of the distribution of the  $^{14}\text{C}/\text{C}$  ratios presented in Table 1 we show the same data in histogram format in Figure 3. We have separated the source material into three categories:

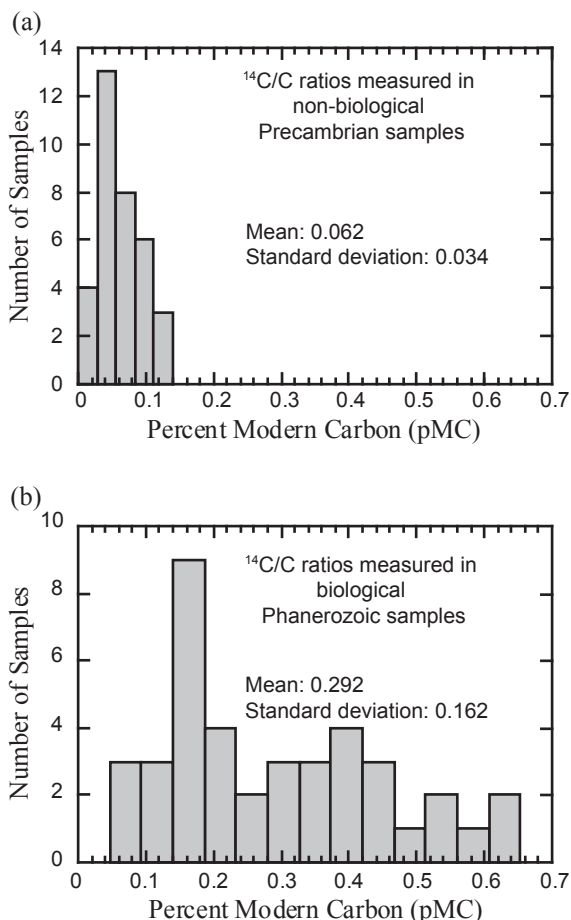
- (1) those (mostly graphites) that are likely from Precambrian geological settings,
- (2) those that are likely from Phanerozoic geological settings, and
- (3) those (mostly marbles) whose affinity is uncertain.

We show categories (1) and (2) in Figure 3(a) and 3(b), respectively, and ignore for these purposes samples in category (3). Some caution is in order with respect to the nature of comparison implicit in Table 1



**Figure 2.** Uniformitarian age as a function of  $^{14}\text{C}/\text{C}$  ratio, in percent modern carbon. The uniformitarian approach for interpreting the  $^{14}\text{C}$  data assumes a nearly constant atmospheric  $^{14}\text{C}/\text{C}$  ratio, 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 global inventory and caused the present atmospheric  $^{14}\text{C}/\text{C}$  ratio to be much higher than it was before the cataclysm.





**Figure 3.** Distribution of  $^{14}\text{C}$  values for (a) non-biogenic Precambrian samples, and (b) biogenic Phanerozoic samples, from Table 1. Given their position in the geological record, all these samples should contain no detectable  $^{14}\text{C}$  according to the standard geological timescale.

and Figure 3. 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 3 is to be understood

**Table 1.** AMS measurements on samples conventionally deemed older than 100 ka.

Item	$^{14}\text{C}/\text{C}$ (pMC) ( $\pm 1$ SD)	Material	Reference
1	0.71 $\pm$ ?*	Marble	<i>Aerts-Bijma et al.</i> [1997]
2	0.65 $\pm$ 0.04	Shell	<i>Beukens</i> [1990]
3	0.61 $\pm$ 0.12	Foraminifera	<i>Arnold et al.</i> [1987]
4	0.60 $\pm$ 0.04	Commercial graphite	<i>Schmidt et al.</i> [1987]
5	0.58 $\pm$ 0.09	Foraminifera ( <i>Pyrgo murrhina</i> )	<i>Nadeau et al.</i> [2001]
6	0.54 $\pm$ 0.04	Calcite	<i>Beukens</i> [1990]
7	0.52 $\pm$ 0.20	Shell ( <i>Spisula subtruncata</i> )	<i>Nadeau et al.</i> [2001]
8	0.52 $\pm$ 0.04	Whale bone	<i>Jull et al.</i> [1986]
9	0.51 $\pm$ 0.08	Marble	<i>Gulliksen and Thomsen</i> [1992]
10	0.5 $\pm$ 0.1	Wood, 60 ka	<i>Gillespie and Hedges</i> [1984]
11	0.46 $\pm$ 0.03	Wood	<i>Beukens</i> [1990]
12	0.46 $\pm$ 0.03	Wood	<i>Vogel et al.</i> [1987]
13	0.44 $\pm$ 0.13	Anthracite	<i>Vogel et al.</i> [1987]
14	0.42 $\pm$ 0.03	Anthracite	<i>Grootes et al.</i> [1986]
15	0.401 $\pm$ 0.084	Foraminifera (untreated)	<i>Schleicher et al.</i> [1998]
16	0.40 $\pm$ 0.07	Shell ( <i>Turitella communis</i> )	<i>Nadeau et al.</i> [2001]
17	0.383 $\pm$ 0.045	Wood (charred)	<i>Snelling</i> [1997]
18	0.358 $\pm$ 0.033	Anthracite	<i>Beukens et al.</i> [1992]
19	0.35 $\pm$ 0.03	Shell ( <i>Varicorbula gibba</i> )	<i>Nadeau et al.</i> [2001]
20	0.342 $\pm$ 0.037	Wood	<i>Beukens et al.</i> [1992]
21	0.34 $\pm$ 0.11	Recycled graphite	<i>Arnold et al.</i> [1987]
22	0.32 $\pm$ 0.06	Foraminifera	<i>Gulliksen and Thomsen</i> [1992]
23	0.3 $\pm$ ?	Coke	<i>Terrasi et al.</i> [1990]
24	0.3 $\pm$ ?	Coal	<i>Schleicher et al.</i> [1998]
25	0.26 $\pm$ 0.02	Marble	<i>Schmidt et al.</i> [1987]
26	0.2334 $\pm$ 0.061	Carbon powder	<i>McNichol et al.</i> [1995]
27	0.23 $\pm$ 0.04	Foraminifera (mixed species avg)	<i>Nadeau et al.</i> [2001]
28	0.211 $\pm$ 0.018	Fossil wood	<i>Beukens</i> [1990]
29	0.21 $\pm$ 0.02	Marble	<i>Schmidt et al.</i> [1987]
30	0.21 $\pm$ 0.06	CO <sub>2</sub>	<i>Grootes et al.</i> [1986]
31	0.20–0.35* (range)	Anthracite	<i>Aerts-Bijma et al.</i> [1997]
32	0.20 $\pm$ 0.04	Shell ( <i>Ostrea edulis</i> )	<i>Nadeau et al.</i> [2001]
33	0.20 $\pm$ 0.04	Shell ( <i>Pecten opercularis</i> )	<i>Nadeau et al.</i> [2001]
34	0.2 $\pm$ 0.1*	Calcite	<i>Donahue et al.</i> [1997]
35	0.198 $\pm$ 0.060	Carbon powder	<i>McNichol et al.</i> [1995]
36	0.18 $\pm$ 0.05 (range?)	Marble	<i>Van der Borg et al.</i> [1997]
37	0.18 $\pm$ 0.03	Whale bone	<i>Gulliksen and Thomsen</i> [1992]
38	0.18 $\pm$ 0.03	Calcite	<i>Gulliksen and Thomsen</i> [1992]
39	0.18 $\pm$ 0.01**	Anthracite	<i>Nelson et al.</i> [1986]
40	0.18 $\pm$ ?	Recycled graphite	<i>Van der Borg et al.</i> [1997]
41	0.17 $\pm$ 0.03	Natural gas	<i>Gulliksen and Thomsen</i> [1992]
42	0.166 $\pm$ 0.008	Foraminifera (treated)	<i>Schleicher et al.</i> [1998]
43	0.162 $\pm$ ?	Wood	<i>Kirner et al.</i> [1997]
44	0.16 $\pm$ 0.03	Wood	<i>Gulliksen and Thomsen</i> [1992]
45	0.154 $\pm$ ?**	Anthracite coal	<i>Schmidt et al.</i> [1987]

Item	<sup>14</sup> C/C (pMC) (±1 SD)	Material	Reference
46	0.152±0.025	Wood	<i>Beukens</i> [1990]
47	0.142±0.023	Anthracite	<i>Vogel et al.</i> [1987]
48	0.142±0.028	CaC <sub>2</sub> from coal	<i>Gurfinkel</i> [1987]
49	0.14±0.02	Marble	<i>Schleicher et al.</i> [1998]
50	0.13±0.03	Shell ( <i>Mytilus edulis</i> )	<i>Nadeau et al.</i> [2001]
51	0.130±0.009	Graphite	<i>Gurfinkel</i> [1987]
52	0.128±0.056	Graphite	<i>Vogel et al.</i> [1987]
53	0.125±0.060	Calcite	<i>Vogel et al.</i> [1987]
54	0.12±0.03	Foraminifera ( <i>N. pachyderma</i> )	<i>Nadeau et al.</i> [2001]
55	0.112±0.057	Bituminous coal	<i>Kitagawa et al.</i> [1993]
56	0.1±0.01	Graphite (NBS)	<i>Donahue et al.</i> [1990]
57	0.1±0.05	Petroleum, cracked	<i>Gillespie &amp; Hedges</i> [1984]
58	0.098±0.009*	Marble	<i>Schleicher et al.</i> [1998]
59	0.092±0.006	Wood	<i>Kirner et al.</i> [1995]
60	0.09–0.18* (range)	Graphite powder	<i>Aerts-Bijma et al.</i> [1997]
61	0.09–0.13* (range)	Fossil CO <sub>2</sub> gas	<i>Aerts-Bijma et al.</i> [1997]
62	0.089±0.017	Graphite	<i>Arnold et al.</i> [1987]
63	0.081±0.019	Anthracite	<i>Beukens</i> [1992]
64	0.08±?	Natural Graphite	<i>Donahue et al.</i> [1990]
65	0.080±0.028	Carrarra marble	<i>Nadeau et al.</i> [2001]
66	0.077±0.005	Natural Gas	<i>Beukens</i> [1992]
67	0.076±0.009	Marble	<i>Beukens</i> [1992]
68	0.074±0.014	Graphite powder	<i>Kirner et al.</i> [1995]
69	0.07±?	Graphite	<i>Kretschmer et al.</i> [1998]
70	0.068±0.028	Calcite (Icelandic double spar)	<i>Nadeau et al.</i> [2001]
71	0.068±0.009	Graphite (fresh surface)	<i>Schmidt et al.</i> [1987]
72	0.06–0.11 (range)	Graphite (200 Ma)	<i>Nakai et al.</i> [1984]
73	0.056±?	Wood (selected data)	<i>Kirner et al.</i> [1997]
74	0.05±0.01	Carbon	<i>Wild et al.</i> [1998]
75	0.05±?	Carbon-12 (mass spectrometer)	<i>Schmidt, et al.</i> [1987]
76	0.045–0.012 (-0.06)	Graphite	<i>Grootes et al.</i> [1986]
77	0.04±?*	Graphite rod	<i>Aerts-Bijma et al.</i> [1997]
78	0.04±0.01	Graphite (Finland)	<i>Bonani et al.</i> [1986]
79	0.04±0.02	Graphite	<i>Van der Borg et al.</i> [1997]
80	0.04±0.02	Graphite (Ceylon)	<i>Bird et al.</i> [1999]
81	0.036±0.005	Graphite (air)	<i>Schmidt et al.</i> [1987]
82	0.033±0.013	Graphite	<i>Kirner et al.</i> [1995]
83	0.03±0.015	Carbon powder	<i>Schleicher et al.</i> [1998]
84	0.030±0.007	Graphite (air redone)	<i>Schmidt et al.</i> [1987]
85	0.029±0.006	Graphite (argon redone)	<i>Schmidt et al.</i> [1987]
86	0.029±0.010	Graphite (fresh surface)	<i>Schmidt et al.</i> [1987]
87	0.02±?	Carbon powder	<i>Pearson et al.</i> [1998]
88	0.019±0.009	Graphite	<i>Nadeau et al.</i> [2001]
89	0.019±0.004	Graphite (argon)	<i>Schmidt et al.</i> [1987]
90	0.014±0.010	CaC <sub>2</sub> (technical grade)	<i>Beukens</i> [1993]

\*Estimated from graph

\*\*Lowest value of multiple dates

only as a low precision means for gaining a bit more insight into these AMS results.

We draw several observations from this comparison, imprecise as it may be. First, the set of samples with Phanerozoic affinity display a mean value significantly different from those without such affinity. In terms of the standard geological timescale, all these samples should be equally  $^{14}\text{C}$  dead. The samples with Phanerozoic 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  $^{14}\text{C}$  content for the Phanerozoic 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  $^{14}\text{C}$  content invites an explanation. A third observation, although weaker than the first two, is that the distribution of values for Precambrian material displays a peak offset from zero. This may provide a hint that the carbon not cycled through Phanerozoic living organisms—in many cases locked away in Precambrian geological settings—may nevertheless contain a low level of intrinsic  $^{14}\text{C}$ .

#### 4. Coping with Paradigm Conflict

How do the various  $^{14}\text{C}$  laboratories around the world deal with the reality that they measure significant amounts of  $^{14}\text{C}$ , distinguishably above the detection threshold of their instruments, in samples that should be  $^{14}\text{C}$  dead according to the standard geological timescale? A good example can be found in a recent paper by *Nadeau et al.* [2001] entitled, “Carbonate  $^{14}\text{C}$  background: does it have multiple personalities?” The authors are with the Leibniz Laboratory at Christian-Albrechts University in Kiel, Germany. Many of the samples they analyze are shells and foraminifera tests from sediment cores. It would be 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 <sup>14</sup>C levels approaching 1 pMC in shells and foraminifera from depths in the record where, according to the standard geological timescale, there should be no detectable <sup>14</sup>C.

Their paper reports detailed studies they have carried out to attempt to understand the source of this <sup>14</sup>C. They investigated shells from a late Pleistocene coring site in northwestern Germany dated by U/Th methods at 120,000 years. The mean <sup>14</sup>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 <sup>14</sup>C value for the outside of the shell was 0.3 pMC, while for the inside it was 0.67 pMC. At face value, this suggests the <sup>14</sup>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 <sup>14</sup>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 <sup>14</sup>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 hydrolyzation of the carbonate samples to CO<sub>2</sub> gas and <sup>14</sup>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 <sup>14</sup>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  $^{14}\text{C}$  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  $^{14}\text{C}$  in these samples and the dates assigned to the geological setting by other radioisotope methods. The measured  $^{14}\text{C}$  levels, however, are distinguishably above instrument threshold as well as any identifiable sample processing contamination. Moreover, the striking difference in  $^{14}\text{C}$  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  $^{14}\text{C}/\text{C}$  ratio. The position the authors take in the face of these conflicts is that this  $^{14}\text{C}$ , 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 timescale would lead one to suspect.

This same approach of treating measurable and reproducible  $^{14}\text{C}$

values in samples that ought to be <sup>14</sup>C dead, given their position in the geological record, as “contamination” is found throughout the current literature. *Bird et al.* [1999], 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 <sup>14</sup>C ages to about 40 ka BP (thousands of <sup>14</sup>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 <sup>14</sup>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<sub>2</sub> in a stepwise manner, at temperatures of 330°C, 630°C, and 850°C, with the resulting CO<sub>2</sub> fractions analyzed separately using AMS. Oxidation of most of any surficial contamination generally occurs at the lowest temperature, and the <sup>14</sup>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 <sup>14</sup>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 fourteen such graphite samples to get a composite value of 0.04±0.02 pMC for this background material. The quoted precision is ± one standard deviation. They note

that a special pre-treatment they use for charcoal samples, applied to four of the fourteen samples, yielded results indistinguishable from the other ten graphite samples that had no pre-treatment. They further note that sample size variation between 0.1 and 2.2 mg among the fourteen samples also made no difference in the results. From this they acknowledge, “the few  $^{14}\text{C}$  atoms observed may already be present in the Ceylon graphite itself.” Indeed, they offer no explanation for the fact that this graphite displays  $^{14}\text{C}$  levels well above the detection threshold of their AMS system other than it might be inherent to the graphite itself.

Measuring notable levels of  $^{14}\text{C}$  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.* [1987] describe their thorough investigation of the potential sources and their various contributions to the  $^{14}\text{C}$  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  $\mu\text{g}$  to 20 mg. They found that samples 500  $\mu\text{g}$  and larger displayed a  $^{14}\text{C}$  concentration of  $0.44 \pm 0.13$  pMC, independent of sample size, implying this  $^{14}\text{C}$  was intrinsic to the anthracite material itself. For samples smaller than 500  $\mu\text{g}$ , the measured  $^{14}\text{C}$  could be explained in terms of this intrinsic  $^{14}\text{C}$ , 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  $\text{CO}_2$  adsorbed within the porous Vicor glass used to encapsulate the coal sample in its combustion to  $\text{CO}_2$  at  $900^\circ\text{C}$ . Another source of smaller magnitude was  $\text{CO}_2$  and  $\text{CO}$  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 <sup>14</sup>C in the coal swamped all the sources of real <sup>14</sup>C contamination. Rather than deal with the issue of the nature of the <sup>14</sup>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 <sup>14</sup>C dead given their position in the geological record, had in fact <sup>14</sup>C levels substantially above AMS machine thresholds, the approach was simply to search for specific materials to use as procedural blanks that had as low a <sup>14</sup>C background level as possible. For example, *Beukens* [1990], 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 <sup>14</sup>C levels. He reports  $0.077 \pm 0.005$  pMC from a sample of industrial CO<sub>2</sub> obtained by combustion of natural gas and  $0.076 \pm 0.009$  pMC from Italian Carrara marble. Previously for his blank material he had used an optical grade calcite (Iceland spar) for which he measured a <sup>14</sup>C level of 0.13–0.15 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 <sup>14</sup>C levels in these [more recent] measurements should therefore be attributed entirely to the lower intrinsic <sup>14</sup>C contamination of these samples and not to changes in sample preparation or analysis techniques. Note that he indeed considers the <sup>14</sup>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 β-decay counting <sup>14</sup>C laboratory. These yielded <sup>14</sup>C levels of  $0.54 \pm 0.04$  pMC for the calcite and  $0.36 \pm 0.03$  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 <sup>14</sup>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  $^{14}\text{C}$ -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  $^{14}\text{C}$  levels well in excess of the AMS machine threshold, even when extreme pre-treatment methods are applied. Experiments in which the sample size is varied by large factors seem to demonstrate in a convincing manner that the  $^{14}\text{C}$  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  $^{14}\text{C}$  levels well above machine threshold. Graphite samples formed under metamorphic and reducing conditions in Precambrian limestone environments commonly display  $^{14}\text{C}$  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  $^{14}\text{C}$  in this Precambrian material? We conclude that one possibility is that this  $^{14}\text{C}$  is primordial. Finding  $^{14}\text{C}$  in diamond formed in the earth’s mantle, as we will describe later, provides support for such a possibility. Establishing that non-organic carbon from the mantle and from Precambrian crustal settings consistently contains inherent  $^{14}\text{C}$  well above the AMS detection threshold hints that the earth itself might be less than 100,000 years old, which, of course, is orders of magnitude younger than the 4.56 Ga currently believed by the uniformitarian community.

## **5. Results of RATE Study of $^{14}\text{C}$ in Coal**

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

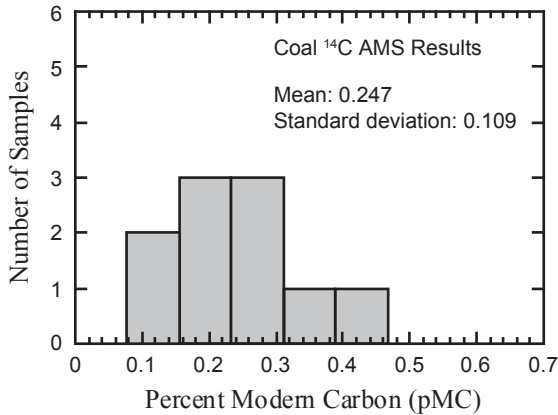
**Table 2.** Results of AMS <sup>14</sup>C analysis of ten RATE coal samples. The reported values shown in the last column are the measured values minus the laboratory's standard background of 0.077±0.005.

Sample	Coal Seam Name	State	County	Geological Interval	<sup>14</sup> 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

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 by the laboratory to be introduced by sample processing. This standard background value is obtained by measuring the <sup>14</sup>C in a purified natural gas. Subtraction of this background value is justified by the laboratory under the assumption that the <sup>14</sup>C in the natural gas analyses must somehow represent contamination. Figure 4 displays these AMS results in histogram format.

### 5.1 Details of RATE Coal Sample Selection and Analysis

The ten samples in Table 2 were obtained from the U. S. Department of Energy Coal Sample Bank maintained at Pennsylvania 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 180 kg quantities from recently exposed areas of active mines, where they were placed in 115 liter steel drums with high-density gaskets and purged with argon. As soon as feasible after



**Figure 4.** Histogram representation of AMS <sup>14</sup>C analysis of ten coal samples undertaken by the RATE <sup>14</sup>C research project.

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 multi-laminate bags and have since been kept in refrigerated storage at 3°C. We selected ten of the thirty-three 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 <sup>14</sup>C analysis at the AMS laboratory we selected involves processing the coal samples to make graphite targets, and then counting the relative numbers of atoms from the different C isotopes in the accelerator mass spectrometer system. Sample processing consists of three steps: combustion, acetylene synthesis, and graphitization. The coal samples are first combusted to CO<sub>2</sub> 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 sixteen 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 sixteen 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 <sup>14</sup>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.

The background standard of this AMS laboratory is CO<sub>2</sub> 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 Iceland 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.

Table 3 gives the measurements in pMC from the four separate targets for our ten coal samples. The numbers in parentheses are the % errors, calculated from the <sup>14</sup>C count rate of the sample and the two NBS standards, and from the transmission of errors in the <sup>12</sup>C and <sup>13</sup>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.

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 interferences

**Table 3.** Detailed AMS  $^{14}\text{C}$  measurements for ten 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  $E/q$  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 C atoms are not extracted as C 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  $^{14}\text{C}/^{12}\text{C}$  ratios) and blank aluminum target pellets (measuring  $^{14}\text{C}$  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 provide little definitive evidence it actually does. Our assessment from the information we

have is that the system background value they apply is derived from the  $^{14}\text{C}$  levels they measure in their background standards. They admit that most of the  $^{14}\text{C}$  measured in these standards is intrinsic  $^{14}\text{C}$ . The values we report in Table 2 and Figure 4 nevertheless include the laboratory's subtraction of their standard background. In any case, the measured  $^{14}\text{C}/\text{C}$  values are notably above their background value.

## 6. Results of RATE Measurements of $^{14}\text{C}$ in Diamond

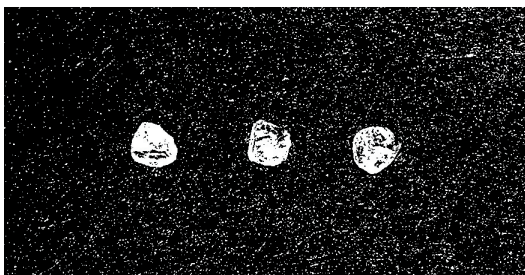
Given the apparent presence of  $^{14}\text{C}$  at levels well above the AMS threshold in a variety of carbon-bearing materials from the Precambrian portion of the geological record (Table 1 and Figure 3), our RATE team realized that testing for the presence of  $^{14}\text{C}$  in samples of natural diamond would be an important step in either establishing or refuting the premise that  $^{14}\text{C}$  exists at detectable levels in all terrestrial carbon. Natural diamond is a good candidate because it requires high pressure for its formation—pressures realizable only at depths greater than 100 km inside the earth. Diamonds that today are found at or near the earth's surface are generally believed by the uniformitarian community to have been formed in the mantle between one and three billion years ago, and in most cases brought to the surface in the more recent past by violent eruptive events through conduits known as kimberlite pipes. Diamond, creation's hardest substance, is extremely resistant to contamination via chemical exchange with the external environment. Finding  $^{14}\text{C}$  in natural diamond at levels well above the AMS threshold would support the thesis that even carbon that has been locked away from exchange with the atmosphere since early in the earth's history nevertheless contains detectable levels of  $^{14}\text{C}$ . Because of  $^{14}\text{C}$ 's short half-life, such a finding would argue that carbon and probably the entire physical earth as well must have a recent origin, unless somehow  $^{14}\text{C}$  can be produced at such levels *in situ* and in the recent past.

The RATE team therefore included a diamond sample along with the ten coal samples in the set of samples sent to the AMS laboratory whose procedures were described in the preceding section. Our sample consisted of about 50 mg of sub-millimeter diamond chips obtained

by shattering a diamond from the Kimberley district in South Africa in a sapphire mortar and pestle. Because of the laboratory's lack of experience in oxidizing diamond, it required several attempts before they were successful. They therefore reported their analysis results for the diamond sample several months after those for the ten coal samples. These results came too late to be included in our paper that appeared in the Proceedings volume of the Fifth International Conference on Creationism [Baumgardner *et al.*, 2003], but they were included in the oral presentation at that conference. The  $^{14}\text{C}/\text{C}$  value for the diamond, which as in the case for the coal samples was a composite number based on four separate AMS runs, was  $0.096 \pm 0.026$  pMC, where the precision represents  $\pm 1\sigma$ , or 68.3% confidence limits. This number, unlike the coal results presented above, does not have the laboratory's standard background of  $0.077 \pm 0.005$  pMC subtracted from it. The reason for reporting the uncorrected measurement here is to be able more clearly to compare it directly with the laboratory's standard background value. From a statistical standpoint, the result for this diamond overlapped, in terms of its confidence limits, the value obtained from a much larger number of runs on the purified natural gas the laboratory uses as its background standard. The fact that the diamond displayed a comparable  $^{14}\text{C}/\text{C}$  value as the natural gas background standard, however, was consistent with our working hypothesis that all carbon in the earth contains a detectable and reproducible (using the AMS technique) level of  $^{14}\text{C}$ . Note that these levels exceed the measurement threshold of  $<0.01$  pMC for the AMS hardware itself by about a factor of ten.

This result from the initial diamond sample encouraged us to obtain and analyze additional diamond samples to either confirm or reject our preliminary conclusion with a higher statistical level of confidence. In September 2003 we acquired several diamonds from two De Beers mines in Botswana. Three of these diamonds are shown in Figure 5. Four such diamonds were crushed to small chips and sent to the same AMS laboratory for analysis. The results from these diamonds, plus one from a placer deposit in the Kankan district of Guinea in West Africa, plus the initial South African diamond, are displayed in Table 4. The  $^{14}\text{C}/\text{C}$  values for these six diamonds cluster tightly about the





**Figure 5.** Photo of three diamonds from the Orapa mine, Botswana, from the set analyzed in this study. Weight of each is approximately 0.20 carats, or 40 mg. The average diameter is about 2.5 mm.

mean value of  $0.12 \pm 0.01$  pMC. From a statistical standpoint, this mean value is consistent with an identical  $^{14}\text{C}/\text{C}$  ratio in all six of the diamonds. With the larger number of diamond analyses, there was now a clear statistical separation between the mean diamond value and the laboratory's background value of 0.08 pMC obtained by repeated runs on a sample of purified natural gas. The laboratory concurred with this conclusion. We note that by using the usual uniformitarian assumptions for converting a  $^{14}\text{C}/\text{C}$  value into an age (which obviously do not apply since these diamonds almost certainly have not experienced any recent exchange of their carbon atoms with those in the atmosphere), one gets a uniformitarian age from this mean  $^{14}\text{C}/\text{C}$  ratio of 55,700 years.

**Table 4.** AMS  $^{14}\text{C}$  results for six African diamonds. The AMS laboratory's high precision procedure was used, but no standard background correction has been applied.

Sample ID	Geological Setting	Country	$^{14}\text{C}/\text{C}$ (pMC)
Kimberley-1	kimberlite pipe (Kimberley)	South Africa	$0.10 \pm 0.03$
Orapa-A	kimberlite pipe (Orapa mine)	Botswana	$0.14 \pm 0.03$
Orapa-F	kimberlite pipe (Orapa mine)	Botswana	$0.11 \pm 0.03$
Letlhakane-1	kimberlite pipe (Letlhakane mine)	Botswana	$0.12 \pm 0.03$
Letlhakane-3	kimberlite pipe (Letlhakane mine)	Botswana	$0.15 \pm 0.02$
Kankan	alluvial deposit	Guinea	$0.11 \pm 0.03$

These results motivated us in early 2004 to obtain additional diamonds, this time from alluvial deposits in Namibia in southwest Africa. Each of these six diamonds was crushed to powder and divided into two samples each of approximately 25 mg size. The six pairs of samples were analyzed by the same AMS laboratory that had performed the earlier coal and diamond  $^{14}\text{C}$  analyses, applying their high precision method that involved four independent measurements on each sample. Results for these additional six diamonds are displayed in Table 5. The values in the table represent the average of the eight analyses for each diamond as provided by the laboratory, without their standard background correction of 0.08 pMC subtracted away.

Whereas there was little statistical variation in  $^{14}\text{C}/\text{C}$  levels among the first six diamond samples, this latter set of samples showed a wide spread in their levels, from a smallest value of 0.12 pMC to a largest value of 0.39 pMC. The latter is five times larger than the standard background and higher than all but two of the ten RATE coal samples. What might be the explanation for the dramatic difference in  $^{14}\text{C}$  statistics between the first set of six diamonds and the second set? One possible contributor could be the difference in geological setting. Whereas five of the first six diamonds were from deep mines in volcanic kimberlite pipes, all of the second set of diamonds had resided near the earth's surface in water-deposited alluvium, probably for most of the time since they were explosively erupted from subcrustal depths inside the earth.

**Table 5.** AMS  $^{14}\text{C}$  results for six alluvial diamonds from Namibia. The AMS laboratory's high precision procedure was used, but no standard background correction has been applied.

Sample ID	Geological Setting	Country	$^{14}\text{C}/\text{C}$ (pMC)
NMBclr1	alluvial deposit	Namibia	0.39±0.02
NMBclr2	alluvial deposit	Namibia	0.25±0.02
NMBclr3	alluvial deposit	Namibia	0.21±0.03
NMByel1	alluvial deposit	Namibia	0.17±0.02
NMByel2	alluvial deposit	Namibia	0.12±0.02
NMBbrn2	alluvial deposit	Namibia	0.15±0.02

Prior to the time we received the results from the Namibian diamond samples, our working hypothesis on the origin of the  $^{14}\text{C}$  in the diamonds was that it likely represented primordial  $^{14}\text{C}$  formed during the creation of the earth itself. But with these newer results that showed such large  $^{14}\text{C}$  variation from one diamond to the next, we began to explore the alternative possibility that much of the  $^{14}\text{C}$  in these diamonds might have been produced recently, but *in situ*, from a very large flux of thermal neutrons. Two other RATE projects were providing noteworthy evidence that hundreds of millions of years worth of nuclear decay of U has occurred in crustal rocks of the earth within the last few thousand years [Humphreys *et al.*, 2003; Snelling and Armitage, 2003; Humphreys, 2005; Snelling, 2005]. In today's world,  $\alpha$ -particles emitted by U and its unstable daughter products interact with lighter elements abundant in crustal rocks such as Si, O, Al, and Mg to generate readily detectable levels of thermal neutrons [Zito *et al.*, 1980]. Episodes of accelerated nuclear decay in the recent past of the sort suggested by our other RATE studies would have generated extreme neutron fluxes throughout the continental crust. As we show in the next section, the  $^{14}\text{C}$  levels generated in turn by such episodes of high neutron flux appear to be of the right order of magnitude to account for the substantial variations in  $^{14}\text{C}/\text{C}$  ratio we observe in our diamonds.

In summary, diamond, the material that ought to be the ultimate "standard background" because of its extreme resistance to external contamination, displayed a  $^{14}\text{C}/\text{C}$  ratio above the laboratory's standard background for each of the twelve samples analyzed. Table 6 displays the measurements shown in Tables 4 and 5 but with the laboratory's standard background subtracted away. Presented in this manner the diamond results can be compared directly with those for the ten coal samples shown in Table 2. Although the  $^{14}\text{C}/\text{C}$  ratios shown in Table 6 are small when the standard background is subtracted away, and in some cases are smaller than the confidence interval of the measurements from which they are derived, they nevertheless are all positive, that is, greater than the laboratory's standard background value. If one averages the values in Table 6 of the five diamonds from kimberlite mines to get better statistics, one obtains the value 0.04 pMC. Doing the same for the

**Table 6.** AMS  $^{14}\text{C}$  results for the twelve diamonds listed in Tables 4 and 5, but with the laboratory's standard background correction applied.

Sample ID	Geological Setting	Country	$^{14}\text{C}/\text{C}$ (pMC)
Kimberley-1	kimberlite pipe (Kimberley)	South Africa	0.02±0.03
Orapa-A	kimberlite pipe (Orapa mine)	Botswana	0.01±0.03
Orapa-F	kimberlite pipe (Orapa mine)	Botswana	0.03±0.03
Letlhakane-1	kimberlite pipe (Letlhakane mine)	Botswana	0.04±0.03
Letlhakane-3	kimberlite pipe (Letlhakane mine)	Botswana	0.07±0.02
Kankan	alluvial deposit	Guinea	0.03±0.03
NMBclr1	alluvial deposit	Namibia	0.31±0.02
NMBclr2	alluvial deposit	Namibia	0.17±0.02
NMBclr3	alluvial deposit	Namibia	0.13±0.03
NMByel1	alluvial deposit	Namibia	0.09±0.02
NMByel2	alluvial deposit	Namibia	0.04±0.02
NMBbrn2	alluvial deposit	Namibia	0.07±0.02

seven alluvial samples, one obtains 0.12 pMC. These data suggest, at least from a statistical standpoint, that  $^{14}\text{C}$  exists in these diamonds to a high degree of certainty, as astonishing as that may seem.

## 7. Quantifying *in situ* $^{14}\text{C}$ Generation in Crustal Environments

Let us now attempt to quantify the levels of  $^{14}\text{C}$  that one might expect to be generated in crustal environments today by subsurface neutrons. *Zito et al.* [1980], in a paper entitled "Possible subsurface production of C-14," identify two primary reactions by which subsurface neutrons can generate  $^{14}\text{C}$  in the context of buried organic materials such as coal and also diamonds. The first is a thermal neutron interacting with a  $^{14}\text{N}$  atom to produce a  $^{14}\text{C}$  atom plus a proton. This reaction, of course, is the one by which most of the  $^{14}\text{C}$  in today's world is produced, involving thermalized cosmic ray generated neutrons converting atmospheric  $^{14}\text{N}$  atoms into  $^{14}\text{C}$ . Thermal neutrons are produced in crustal rocks, however, primarily by the interactions of  $\alpha$ -particles generated by U and Th decay with common isotopes of O, Al, Mg, and Si that are abundant in crustal minerals. Nitrogen-14 occurs at modest levels in most organic materials and also exists at low levels as an impurity in

diamonds. The second reaction that conceivably might be important is that of a thermal neutron interacting with a <sup>13</sup>C atom to produce a <sup>14</sup>C atom plus a  $\gamma$ -ray. About one percent of C atoms, including those in diamond, are <sup>13</sup>C. However, because the cross-section for this second reaction with <sup>13</sup>C is some 2,000 times smaller than that of the first reaction involving <sup>14</sup>N [Stehn *et al.*, 1964], it is probable that in most circumstances this second reaction can be ignored relative to the first. In any case, the following analysis applies to both.

Reliable measurements exist for the volume production rate  $Q$  of thermal neutrons currently being generated by radioactive decay processes in various crustal environments, including granite in which moderately high levels of radioactivity are common. In addition, the mean neutron lifetime  $\tau_n$  and mean velocity  $v$  of such thermal neutrons are well known. The subsurface thermal neutron flux  $\Phi$  in neutrons per unit area per unit time is simply the product of these three quantities, that is,  $\Phi = Q\tau_n v$  [Beckurts and Wirtz, 1964; Glasstone and Sesonske, 1967]. Using 2200 m/sec for the most probable velocity of thermal neutrons at 20°C [Beckurts and Wirtz, 1964],  $10^{-3}$  sec for the measured lifetime of thermal neutrons in dry rock [Humphreys *et al.*, 1983] (it is even shorter if any water is present), and  $3.3 \times 10^7$  thermal neutrons/m<sup>3</sup>/yr as a maximum observed value for the thermal neutron volume production rate in granite in deep mine environments [Kuhn *et al.*, 1984], we obtain an upper bound for the thermal neutron flux  $\Phi$  in crustal granite of  $7.3 \times 10^7$  neutrons/m<sup>2</sup>/yr.

The volume rate of <sup>14</sup>C production in turn is the product of the volume density of <sup>14</sup>N atoms, the thermal neutron cross section  $\sigma$ , and the thermal neutron flux  $\Phi$ . If we seek the steady state <sup>14</sup>C/C ratio in which the rate of <sup>14</sup>C production equals the rate of <sup>14</sup>C decay and normalize by the number of C atoms per unit volume, we get the relation  $(^{14}\text{C}/\text{C})_{\text{abs}} = ^{14}\text{N}/\text{C} \sigma \Phi \tau_b$ , where  $\tau_b$  is the lifetime of <sup>14</sup>C. The measured thermal neutron cross section for this reaction is 1.8 barns =  $1.8 \times 10^{-28}$  m<sup>2</sup> [Stehn *et al.*, 1964], and  $\tau_b$  for <sup>14</sup>C is  $5730/\ln 2 = 8267$  years. If we assume a <sup>14</sup>N concentration of 0.1% = 0.001 or 1000 ppm, which is well above the 200 ppm average for peridotitic diamonds and 300 ppm average for eclogitic diamonds [Dienes *et al.*, 1993; Cartigny, 2005], we obtain an

absolute steady state  $^{14}\text{C}/\text{C}$  ratio of  $1.1 \times 10^{-19}$ . If we then convert this to percent modern carbon (pMC) by dividing by the modern  $^{14}\text{C}/\text{C}$  ratio of  $1.2 \times 10^{-12}$  and multiplying by 100, we get the steady state value  $^{14}\text{C}/\text{C} = 9 \times 10^{-6}$  pMC. This is more than 13,000 times smaller than the mean value of  $0.12 \pm 0.01$  pMC we measured for our first six diamond samples and is far below the AMS detection threshold. We therefore conclude that *in situ* production of  $^{14}\text{C}$  by thermal neutrons at presently observed levels is unable, by several orders of magnitude, to account for the  $^{14}\text{C}$  levels we measure in our diamond samples. On the other hand, a recent episode of accelerated nuclear decay corresponding to, say, 500 million years worth of U decay, would generate on the order of  $5 \times 10^8 / \tau_p$  times the steady state  $^{14}\text{C}/\text{C}$  ratio, or  $6 \times 10^4$  times  $9 \times 10^{-6}$  pMC, or 0.5 pMC, which is close to what we measured in our diamond samples. Moreover, given that the local concentration of U in crustal rocks as well as the N concentration in organic materials are both highly variable, it is not implausible that much if not most of the  $^{14}\text{C}$  variability observed in C samples that ought to be  $^{14}\text{C}$  dead can be accounted for in this manner also.

## **8. Major Features of the Geological Record Challenge Uniformitarian Belief**

Carbon-14 measurements that yield uniformitarian ages of 40,000–60,000 years for organic samples such as coal with uniformitarian ages of 40–350 million years provided by long half-life isotope methods applied to the surrounding host rocks, not to mention the notable  $^{14}\text{C}$  levels in diamonds with uniformitarian ages exceeding a billion years, represent an obvious inconsistency among radioisotope dating techniques. Our hypothesis is that the source of the discrepancy is the interpretational framework that underlies the long half-life methods. We are convinced the proposition, promulgated 180 years ago by Charles Lyell, that the present is the key to the past, simply is not valid. Hence 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 leads to unsound conclusions. As authors of this

book 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, one that generated most of the Phanerozoic geological record. Indeed, we are persuaded it is no longer possible successfully to defend the claim that geological processes and rates observable today can account for the majority of the Phanerozoic sedimentary record. To us the evidence is persuasive that global scale processes operating at rates much higher than any observable on earth today are responsible for this geological change (for example, *Austin et al.* [1994] *Baumgardner* [1994a, b, 2003]). Not only are the  $^{14}\text{C}$  data at odds with the standard geological timescale, 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. We are convinced that not only do the observations strongly support this interpretation of the geological record, but a theoretical framework also now exists to explain it [*Baumgardner*, 1994a, b, 2003]. Our approach for making sense of these  $^{14}\text{C}$  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 and in many other ancient documents.

## **9. What Was the $^{14}\text{C}/\text{C}$ Ratio in the Biosphere Before the Flood Cataclysm?**

With a date for the Biblical Flood derived from the Masoretic Hebrew text of only about 4500 years ago, which is less than the  $^{14}\text{C}$  half-life, one would expect that  $^{14}\text{C}$  in plants and animals buried in this cataclysm to be detectable today. What sorts of  $^{14}\text{C}/\text{C}$  values might we expect to find today in organic remains of plants and animals that perished during this global event which rapidly formed the Cambrian to middle-upper Cenozoic part of the Phanerozoic geological record? Such a cataclysm would have buried a huge amount of C 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 C in this inventory are typically several hundred times greater than what resides in the biosphere today [*Brown, 1979; Morton, 1984; Scharpenseel and Becker-Heidmann, 1992; Giem, 2001*]. These studies indicate the biosphere just prior to the cataclysm would have had, conservatively, 300–700 times the total C relative to our present world. Living plants and animals would have contained most of this biospheric C, with only a tiny fraction of the total resident in the atmosphere. The vast majority of this C would have been  $^{12}\text{C}$  and  $^{13}\text{C}$ , since even in today's world, only about one C atom in a trillion is  $^{14}\text{C}$ .

To estimate the pre-Flood  $^{14}\text{C}/\text{C}$  ratio we of course require an estimate for the amount of  $^{14}\text{C}$ . As a starting point we might assume the total amount, that is, the total number of atoms, of  $^{14}\text{C}$  was similar to what exists in today's world. If that were the case, and this  $^{14}\text{C}$  were distributed uniformly throughout the biosphere, and the total amount of biospheric C were, for example, 500 times that of today's world, the resulting  $^{14}\text{C}/\text{C}$  ratio would be 1/500 of today's level, or about 0.2 pMC. This follows from the fact that 500 times more C in the biosphere would dilute the available  $^{14}\text{C}$  and cause the biospheric  $^{14}\text{C}/\text{C}$  ratio to be 500 times smaller than today. But this guess of 0.2 pMC is very soft because of the large uncertainty in knowing the total amount of  $^{14}\text{C}$  in the pre-Flood world. The short span of time of less than 2000 years between Creation and the Flood, according to the Masoretic text, would mean generation of  $^{14}\text{C}$  by cosmic rays in the atmosphere would fall far short of creating the amount of  $^{14}\text{C}$  we observe in today's world, even with today's magnetic field strength. A stronger magnetic field would have provided more effective deflection of charged cosmic ray particles and even less  $^{14}\text{C}$  generation in the atmosphere. On the other hand, there may well have been some significant amount of  $^{14}\text{C}$  generated at Creation as a consequence of the large amount of nuclear disintegration of elements like U and the resulting neutron interactions with  $^{14}\text{N}$ . As our other RATE projects document, large amounts of U daughter elements indeed exist today in the earth's earliest rocks. Our present conjecture is that the total mass of  $^{14}\text{C}$  in the pre-Flood world was likely not much greater than that of our present world. This then



implies a pre-Flood  $^{14}\text{C}/\text{C}$  ratio of about 0.2 pMC. Again, we emphasize this estimate is very soft. Accounting for the  $^{14}\text{C}$  decay over the span of 4500 years since the Flood catastrophe reduces the pre-Flood level by a factor of 0.6, so that organisms with 0.2 pMC  $^{14}\text{C}$  4500 years ago would display a level of 0.12 pMC today. This is a level that can be measured by the AMS technique. Indeed, many of our samples and many of those reported in the radiocarbon literature for samples with uniformitarian ages greater than 100,000 years are in this range.

We note, however, that the amount of  $^{14}\text{C}$  potentially generated *in situ* from an episode of accelerated nuclear decay during the Flood catastrophe, as outlined in a preceding section, can be of comparable or even larger amplitude as that just discussed for the  $^{14}\text{C}$  that existed in the tissues of the pre-Flood organisms. Therefore, as a tentative working explanation of the available measurements, we favor a model that includes both these sources for the observed  $^{14}\text{C}$ . In this working model, the pre-Flood  $^{14}\text{C}$  component would provide a low, more or less uniform, contribution to the total  $^{14}\text{C}/\text{C}$  ratio of perhaps 0.05–0.1 pMC. The *in situ* component, on the other hand, would be much more variable and depend on the local U concentration and the amount of N in the sample. Its contribution could be in the range from zero to, perhaps, 1 pMC. The complexity and uncertainties in this working model, however, in no way detract from the reality that the documented levels of  $^{14}\text{C}$  in materials throughout the Phanerozoic record represent a genuine and as yet unresolved difficulty for the uniformitarian framework.

In the context of this section on the pre-Flood  $^{14}\text{C}/\text{C}$  ratio, it is useful to note that it is necessary for the  $^{14}\text{C}/\text{C}$  ratio to have increased dramatically and rapidly, by a factor on the order of 500, to reach its present value after the cataclysm. The means by which this could have occurred has long been a difficulty for the young-earth Creation/global Flood framework. However, the presence of high levels of crustal neutrons arising from accelerated nuclear decay during the Flood would have converted substantial amounts of crustal N to  $^{14}\text{C}$ , most of which would have been oxidized to  $\text{CO}_2$  and eventually escape to the atmosphere. The notable  $^{14}\text{C}$  variations among separate species dwelling in a common Pleistocene environment as well as the striking  $^{14}\text{C}$  differences within

the shell of a single specimen, as reported by *Nadeau et al.* [2001] and summarized earlier in Section 4 of this chapter, support the notion that large spatial and temporal variations in the  $^{14}\text{C}/\text{C}$  ratio did indeed exist during the interval immediately following the cataclysm.

## 10. Effect of an Accelerated Decay Episode on $^{14}\text{C}$ Decay

As already mentioned other RATE projects are building a case for episodes of accelerated nuclear decay accompanying the creation of the earth as well as the Genesis Flood [*Humphreys, 2005; Snelling, 2005*]. Evidence from this research suggests that several billions of years worth of cumulative decay at today's rates occurred for isotopes such as  $^{238}\text{U}$  during the creation of the physical earth and that a significant amount of such decay likewise took place 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  $^{14}\text{C}$ . The surprising levels of  $^{14}\text{C}$  in fossil material from organisms that were alive before the cataclysm suggests that perhaps only a modest amount of accelerated  $^{14}\text{C}$  decay took place during the cataclysm itself, an amount insufficient to eliminate the  $^{14}\text{C}$  that existed in these organisms prior to the cataclysm. Accordingly, we here offer the tentative hypothesis that, whatever the physics was describing the decay acceleration, it did not operate in so simple a manner as to reduce temporarily the effective half-lives of all radioisotopes by the same factor. Had this simple description of the process been the case, then all radioisotopes would have experienced a fractional amount of accelerated decay given by  $2^{-\alpha t/\tau_{is}}$ , where  $t$  is the time over which the accelerated decay occurred,  $\tau_{is}$  is the present half-life of a given radioisotope, and  $\alpha$  is the dimensionless acceleration factor. A value of  $\alpha$  large enough to produce 500 million years worth of decay in  $^{87}\text{Rb}$  with a half-life of 48.8 billion years, for example, would entirely annihilate any  $^{14}\text{C}$  that might have been present before the accelerated decay episode occurred. Note that the half-life of  $^{87}\text{Rb}$  is 8.5 million times larger than the  $^{14}\text{C}$  half-life of 5730 years.

*Snelling et al.* [2003] and *Austin* [2005], in studies of the K-Ar, Rb-Sr, U-Pb, and Sm-Nd systematics of a Precambrian diabase sill in the

Grand Canyon, provide documentation that the amount of decay for these isotopes does not obey the simple formula of the preceding paragraph. Deviation from this formula is reflected in the discordant isochron dates for this single rock unit. For example, <sup>147</sup>Sm yielded a mineral isochron age of  $1379 \pm 140$  Ma while <sup>238</sup>U/<sup>235</sup>U decay yielded a Pb-Pb whole-rock isochron age of  $1250 \pm 130$  Ma. Each decays by  $\alpha$ -emission, and <sup>147</sup>Sm has a greater half-life than either <sup>238</sup>U or <sup>235</sup>U. Similarly, of the  $\beta$ -emitters, <sup>87</sup>Rb, with the longer half-life yielded a whole-rock isochron age of  $1055 \pm 46$  Ma and a mineral isochron age of  $1060 \pm 24$  Ma, compared to a K-Ar whole-rock isochron age of  $841.5 \pm 164$  Ma. The trend in these data is that the shorter the half-life, both for  $\alpha$ - and  $\beta$ -emitters, the less is the amount of decay in terms of elapsed time at today's rates. Carbon-14 is a  $\beta$ -emitter. If one extrapolates the fractional decrease in isochron age, assuming this decrease to scale directly with half-life, obtained for the two  $\beta$ -emitters <sup>87</sup>Rb and <sup>40</sup>K in this diabase sill to the case of <sup>14</sup>C, one obtains an amount of <sup>14</sup>C decay of only 3860 years at today's rate. In terms of cumulative radioisotope decay, this Precambrian diabase sill displays about twice the radioisotope age of the earliest Flood rocks. Hence this scaling, speculative as it may be, suggests only about 2000 years worth of accelerated <sup>14</sup>C decay occurred during the Flood. This amount of decay represents  $1 - 2^{-2000/5730} \sim 20\%$  reduction in <sup>14</sup>C as a result of accelerated decay. This is well within the uncertainties in the <sup>14</sup>C/C ratio we considered in connection with the pre-Flood world, so it has little impact on the larger issues discussed in this chapter.

## 11. Discussion

The initial vision that high precision AMS methods should make it possible to extend <sup>14</sup>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 <sup>14</sup>C! The diverse set of samples studied includes many that uniformitarians presume to be millions, even hundreds of millions, of years old. At face value, these <sup>14</sup>C AMS determinations suggest—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 past two decades have continued to confirm that  $^{14}\text{C}$  is an intrinsic component of the sample material being tested, such  $^{14}\text{C}$  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 call into question 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  $^{14}\text{C}$  exists in fossil material from all portions of the Phanerozoic record are already established in the standard peer-reviewed literature. Moreover, 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 on samples from deep within the Phanerozoic record can make the case only marginally stronger than it already is.

Indeed, the AMS results for our ten coal samples, as summarized in Table 2 and Figure 4, fall nicely within the range for similar analyses reported in the radiocarbon literature, as presented in Table 1 and Figure 3(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 a geological interval, we obtain mean values of 0.26 pMC for Eocene, 0.21 pMC for Cretaceous, and 0.27 pMC for Pennsylvanian—remarkably similar to one another. These results, limited as they are, indicate little difference in  $^{14}\text{C}$  level as a function of position in the Phanerozoic portion of 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 spread in the  $^{14}\text{C}$  ratios among the ten samples of Table 2 was at first not obvious to us. However, as we calculated the levels of  $^{14}\text{C}$  that would be generated by thermal neutrons in the crust as a consequence of an episode of accelerated nuclear decay during the Flood, we realized that such an *in situ* source of  $^{14}\text{C}$  possibly is of sufficient magnitude to account for the observed variation, given the large variations in N content and local U concentration.

If through further study we are able to find a reliable means to resolve the fraction of the total <sup>14</sup>C that is due to *in situ* generation from that which was present in the material before the accelerated decay episode, we can potentially, using <sup>14</sup>C, place strong constraints on the age of the earth itself. Establishing, for example, that diamonds contain a component of their <sup>14</sup>C that cannot be accounted for by *in situ* generation would, because of the short <sup>14</sup>C half-life, limit the age of the earth to mere thousands of years instead of the uniformitarian billions. A nearly constant <sup>14</sup>C/C ratio in diamonds characterized by low N levels could imply, for example, their <sup>14</sup>C is primordial and not from *in situ* generation. Already documented in the radiocarbon literature are inorganic materials such as Iceland spar that display consistent and reproducible levels of <sup>14</sup>C. These could be analyzed further for their N content and, if sufficiently low, would add support to the case that a low level of <sup>14</sup>C, on the order of 0.005–0.1 pMC, is still present from the earth's earliest history. This would be significant evidence for a young earth. We therefore believe a research effort focused on these issues deserves continued earnest support.

## 12. Conclusions

The careful investigations performed by scores of researchers in more than a dozen AMS facilities in several countries over the past twenty years in an attempt to identify and eliminate sources of contamination in AMS <sup>14</sup>C analyses have, as a by-product, served to establish beyond any reasonable doubt the existence of intrinsic <sup>14</sup>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 <sup>14</sup>C levels that are well above the AMS machine threshold, reliably reproducible, and typically in the range of 0.1–0.5 pMC. Such levels of intrinsic <sup>14</sup>C represent an obvious difficulty for uniformitarianism. After one million years, corresponding to 174.5 <sup>14</sup>C half-lives, the fraction of original <sup>14</sup>C remaining is  $3 \times 10^{-53}$ . Yet a mass of <sup>14</sup>C equal to the entire mass of the earth ( $6 \times 10^{24}$  kg) contains only about  $3 \times 10^{50}$  <sup>14</sup>C atoms.

Under uniformitarian assumptions, not a single atom of  $^{14}\text{C}$  formed one million years ago anywhere in or on the earth should conceivably still exist. The clear inconsistency between the ages implied by the AMS-determined  $^{14}\text{C}/\text{C}$  ratios and the corresponding rock ages provided by  $^{238}\text{U}$ ,  $^{87}\text{Rb}$ , and  $^{40}\text{K}$  techniques can no longer be treated merely as a yet to be understood anomaly by the specialists, for the time being to be explained away as “ $^{14}\text{C}$  contamination,” and therefore ignored by rest of the scientific world. Inconsistency of this magnitude demands substantive explanation. Our explanation is that the assumption of time-invariant nuclear decay rates is almost certainly not correct and is, in fact, the root of this inconsistency. Our other RATE research projects (for example, *Humphreys* [2005] and *Snelling* [2005]) lend strong support to this conclusion. Put simply, the evidence of  $^{14}\text{C}$  throughout the Phanerozoic part of the geological record argues the half billion years of time uniformitarians assign to this portion of earth history was instead a much briefer interval. Moreover, the relatively narrow range of  $^{14}\text{C}/\text{C}$  ratios suggests all Phanerozoic fossil organisms prior to somewhere in the middle to upper Cenozoic were contemporaries and perished almost simultaneously in the not so distant past. Finally, we note the presence of detectable levels of  $^{14}\text{C}$  in natural diamonds, formed deep within the earth during its early history, hints the age of the planet itself may likewise be constrained by the brief life span of  $^{14}\text{C}$ . We therefore conclude the  $^{14}\text{C}$  data provide noteworthy support for a recent global Flood and a young earth.

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production in subsurface crustal environments due to thermal neutrons arising from nuclear decay processes as presented in Section 7 of this chapter. I thank several anonymous reviewers for their careful reviews of the chapter and for the considerable improvement these reviews afforded. I also express heartfelt appreciation to the RATE donors who provided the financial means to undertake the AMS analyses of the coal and diamond samples.

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