CO_2 Gas Well Effluent Analysis

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Abstract

Radiocarbon is found throughout the geological record, thus indicating a young earth. This research expands that information base by sampling the carbon dioxide in four of the five major CO_2 gas fields in the USA, and performing isotopic analyses. The data is consistent with the young earth creationist paradigm and provides additional incentive to investigate the isotopic composition of the earth's crustal gases.

Introduction

This paper investigates another piece of the origins puzzle. It is an attempt to provide a partial answer to the question: *Is there still radioactive carbon-14 in* all *carbon compounds in the geological record?* Since creationists believe that the Bible is the truthful revelation of God and His work, then we who believe in a recent creation would expect to find detectable carbon-14 in naturally occurring carbon dioxide well gas because of the relatively short carbon-14 half-life of 5730 years. This work experimentally verifies detectable carbon-14 and the amount may suggest whether the carbon may be of flood origin. Evolutionists claim that high pressure gases in the earth's crust (natural gas, carbon dioxide and noble gases) are trapped in rock impermeable enough to hold the reservoirs for many millions of years (Ballentine et al., 2001) Thus, they assume carbon dioxide gas as well as natural gas extracted from anywhere within the Mesozoic and Paleozoic record to be totally devoid of carbon-14. One reasonable explanation for the presence of the radiocarbon is flood deposition of organic material and the subsequent degradation thousands (not millions) of years ago.

Background

Examination of an aeronautical sectional map for remote private airstrips in eastern New Mexico revealed a location near Bueyeros labeled "CO_2 Gas Plant."

I wondered, "What in the world is a CO_2 gas plant doing in the hinterlands of northeastern New Mexico?" My perception of a CO_2 gas plant was a dull gray dingy building by the railroad tracks with a fading "Dry Ice" sign on top.

Of the six major CO_2 gas fields in the world, five are in the USA. Four of them are within easy driving distance of my home in Albuquerque. They are the Bravo Dome field at Bueyeros, NM; the Sheep Mountain field at Gardner, CO; the McElmo Dome field at Cortez, CO; and the St. Johns field near St. Johns, AZ. The fifth field is the NE Jackson Dome in Mississippi and the sixth is the Dodan field in Turkey.

In three of the four fields of interest to this investigation, the producing strata commonly sit just above the Precambrian. All the fields are characterized by northwest to southeast oriented anticlines. Furthermore, all four fields are immediately adjacent to volcanic uplifts. Sheep Mountain itself is of volcanic origin. Cinder cones and lava flows sitting atop portions of the St. Johns field are common. The McElmo Dome field wells are within a radius of five to twenty miles north of the Ute Mountain laccolith. The Bravo Dome field is a southeast tending extension of the Sierra Grande uplift. It also has volcanic intrusions. An example is the Black Hills six miles east of the Mitchell #16 well sampled in this work. The Black Hills and the lava covered Ute Creek Mesa are visible southern extensions of the large Sierra Grande uplift. Photos of gas well sites are shown in figures 1 through 4.

Curiosity led me to request a visit of the Bueyeros facility. No one at the plant could answer the question, "How did pure CO_2 get down there in the strata in first place?" Ron Broadhead of the New Mexico Bureau of Mines and Mineral Resources Geological Survey has stated, "The

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Figure 1. Bravo Dome Well Site (Mitchell #16) looking west. Sample point is the vertical pipe with valve on the far right.

Figure 2. St. Johns Field CO_2 gas well sampling

Figure 3. Sheep Mountain Field CO_2 gas well site. Little Sheep Mountain in the background. Many wells are slant drilled from one location.

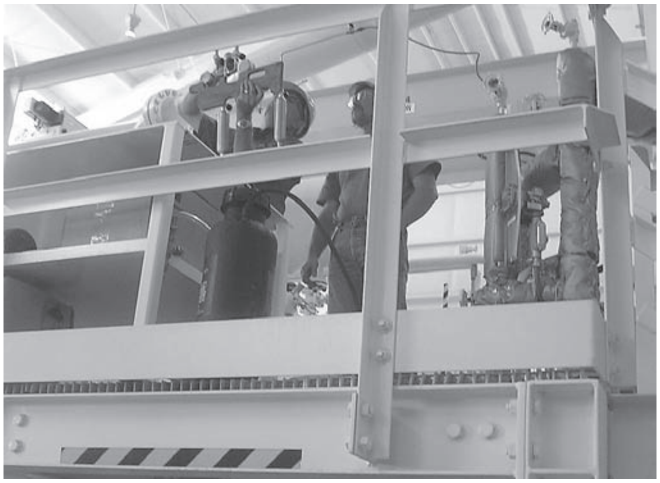

Figure 4. CO_2 gas sampling inside the Hovenweep facility at the McElmo Dome.

source of CO_2 gases encountered in northeast New Mexico is enigmatic" (Broadhead, 1993).

Indeed, the origin of the CO_2 gas has puzzled many investigators. The possible sources are: (1) thermal decomposition of carbonates by contact metamorphic processes, (2) carbonate dissolution linked to silicate hydrolysis, (3) bacterial degradation of organic matter, (4) bacterial hydrocarbon oxidation, (5) migration directly from intrusive igneous rocks, and (6) migration of juvenile CO_2 gas from the mantle and crust (Cappa and Rice, 1995).

Radiocarbon (Carbon-14)

Recent creationist work (Baumgardner et al., 2003) has shown the same average amount of ^{14}C is found in coal in three distinct portions of the stratigraphic record (Eocene, Cretaceous, and Pennsylvanian) indicating that the coal was laid down at the same time, thus confirming the young earth creation-flood model. The mean value of the $^{14}C/C$ ratio in percent modern carbon (hereafter referred to as pmc) for their samples was 0.247. That mean value compares closely with 0.292 pmc value obtained from the compilation of ^{14}C data from every portion of the Phanerozoic record. The mean value of non-biological Precambrian samples was 0.062 pmc. Subsequent work (Baumgardner, 2004. Personal communication) has shown the presence of ^{14}C in diamonds. The mean value of the $^{14}C/C$ ratio for the diamonds is 0.121 ± 0.021 pmc. Thus, if the $^{14}C/C$ ratio for the CO_2 gas samples obtained in this work exceeds 0.2 pmc, the source would most likely be carbon in rocks deposited in the Flood.

Four values for the $^{14}C/C$ ratio have been reported specifically for carbon dioxide gas, 0.077 pmc (Beukens, 1993), 0.12 pmc (Aerts-Bijma et al., 1997), 0.17 pmc (Gulliksen and Thomsen, 1992), and 0.21 pmc (Grootes et al., 1986). In all cases, the gas samples were derived from the combustion of natural gas and were used in efforts to calibrate their respective Accelerator Mass Spectrometer (AMS) devices. However, all these values are well above instrument resolution thresholds and beyond what is normally expected as "contamination" error. Thus, they have some carbon-14 present intrinsic to the samples. There have been no carbon-14 measurements of naturally occurring CO_2 well gas reported in the scientific literature. The sources for the CO_2 gas sample sets in this work are shown in Table I. The West Bravo Dome field gas sample taken from the Mitchell #16 well is a dry gas sample (no water in the formation). All the other samples were taken from strata where water was present in the gas.

The Stable Isotopes

Investigators examine the values of the stable isotopes of carbon and oxygen, $\delta^{13}C$ and $\delta^{18}O$, to determine the origin of the items (rocks, gases, artifacts, etc.) that contain these isotopes. The usual standard for stable carbon isotope, $\delta^{13}C$, is taken from the fossil belemnites of the Cretaceous Peedee Formation of South Carolina, abbreviated "pdb" and is measured in parts per thousand represented by the symbol "‰" (Krauskopf, 1979). Since the previously

Table I. CO_2 gas sample set sources

Set #	Field	Stratagraphic Formation	Production Depth
1, 2	Bravo Dome	Permian, Tubb sandstone (1)	2950 ft.
3	St. Johns	Permian-Supai, Big A Butte (2)	1600 ft.
4	McElmo Dome	Mississippian, Leadville limestone (3)	8500 ft.
5	Sheep Mtn.	Cretaceous, Dakota sandstone (4)	4450 ft.

Table I references: (1) Broadhead, 1987. (2) Rauzi, 1999. (3) Gerling, 1983. (4) Roth, 1983.

measured $\delta^{13}C$ values of Bravo Dome CO_2 gas (-3.9‰ pdb and -4.1‰ pdb) were nearly identical with the Mid Ocean Ridge Basalts (MORB) values (-3.8‰ pdb), Staudacher (1987) concluded that the origin of that CO_2 gas was the earth's upper mantle; i.e., juvenile magmatic. Indeed, there is a strong argument for this position when one compares Staudacher's values with those obtained from volcanic parental sources that ranged from -2.29‰ to -4.16‰ pdb with an average of -3.2‰ pdb (Gerlach and Thomas, 1986) and -2.7‰ to -3.4‰ pdb (Baubron et al., 1990). Similar $\delta^{13}C$ values previously reported for high purity McElmo Dome CO_2 gas were between -3.77‰ and -4.43‰ pdb (Cappa and Rice, 1995). However, analysis of the associated well drill core samples gave values similar to that of calcite (-0.64‰ pdb). Although the $\delta^{13}C$ values were essentially identical to Bravo Dome, MORB, and volcanic gases deemed juvenile magmatic, the origin of the McElmo Dome CO_2 gas was thought to be the high temperature thermal decomposition of carbonates in the producing dolomite layers of the Leadville limestone formation which produces the CO_2 gas (Cappa and Rice, 1995). The usual range of values for marine carbonates is -1‰ to +2 ‰ pdb and -2.2‰ to -7.7 ‰ pdb for freshwater carbonates (Faure, 1986). Veizer and Hoefs (1976) collected 1931 data points for carbon-13 in sedimentary carbonate rocks. The majority of the data fell within the range of -4‰ to +4‰ pdb. No $\delta^{13}C$ values have been reported for either the St. Johns field or the Sheep Mountain field. The $\delta^{13}C$ value for coal is -25‰ pdb (Faure, 1986), the value range for diamonds is -2.0 to -10‰ pdb (Faure, 1986). The $\delta^{13}C$ value for kimberlites is -4.7‰ pdb (Faure, 1986). The range of $\delta^{13}C$ values given above is shown in Figure 5. Thus, considering the range of the $\delta^{13}C$ data and the differing interpretations, it is no wonder that the source of the CO_2 gas is considered enigmatic. More information is needed to try to solve the source puzzle.

The stable oxygen isotope, $\delta^{18}O$, value for seawater (the standard) is zero, (standard mean ocean water, abbreviated as "smow"). The value for meteoric water varies from -25‰ to 0‰ smow. The mantle has a value of about +6‰. Air has value of +23.5‰ and atmospheric CO_2 is +41‰. Detrital sedimentary rocks have a range of +9‰ to +18‰. (Wickham and Taylor, 1990). Consistent with their thorough compilation of $\delta^{13}C$ data, Veizer and Hoefs (1976) compiled 2011 data points for the oxygen-18 isotope for sedimentary carbonates. The majority of the data fell within the range of +20‰ to +30‰ smow as also reported by Wickham and Taylor (1990). The usual value for calcium carbonate at 25°C is +28.6‰ (Krauskopf, 1979). The presence of the $\delta^{18}O$ isotope in the CO_2 is usually indicative of an exchange between the CO_2 and ground water. The issue then becomes the source of the water, meteoric or magmatic? (Krauskopf, 1979) It can also be a product of the

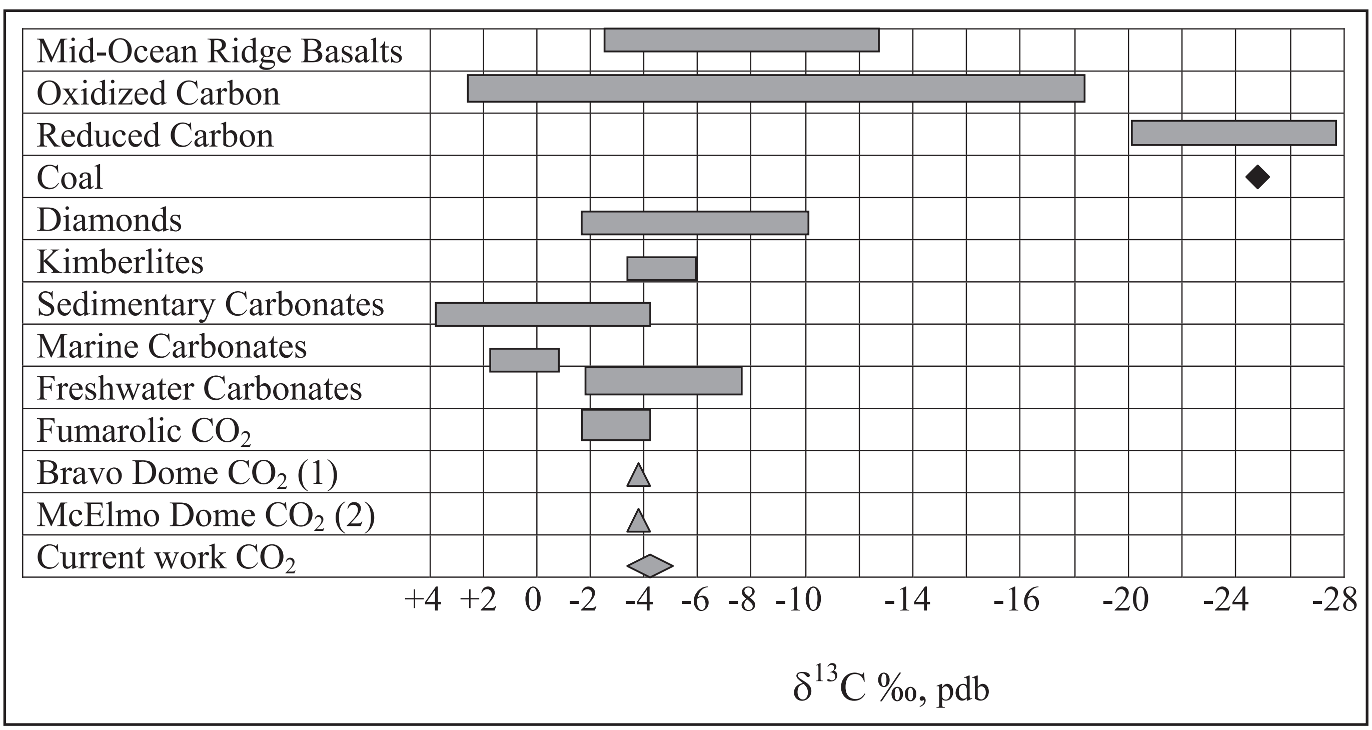

Figure 5. Range of Carbon–13 values for various rocks and gases.
References: 1. Staudacher (1987) 2. Cappa & Rice (1995)

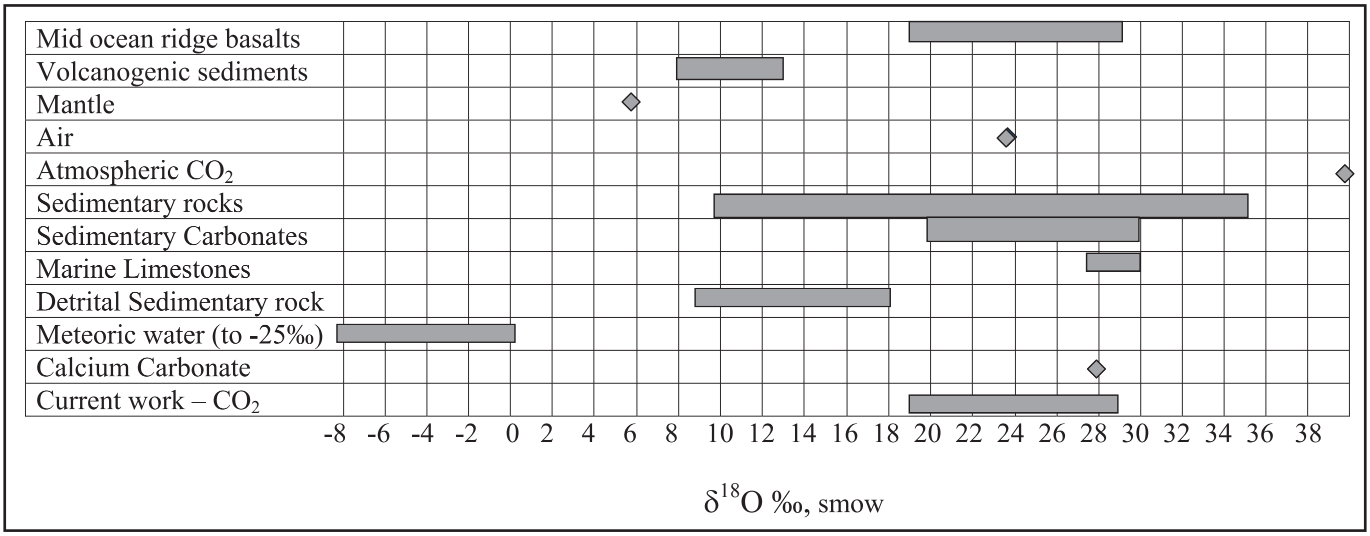

Figure 6. Range of Oxygen–18 values for various rocks and gases.

wollastonite formation and other metamorphic reactions. Common values for $\delta^{18}O$ for rocks such as sandstones, greywackes, arkoses, and volcanogenic sediments are +8 to +13‰ (Taylor, 1974). For sedimentary rocks the values range from +10‰ for quartz sandstone up to +35‰ for chert (Faure, 1986) and +28‰ to +30‰ for marine limestones (Faure, 1986). Of initial interest to this work is that done on Mid-Atlantic Ridge basalts containing CO_2 rich vesicles. Both $\delta^{13}C$ and $\delta^{18}O$ values were obtained from a lava tube source. The values obtained via acid extraction were -3.5‰ to -12.7‰pdb and +19.4‰ to 29.2‰ smow respectively. Similar values obtained by crushing were -8.0‰ pdb and +24.1‰ smow respectively (Pineau et al., 1976). No δ^{18} O values have been reported previously for any of the four CO_2 gas fields examined in this work. The range of values for the oxygen isotope is given in Figure 6. With all the possibilities for interpretation of the stable isotopes, Faure (1986) wrote, "However, the $\delta^{13}C$ as well as $\delta^{18}O$ values of carbonate rocks may be altered after deposition making such interpretations uncertain" (p. 498).

Therefore, some pursue analyses of noble gas isotope data for more insight. Such analyses seem to indicate a mantle source for the Bravo Dome well gas (Ballentine, 1997). Some noble gas isotopic analyses even point, perhaps unknowingly, to a young earth (Ozima et al., 1985).

Description of Sampling Apparatus and Procedures

A sampling system was constructed using stainless steel parts rated at 1800 psi. (Herein psi represents the actual gauge pressure.) It features a sampling port through which the CO_2 enters the system. The system has two 300 cc cylinders. One is used as a pressure surge damper and the second is used for pressure control and a container for additional sample gas. The gas samples sent to the University of Arizona Accelerator Mass Spectrometer (AMS) laboratory were in two 10 cc stainless steel cylinders. The system has a high pressure gage rated to 800 psi, and a low pressure gage which has a range of vacuum to 30 psi. The sampling system is shown in Figure 7.

Prior to going to the field, the system was filled with helium at 42 psia (absolute, not gauge pressure). It was then pumped down to 1.2 psia with a vacuum roughing pump (Becker Model VT 4.4). It was then filled and purged 18

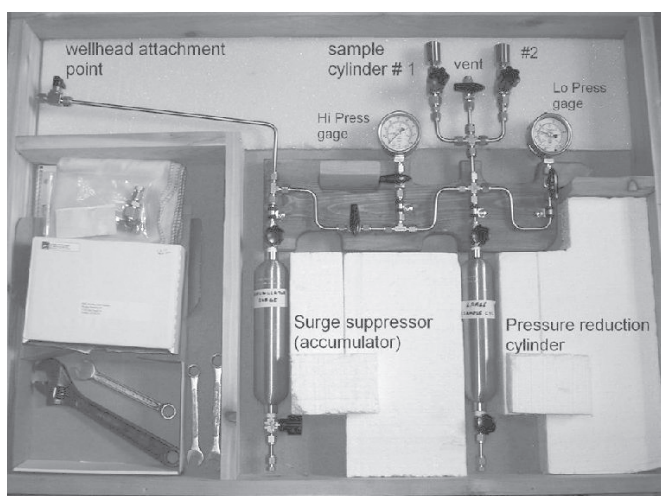

Figure 7. CO_2 Gas Sampling System in the carrying case.

times to remove all the initial air in the system. The volume was 656 cc. The mass reduction factor was 35.2 for each cycle. After 18 cycles there would have been less than one ^{14}C atom in the system. The system was pumped down again to 1.2 psia and all valves were closed. The system was then taken to the field in its carrying case.

Prior to attaching the system to the wellhead, the source valve was opened and some gas was vented to clear the wellhead port. The sampling system was attached to the wellhead port. The system input valve was opened and then the valves on either side of the surge suppressor cylinder. The gas was cycled through that side of the system nominally four times with the source system valves fully open. The valves to the high pressure gage were opened and the value recorded. The vent was then opened and a continual flow was established. The vent was closed and the valves for the two small 10 cc sample cylinders were opened. The sampling system valve was then closed, as was the valve ahead of the high pressure gage, thus isolating the left hand side of the system. If the pressure was greater than 160 psi, the vent was slowly opened to drop the pressure to that value. The vent was closed once again and the valve to the pressure reduction cylinder was opened. The pressure dropped to 6 psi in the right hand side of the system and the small cylinder valves were closed. All other valves were closed. The sampling system was detached from the wellhead. The small cylinders were detached from the system and capped.

These cylinders were then mailed to the University of Arizona AMS lab. The U.S. Postal Service allows the shipment of small gas cylinders if they are less than 10 psi. Once the small cylinders arrived at the AMS lab, they were attached to a vacuum system and the air that was between the valve and cap was pumped out. A small sample was then removed for stable isotope analysis. The remainder was then used to make the graphite targets for the AMS instrument. The usual turnaround time for the lab is three months. Four sample sets each were submitted in January and April, 2004. The final sample set of two was submitted in late May, 2004. It was a repeat of the first Bravo Dome gas sample that was obtained in 1999. The first Bravo Dome samples were transferred into the small cylinders that had only been through four purge and fill cycles. The second Bravo Dome sample set was obtained in the same fashion as the other field samples; i.e., after the system had been through 18 purge and fill cycles. Two separate samples of the same gas provide redundancy and contingency should there be an error in one of them.

Results

The physical characteristics of the well gases sampled at the wellhead in the four CO_2 gas fields are shown in Table II. The exception was the McElmo Dome where the sample was taken downstream of a dryer. The wellhead pressure was too high (800 psi) for a sample to be safely obtained directly from the wellhead. All samples were taken from producing (flowing) wells.

Two identical samples from each of the four CO_2 gas fields were sent to the NSF-Arizona AMS laboratory in Tucson. The samples were analyzed for their content of $\delta^{13}C$, and $\delta^{18}O$, and for the $^{14}C/C$ ratio. The Bravo Dome sampling was repeated because the technique for the first two samples was different than those for the other three fields. Thus, another set was acquired using the identical system preparation and sampling technique to better assure consistency in the data foundation. The results are shown in Table III. As noted in Table III, the isotopic mean values are $\delta^{13}C$ = -4.053‰ pdb, $\delta^{18}O$ = 23.44‰ smow, $^{14}C/C$(uncorrected) = 0.636 pmc and $^{14}C/C$(corrected) = 0.446 pmc

Discussion

The values in the four data sets for the stable isotopes, $\delta^{13}C$ and $\delta^{18}O$, fall nicely in the range of sedimentary carbonates, -5‰ pdb and +20 to +30‰ smow. On the other hand, the values also compare closely with CO_2 gas data obtained

Table II. Well Gas Characteristics

Field	Well sampled	Pressure psig	Temp. °F	Purity, %	Impurities
Bravo Dome	Mitchell #16	385	50	99.8	N_2, CH_4, noble gases
St. Johns	10-22 State	510	50	~90	N_2, H_2O, He, A, CH_4
McElmo Dome	Hovenweep	628	49	92	N_2, H_2O, He, A
Sheep Mtn.	3-4-0	160	38	98.3	N_2, H_2O, CH_4

Table III. Field Sample Isotope Values

Field Sample	Date sampled	Date analyzed	Mass mg	$\delta^{13}C$, PDB	$\delta^{18}O$, SMOW	$^{14}C/C$, pmc uncorrected	$^{14}C/C$,pmc corrected
Bravo Dome #1	5/29/01	2/24/04	0.84	-3.87	19.063	**0.83±0.1**	**0.52±0.1**
Bravo Dome #2	5/29/01	2/24/04	0.80	-3.879	19.078	**0.61±0.1**	**0.31±0.1**
Bravo Dome #3	5/28/04	8/24/04	1.15	-4.02	19.78	0.19±0.1	<0.20
Bravo Dome #4	5/28/04	8/24/04	1.29	-4.27	19.15	0.25±0.1	<0.20
St. Johns #1	1/09/04	2/24/04	1.45	-4.277	24.828	0.98±0.1	0.67±0.1
St. Johns #2	1/09/04	2/24/04	1.45	-4.278	24.050	0.46±0.1	<0.36
Sheep Mtn #1	3/18/04	6/22/04	**0.56**	-3.356	29.109	**1.53±0.11**	**1.21±0.11**
Sheep Mtn #2	3/18/04	6/22/04	1.37	-3.401	28.629	0.42±0.1	<0.31
McElmo Dome #1	3/30/04	6/22/04	1.37	-4.583	25.379	0.66±0.1	0.35±0.1
McElmo Dome #2	3/30/04	6/22/04	1.37	-4.594	25.335	0.43±0.1	<0.33

Notes:
1. The low mass for Sheep Mtn #1 compared to Sheep Mtn #2 suggests loss of mass in handling and possible contamination.
2. The marked difference between the Bravo Dome #1 & #2 and Bravo Dome #3 & #4 $^{14}C/C$ data sets is largely due to the increased number of purge and fill cycles prior to sampling the latter.
3. The isotopic mean values are $\delta^{13}C$ = -4.053‰ pdb, $\delta^{18}O$ = 23.44‰ smow, $^{14}C/C$(uncorrected) = 0.636 pmc and $^{14}C/C$(corrected) = 0.446 pmc.

from vesicles in mid-Atlantic ridge lava tube basalts (-3.5 to -12.7‰ pdb for $\delta^{13}C$, and +19.1 to +29.2‰ smow for $\delta^{18}O$) by Pineau et al. (1976) cited earlier. Therefore, without the ^{14}C data, one could just as well conclude that the CO_2 source is juvenile magmatic.

Not surprisingly, the $^{14}C/C$ values show a significant amount of ^{14}C in the well gas. This is especially remarkable when one considers that the AMS lab subtracted a "contamination or background correction" factor on the order of 0.30 pmc from the $^{14}C/C$ raw data values. Doing such is standard practice and is in line with the fact that the AMS lab quotes a pmc value of 0.25±0.1 for their "carbon dead" CO_2 gas which is derived from natural gas. The $^{14}C/C$ values reported as a less than (<) value were outside the uncertainty bound of the AMS instrument of approximately 0.6 pmc. Thus, if a measured value is 0.46±0.1 as is the case for the St. Johns #2 sample, then the lab reports a value that is 0.1 pmc less than the raw data value. As shown in on the histogram in Figure 8, the mean value for the $^{14}C/C$ data is 0.446 pmc for all data points and 0.361 pmc if the Sheep Mountain #1 sample is not included. That sample was deemed spurious due to low sample mass (41% of the #2 sample) and a definite possibility of a handling and contamination problem. The differences between the first and second data sets from the Bravo Dome also indicate the possibility of slight contamination in the first set. Taking the value that best represents the entire data, 0.361 pmc, results in an uniformitarian age of 45,200 years using the convention of 5,568 year half-life for reporting age by ra-

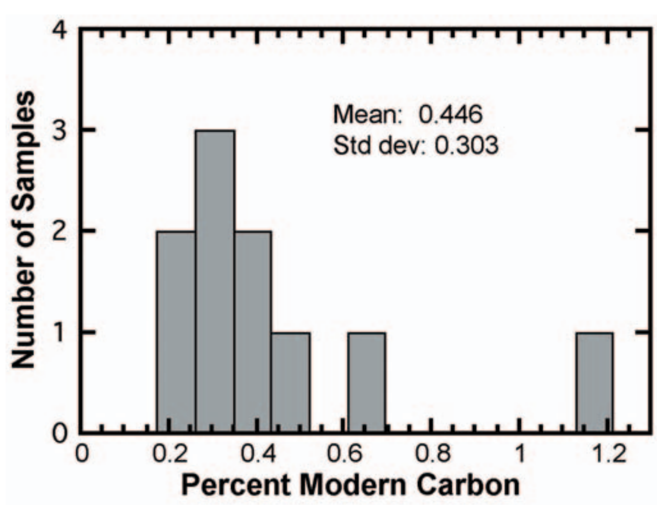

Figure 8. Distribution of ^{14}C values for the four CO_2 gas wells.

diocarbon dating labs. The $^{14}C/C$ values being in the range of flood deposit values (Baumgardner et al., 2003) indicate sedimentary rock sources for the CO_2. If the CO_2 source was juvenile magmatic CO_2 , it probably should have been on the same order as the $^{14}C/C$ values for diamonds (~0.12 pmc) and other Precambrian sources.

Consider the $\delta^{13}C$ values for coal, -25‰ pdb (Faure, 1986); and the values for diamonds, -2.0‰ to -10‰ pdb, (Faure, 1986), and -4.7$\pm$1.2‰ pdb for kimberlites (Faure, 1986). Clearly, the $\delta^{13}C$ values agree only for the very old diamonds and kimberlites, and not the Phanerozoic coal data. Yet the C^{14}/C ratios of this work are definitely more similar to those of coal than those of diamonds. Specifically the Bravo Dome #3 and #4 uncorrected values are quite similar to the Blind Canyon, Utah (Cretaceous period) and Lykens Valley, Pennsylvania (Pennsylvanian period) uncorrected C^{14}/C ratios of 0.18 pmc and 0.214 pmc respectively (Baumgardner et al., 2003). The resolution of this seemingly discordant data follows.

Faure (1986) noted that the isotopic composition of carbon in the *oxidized* form (carbonates and CO_2 gas) differed markedly from that in the *reduced* state (graphite, carbides, and organic compounds). The *reduced* carbon is strongly enriched in ^{12}C and has $\delta^{13}C$ values between about -20‰ and -28‰ pdb, on the same order as that of coal. The *oxidized* carbon has distinctly different $\delta^{13}C$ values ranging from +2.9‰ to -18.2‰ pdb. Faure (1986) also noted that the difference in $\delta^{13}C$ values of coexisting CO_2 and CH_4 of fumarolic gases may be due to isotope fractionation associated with the equilibrium reaction:

$$CO_2 + 4H_2 = CH_4 + 2H_2O$$

Mixtures of CO_2 and CH_4 from steam jets had average $\delta^{13}C$ values of $\delta^{13}C(CO_2)$ = -3.74‰ and $\delta^{13}C(CH_4)$ = -26.74‰ pdb. The difference is: $\Delta(CO_2 - CH_4)$ = 23.00‰. This indicates an average equilibration temperature between 258°C and 328°C depending on whose fractionation factors are used. Thus, there is a distinct shift between the $\delta^{13}C$ values of CO_2 and CH_4 in fumarolic gases due to isotope fractionation at elevated temperatures. Similarly, if one takes the mean value of the $\delta^{13}C$ from the four CO_2 gas fields, -4 ‰ pdb, and compares it with the nominal $\delta^{13}C$ value of organic matter in sedimentary rock, -28‰ pdb (Faure, 1986), the fractionation shift is: $\Delta(CO_2 - C_XH_Y)$ = 24‰. That suggests a heating of the sediments in the temperature range of 240°C to 310°C occurred in the recent past.

From the creationist view, the current RATE work is advocating a significant increase in radioactivity (accelerated decay) at the time of the Flood. That, coupled with an antediluvian atmosphere that was rich in CO_2 and O_2, the sediments being heated and oxidized (further heat release) would account for the enriching shift of $\delta^{13}C(CO_2)$ values. Note once again that the four fields from which the samples were obtained are closely associated with volcanic activity. A model which includes the thermally induced enriching shift makes the $\delta^{13}C(CO_2)$ values compatible with the C^{14}/C ratios found in this work.

Conclusion

The CO_2 gas derived from the Permian, Mississippian, and Cretaceous geological strata is of recent origin and not the commonly accepted 100 to 350 million year timeframe. One possible source of the CO_2 is from the flood deposition of sediments and subsequent degradation of the organic material. The mean isotopic signature for this naturally occurring CO_2 well gas is $\delta^{13}C$ = -4‰ pdb, $\delta^{18}O$ = 23.4‰ smow, and $^{14}C/C$ = 0.36 pmc. This work provides additional evidence that the earth is indeed young as revealed in the Bible.

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"Speak to the earth, and it will teach you," Job 12:8.

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Book Review

Red Earth, White Lies by Vine Deloria, Jr.

Fulcrum Press, Golden, CO, 1997, 271 pages, $16.95.

While visiting Wupatki National Monument near Flagstaff, Arizona, I picked up this very unusual book. It is a young-earth creationist book written from the viewpoint of a Native American. Vine Deloria, Jr. is a professor of history, law, religious studies, and political science at the University of Colorado in Boulder. Though his viewpoints may shake the foundations of evolution, he is not impressed with what he calls "fundamentalist Christianity." His reasons are outlined in the first chapter, *Behind the Buckskin Curtain*, where he shows that those who professed Christianity in the past, especially with their treatment of the Indians, did not demonstrate very much difference from others. Though he makes the common mistake of rejecting the validity of Christianity by evaluating its worst examples, it is evident that false doctrine and hypocrisy within the church have done much damage to Native Americans.

Deloria recognizes that a false dichotomy exists between the secular and spiritual, and this causes damage to Christianity as well as others who search for the truth. The advent of Darwinism destroyed the effectiveness of the message of Christianity and set up a secular academic world devoid of spiritual life. He gives many reasons to reject the orthodox evolutionary paradigm and speculates that the reason it has persisted so long is because at heart, scientists are "incredibly timid people. Many of them are intent primarily on maintaining their status within their university or profession" (p. 28).

In all of this, the oral traditions of Indians (he does not object to the use of this term) are basically ignored by Western thought, where indeed they may be parallel and give insights into the catastrophic origins of many of the geological features in America. Respect for non-Western traditions is difficult to achieve, and nonsensical theories concerning the origin of the Indians in America abound, though there is no corroboration with Indian oral tradition. One such academic myth is the Bering Strait land bridge theory, which he refutes in detail. Some Indian traditions talk about migration by boat, which most academics reject because of their belief that the Paleo-Indians were too primitive to build such craft. But that notion has been challenged by Thor Heyerdahl and others who have duplicated the migration of the Polynesians by boat. There are numerous physical problems and geographic barriers concerning the migration of people and animals across a land bridge. He also spends several chapters refuting the notion of Indians killing off the mega fauna leading to mass extinctions. He rather attributes this to catastrophic geologic events and cites the Indian oral traditions that describe these events.

The Indian view is that the world is alive. Though Vine Deloria is not a Christian, he argues that the Bible validates the Indian oral traditions rather than the other way around. I would say that both should be considered in the search for truth although modern academia favors naturalism. Deloria's impression is that evolutionists place the American Indian at the bottom of the human evolutionary scale along with other tribal peoples and this has led to many atrocities.

Deloria is somewhat familiar with the early writings of creationists and quotes extensively from Donald Patten's 1966 book, *The Biblical Flood and the Ice Epoch*. He favorably regards the ideas presented there. He rejects radioisotope dating and suggests a young world, though he might go back as far as 250,000 years for the age of the earth. Indian traditions talk about a white race, a mean-spirited, bearded people who fought the Salish, Sioux and Algonkians, and were subsequently driven northeast and across the Atlantic ocean. They also talk about giants and people who lived to be 200 years old.

The chapter on Geomythology and the Indian Traditions was particularly interesting and should be studied by creationists. According to the oral tradition of a very old Wishram woman, the Columbia River flowed underground west of The Dalles for a long distance through the Cascades, and the Indians would fasten their canoes together one behind the other and pray to the Great Spirit for guidance as they paddled through the long dark tunnel. Then, Mount Hood and Mount Adams quarreled, hurling fiery stones at one another, and the bridge collapsed. This event took place in the time of her grandfathers, which would have been about 1750–1760. Oral traditions also tell about the eruptions of Mount Hood, Mount Rainier and Crater Lake. Mount Rainier, according to tradition, moved away from the Olympic Mountains forming the Puget Sound. Also, the Three Sisters was once the tallest mountain in the area, reaching a height of 15,000 feet, but blew its top, leaving the three peaks that remain today. This tradition is verified by geological evidence, though geologists would not believe that the event occurred in historic times. A detailed Klamath story tells about the eruption and collapse of Crater Lake. Also the Hopi Indian legend of the eruption of Sunset Crater near Flagstaff was not regarded because it didn't match the traditional geologic dates, but now is given much more weight because the story matches the evidence.

Deloria also tells of Indian legends that corroborate the Bretz flood which carved the eastern scablands of Washington. From his own tribe's tradition, he tells of the Badlands of South Dakota being formed as the result of the Pennsylvanian coal beds catching fire, burning for many years. Finally, he talks about the many traditions and petroglyph sites that describe extinct creatures he believes to be dinosaurs. He also mentions the mythical "water panther" Me-she-pe-shiw found in many petroglyph carvings (p. 222), and believes this to be a creature much like the stegosaurus. One such site where drawings of this creature exist is the Sanilac Petroglyphs in Michigan's Thumb area. I recently visited this site, took pictures and have an article concerning this at http://www.rae.org/sanilac.html.

Deloria writes, "We are living in a strange kind of dark ages (sic) where we have the immense capability of bringing together information but when we gather this data, we pigeonhole it in the old familiar framework of interpretation, sometimes even torturing the data to make it fit" (p. 211). I believe Deloria's book should be required reading for creationists and the information he presents should be carefully considered.

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