Appendix 1. Radiometric Dating

"Absolute" dates are typically derived for the geologic record by radiometric dating. The several techniques are based on the radioactive decay rates of selected isotopes. These isotopes decay at a measurable rate known as a "half-life". For each period of time equal to the half-life, one half of the isotope decays to another element. After ten half-lives only one thousandth of the original material remains. That is the basis for the radiometric "clocks" used to date the rocks. The original material is called the "parent" and the resulting element(s) are called "daughter(s)".

There are several isotopes by which long ages may be postulated and one for modern ages. Long ages come from (a). the uranium-to-lead series, (b). potassium-to-argon decay, (c). rubidium-to-strontium decay and a few others. The isotope for modern ages is carbon, ^{14}C. Details can be found in numerous books, including *The Young Earth* by John D. Morris and *Grand Canyon, Monument to Catastrophe* by Steven A. Austin, and both volumes of *Radioisotopes and the Age of the Earth* by Vardiman, Snelling, and Chaffin. They are available from the Institute for Creation Research and Master Books at the addresses in Appendix 15.

Radiometric dates are generally presented to the public with a semblance of authority. However, there are numerous assumptions behind the derivations, many of which may not be valid. These include, 1. that the relative amounts of parent and daughter are known at the time the clock starts (time zero), 2. that the decay rate has remained constant throughout time, 3. that there has been no movement of parent or daughter elements out of or into the rock throughout time, 4. that there has been no contamination of the sample by non-radiometric isotopes of the same type, and 5. that the present amounts of parent and daughter can be accurately measured (usually a reasonable assumption). Sedimentary rocks cannot generally be dated by such heavy isotope techniques because they are made up of mineral grains that came from elsewhere, bringing with them supposed dates from a variety of sources. It is usually the igneous rocks that are used for dating long periods of time.

Austin recently "dated" some of the igneous rocks of the Grand Canyon, in particular some basalt flows in the northwestern area near the Vulcan's Throne volcano (black top surface in Appendix 8, Figure A8-1). They are so recent that they have overflowed the rim of the existing Grand Canyon at Lava Falls and coated the canyon walls to within 50 feet of the bottom. Most geologists agree that they must be younger than a couple of million years in the evolutionary time scale. They even discount potassium-argon dates of tens of millions of years for such rocks, claiming "excess argon" and adjusting their numbers to what they think is more reasonable. Another series of rocks in Austin's sample came from the Cardenas Lava, a Precambrian flow in the tilted strata (dark diagonal layer at right in Appendix 8, Figure A8-1) in the eastern Grand Canyon below the Tapeats and other horizontal layers. It is assumed to be exceedingly old. Austin's samples were sent to four commercial laboratories. The numbers that came back put the old Cardenas Lava at about 1.0 billion years by the rubidium-strontium method (considered to be the best). Most geologists would accept such a date. However, the most recent lava came back at about 1.4 billion years by the same technique. Moreover, when the same rock samples from both areas were dated by other techniques, the answers usually did not agree with each other.

The implication is that the "dates" have nothing to do with a calendar but with original parent/daughter ratios in the magma.

More recently, Austin has had 10-year-old rock from the newest (1986) lava dome of Mount St. Helens dated by the potassium-argon method. The measurements gave a youngest indicated age of 0.34 $\pm$ 0.06 million years for the feldspar-glass component in the rock and an oldest age of 2.8 $\pm$ 0.6 million years for a pyroxene concentrate. Austin suggests that the excess argon is related to argon pressure at depth or to the tightness of the various mineral structures, not to emplacement date. None of the "dates" are compatible with the ten-year real age of the rock. Someone has said, if we cannot date the present (near zero age), how can we be certain that our older dates are valid.

The potassium-argon method as commonly used in the past suffered because the daughter argon is identical to the argon that makes up one percent of the earth's atmosphere. More modern techniques try argon-argon isotope ratios to solve the contamination problem. The uranium-lead method suffers from the mobility of mother and some daughter products in the earth, particularly in water. One can never be sure how much uranium has been added to or leached from the deposit over time. The radioactivity of the dinosaur bones on Dinosaur Ridge serve to remind us of this uranium mobility. The most interesting analyses have been with radioactive isotopes sealed within zircon crystals in igneous rocks. That appears to be a "closed system" and ancient dates have been obtained, confirming that much radioactive decay has occurred. Recent measurements have determined the rate at which the resulting helium, from alpha particles, diffuses out of the crystals as a function of temperature. There is still much radiogenic helium sealed within the crystals, indicating by more than five orders of magnitude, that only thousands of years have passed since the creation of the helium. The present interpretation is that there was an accelerated rate of decay in the recent past which created the appearance of much older ages.

Carbon-14, normally written ^{14}C, is produced in the upper atmosphere by the interaction of cosmic rays and nitrogen gas. It then diffuses down into the biosphere and is incorporated into plants and animals as long as they are living. Once the organism dies the "clock" is no longer replenished and starts "ticking". By measuring the ratio of ^{14}C to normal ^{12}C the "date" is determined from the half-life and the assumed beginning ratio. This process has several traps. The amount of ^{14}C in the atmosphere is presently less than the equilibrium value appropriate for the modern production rate. That suggests less ^{14}C in the past, exaggerating long ages. The cosmic ray flux in the past may not have been the same as today's flux. The stronger magnetic field of the earth in the past reduced their penetration. Some of the cosmic rays come from the sun. Several centuries ago the sun went through a long-term sunspot minimum. Carbon dates from that period appear older than historical records show because of the decreased ^{14}C production in the atmosphere. If the rest of today's cosmic rays are from a variable astronomical source then all ancient dates are in error. The former atmosphere may have had a higher concentration of carbon dioxide, now captured in the ocean, rocks, and dead vegetation. That would have diluted the ^{14}C and exaggerated the apparent ages of formerly living matter.

The ^{14}C method appears to do fairly well against tree ring samples for a couple of thousand years, but may not be trustworthy for extremely ancient dates. Furthermore, ^{14}C can never be used for

dates older than about 50,000 years because of the 5730 year half-life. Sample contamination is a severe problem in the analysis. Rain water can bring with it dissolved carbon dioxide that interacts with carbon in the material. Plants that get their carbon from carbonate rock will appear ancient because of the lack of ^{14}C in those rocks. So while carbon dating can be useful for historical times, with some fluctuations caused by the sun and leaching environment, it does not appear trustworthy for prehistoric times unless the assumptions are carefully checked.

Recent observations have found that ^{14}C is found in all fossil fuels (natural gas, petroleum, coal) and diamonds, in great contradiction to the usual assumption of ages more than about 100 million years. Age calculations are at about 24 thousand years. That is certainly in opposition to the evolutionary time scale and seemingly in excess to a Biblical time scale of about 6000 years. However, the assumptions behind ^{14}C "dating" can allow a calendar age of about 4000 years for such radiometric "ages".

Appendix 2. Comments on Dinosaur Bone Preservation

Figure A2-1. Two of three deer carcasses in the gravel of an irrigation ditch. Will they turn into fossils?

How fast does an animal have to be buried to become a fossil? A good analogy is the road-kill of a deer. How long does it last beside the road? Experience tells us that it will be mostly gone within a year. It will be either scavenged or will rot. Occasionally the deteriorating bones might last longer in dry climates. The picture in Figure A2-1 shows deer bones in an irrigation ditch. That is like dinosaur bones beached on a sand and gravel bar, such as on a sign at the bone site. A general rule is that the animal must be buried by more than its own thickness in a fraction of a year. That means deposition rates in excess of a meter per year for a dinosaur. (Note: that rate is about a million times faster than an average rate derivable for Dinosaur Ridge by the evolutionary time scale.) Even that does not guarantee a fossil. Bacteria, worms, insect larvae, and other organisms can still destroy the bones after they are buried. Fossilization usually requires submersion in mineral-laden water in conditions without the presence of oxygen. There are anaerobic bacteria even in those conditions that can consume the animal remains. A fossil is generated when the minerals in the water permanently replace the organic and bone materials of the animal carcass.

Fossilization is rare. Other literature will point out that more than 90 percent of existing fossils are marine in origin. Only a small fraction of a percent are of large land-dwelling animals like the dinosaur bones you can see at the Ridge. There are many examples, besides required sedimentation rates, that fossilization is associated with catastrophic conditions. A few of the fish seen in the fossils from Wyoming are caught in the act of swallowing another fish. The dinosaur bones at this site are typically dismembered by something forceful, such as a powerful flood. In a few locations the bone deposits are great heaps of many different types from different ecological zones.

In general, remember that for you to see a fossil at all, catastrophic conditions (rapid burial) were required for its preservation. Reinforce that in your mind whenever you see a carcass along the road.

Appendix 3. Comments on DNA findings in fossil material

In recent years scientists have started to carefully examine extremely well-preserved specimens of formerly living things. It started with the finding of a green magnolia leaf in ancient shales. The chlorophyll should have decomposed long ago, but it did not until exposed to air after its discovery. Some scientists tried to extract DNA fragments from such samples and discovered that DNA fragments were indeed present. Nobody had tried to do so before. Laboratory work had shown for decades that DNA and related organic molecules spontaneously decay rapidly, especially when exposed to air and water. It was calculated that DNA and its fragments cannot last much more than ten thousand years, even in the best environments.

The finding of real DNA fragments in amber helped fuel the story line in the movie Jurassic Park. It is not possible, however, to clone dinosaurs from such DNA. There is so much intelligent coding (design) in the DNA of every living thing that it is impossible to reassemble the fragments in the correct order. Such a task is greater than correctly recovering the contents of a library of books from piles of words, most of which are missing or garbled. Nor can correct DNA sequences be cloned successfully in anything other than a living egg of the same genus or species. Therefore extinct species can never be recovered.

The importance of the DNA and other soft tissue findings lies in the implications for dating. If the real DNA fragments found in amber and elsewhere cannot be more than ten thousand years old, then the dinosaurs found in strata of the same age cannot be more than ten thousand years old. Creationists therefore applaud the DNA discoveries as supportive of a young earth. Old-earth scientists have to ignore the laboratory results and claim special preservation circumstances in order to continue to adhere to their millions-of-years time scales.

Appendix 4. Further Comments on Radioactivity in the Dinosaur Bones

Water can move through the sedimentary rocks in which fossils are found. That water sometimes contains dissolved uranium compounds leached from rocks in volcanic and crystalline Precambrian formations. Organic carbon acts as a catalyst for the precipitation of uranium. On the Colorado Plateau to the west are found petrified logs now composed almost entirely of yellow carnotite, a uranium mineral. The organic carbon in these bones similarly attracted uranium. (The charcoal in the Dakota Formation of Dinosaur Ridge did not, however.)

The radioactive bone fossils can teach us an important lesson about radiometric dating assumptions. To arrive at a "date" by radioactive decay, scientists measure the present conditions in a sample: the amount of "mother" material, such as uranium, and the amount of "daughter" material of the correct isotopes, such as lead or intermediate elements. They measure (in the present) decay rates (half-lives) by which one element is transformed into another. They then assume that the decay rates in the ancient past were the same as those in the present, which seems

reasonable but has not been proven. (There is now evidence - see Appendix #1 - that there may have been accelerated decay in the recent past.) They assume that they can estimate the amounts of mother and daughter elements originally present in a sample. That usually means zero daughter material present, though natural substances nearly always have impurities of many types. They must also assume that the sample has been in a "closed system", meaning that no mother or daughter material has ever been added to the sample or removed from it. The mobility of uranium as shown in these dinosaur bones speaks against the reasonableness of the last assumption. Any movement of uranium atoms in these rocks resets the "clock" and makes its time estimates unreliable.

Appendix 5. Further Comments on Dinosaur "Bulges"

Notice that the material filling the depression (upper part of Figure A5-1) is essentially uniform sand. This indicates rapid burial during one episode of deposition. If there were multiple episodes, or long time periods involved, then the material would be horizontally stratified, as depicted in the bottom of Figure A5-1. So here we have rapid deposition of tens of centimeters of material in a small fraction of a year. Furthermore, the deposition happened soon after the footprints were made, before they were destroyed by erosion or received a small horizontal deposit in the bottom made from material washed from the sides of the footprint.

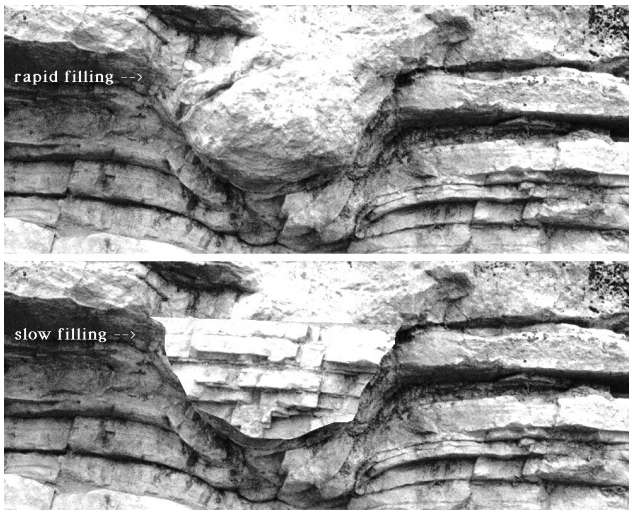

Figure A5-1. The layering (or lack of it) in the dinosaur bulges gives clues about the speed of filling.

Appendix 6. Comments on radiohalos in Biotite Crystals

This following material (photographs, etc.) was excerpted from *Creation's Tiny Mystery* by written permission of the author, Robert V. Gentry (3rd edition, 1992, Earth Science Associates, P.O. Box 12067, Knoxville, TN 37912-0067).

Table 1. Characteristics of haloes in biotite from the Uranium decay series, alpha decays only.

Isotope:	^{238}U	^{234}U	^{230}Th	^{226}Ra	^{222}Rn	^{218}Po	^{214}Po	^{210}Po
Energy, Mev:	4.19	4.77	4.68	4.78	5.49	6.00	7.69	5.30
Radius, mm:	12.6	15.3	15.1	15.3	18.7	22.3	32.7	19.3
Half-life:	4.5E9y	2.5E5y	7.6E4y	1.6E3y	3.8d	3.0m	5.2E-6s	138.4d

(4.5E9y means 4.5 x 10^9 years; d for days, m for minutes, s for seconds. radii approximate.)

Biotite is an iron-rich mineral in the mica series and is dark in color. Its crystal structure allows one to peel off layers in thin sheets and look through them. Microscopic views of biotite sometimes reveal tiny nested spheres of discoloration called radiohaloes. When the spheres are carefully sectioned and examined, they appear as concentric circles or haloes. At the centers of

those spheres are radioactive impurities. The radii of the spheres directly identify the particular radioactive decay parent isotopes that produced them. The alpha-decay products (helium nuclei) are ejected from the centers to a distance approximately proportional to the energy of the nuclear decay of particular atomic isotopes, and there they darken the biotite. The energy tends to be inversely proportional to the logarithm of the half-life of the decay rate. So those isotopes with the most rapid decay tend to make spheres with the biggest radii.

The haloes usually have uranium, ^{238}U, in their centers and show eight haloes (see top of Figure A6-1), some superimposed. These are from the eight isotopes that have alpha decay in the series leading to lead, ^{206}Pb. Until the last step in the decay chain, the half-lives decrease and the energies increase. The farthest-out haloes are from the elements radon, ^{222}Rn, and polonium, ^{218}Po, ^{214}Po, and ^{210}Po. The accompanying table gives the numbers.

There are a minority of haloes that have only one, two, or three haloes, all from polonium, with no predecessor or parent isotopes. These are shown in the middle of Figure A6-1, labeled by the isotope that starts the series of haloes. The biotite crystals formed, encapsulating only polonium at those radiation centers and then the polonium decayed to lead. Only lead ^{206}Pb is now found in the centers of such haloes. Similar haloes are also found in the minerals fluorite and cordierite, and in coalified wood but with different radii. The latter, illustrated at the bottom of Figure A6-1, is larger because the wood offers less resistance to the alpha particles. The crystal lattice of biotite, fluorite, and cordierite prevents the movement of contaminants into or out of the crystal once it is formed. There are usually no microcracks in most of the halo examples by which fluids could have entered the crystal.

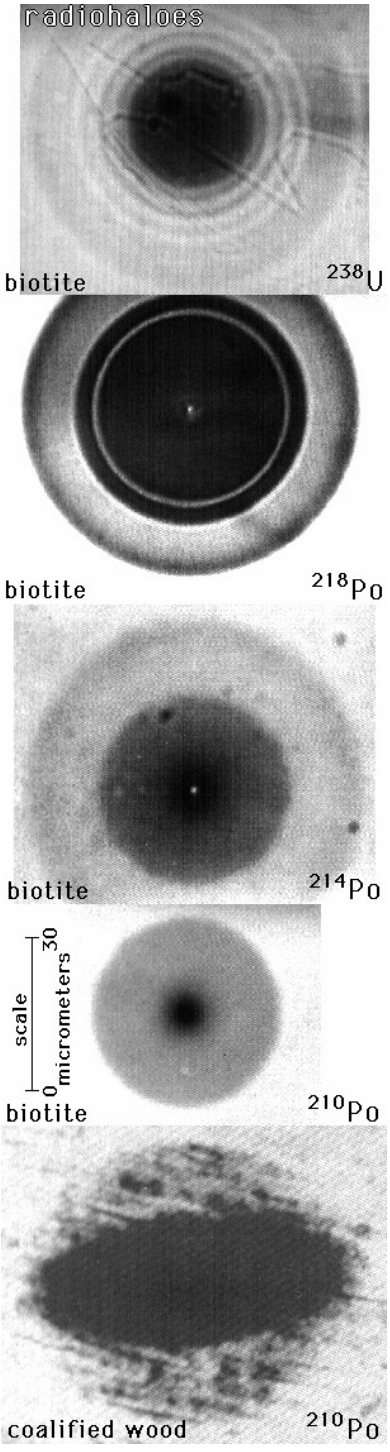

Figure A6-1. Radiohaloes in biotite and coalified wood as formed by the indicated radioisotopes.

This may not seem all that interesting until one thinks through some of the implications. The biotite crystal must be solid or no halo can be recorded. For a complete, uniform halo, the center must contain millions of radioactive atoms of the same isotope type, not just a few, nor can they be dispersed. Twenty half-lives reduces the concentration of the isotope to a millionth of its original value. For parentless haloes (no radon or radium haloes, for example) there is no replenishment. Pure polonium haloes therefore represent extinct radioactivity, with essentially nothing but stable lead left after a few decades. The biotite crystal has been thought to be formed from an igneous melt over thousands of years of cooling. For a ^{218}Po halo to form without the other predecessors means that within about 3 minutes of when the

crystal is solid half the polonium decays and the halo is formed. That is instantaneous on any geologic time scale. The timing is even worse for the rare ^{214}Po halo at 5 microseconds after solidification. This "mystery" strongly suggests that the Precambrian rocks (granites and others) in which such crystals are found were created in a cold state, or only briefly molten. Long ages are not compatible with the existence of parentless polonium haloes. Dr. Robert V. Gentry suggests that this phenomenon might be the signature of the Creator in the rocks. (Others attribute the phenomenon to the Flood period.) Within three minutes after Creation the ^{218}Po haloes were "zapped" into the rock crystals. After an hour only one millionth of the original ^{218}Po remained.

Gentry also describes the finding of ^{210}Po haloes in coalified wood from the Colorado Plateau area of Utah. The samples are from the Triassic, Jurassic, and Eocene geologic periods. There is not as much problem with time because of the 138 day half-life. But something else was found. The haloes were crushed. The overburden of accumulating rock compressed the gel-like woody material as it was turning into coal. The haloes that had formed became ellipsoids. In a small minority of crushed haloes there was still some ^{210}Po left in the center to form another halo concentric with the original. These secondary haloes were not crushed, as shown in the bottom of Figure A6-1. That means that the wood was crushed in a fraction of a year. Such would be consistent with the Genesis Flood time scale, which would have many layers (most of the geologic sedimentary record), with wood accumulation and compression within a fraction of a year.

The latest research on polonium haloes subjected them to heat. It was found that a few hours at temperatures of a few hundred degrees Celsius healed (annealed) the biotite crystal lattice and made the haloes permanently vanish. That also rules out the slow formation of the biotite crystals from an igneous melt. The residual heat would destroy all polonium haloes within hours. (The reference is, M. Armitage and E. Back, 1994. The thermal erasure of radiohalos in biotite. *Creation Ex Nihilo Technical Journal.* **8**, 212- 222.)

Figure A7-1. A rock with fecal pellets found near the channel sandstone on the south side of the road cut at Dinosaur Ridge.

Appendix 7. Fecal Pellets

On April 10, 1993, during a training session for future tour guides for Friends of Dinosaur Ridge I spotted a fallen rock near the channel sandstone at the hairpin turn of Alameda Parkway. It had a bedding plane covered with fecal pellets, the excretions of some small invertebrates. That rock, illustrated in Figure A7-1 with a 20 cm ruler, is now stored in the Morrison Museum of Natural History. Similar rocks have fallen in recent years. The presence of the fecal pellets on a rock that comes from layers with abundant plant debris (most interpreted as charcoal fragments) may indicate that some of the plant matter was still digestible after burial.

There is an apparent passage of time involved in the eating of the plant matter, or at least ingesting sediment, but further sedimentation above did not have to cease. The overburden needed only to be restricted enough so as not to crush the combined plant matter (logs?) and whatever was eating it.

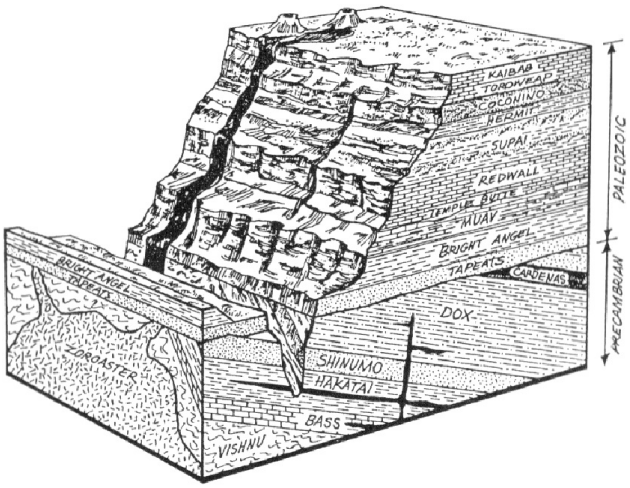

Figure A8-1. A schematic diagram of the Grand Canyon, showing the relative locations of various strata. The Hakatai shale is near the bottom.

Appendix 8. Fossil Pine Pollen

The question is often asked by visitors if pine trees were present at the time of the dinosaurs. While the Lockley guide to Dinosaur Ridge does not name pines in its brief description of this stop, there is evidence that pines have been around since the beginning of life on earth. In 1965 Clifford Burdick discovered fossil pine pollen in the Hakatai shale at the bottom of the Grand Canyon. Other workers gathered samples in 1970 and 1984, and confirmed its presence. The fossil pine pollen in the illustration (Figure 20) is from the 1984 samples. The schematic diagram (from *Grand Canyon, Monument to Catastrophe* by Steven A. Austin) in Figure A8-1 shows the relative location of the Hakatai shale. It is the second sedimentary layer above the crystalline basement rocks, all of which are tilted and lie below the Tapeats sandstone, the lowest horizontal layer. These tilted rocks are designated Precambrian. According to evolutionary theory, the most that should be found in Precambrian rocks are single celled and simple multi-celled plants and animals. To have mature pine trees, as evidenced by the presence of the pollen, speaks against the evolutionary theory. It confirms the position that living things were fully developed from the beginning.

The 1965 discovery was criticized for the possibility of contamination with modern pollen during analysis. Yet Burdick repeatedly found that his Hakatai shale samples contained pine pollen while his samples from higher layers, treated the same way, had none. Furthermore the fossil pollen was stained red with the rest of the rock materials and modern pollen is always yellow. The 1970 samples were found by some workers to have pine pollen while other workers, who used hydrofluoric acid, found none. The 1984 samples were collected in February when snow covered the ground beneath the local pine trees and all plants were dormant; no pollen should have been in the air. The rock samples were immediately sealed in new plastic bags. Care was taken in the laboratories to minimize possibilities of any other contamination. Again the Hakatai shale samples had fossil pine pollen and samples from the higher Hermit shale and Supai group, all treated the same way, had none. The same workers also intentionally exposed many slides to one to eight weeks of laboratory and classroom air and found only three possible pollen grains amongst mostly spores and other organic debris. Their studies virtually eliminated the possibility of modern contamination of these ancient rock samples. Readers are encouraged to read the original papers (some listed below) for the details of the research.

The comparison between the fossil pine pollen and the modern pine pollen under the microscope

shows that the pollen shape has not changed appreciably since the beginning. That is in keeping with many other things in the fossil record. The first ant, dragonfly, bat, coelacanth fish, etc., look like those living today with variations within the range of those observed in present kinds.

Some pine pollen references (CRSQ=*Creation Research Society Quarterly*):
Burdick, C.L., 1966. Microflora of the Grand Canyon. CRSQ **3**,38-50.
Burdick, C.L., 1972. Progress report on Grand Canyon palynology. CRSQ **9**, 25-36.
Howe, G.F., E.L. Williams, G.T. Matzko, and W.E. Lammerts, 1986. Pollen research update. CRSQ **22**, 181-182.
_____, 1986. Creation Research Society studies on Precambrian pollen, Part I--a review. CRSQ **23**, 99-104
_____, 1988. Creation Research Society studies on Precambrian pollen, Part III: a pollen analysis of Hakatai shale and other Grand Canyon rocks. CRSQ **24**, 173-182.
Lammerts, W.E., and G.F. Howe, 1987. Creation Research Society studies on Precambrian pollen--Part II: Experiments in atmospheric pollen contamination of microscope slides. CRSQ **23**, 151-153.
The references in these articles can lead the reader to the other reports.)

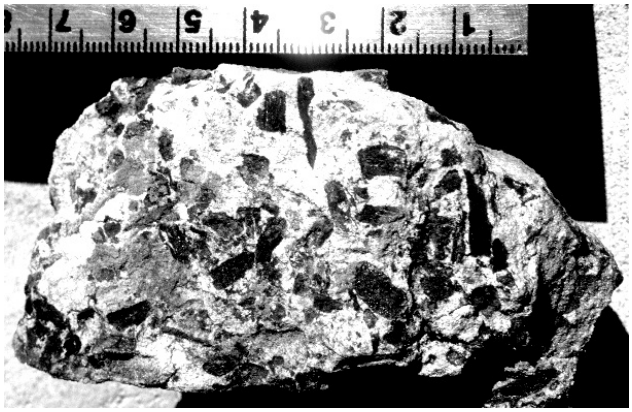

Figure A9-1. An example of charcoal (black) in Dakota sandstone found in Morrison. The ruler

Appendix 9. Further Comments on the Plant Fossils

Charcoal Most of the remains of former plants at Dinosaur Ridge are casts with black coloration, as in Figure A9-1. Others lack the black. The black casts are usually in a silt and sand matrix that only recorded the basic size and shape of the wood chip or bark fragment. A few of the carbon-free casts have surfaces hardened by hematite concretion material. The concretion deposits are similar to those in the pipes of my bathroom (Figure A9-2). Those reddish brown casts,

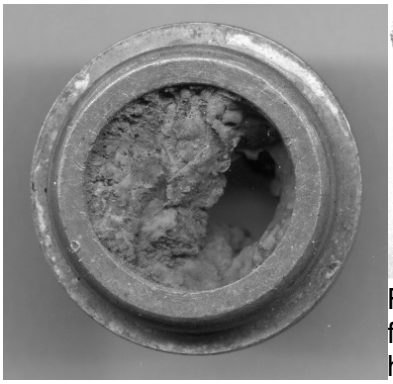

Figure A9-2. Concretion deposits in bathroom pipe.

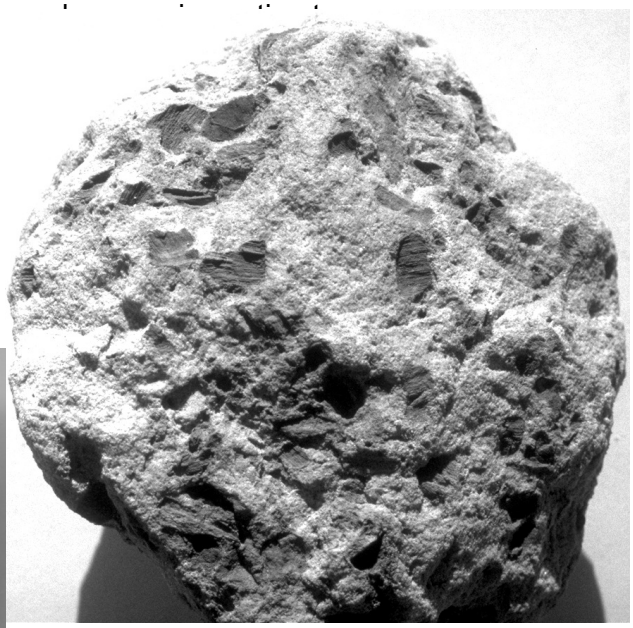

Figure A9-3. The hematite-hardened plant fossil impressions in this 10-cm diameter stone have recorded the wood grain direction. There are also sharp fractures perpendicular to the wood grain.

Figure A9-4. A naturally-broken wood fragment, from Buffalo Creek fire site.

Figure A9-5. Naturally-fractured charcoal from the Buffalo Creek fire site. The cracks are perpendicular to the wood grain direction.

shown in Figure A9-3, are detailed enough to show the wood grain direction. They also show that the wood chips have clean-cut fractured ends perpendicular to the wood grain. If green wood is broken, as by severe turbulence in a flash flood, the fragment ends perpendicular to the wood grain should be frayed (Figure A9-4) and they will rarely be as small as wood chips in size. Charcoal has a natural fracture perpendicular to the wood grain (Figure A9-5) and that is what we see in these fossil impressions.

Sometimes semi-rotten wood can fracture with sharp edges. However, as can be verified at a campfire, charcoalized twigs and branches commonly fracture into shorter cylinders, matching the pattern in the fossils. With so much carbon associated with the Dakota Formation plant fossils, much of it in powdered form (also easy for charcoal), the charcoal hypothesis seems to fit best. The fracture pattern with respect to the wood grain direction is the main indicator, followed by the presence of carbon.

Normal Burial It seems that a forest fire environment is a good model to investigate for the depositional processes that created the plant fossil materials of Dinosaur Ridge. The creek draining the Sugarloaf Mtn. 1989 fire site, west of Boulder, Colorado, was checked two years and 5.5 years after the

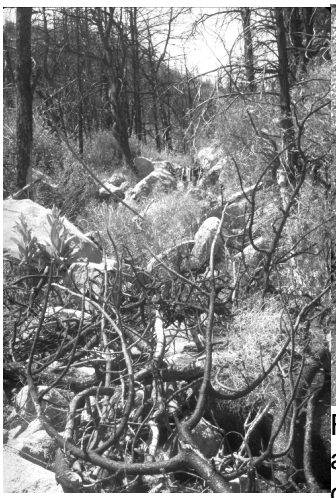

Figure A9-6. Charcoal and sand are both arriving in the creek bed years after a forest fire.

Figure A9-7. Trenches dug in sandbars formed after the Sugarloaf forest fire were always devoid of charcoal within. Both charcoal and dried twigs were, however, on the surface. The pen shows the scale. A sieved coring of this area is shown in Figure A9-8.

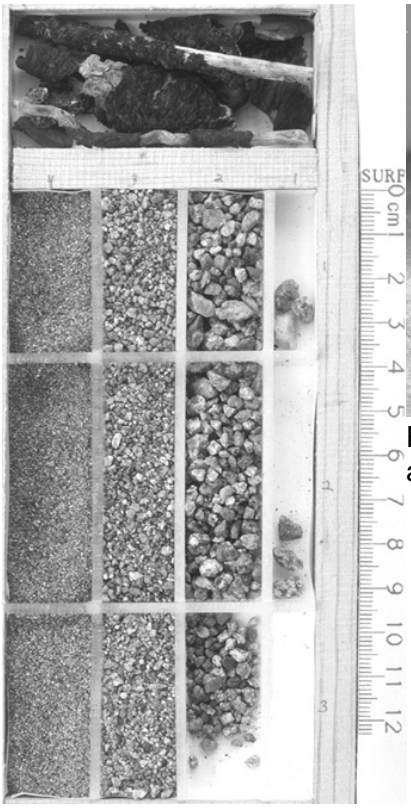

Figure A9-8. A core of sand at the Sugarloaf Mtn. Fire site.

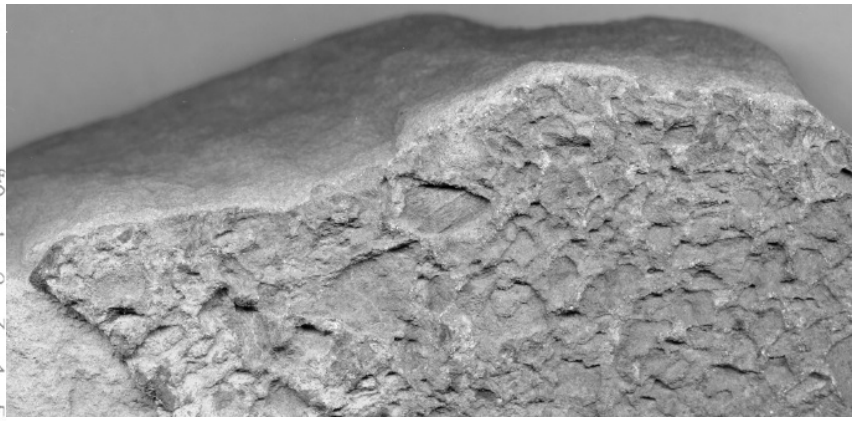

Figure A9-9. A sample of fossil charcoal wood chip impressions at a flat bedding plane. These have hematite hardening.

fire. At both times (see Figure A9-6) sand and charcoal were still being washed off the slopes and were present in the creek bed. Spring flooding had caused the creek to overflow in many locations, creating new sand deposits since the fire. Small waterfalls had new sand bars beyond their plunge pools. These sand deposits were trenched (Figure A9-7) and cored (Figure A9-8) to see if the charcoal/sand mixtures found at Dinosaur Ridge could be found there. They were not. The sand was always pure, with charcoal resting on the surface.

Figure A9-8 shows the contents of a 14-cm deep core made by pushing a can into a sandbar at the Sugarloaf Mtn. fire site. The contents were divided into three levels, as shown, and sieved to separate the grain sizes. No carbon was found mixed with the sand. At the top are some pieces of wood, bark, and charcoal found on the surface within a meter of the core site.

There is an important buoyancy difference between plant matter and sand. Quartz sand has a density of 2.65 while plant matter density can range from about 0.2 to 1.1 depending on whether it is green, rotten, charcoal, or waterlogged. Therefore in situations of sufficient water and agitation, such as normal stream processes, the plant matter will be separated from the sand by buoyancy. Later processes, like plant root growth, may trap debris at the top surface when a subsequent layer of sand is deposited on top. This will create a layer of plant

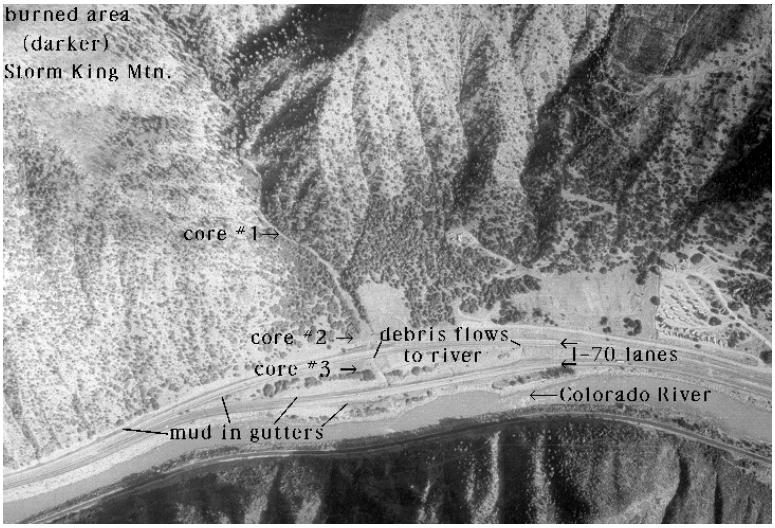

Figure A9-10. AN aerial view of the Storm King Mtn. Mudslide that blocked the Interstate highway for three days. The red mud was easy to see in the original color version.

debris at a bedding plane, as in Figure A9-9. Some of the plant fossil material at Dinosaur Ridge is at bedding planes. However, much of it is mixed within the sandstone in a style not observed at Sugarloaf Mtn. That requires a different style of deposition.

Catastrophic Burial There was a severe fire at Storm King Mountain, west of Glenwood Springs, Colorado, on July 6, 1994, that killed 14 fire fighters. On the evening of September 1, 1994, a thunderstorm washed the fire site, causing a flow of debris that blocked Interstate-70 for

the next three days. The aerial photograph in Figure A9-10 shows the site on September 6. This catastrophic flow presented another set of deposition conditions in which charcoal and sand were involved. Three cores of the deposit were taken on September 4, while the soft mud was drying and forming mud cracks. One was

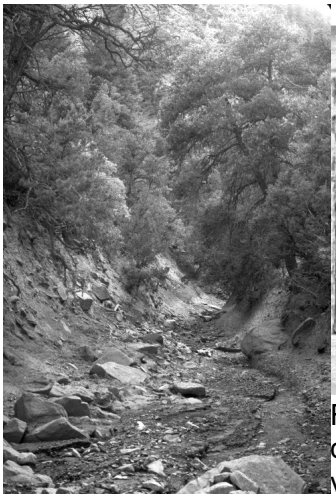

Figure A9-11. The creek bed was scoured by a 2-meter high debris flow.

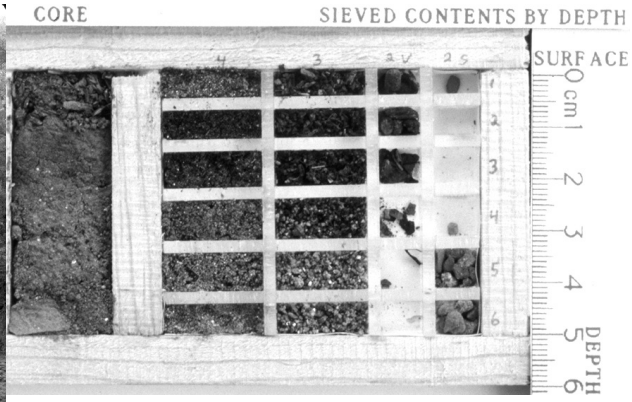

Figure A9-12. A coring, sorted by size and depth, made in a settling pool located in the view of Figure A9-11, was highly stratified. Charcoal and other plant matter was on top, then silt, then sand and stones on the bottom.

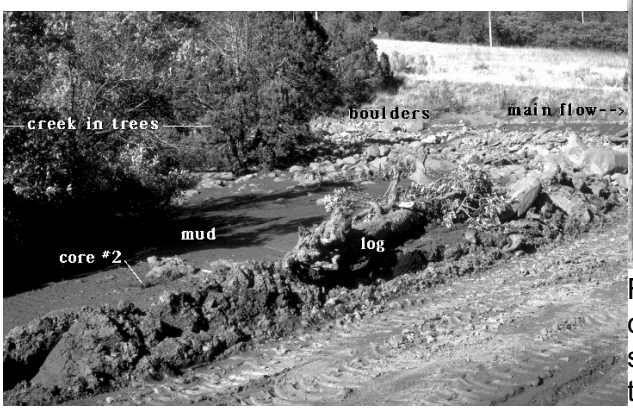

Figure A9-13. A mixture of charcoal and mud was cored adjacent to the dump of boulders of the debris flow.

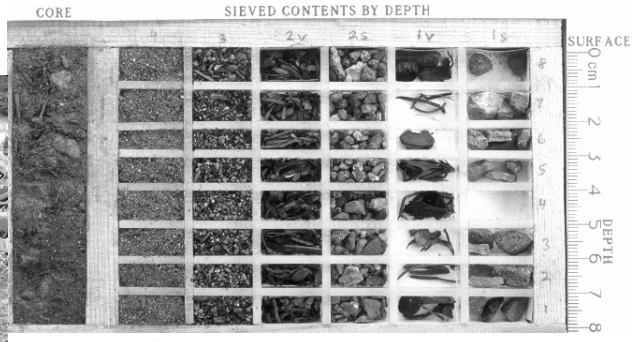

Figure A9-14. The sieved and depth-sorted core, obtained from a site in Figure A9-13, shows charcoal and plant matter distributed throughout the core depth. The larger sizes were also sorted to plant matter or stones.

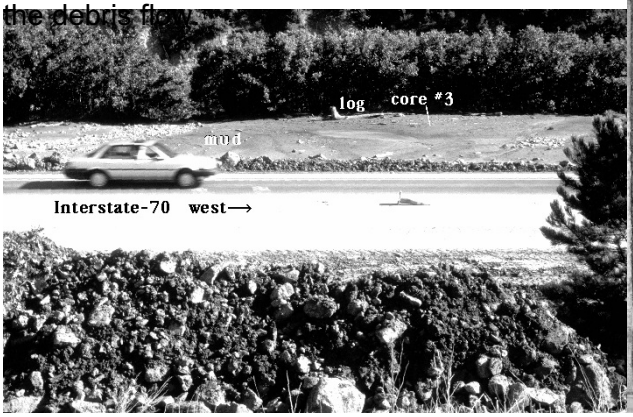

Figure A9-15. The debris and mud crossed this I-70 lane, the median beyond, the east-bound lane and then entered the Colorado River. The location of the mud core shown in Figure A9-16 is indicated.

Figure A9-16. The third core also shows plant matter and charcoal distributed throughout a depth that was 14 cm before it settled and dried. The larger sizes were also sorted by plant matter or stones.

in the creek bed channel (Figure A9-11) that had been scoured by the two-meter high debris flow. A minor depression had been refilled by receding waters and lingering debris. That core showed (by x-ray and the dissection, Figure A9-12) the expected pattern of coarse sand on the bottom, fining upward to silt in the middle, and then an abrupt transition to charcoal and other vegetation fragments on top. Buoyancy and settling speeds had created highly stratified layers in this small deposit. Preservation of the deposit in the geologic record would show the plant matter confined to a bedding plane for the aftermath of a catastrophic debris flow.

The two other cores were taken to the north (Figure A9-13) and south (Figure A9-15) of the westbound Interstate lanes. Charcoal and log debris were on top, as expected from buoyancy considerations. Both x-rays and sieved dissection (Figures A9-14 and A9-16) showed charcoal and other plant fragments mixed throughout depths to 14 cm. There apparently was enough water to move the debris into place but not enough water to separate it by buoyancy. That indicates that a catastrophic flow of charcoal and sand can create the mixing found in much of the deposit at Dinosaur Ridge. Fossilization of the Storm King deposits at the second and third core locations would create charcoal throughout the deposit with concentrated charcoal at a bedding plane representing the top of the debris flow.

Interpretation The reader can now interpret the individual layers in the Dinosaur Ridge plant fossil deposit. Look closely at the individual rocks in the roadcut. If you find the fossils concentrated at a bedding plane in this cross-bedded sandstone, but none within the sandstone layer below, then the charcoal settled at this surface as the sand was deposited under normal conditions or buoyancy lifted the charcoal from a very wet slurry. Something then caused the charcoal to adhere to the surface so that it did not float away when the next sand deposit was placed on top. If you find charcoal fragments mixed within the sand itself, then the layer was deposited by a catastrophic flow. There may still be a higher concentration of charcoal at the bedding planes.

Such a close examination should show that much of the deposit, exceeding 10 meters in depth, was from catastrophic processes, with each flow happening within a small fraction of an hour as at Storm King Mtn. Next look at the bedding planes again for evidence of the passage of time. Are there plant roots, animal burrows, or soil formation that disrupt the bedding planes? None have been found yet. Therefore it is possible to claim that the entire plant fossil deposit of over 10 meters of cross-bedded sandstones was placed here in a fraction of a year. The few shale layers within the deposit could have had the mud settle out in calm interludes of several days. So we are not dealing with millions of years for the deposition of these plant fossils. The deposition rate exceeds meters per year. That is a million times faster than the average deposition rate achieved from the evolutionary time scale. The catastrophic processes necessary for a deposit like that at Dinosaur Ridge are rare today, but are still observable on a small scale.

Extent. This research is not finished. I have found this style of broken charcoal two-thirds of the way up through the Dakota formation at many locations:

1. locally: along this hogback from Bellevue Avenue to I-70. The deposit styles vary from scattered impressions at Bellevue Ave., carbon powder at Route 285, intact charcoal at Morrison,

black and red impressions at Dinosaur Ridge, to impressions and carbonaceous shale at I-70. Catastrophic signatures are mainly at Dinosaur Ridge. The variety suggests many local streams, like the channel sandstone at Dinosaur Ridge, each having somewhat different deposition conditions.

2. to the west: I found intact charcoal chips southwest of Montrose, on the West Slope of Colorado, along route 90. Charcoal signatures are hard to find near the Gunnison River northwest of Delta. On top of Black Ridge, west of Grand Junction, the charcoal is mixed within the sand and is close to a layer of centimeter-sized quartzite gravel. That gravel is present at Dinosaur in northwestern Colorado but without charcoal signatures. North of Vernal, Utah, the targeted strata contain a coal seam. The charcoal signature is present at the I-70 road cut at Wolcott, Colorado, along with thick carbon layers. The quartzite gravel suggests a more energetic environment closer to the sediment source. However, the land was covered by the shales and sandstones of the Morrison Formation westward to about central Utah. Quartzite sources were probably west of there, possibly in the Uinta Mountains according to some geologists. So far the variety of deposits suggests large meandering rivers.

3. to the south: I saw a much thinner (15 cm) layer on the Skyline Drive hogback on the west side of Canon City, far to the south of Dinosaur Ridge. That layer is closer to the bedding plane style rather than a catastrophic mixing. There are oval impressions in some rocks that initially look like the charcoal fragment impressions, but close examinations shows some of them to be filled with clay balls. Rolled clay balls in sandstone suggest energetic deposition conditions, but the clay is not the subject here. There is only carbonaceous shale at Garden of the Gods near Colorado Springs.

4. to the north: At Fort Collins the broken charcoal is still black at bedding planes, some of which have a steep angle of crossbedding to the (then) local horizontal. In a thick deposit at Newcastle, Wyoming, to the west side of the Black Hills, the charcoal is sometimes in centimeter-sized pieces that can be removed from the rock and crushed in one's fingers. Both rapid and slow deposition rates and some hematite hardening are represented there.

5. elsewhere: It appears that at least the broken charcoal phenomenon is widespread. The catastrophic burial style was represented at the Dinosaur Ridge area, Grand Junction, Wolcott, and Newcastle. Further research could check for charcoal and bedding styles in the many drill cores through the Dakota Formation stored at the USGS Core Research Laboratory, Building 810, at the Denver Federal Center, just east of Dinosaur Ridge.

For those deposits that are catastrophic in nature, an energy mechanism still needs to be identified. There was not supposed to be much vertical relief in the landscape as the Dakota layers were being deposited. There was no equivalent of Storm King Mountain in the area to get the debris and mud moving. Did a hurricane or tsunami or asteroid impact cause the burial? To help answer these questions the geographic extents and bedding type of the charcoal deposits need to be mapped along with any indicators of flow direction.

Footprints. While I was walking in the soft mud at the Storm King Mountain debris flow site I

was leaving footprints, some of which are visible in my photographs. Deer prints were also made in my absence. Though no study was made of those footprints, it could have been an interesting one. How long would the footprints have remained? That would depend on the rates of baking of the mud versus the occurrence of the next showers of rain. Presumably the best preservation would be for the mud to bake hard and then be overlaid by another mud flow before water had a chance to soften the mud that I walked upon. If rain got to the footprints before preservation they would be damaged or destroyed. The study would have shown that catastrophic processes (rapid deposition) are usually necessary for the preservation of footprints in the geologic record. My footprints were presumably destroyed by rains and melting snow before the next mud flows which occurred at the end of May 1995.

Figure A10-1. One bowl contains sand and the other charcoal, both from forest fire sites.

Appendix 10. Lab Experiment: Mixing Charcoal and Sand

The power of buoyancy in separating a mixture of charcoal and sand can be observed by a simple experiment. I have taken materials from two forest fire sites. You can gather similar materials from any source. Figure A10-1 shows two bowls, one with sand from the Sugarloaf Mtn. fire site, the other with charcoal from the Buffalo Creek fire site gathered after the first flash flood. On March 18, 1996, the Buffalo Creek fire consumed several square miles of forest southwest of Dinosaur Ridge. In the weeks and months thereafter numerous torrential thunderstorms washed the slopes and caused flooding in stream channels. One flood washed out roads and bridges and killed two people. The first

Figure A10-2. If a charcoal and sand mixture is dry or slightly wet, it can remain mixed, as in this jar. Vibrations can cause the sand to sink and the charcoal to rise.

Figure A10-3. Charcoal is much more buoyant than sand in a water environment, even if waterlogged. These separated in about five seconds.

flood in early June moved both sand and charcoal. None of the charcoal mixed into the sand; it was all deposited on top because of buoyancy. A bag of charcoal was gathered from the deposits. The fine fragments were screened out and the giant fragments were removed by hand.

The medium sizes (several mm to cm) were mixed in a jar with sand from the Sugarloaf Mtn. fire site. If no water was added to the jar, or only enough to make the mixture damp, then the sand and charcoal would readily mix and stay that way, as seen in Figure A10-2. However, vibrations from travel in a car can cause a dry mixture to stratify with charcoal on top. Adding water to about two inches above the sand layer initiated strong buoyancy forces. Twirling and shaking the jar temporarily mixed the materials, but the initially dry charcoal rose to the top of the water in about 1 second after agitation stopped. After the charcoal was mostly waterlogged for a month, similar shaking resulted in most of the charcoal rising only to the top of the sand in about 5 seconds (Figure A10-3). A few pieces of charcoal remained in the sand because of confinement in a dense part of the slurry. This simple experiment shows the strength of the buoyancy forces in a charcoal-sand-water mixture.

Appendix 11. Genesis Flood Overview and Mechanisms

A global Flood like that described in the book of Genesis in the Bible is difficult for many people to accept, particularly those who have been taught the theory of millions and billions of years of evolutionary development. For this past century it has not been "politically correct" to promote or do research supportive of the young-earth position, even though most of the great scientists of the past did so. In recent decades a minority of scientists have begun to re-examine the evidence and make new research discoveries. The sources listed in Appendix 15 will lead you to their writings. The International Conferences on Creationism have been particularly helpful in focusing scientific and Biblical research towards an understanding of Genesis events using modern tools. I'll sketch one series of investigations that is emerging from peer review as particularly worthy of attention. All conference proceedings have several papers on the latest research.

First consider a former state of the earth, with a hot interior caused by primordial heat, heat from short- lived radioactivity that is now extinct, heat from a decaying magnetic field, and heat from tides in the rocks. The first three should exhibit near-exponential decay of their intensity. The ocean crust and upper mantle are basically of the same composition, basalt. The ocean crust is cooler than the mantle and therefore more dense. Buoyancy laws indicate that such is an unstable situation, and the crust should seek to overturn with respect to the mantle. What limits such an overturning today to a slow subduction is the great viscosity of the rock. However, consider a state in which the mantle was hot enough in the past, from the greater heat sources, to be much less viscous.

Numerical modeling of the 3-D mantle structure with crustal plates, both oceanic and continental, by John Baumgardner has shown that the overturning of the ocean mantle under less viscous conditions can become a run-away process, with crustal movements at speeds like 3 m/s rather than the maximum of 0.1 m/yr observed today. The simulations show continental breakup and drift. Modern earthquake analyses show piles of denser rock at the base of the mantle under

past subduction zones. These could be the deposits from a catastrophic ocean mantle overturning. That they are still dense and have not totally warmed up indicates that the passage of time since the subduction has not been great. So creationists are becoming comfortable with some parts of the continental drift/plate tectonics evidences (first proposed by creationists in the last century), but champion a much higher speed at the time of the Flood, exponentially decaying to today's slow rates.

The mantle convection, with cold oceanic crusts dumping onto the earth's core would cause severe fluctuations in the magnetic field of the earth, in turn causing local reversals at the earth's surface without zeroing the primary magnetic moment of the earth. The magnetic fluctuations and changes from convection may have been similar to what we see on the sun. The studies of Russell Humphreys give better details. (He correctly predicted the magnetic intensities of Uranus and Neptune before they were measured by Voyager 2.) His theories suggest a freely decaying magnetic moment of the earth before the Flood, chaotic reversals of weak intensity during the Flood, recovery until about 2000 years ago, and a resumption of the free exponential decay that is measured today.

In the overturning of the mantle and rapid subduction of the old ocean crust, new hot ocean crust was formed. Being hot, it was less dense and took up more volume. The ocean water was thereby displaced and had no place to go but onto the continents (the global Flood!). This corresponds to the abundance of marine sediments during Paleozoic times. Recent computer modeling of the new ocean currents (friction included) over the former continental masses suggests high velocity shallow water in giant spinning vortices. The conditions are appropriate in many locations for the rapid destruction of rock by the process of cavitation. This may be the mechanism for rapidly reducing hard rock landscapes to sand and mud for the production of later sediments.

A hot ocean floor (cooling basalt) heated the waters above the spreading zones, while evaporation and return flow from precipitation and rivers, if any, cooled the oceans. We have been learning in recent decades what a strong influence warm ocean water (El Nino effect) has on rainfall patterns on the continents. A warm water surface evaporates water much more rapidly than cool water. That water vapor enters the weather patterns, releasing heat energy in clouds and fueling the precipitation from them. Though atmospheric dynamics cause droughts in some areas, warm oceans cause a net increase in precipitation globally. A hot ocean at the time of the Flood would have caused greatly increased cloudiness and torrential rains (that is also in the Flood story).

Increased cloudiness produces a cooler atmosphere by reflecting the energy from the sun back into space. Cooling is greatest over the continents where the heat loss is not offset by hot ocean water. A temperature contrast between warm atmospheres over the oceans and cold atmospheres over the continents greatly increases jet stream strength and storm intensity. That amplifies the precipitation cycle where the warm and cold atmospheres meet.

As the oceans gradually cooled after the Flood, there was an onset of snow from storms over the continents, especially continental margins. The cloudiness and abundant snowfall rate prevented

the appreciable melting of the snow and lead to the continental glaciers. Eventually the oceanic cooling was sufficient to reduce cloudiness and precipitation rates, allowing the glaciers to decay and recede. This scenario, by Michael Oard, indicates that the hot ocean waters after the Flood produced the Ice Age. It lasted only centuries, however, not hundreds of thousands of years.

Asteroid impacts are allowed in this growing model of the Flood, but seem incidental. They may have triggered the start of the mantle overturning, fractured continents, and punctuated the story thereafter. There may have been islands of refuge for some animals during the early chaos of the Flood, but eventually all land areas were affected. There are other implications of this Flood model and other details to be worked out. Interested readers should seek out past issues of the references listed in Appendix 15 and monitor future issues.

These studies have detailed how natural processes could have been involved in the Flood described in the Book of Genesis. They leave out miracles, apart from the timing and triggering of events. It is likely that some parts of the scenarios will never be determined. The only records we have of the event are the writings of numerous cultures around the world and the geologic record. Creationist scientists generally trust the Biblical record as most correct but severely lacking in the details about which we are highly curious. Furthermore, we ultimately do not have to exclude the miraculous from the scenario. The few details we have from the Biblical record appear to be compatible with geologic evidences when interpreted from a catastrophic viewpoint.

Appendix 12. Dinosaurs and Humans Together

The question is often asked how the dinosaurs fit into the Biblical time scale. This is still being debated. Consider this scenario: First they were created by God during the fifth (ocean dinosaurs and flying reptiles) and sixth (land dinosaurs) days of Creation Week, just before the creation of Adam and Eve. They were among the creatures that Adam needed to name. Dinosaurs and people lived on the earth at the same time, though possibly in different locations, up to the time of Noah. Most were killed, along with all except 8 people, during the Flood of Noah's time. Notice that all dinosaur fossils and footprints are buried in sediments laid down by water all over the earth. That is a strong correlation for what killed them. Some of every kind of land-dwelling, air-breathing dinosaurs were preserved on the ark (boat) with Noah's family and the other animals. They could have been juveniles (to save space) and may even have been in a hibernation or lethargic state in the darkness of the ship's hold. Those dinosaurs at home in the water or on floating islands of vegetation (probable source of thick coal deposits) did not need shelter on the ark, though most probably died during that year. The chaotic conditions during the Flood may have included asteroid impacts and volcanic eruptions as well as severe erosion of the landforms and abundant sedimentation. The presence of footprints in the fossil record suggests that there may have been times when dinosaurs outside the ark could walk on damp sediment before they died. Those dinosaurs surviving the entire Flood, either on the ark or in the water, most likely experienced different climatic conditions afterwards, including the ice age. Many may have died because they could not cope with the new conditions.

Finally, consider the ancient legends of most cultures. There are creatures described in them that would fit dinosaurs. Those legends frequently tell of people killing those creatures. Yet

dinosaurs were not discovered until within the last two centuries. The word dinosaur did not exist until about 1840. So what did those people really see so that they gave them dinosaur descriptions? In English they were called dragons. It therefore seems that people and dinosaurs did indeed live together at least until perhaps a thousand years ago. So then, what really killed off the dinosaurs? First the Flood killed most of them, just like the fossil record reveals. Then the different post-Flood climate claimed most of the rest. The story of Job in the Bible apparently comes from ice age times. Two creatures, the behemoth and the leviathan, fit dinosaur descriptions much better than any modern animals. Finally, people killed the remaining dinosaurs. Or did they? There are still some reports from recent times that suggest that a few are still in remote places, such as African jungles and jungles near or in Southeast Asia. (The supposed plesiosaur caught off the coast of New Zealand a few decades ago was not one of them; it was the carcass of a basking shark.) Many of the books and articles traceable through Appendix 15 contain further details on this subject.

Appendix 13. Zircon Studies at Dinosaur Ridge

Figure A13-1. Large zircon crystals.

Zircon ($ZrSiO_4$) crystals originate in igneous rocks, being of such a hot melting temperature (2550 C, compared to 1100 to 1600 for common igneous minerals like quartz and feldspars) that they are some of the first minerals to crystalize from cooling magma. They are dense (4.68), hard (7.5), and of tetrahedral crystal structure. Some large zircon crystals from an erratic rock found near Lake Placid, NY, are shown in Figure A13-01. Notice the prismatic or pyramidal ends on some of them. Their durability nearly ensures that zircon fragments will exist in all sediments ultimately derived from weathered igneous rocks.

Zircon crystals always contain hafnium (Hf) in small amounts and radioactive uranium (U) and thorium (Th) in lesser amounts. The latter two decay to lead (Pb) and intermediate elements. Therefore zircon crystals are frequently used for radiometric dating, measuring the concentration ratios of uranium and thorium isotopes compared to lead isotopes.

At Dinosaur Ridge microscopic (small fraction of a millimeter) zircon crystals were extracted in a USGS study from the volcanic ash layer on the western side of the road cut. The sample site was actually on the north side of the road rather than the south side where the sign describing the observations is located. Three crystals with prismatic ends were selected and sent to Canberra, Australia, for precision radiometric dating. Selection of the prismatic ends, as opposed to ends rounded by abrasion, was done in an attempt to ensure that the crystals came from the volcanic ash fall rather than stream deposits. A radiometric “date” of 106 million years was obtained, which is what was expected for a Cretaceous time period appropriate for the Dakota Formation.

The report about the measurements indicated that the environment was a fresh water lake, in accordance with the shale layers above and below the volcanic ash layer. Clays washed into the lake by (fluvial) rivers and streams ultimately coming from western mountain erosion were settling out on the lake bottom to form the shales. These sediments also contained zircon crystals, but their source was from the igneous rocks (like granites) from the western mountains. Their radiometric age would apply to those rocks and therefore be much older than an age of the volcanic ash being simultaneously deposited in the lake. The ash layer is therefore likely contaminated with zircons from the fluvial sources in the upstream mountains. No proof was offered, other than the prismatic crystal ends, to show that the zircon crystals examined were actually from the volcano and not from the mountains. The measurements should have included zircon crystals extracted from the shales above and below the ash layer for comparison. If there is no radiometric age difference, then the ash layer zircons came from the mountains and the 106 million year date does not represent the "age" of the volcanic eruption, which must be much younger than the mountain "age".

A portable x-ray fluorescence instrument, Niton model 703 with a ^{109}Cd source, was used in bulk mode on 27 and 29 September 2001 and 3 November 2001 to examine rocks at Dinosaur Ridge. It shines gamma rays into the rocks and measures and analyzes the resulting x-ray spectrum returning to the instrument to estimate heavy element concentrations. The instrument does not measure zircon directly but the element zirconium. However, zirconium in these rocks is represented by zircon crystals.

Rocks on the south side of the road cut were examined at 2.5 meter horizontal resolution, with zero defined as the Cretaceous Period sign post. A 50 m steel tape measure was laid westward, following just behind the next two sign posts to the west. A 7.5 meter steel tape measure was used to determine distances eastward and westward of the longer tape measure. Irregularities in the ground elevation are not considered to harm these measurements; the long tape was not tightened to prevent sag. The "Puzzle" sign was at 29.4 m; the initial volcanic ash sign was at 48.4 m.

Niton measurements were made perpendicular to the tape measure at heights ranging from knee to shoulder height, at some surface of convenience, while avoiding orange concretions. The positions of the measurements were not marked and so should be considered approximate. The measurements were made every 5 meters at the 5 meter marks and then every 5 meters at the 2.5 meter marks, except for the extreme west end. In that way any drift in the measurements would have been partly compensated for by the alternating sequence pattern. The panorama of Figure

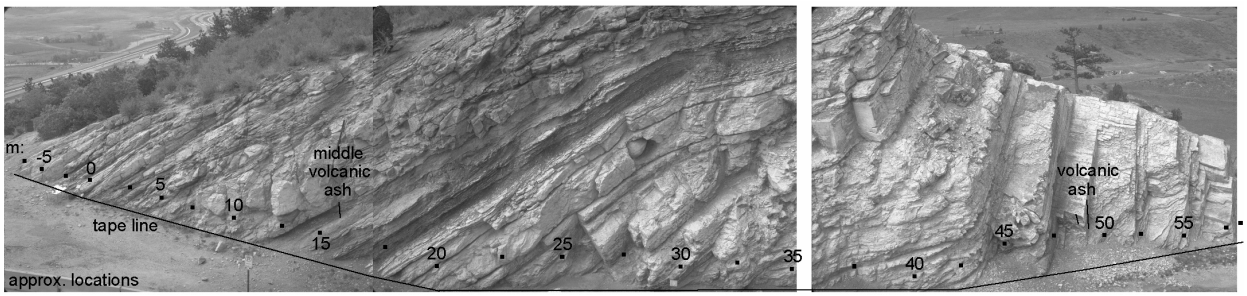

Figure A13-2. Niton measurement locations along the south side of the road cut, in meters.

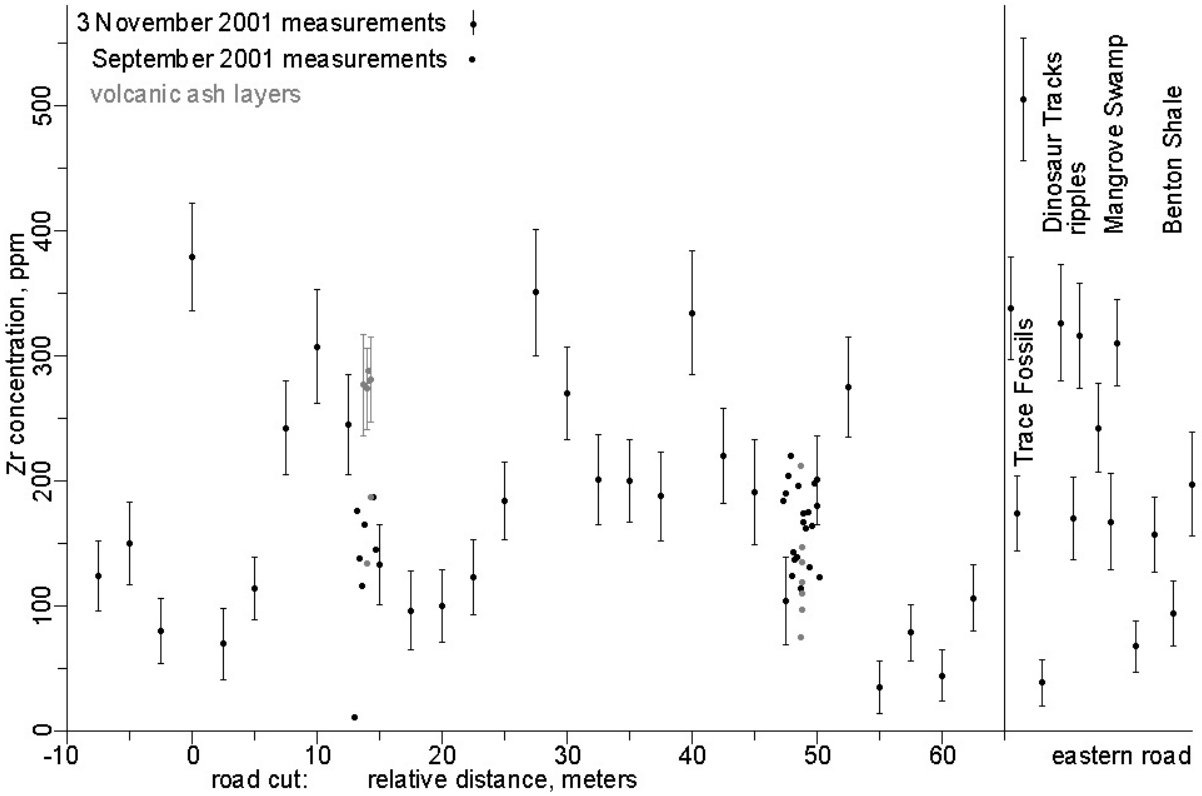

Figure A13-3. Zirconium concentrations throughout the road cut, plus along portions of the eastern roadway. Error bars are those given by the Niton instrument.

A13-2 shows the approximate locations of the samples. The photo vintage is 1994 or before. The downward view prevents accurate mosaicking of the frames. The rock surfaces have changed since the photos, markedly in some places.

The readings for zirconium concentration (proxy for zircon crystals) are plotted in Figure A13-3 on a distance scale for the road cut and arbitrarily for samples from the eastern road between the Trace Fossils and Benton shale. Readings from 3 November are plotted with error bars. Readings from late September are plotted without error bars (the error bars are shown in the following figures) and with somewhat arbitrary positioning to convert from a vertical sequence to horizontal locations. The ash layers are plotted in gray, with and without error bars. It is easily seen that zirconium is present in all samples. It is also obvious that the concentration of zirconium in the ash layers is not significantly different from the concentration in other sediments at Dinosaur Ridge.

The September measurements were at the two large volcanic ash layers, the western layer that was sampled for the USGS radiometric dating study, and the middle ash layer below the channel sandstone. Both were measured on the south side of the road cut. Distances perpendicular to the bedding planes, above and below the ash layers, were identified with a tape measure. The results are presented in Figures A13-4 for the western ash layer and A13-5 for the middle ash layer.

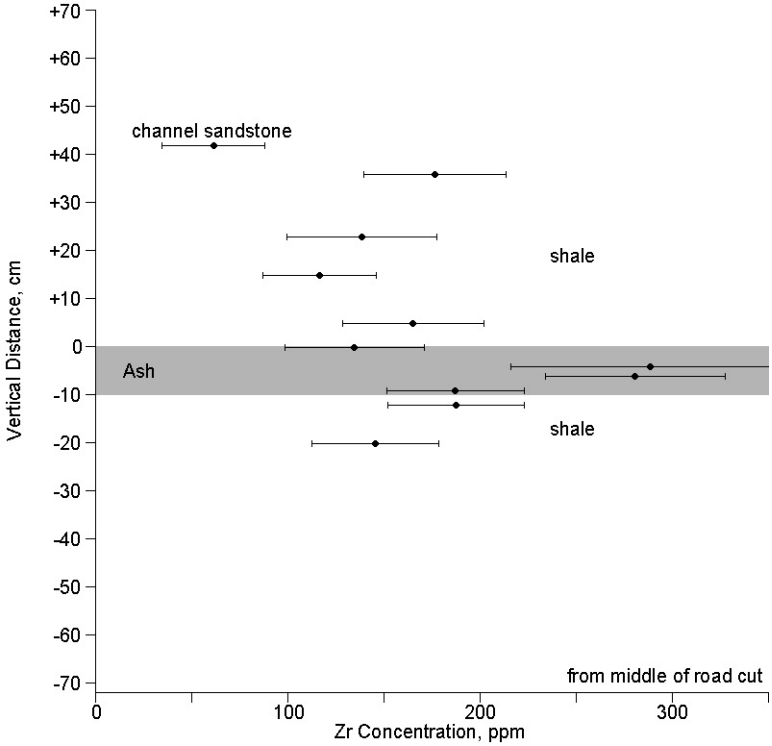

Figure A13-5. Zr concentrations at middle ash layer.

The zirconium concentrations in Figure A13-4 (western ash layer) appear slightly less than in the general shale of adjacent layers. This could indicate that the ash load diluted the zirconium that was coming from the sediments, and that the volcanic ash was not a significant source of zirconium (or zircon crystals). In Figure A13-5 (middle ash layer) two quality measurements in the ash layer are not different from the shale measurements, while two other measurements are about double in size. That might indicate an enhancement of zirconium coming from the volcanic ash, but still half or more of the zirconium is coming from the sediments.

It is the western ash layer that was used for radiometric dating. The evidence from this x-ray fluorescence study strongly suggests that the selected zircon crystals may have been from the sediments that created the shales, not from the volcanic ash. They just happened to be mixed into the ash during the sedimentation process. That means that the 106 million year age of the zircons may not apply to the timing

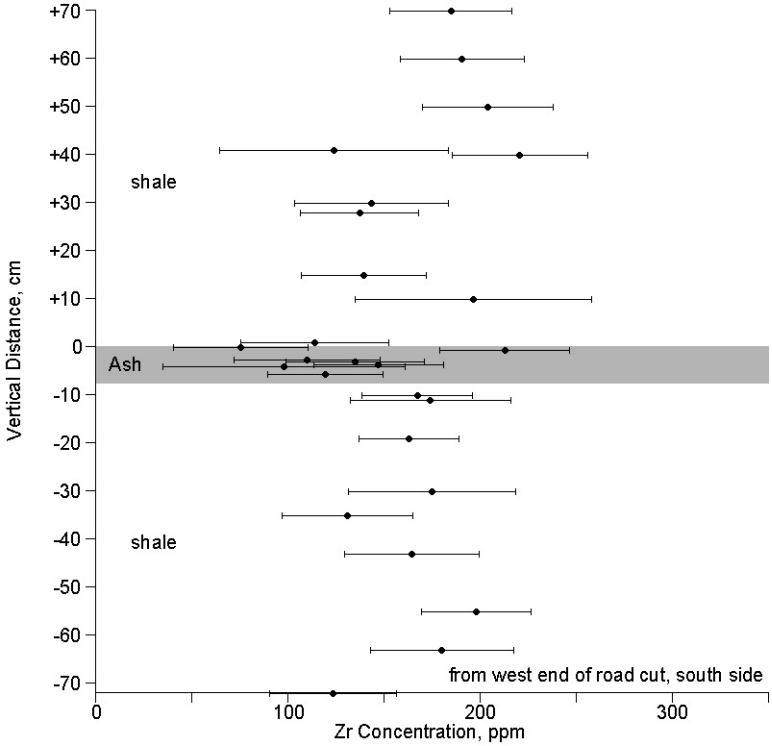

Figure A13-4. Zr concentrations at western ash layer.

of the ash layer nor the adjacent sediments. It applies instead to the emplacement of the igneous rocks that were the ultimate sources of the muds that made the shales. There may have been intermediate sedimentary deposits that gathered the initial erosion products from the igneous sources and later eroded to produce the final muds. All of this indicates a significant amount of erosion and transportation time between the 106 million years and whenever the sediments of Dinosaur Ridge were put in place.

As followup, zircon crystals need to be extracted from both ash layers and from the shales above and below. The crystals should be compared for size distributions and degree of degradation of prismatic ends. The latter would help indicate which crystals were fresh and which were abraded by tumbling in upstream tributaries. In preparation for such studies, samples were gathered from the western ash layer, at 36 and 70 cm below the ash, and at 26 and 69 cm above the ash. Samples were gathered from the middle ash layer where it is exposed at the ridge top on the south side of the road cut, under a sandstone layer. At the time of sampling the ash and shales there were soft. The samples were simply labeled as from the middle ash layer, above it, and below it. Portions of the various samples have been crushed and sorted with soil sieves into various size categories. Some separate samples were soaked in sodium phosphate in an attempt to loosen the adhesion of the shale and ash particles. An apparatus for separating zircons from other minerals by particle density has not yet been constructed. So detailed examination of the zircon crystals is yet to be done.

For an additional comparison, a large bag of new volcanic ash from the Mount St. Helens eruption was sampled at the Winchester Wasteway near Dodson Road southwest of Moses Lake, Washington. The ash layer was several inches thick. Large zircon crystals may have winnowed out of the ash close to the volcano, so it is not known what might remain in central Washington state. Volcanic ash samples were also collected at La Merced, east of Quito, Ecuador, in order to see if anything is different in zircon crystals from another part of the world. Examination of these samples is also waiting for construction of a device to separate minerals by their density.

Appendix 14. My Christian Biases

All people, including scientists, have biases and world views that affect their viewpoints and interpretations. In the main text you saw my present bias towards a young-earth perspective. The discussion was mostly on scientific evidences. That is because I am a scientist. My degrees are a B.S. in astrophysics (Univ. of Rochester, NY, 1966) and a Ph.D. in atmospheric science (State Univ. of NY at Albany, 1971). In the early 90's I took geology classes, mostly from the Colorado School of Mines. I have been doing scientific research since my late high school years. I did not rely in the main text of this booklet upon anything directly Biblical nor any miracles. In the Appendices I explained some things with Biblical references. I have found over the past few decades that most creationist theories can be defended on scientific grounds alone. It is also satisfying that creationist theories, properly developed scientifically, are usually in agreement with teachings in the Bible.

I grew up in a branch of the Lutheran church that had a liberal theology. I was content with the theory of evolution I learned during my years in public school, college, and graduate school. I

was basically a theistic evolutionist, believing that God used evolution to make everything that there is, and that he did so over billions of years. I was already a Christian in the Biblical sense by my teenage years, having grown in the faith through Sunday School instruction and worship services. By the time of my confirmation in the Lutheran church I could truly say publicly that I believed the doctrines of the Trinitarian Christian faith, trusted only in the work of Jesus Christ for my salvation, and wanted to serve Him as my Lord for the rest of my life. I had no unusual conversion experience. About five years later, however, I was given a significant spiritual experience in which God made his loving care personally real to me and started a healing of my loner tendencies that I had developed during high school and college. Though I was already devoted to my Lord (1st Great Commandment), God pointed out to me that I do not "love my neighbor" (2nd Great Commandment) by ignoring him (as a loner). I could not heal myself, only lament my condition. So God's healing was a gift. All of the important ministries that the Lord has given me have dated since that time.

My exposure to creationist teachings began during the final year of my work on my Ph.D thesis. I heard a series of radio broadcasts by John D. Jess on his Chapel of the Air program titled "The Birds and the Bees." I reacted against them because they seemed to be saying things that were not scientifically true. I got his book of the same title to do some constructive criticism. After careful study I realized that he was talking from a creationist position, that God directly created everything, and not very long ago. His scientific and Scriptural defenses were justified, even if they were strange to me. A year or two later I started to encounter creationist literature during my three-year stay in Australia. The most important book was *The Genesis Flood* by Whitcomb and Morris, which presented more details of both the scientific and Biblical justification for creation, as opposed to evolution. I still did not like the new ideas but realized that I had to pay attention to them because they were properly justified. It took me a decade of reading more creationist literature before I was comfortable with most of the theories. It was also in Australia that the books of Francis Schaeffer, the theology of the Lutheran Church in Australia, and seeing God in direct action in some parachurch youth organizations, particularly in what is now Fusion, converted me to a conservative theology in terms of trusting what God taught in the Bible. The book *Evangelism Explosion* by D. James Kennedy was a great help in giving me words by which I could express my faith.

In 1986 I decided to attend the First International Conference on Creationism, held in Pittsburgh (and every four years thereafter). In the 1970's I had encountered some scientifically poor writings amongst some of the creationist literature (I use the phrase "all faith and no brains") and wanted to see what some of the writers were really like. At the conference I was impressed by both the scientific quality of the speakers and, by living with them for a week, developed a trust of them personally. I did not encounter the types of creationists that I wanted to avoid. Since then I have been content and eager to work with the teams, listed in Appendix 15, and contribute to the creationist effort by original research, publishing, and speaking. Most of the great scientists of the past supported creationist positions, and I am pleased to align my own scientific efforts in that direction.

The promotion of the theory of evolution in the past two centuries has been strong by those people who want to deny any accountability to a superior being, the Creator. Evolution provided

an excuse for leaving God entirely out of the picture. Everything was left to "Nature" and natural laws. Today we can see what evolutionary indoctrination of the general public has caused. If there is no ultimate accountability to a God, then we can make up our own rules, do whatever we please, and change those rules whenever it suits us. The ills of society have accordingly increased. Notice how fiercely and religiously evolution is championed today, in spite of the evidence against it. The deep underlying issue is accountability to a superior being who is the Creator.

Evolution is a stumbling block that prevents many people from even considering the claims and teachings of Jesus Christ, whom the Bible identifies as God himself, the Creator of all that we see and cannot see. It is His rules that we are obligated to follow, and they do not change. When we seriously examine our lives we realize that it is impossible to perfectly satisfy God's rules for our lives. We fall far short of His standards; we sin. Yet God requires that perfection if we are foolish enough to try to earn the right to be with Him forever. Our holy God cannot tolerate any imperfection in his presence. All people are therefore condemned to be excluded from God's presence forever, a state commonly called Hell. The Bible says that mankind was created perfect in the beginning by our perfect Creator. The willful disobedience of the first people has permanently flawed all of their descendants, making us all unacceptable to God. It is like a genetic disease that we inherit just for being human. Yet God's love for us was so great that He visited us in many forms and at numerous times. The ultimate visit was in the person of Jesus Christ, who was truly man and truly God at the same time. He was the only one to live a perfect life as God required. He then willingly offered His life as a perfect sacrifice (the style required by God in payment for our sins) by dying on the cross. God accepted that sacrifice as sufficient for the sin of the whole world; past, present, and future; and raised Jesus back to life.

We are now accountable to God through Jesus Christ. In His love and mercy for us He offers us an "unfair" exchange: He will trade (in God's eyes) our sinfulness for the perfection of Jesus. Then we can be with Him forever (Heaven), regardless of how flawed our lives have been here on earth. It is a free gift. It is received by faith that Jesus has done everything and we do nothing to earn it. God even supplies that initial faith. It is the same for all people, even those who are mentally handicapped and those who cannot understand what Jesus did because of age. Yet most people want to reject those conditions and thereby exclude themselves from God's free offer. Discovering and accepting by faith what Jesus has done for us is more important than anything else in life. It does not matter whether you prefer evolution or creation theories. If, however, evolutionary ideas are keeping you away from Jesus Christ, then I hope that the this document and in those offered by the groups listed below will free you to more seriously consider the claims of the Bible. The end of the Bible shows that people in heaven worship Jesus, praising Him as our Creator and praising Him as our Savior and Redeemer for lovingly rescuing us from what would otherwise be banishment from His presence forever.

The resources listed in Appendix 15 will lead you to an abundance of good creationist literature, tapes, videos, films, speakers, and conferences. I cannot do justice to the range of topics in this brief booklet.

Appendix 15. Resources

The author can presently be contacted at his home address: Dr. Edmond W. Holroyd, III; 5395 Howell St.; Arvada, CO 80002-1523-95; (303) 279-5395; eholroyd@juno.com. There are numerous topics on his web site at **www.EdHolroyd.info**, including the texts of some published articles.

A partial list of creation resources:

Answers In Genesis; P.O. Box 510; (2800 Bullittsburg Church Rd.); Hebron, KY 41048; www.AnswersInGenesis.org; (859)727-2222; www.AnswersBookstore.com. Visit their Creation Museum, near Cincinnati airport in Kentucky. Publish the *Answers* magazine, $24/yr. Numerous speakers available.

Creation Ministries International; 4355 J. Cobb Parkway; PMB 218; Atlanta, GA 30339-3887; 1-800-6161-CMI; www.Creation.com. Get *Creation* magazine ($25/yr) and the technical *Journal of Creation* ($39/yr). CreationMag@creation.info.

Institute for Creation Research; P.O. Box 59029; Dallas, TX 75229; (214) 615-8330; www.icr.org. Publish the monthly newsletter (free, but donations appreciated) *Acts and Facts*. Speakers and tours available. Visit their museum in Santee, CA. Radio program "Science Scripture, and Salvation" available on many stations.

Creation Research Society; 6801 N. Highway 89; Chino Valley, AZ 86323; (928) 636-1153; www.creationresearch.org; crsvarc@starband.net. Publish the technical *CRSQ* journal, $32/yr. Voting members must have a graduate degree in a field of science. Books available.

Proceedings, International Conference on Creationism, thick hard-bound books released about every 4 or 5 years with latest research findings. From Creation Science Fellowship, Inc.; 705 Washington Drive; Pittsburgh, PA 15229; also P.O. Box 99303; Pittsburgh, PA 15233-4303.

Eden Communications / Films For Christ; P.O. Box 200; Gilbert, AZ 85299; (480)-507-3621; mail@eden.org; www.eden.org; www.ChristianAnswers.net. Films, videos, web site answers available.

Alpha Omega Institute; P.O. Box 4343; Grand Junction, CO 81502; (970) 523-9943; www.discovercreation.org. Speakers, books, family camps available.

Rocky Mountain Creation Fellowship; www.youngearth.org. Meetings second Friday of month at Bethlehem Lutheran Church, 2100 Wadsworth Blvd., Lakewood, CO; 7 PM. Books and tapes available.