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RADIOACTIVE HALOS: IMPLICATIONS FOR CREATION

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ABSTRACT

If the earth was created, it is axiomatic that created (primordial) rocks must now exist on the earth, and if there was a Flood there must now exist sedimentary rocks and other evidences of that event. But, if the general uniformitarian principle is correct, the universe evolved to its present state only by the unvarying action of known physical laws and all natural phenomena must fit into the evolutionary mosaic. If this fundamental principle is wrong, all the pieces in the evolutionary mosaic become unglued. Evidence that something is drastically wrong comes from the fact that this basic evolutionary premise has failed to provide a verifiable explanation for the widespread occurrence of Po halos in Precambrian granites, a phenomena which I suggest are in situ evidences that those rocks were created almost instantaneously in accord with Psalm 33:6,9: "By the word of the Lord were the heavens made; and all the host of them by the breath of his mouth. For he spake, and it was done; he commanded, and it stood fast." I have challenged my colleagues to synthesize a piece of granite with ^{218}Po halos as a means of falsifying this interpretation, but have not received a response. It is inescapable that this synthesis should be possible if the uniformitarian principle is true. Underdeveloped U halos in coalified wood having high U/Pb ratios are cited evidences for a Flood-related recent (within the past few thousand years) emplacement of geological formations thought to be more than 100,000,000 years old. Results of differential He analyses of zircons taken from deep granite cores are evidence for a recently created, several-thousand-year-age of the earth. A creation model with three singularities, involving events beyond explanation by known physical laws, is proposed to account for these evidences.

URANIUM AND THORIUM RADIOHALOS IN MINERALS

A radioactive halo is generally defined as any type of discolored, radiation-damaged region within a mineral and usually results from either alpha or, more rarely, beta emission from a central radioactive inclusion. When the central inclusions, or radiocenters, are small (about 1 micrometer), the U and Th daughter alpha emitters produce a series of discolored concentric spheres, which in thin section appear microscopically as concentric rings whose radii correspond to the ranges of the various alpha emitters in the mineral.

Ordinary radiohalos are herein defined as those which initiate with ^{238}U and/or ^{232}Th alpha decay (1), irrespective of whether the actual U or Th halo closely matches the respective idealized alpha decay patterns. In a few instances the match is very good.

Compare, for example, the idealized U halo ring pattern in Fig. 1a with the well developed U halos in biotite (Fig. 1f) and fluorite (Fig. 1h,h'); these halos have ring sizes that agree very well (1,2) with the ^{4}He ion accelerator-induced coloration bands in these minerals (See Table 1 at the end of the paper). In general a halo ring can be assigned to a definite alpha emitter with confidence only when the halo radiocenter is about 1 micrometer in size.

In other cases, however, such as the halos in fluorite (1,2) shown in Fig. 1(g, i-m), much work was required before these halos could be reliably associated with U alpha decay (2). As explained elsewhere (2), reversal effects accompanying extreme radiation damage caused the appearance of rings that could not be associated with definite alpha emitters of the U decay chain. Thus some halos may exhibit a ring structure different from the idealized U and/or Th alpha decay patterns because of reversal effects. And even though most other halos exhibit blurred ring structures due to the large size of the inclusions, nevertheless the outer dimensions allow them to be classified as U and/or Th types.

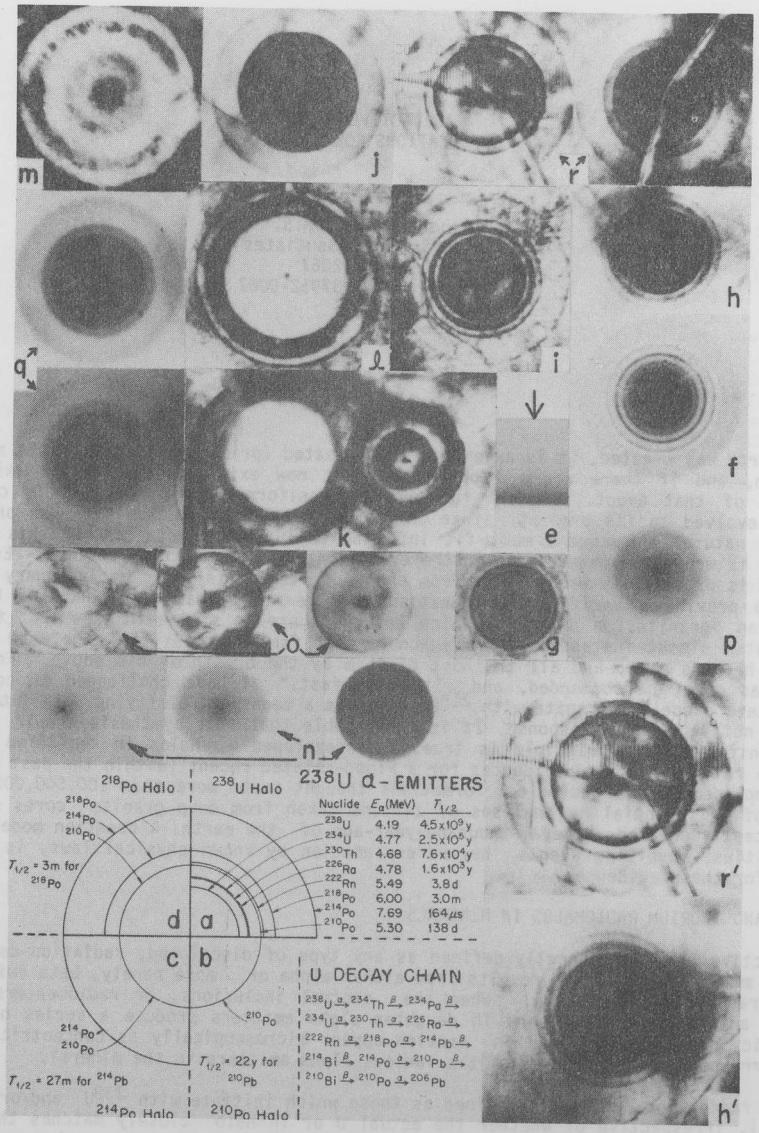

Figure 1. Scale is about 1 cm = 30.0 micrometers, except for (h') and (r'), which are enlargements of (h) and (r). (a)Schematic drawing of ^{238}U halo with radii proportional to ranges of alpha particles in air. (b)Schematic of ^{210}Po halo. (e)Coloration band formed in mica by 7.7-MeV ^{4}He ions. Arrow shows direction of beam penetration. (f)A ^{238}U halo in biotite formed by sequential alpha decay of the ^{238}U decay series. (g)Embryonic ^{238}U halo in fluorite with only two rings developed. (h)Normally developed ^{238}U halo in fluorite with nearly all rings visible. (h')Same halo as in (h) but at higher magnification. (i)Well developed ^{238}U halo in fluorite with slightly blurred rings. (j)Overexposed ^{238}U halo in fluorite, showing inner ring obliteration. (k)Two overexposed ^{238}U halos in fluorite, showing outer ring reversal effects. (m) Second-stage reversal in a ^{238}U halo in fluorite. The ring sizes are unrelated to ^{238}U alpha particle ranges. (n)Three ^{210}Po halos of light, medium, and very dark coloration in biotite. Note the difference in radius. (o)Three ^{210}Po halos of varying degrees of coloration in fluorite. (p)A ^{214}Po halo in biotite. (q)Two ^{218}Po halos in biotite. (r)Two ^{218}Po halos in fluorite. (r')Same halos as in (r) but at higher magnification.

Modern analytical techniques such as Scanning Electron Microscope X Ray Fluoresence (SEMXRF) and Ion Microprobe Mass Spectrometry (IMMA) methods have been utilized to show that U and Th and their respective end-product isotopes of Pb are contained within the U and Th halo radio centers. As is noted shortly, these modern analytical techniques have proved quite valuable in demonstrating that Po halo radiocenters in minerals contain little or no U or Th, which is in direct contrast to the abundance of these elements detected in the U and/or Th halo radiocenters (2,3).

RADIOACTIVE HALOS AND THE QUESTION OF INVARIANT DECAY RATES

A most important question pertaining to the evolution/creation issue is whether radioactive decay rates have remained invariant during the course of earth history. If they have, geochronologists are justified in interpreting various parent/daughter isotope ratios found in undisturbed rocks in terms of elapsed time. If on the other hand there have been periods in earth history where the decay rate was higher (i. e., during a singularity), then in general the isotope ratios in rocks would not reflect elapsed time except in the specific case where secondary rocks or substances containing only the parent radionuclide formed at the end of the most recent singularity. The practical significance of this last statement will be evident in the discussion of the secondary U halos found in coalified wood specimens from the Colorado Plateau.

Even though most of Joly's (4) measurements of U and Th halos showed their radii were about the sizes expected from the alpha decay energies of the U and Th decay chains, nevertheless he claimed there were slight discrepancies which raised questions about whether the radioactive decay rate had been constant over geological time. His result was not confirmed however by later halo radii measurements (5-10), which agreed to within experimental error with the theoretical sizes. To eliminate any uncertainty about this correspondence I irradiated specimens of various minerals with He ion beams of varying energies to produce different size coloration bands whose widths corresponded to the various alpha energies of the U decay chain. The results of these experiments, presented in Table 1, show there is excellent agreement between the U and Th halo radii and equivalent He ion produced penetration depths (2).

The basis for thinking that standard size U and Th halos imply an invariant decay rate throughout geological time proceeds from the quantum mechanical treatment of alpha decay, which in general shows that the probability for alpha decay for a given nuclide is dependent on the energy with which the alpha particle is emitted from the nucleus. The argument is that if the decay rate had varied in the past, then the U and Th halo rings would be of different size now because the energies of the alpha particles would have been different during the period of change. This argument assumes that a change in the decay rate must necessarily be explainable by quantum mechanics, which is of course an integral part of the uniformitarian framework. Thus, the usual proof of decay rate invariance based on standard size U and Th halos is nothing more than a circular argument which assumes the general uniformitarian principle is correct.

In fact, the failure of the uniformitarian principle to explain the evidence for creation presented herein invalidates the basis for the above proof.

POLONIUM, DWARF, AND GIANT HALOS IN MINERALS

Of the three types of unusual halos that appear distinct from those formed by U and/or Th alpha decay, only the Po halos, Fig. 1 (b-d, n-r, r'), can presently be identified with known alpha radioactivity (1-3,11-13). Po halos occupy a special niche in my creation model, and these halos will be discussed in more detail subsequently. Several lines of evidence which indicate the enigmatic dwarf halos (see Fig. 2) were produced by some presently unidentified radioactivity have been summarized (1,12,14,15). The rapid etch from HF and the K/Ca inversion are strongly characteristic of highly radiation-damaged regions.

The characteristics of the giant halos found in a certain Madagascan mica have also been summarized (1,14,16), and while no definitive evidence as yet exists for a radioactive origin, some halos with opaque inclusions in this same mica exhibit isotopic anomalies which raise questions about the uniformity of U and Th alpha decay. For example, the mass scans and x-ray fluorescence analyses shown in Fig. 3 clearly indicate that, whereas both the monazite and opaque inclusions exhibit ^{206}Pb and ^{207}Pb from U decay, the opaque inclusions exhibit a marked deficiency of ^{208}Pb from ^{232}Th decay (14).

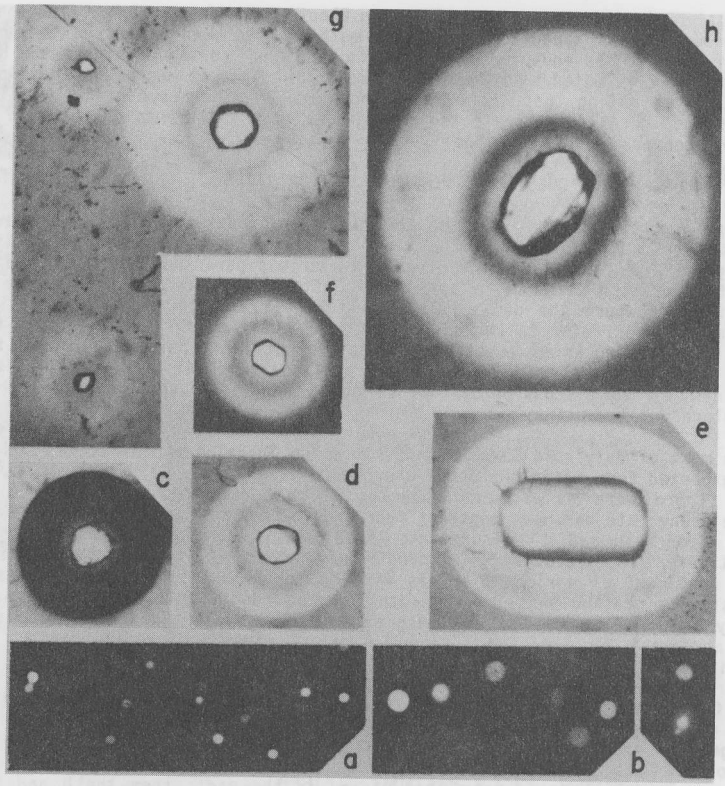

Figure 2. Scale is about 1 cm = 46 micrometers. (a)Dwarf halos (about 2 micrometers radius) in Ytterby mica. (b)Dwarf halos (3 micrometers < r < 9 micrometers) in Ytterby mica. (c)Overexposed Th halo in ordinary biotite. (d)Th halo in Madagascan mica. (e)Th halo in Madagascan mica with a larger inclusion. (f)U halo in Madagascan mica. (g)Giant halo of 65 micrometers radius, and two light Th halos in Madagascan mica. (h)Giant halo of 90 micrometers radius in Madagascan mica.

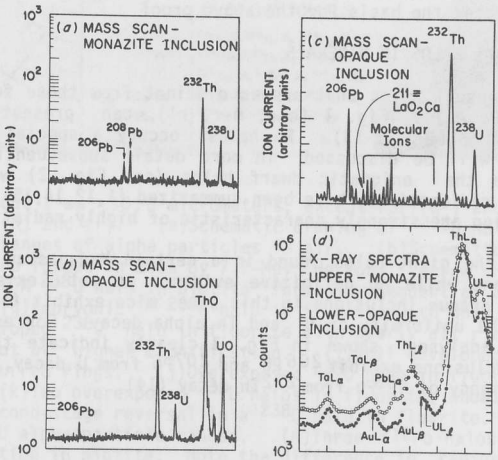

Figure 3. Mass scans and an x-ray fluorescence spectrum of a monazite and an opaque halo inclusion in Madagascan mica, showing Pb deficiency in the latter.

SECONDARY RADIOHALOS IN COALIFIED WOOD

All the various types of halos discussed thus far are termed primary halos because they developed from alpha radioactivity emanating from small accessory inclusions that were present when the mineral crystallized. But secondary halos also exist in pieces of coalified wood taken from highly uraniferous deposits in the Colorado Plateau. There is abundant evidence that U solutions infiltrated much of the sedimentary material in the geological formations of that region when the wood was still in a gel-like condition (17). When U-bearing solutions passed through pieces of wood, certain active sites within these specimens preferentially collected U, other sites collected rare earth type elements, and still others Se, Po, and Pb. It is quite significant that the U halos, which developed around the tiny U-rich sites, are all underdeveloped, which, on the basis of a uniform decay rate (the rationale for using this assumption for these specimens will be explained subsequently), suggests only a relatively short time since U infiltration. Ion microprobe mass scans of these U halo centers have shown extremely high $^{238}U/^{206}Pb$ ratios, which, again on the assumption of a uniform decay rate, is consistent with a U infiltration within the last several thousand years (17).

Similar underdeveloped U halos have been found in the coalified wood from the Chattanooga Shale, and in fact recent ion microprobe analyses show, in agreement with earlier results (17), that the $^{238}U/^{206}Pb$ ratios of the U halos in the Colorado Plateau samples (Eocene, Triassic, and Jurassic) and the Chattanooga Shale (Devonian) are virtually indistinguishable. These results suggest that U-infiltration occurred concurrently in all these formations.

Another class of more sharply defined halos was also discovered in the Colorado Plateau coalified wood specimens (17). The centers of these halos exhibit a distinct metallic-like reflectance when viewed with reflected light. Three different varieties of this halo exist: one with a circular cross section, another with an elliptical cross section with variable major and minor axes, and a third most unusual one that is actually a dual halo, being a composite of a circular and an elliptical halo around exactly the same radio- center (see Figs. 4,5,6).

Although the elliptical halos differ radically from the circular halos in minerals, the circular type resembles the ^{210}Po halo in minerals and variations in the radii of circular halos approximate the calculated penetrated distances (26 to 31 micrometers) of the ^{210}Po alpha particle (energy E = 5.3 MeV) in this coalified wood (17). Henderson (18) theorized that Po halos might form in minerals when U-daughter Po isotopes or their alpha precursors were preferentially accumulated into small inclusions from some nearby U source. This hypothesis has not been confirmed for the origin of three distinct types of Po halos in U-poor minerals (1,2,11), but it does seem to provide a reasonable explanation for the origin of the ^{210}Po halos in U-rich coalified wood specimens.

Electron microscope x-ray fluorescence analyses showed these halo centers were mainly Pb and Se. This composition fits well into the secondary accumulation hypothesis for both of the U-daughters, ^{210}Po (half-life, $t_{1/2}$ = 138 days) and its beta precursor ^{210}Pb ($t_{1/2}$ = 22 years), possess the two characteristics that are vitally essential for the hypothesis: (i) chemical similarity with the elements in the inclusion and (ii) half-lives sufficiently long to permit accumulation prior to decay, a requirement related to the nuclide transport rate.

What is the meaning of the ^{210}Po halos in Figs. 4,5,6? Clearly, the variations in shape can be attributed to plastic deformation which occurred prior to coalification. Since the model for ^{210}Po formation thus envisions that both ^{210}Po and ^{210}Pb were accumulating simultaneously in the Pb-Se inclusion, a spherical ^{210}Po halo could develop in 0.5 to 1 year from the ^{210}Po atoms initially present and a second similar ^{210}Po halo could develop in 25 to 50 years as the ^{210}Pb atoms more slowly beta decayed to produce another crop of ^{210}Po atoms. If there was no deformation of the matrix between these periods, the two ^{210}Po halos would simply coincide. If, however, the matrix was deformed between the two periods of halo formation, then the first halo would have been compressed into an ellipsoid, and the second would be a normal sphere. The result would be a dual "halo" (Fig. 6). The widespread occurrence of these dual halos in both Triassic and Jurassic specimens can actually be considered corroborative evidence for a one-time introduction of U into these formations, because it is then possible to account for their structure on the basis of a single specifically timed tectonic event (17).

HALOS IN COALIFIED WOOD: A FLOOD-RELATED PHENOMENA

A worldwide Flood, which is postulated to have occurred about 1650 years after creation, is the third singularity in the creation model proposed herein. I have advanced the hypothesis that the underdeveloped U halos in both the Colorado Plateau and Chattanooga Shale coalified wood specimens exhibit very high U/Pb ratios because the uranium infiltration of the wood occurred only when those geological deposits were being emplaced at the time of the Flood

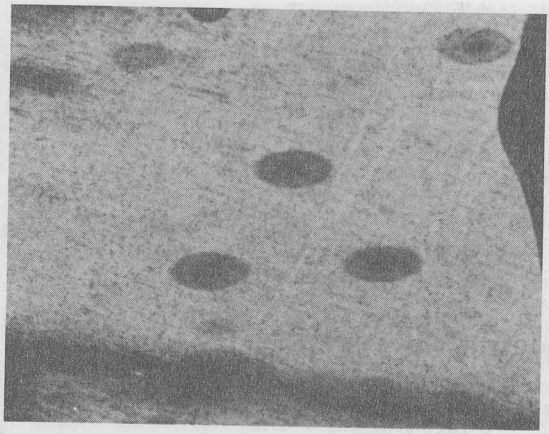

Figure 4. Elliptical (compressed) ^{210}Po halos in coalified wood from the Colorado Plateau.

Figure 5. Circular ^{210}Po halos in Colorado Plateau coalified wood.

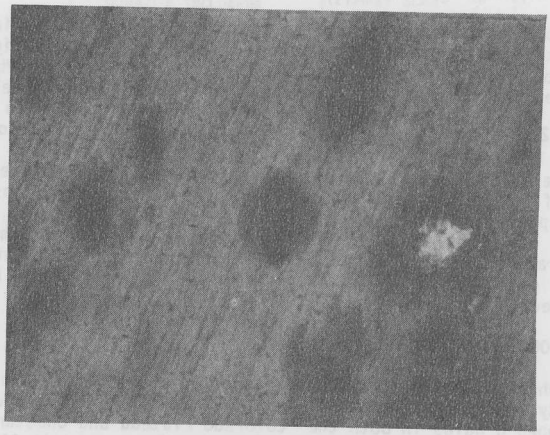

Figure 6. Circular and elliptical ^{210}Po halo in Colorado Plateau coalified wood.

several thousand years ago, instead of the 60 to 400 millions of years ago accepted by uniformitarian geology. I suggest at least part of the U-series disequilibria (19) found in the Colorado Plateau U deposits is because some U-daughter radionuclide separation occurred at the time of the Flood, and there has been insufficient time since then to reestablish equilibrium conditions.

The high U/Pb ratios and secondary ^{210}Po halos in the coalified wood samples from the Eocene epoch and the Triassic and Jurassic periods suggest to me that the wood in all these formations was in the same gel-like condition when infiltrated by the U-bearing solutions. To me these data represent evidence for a concurrent, single-stage invasion of U into all the different geological formations represented by the coalified wood samples. This is precisely what would be expected on the basis of a Flood-related phenomenon.

The dual Po halos also fit well into the Flood scenario; i.e., the presence of a spherical and elliptical Po halo around the same radiocenter suggests a tectonic event occurred within 50 years after the initial infiltration of uranium into the wood samples. A readjustment of the earth's crust after such a massive event is not unexpected. Another implication of the existence of ^{210}Po halos in these specimens is that the transformation of the wood to a semi-coal-like condition must have occurred within a period of about one year. This evidence for a rapid coalification process is in contrast to the generally accepted view that coalification is a long-term geological process.

THREE TYPES OF POLONIUM HALOS IN MINERALS

Now there are two other Po isotopes (^{214}Po and ^{218}Po) in the U decay chain besides ^{210}Po, but no halos representative of these other Po isotopes have been found in coalified wood. This is not surprising, because the half-lives of the other Po isotopes are rather short, i.e., $t_{1/2}$ = 3 minutes for ^{218}Po and $t_{1/2}$ = 164 seconds for ^{214}Po, as are the half-lives of the beta precursors of ^{214}Po, i.e., $t_{1/2}$ = 26.4 minutes for ^{214}Pb and $t_{1/2}$ = 19.8 minutes for ^{214}Bi (the precursor of ^{218}Po is the inert gas ^{222}Rn). What is surprising is that all the three types of Po halos occur in certain minerals which typically contain orders of magnitude less uranium than the U-rich coalified wood. Further, the minerals such as biotite and fluorite must have diffusion rates considerably lower than those expected for a U-solution-infiltrated specimens of gel-like wood. Figure 7 shows the idealized structure of the different Po halos in comparison with the U halo.

Photographic evidence relating to the existence of different types of Po halos in minerals is shown in Fig. 1. Figure 1(n) shows three ^{210}Po halos of light, medium, and very dark coloration. The slightly higher radii for the darker halos is attributable to the higher dose. Figure 1(o) shows three different ^{210}Po halos in fluorite. Figure 1(p) shows a ^{214}Po halo in biotite, and Fig. 1(q) shows two ^{218}Po halos in biotite. Comparison of these halos with the idealized ring structure in Fig. 7 shows that Po halos in minerals can be clearly identified by ring structure studies alone. The data in Table 1 shows there is an excellent agreement between the experimentally produced He ion produced coloration bands and the Po halo ring radii.

An important observation from Fig. 7 is that in the idealized ^{238}U and ^{218}Po halo patterns, it is evident that the ^{222}Rn ring should be missing from the ^{218}Po halo and present in the U halo. Figures 8 and 9 show the presence of the ^{222}Rn ring in the U halo in contrast to its absence in the ^{218}Po halo. This is unequivocal evidence that the ^{218}Po halo initiated with ^{218}Po rather than with any earlier alpha emitter in the U decay chain. Figs. 10 and 11 show a ^{238}U halo and a ^{218}Po halo in two different types of biotite.

Henderson's (18) original idea that Po halos in minerals may have originated from a secondary source of radioactivity encounters formidable obstacles when closely examined. In most cases the minerals contain only ppm abundances of uranium, which means only a negligible supply of Po daughter atoms is available for capture at any given time. To form a halo these daughter atoms must migrate or diffuse so they can be captured at a collecting site, a problem which is compounded by the low diffusion rates in minerals (11,20,21). Despite these objections, in 1979 several investigators suggested their results (22) might provide support for secondary Po halo formation in minerals after all. They were apparently unaware that three years earlier I had reported the experimental observation of secondary ^{210}Po halos in coalified wood (17). In that report I discussed how even under the most favorable conditions (i. e., an abundant supply of U-daughters in a highly mobile environment) for the formation of secondary Po halos, only the longer half-life ^{210}Po halos actually formed, the reason being that the shorter half-life Po isotopes generally decayed away before they could be captured at the tiny Pb-Se sites. If these other two Po halo types didn't form under the best conditions in the gel-like wood, how could it be expected they would form naturally in the granites where diffusion rates are vastly lower and the supply of Po atoms is negligible?

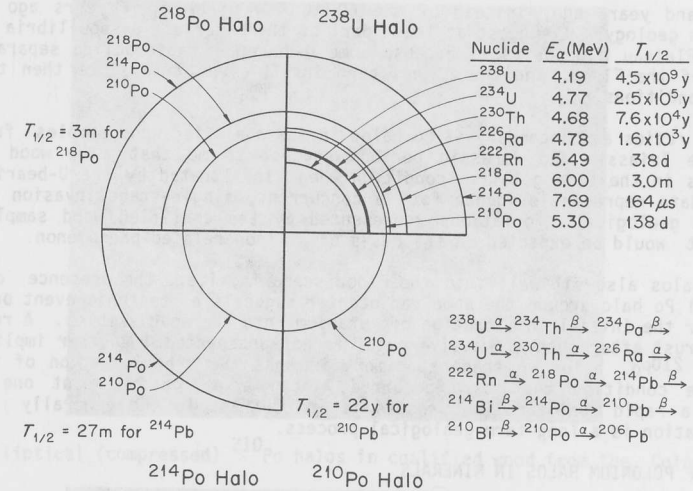

Figure 7. Idealized schematic of ^{238}U, ^{218}Po, ^{214}Po, and ^{210}Po halos.

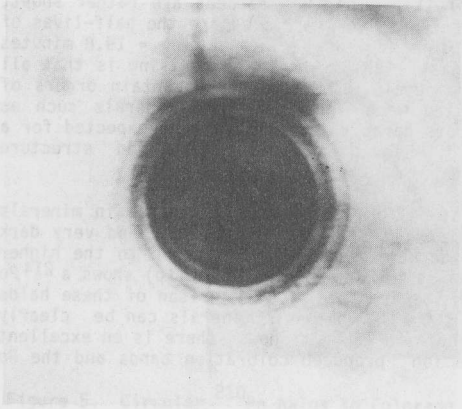

Figure 8. ^{238}U halo in fluorite.

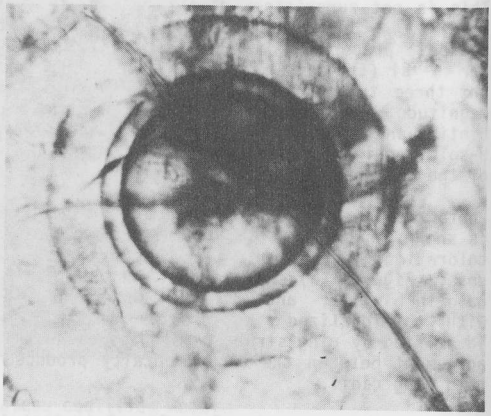

Figure 9. ^{218}Po halo in fluorite.

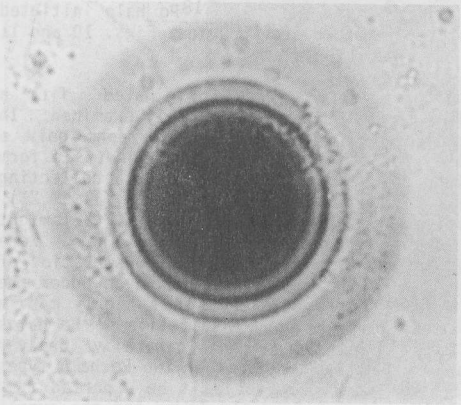

Figure 10. ^{238}U in mica.

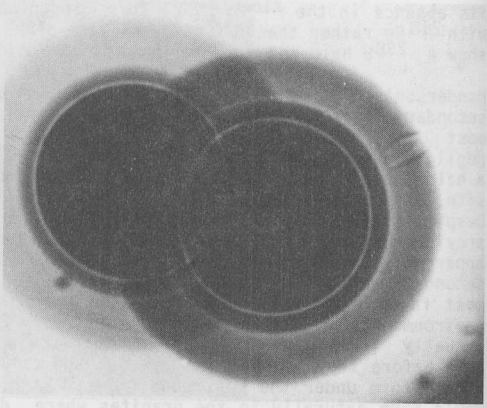

Figure 11. ^{218}Po halo in mica.

The identity of U, Th and Po halos in minerals has been confirmed by analyzing the various types of halo radiocenters using scanning electron microscope x-ray fluorescence (SEMXRF) and ion microprobe mass spectrometric (IMMA) techniques (2,3). Studies of various Po halo radiocenters in biotite and fluorite have generally shown little or no U in conjunction with anomalously high $^{206}Pb/^{207}Pb$ and/or Pb/U ratios which would be expected from the decay of Po without the U precursor which normally occurs in U radiohalo centers (2,3). These results were obtained clearly in the analysis (3) of the most unusual array of Po halos which I ever found. That array, shown in Figure 12, has the appearance of a pair of spectacles, hence the designation 'Spectacle Halo.' The Spectacle Halo appearance compounds the problem of explaining its existence on the basis of known physical laws. In conclusion, in spite of attempts to define them out of existence (23), there is demonstrable evidence that Po halos do exist as separate entities (1-3).

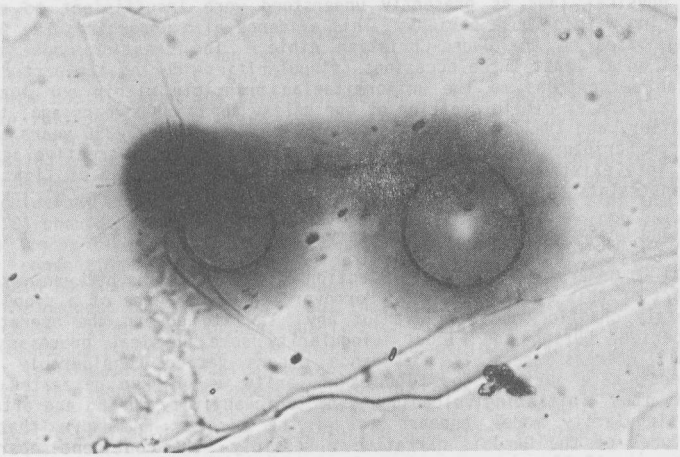

Figure 12. The Spectacle Halo, an overlapping series of ^{210}Po halos discovered in a piece of biotite from the Silver Crater mine, Faraday Township, Ontario.

POLONIUM HALOS IN MINERALS: AN INDEPENDENT EVALUATION

Because of the implications which will be attributed to the presence of Po halos in minerals, it is important that my colleagues be apprised of the independent investigation of these phenomena by Professor Norman Feather. In an exhaustive theoretical treatment (24) of the problem concerning their origin in minerals, Feather concludes it is difficult to account for the existence of Po halos in certain minerals on the basis of known physical principles. His exact words, as given in the synopsis of his paper, are as follows:

> Ever since the discovery of Po-haloes in old mica (Henderson and Sparks 1939) the problem of their origin has remained essentially unsolved. Two suggestions have been made (Henderson 1939; Gentry et al. 1973), but neither carries immediate conviction. These suggestions are examined critically and in detail, and the difficulties attaching to the acceptance of either are identified. Because these two suggestions appear to exhaust the logical possibilities of explanation, it is tempting to admit that one of them must be basically correct, but whoever would make this admission must be fortified by credulity of a high order.

POLONIUM HALOS AND PRIMORDIAL ROCKS: A TEST OF THE HYPOTHESIS

I have advanced the hypothesis (25,26) that the three different types of Po halos in minerals represent the decay of primordial Po, in which case the rocks that host these halos, i.e., the Precambrian granites, must be primordial rocks (25,26). By this reasoning the Precambrian granites are identified as rocks that were created almost instantly as a part of the creation event recorded in Genesis 1:1 rather than rocks that are a product of the evolution of the earth. This rationale would be without scientific content if I had not also stated (25) that the laboratory synthesis of a hand-sized piece of granite or biotite would be accepted as falsifying my view that the Precambrian granites are created rocks and, likewise, that the subsequent production of ^{218}Po halos in that synthesized specimen of granite or biotite would be accepted as falsifying my view that Po halos in Precambrian granites originated with primordial polonium. The only response to my repeated (25,26) challenges to perform these laboratory syntheses and falsify the aforementioned evidences for creation has thus far been silence. It is inescapable that these experiments should be

successful if the uniformitarian principle is true. Thus, with so much at stake for evolution, I suspect the reason why my evolutionary colleagues have failed to achieve success is because the Precambrian granites never formed by the uniformitarian principle to begin with; hence, to attempt to utilize it now to produce a synthesized piece of granite is just a futile effort. The end result is that the uniformitarian principle is essentially falsified because of its failure to live up to its own predictions. But since all the pieces in the evolutionary puzzle are glued together by this principle, we must now come to the same conclusion about evolution itself.

A PROPOSED CREATION MODEL AND THE AGE OF THE EARTH

The evidence for creation cited above suggests there may have been special periods in earth history when physical laws as presently understood were insufficient to explain all the events transpirjng within those periods. This evidence also undergirds the formulation of a creation model based on the Judeo-Christian ethic. The creation model proposed herein postulates that on at least three occasions (singularities) during the past 6000 years there were significant exceptions to the uniformitarian principle within our local cosmos (the Milky Way), viz., the ex nihilo creation of our galaxy about 6000 years ago, the Fall of man shortly thereafter, and the occurrence of a worldwide Flood about 4350 years ago. These ages are derived from Scriptural chronology. It is assumed that the creative act which brought the Milky Way into existence also caused the immediate propagation of light throughout the galaxy. No constraints are placed on the age of the universe.

Singularities and Uniformities: A Complementary Approach

It is essential to understand that uniform action of physical laws between singularities is an integral part of this creation model. Moreover, the occurrence of a singularity does not mean a completely chaotic condition without any laws to govern the operations of nature during that period. During the Flood singularity some physical processes may not have changed at all whereas there is evidence others varied considerably. An enhanced radioactive decay rate during the Flood singularity would have generated a considerable amount of heat, thus initiating volcanic and tectonic activity during and after that period. This three-singularity model appears to be the minimum framework that includes the essential features of the Genesis narrative. Possibly the continent-separating episode recorded in Genesis 10:25, when the earth was divided in the days of Peleg a few hundred years after the Flood, should also be included as a singularity; certainly it must figure prominently in any creation-based reconstruction of earth history that deals with continental drift. However, to simplify matters, the following comments exclude consideration of this event.

Singularities and the Interpretation of Radioactive Decay as Elapsed Time

In summary, the creation model envisions an initial creation singularity followed by a short period of uniformity until the the second singularity, an event which involved degenerative changes in the biological world and quite possibly modification of some of the original physical laws which governed the earth and our near celestial environment. Another period of uniformity follows, with the modified physical laws now in effect, for about 1600 years down to the longer-duration Flood singularity. The last period of uniformity extends down to the present. In this scenario U/Pb ratios are presently utilized as indicators of elapsed time since the last singularity. $^{238}U/^{206}Pb$ ratios are not used as time measures prior to this last singularity because of conflicting evidence of very high Pb and He retention in natural zircons subjected to a prolonged high temperature environment in deep granite. Those results, discussed below, are consistent with a very young age of the earth, and suggest that the radioactive decay rate may have been enhanced (indeed, had to be if this creation model is correct) during any one of the three singularities. (The Peleg episode potentially adds one more possibility.) The assumption of uniform decay since the Flood is the basis for interpreting the very high U/Pb ratios in coalified wood samples as evidence for a several-thousand-year age of specimens which conventional geology holds to be about 60 to 400 million years old.

Possible Evidence of Enhanced Radioactive Decay from 'Blasting' Halos

Additional evidence for an enhanced radioactive decay rate comes from Ramdohr's observations on fractured radioactive halos in polished ore sections. He reports (27) that certain radioactive inclusions, which exhibit a considerable volume increase due to isotropization from radioactive decay, have in numerous cases been observed to fracture the surrounding mineral in a random pat tern. Ramdohr points out that the surrounding mineral should expand slowly over geological time due to radioactive isotropization, and individual cracks should appear as soon as the elastic limit is reached. He further points out that, while these expansion cracks should occur first along cohesion minimums and grain boundaries, nothing like this happens. Individual cracks surrounding the radioactive inclusion are randomly

distributed and evidently occur quite suddenly in the form of an explosive fracture and not a slow expansion. Ramdohr shows many photographs of instances wherein the central inclusion fractures the non-isotropic outer zone. The occurrence of this phenomenon is worldwide.

While there might be other alternatives, one possible explanation of these "fractures" or "blasting" halos is that the rate of radioactive decay was at one time far greater than that observed today. The isotropization of the host minerals would have occurred very rapidly due to an anomalous decay rate, and hence fracturing of the outer mineral would be expected.

The Age of the Earth and Pb Retention in Deep Granite Cores

Results pertaining more specifically to a recent creation of the earth come from studies of Pb retention in zircons taken from deep Precambrian granite cores (28). To understand the rationale for this last statement, it must first be understood that the Pb in these zircons is primarily a secondary trace component derived from the decay of small amounts of U and Th. Secondly, this radiogenic Pb has a tendency to migrate or diffuse out of the zircon crystals far more rapidly than the parent U and Th because these elements are relatively tightly bound in lattice sites, whereas the Pb atoms really do not fit into the zircon lattice. Further, since all elements show an exponential increase in the bulk diffusion rate with increasing temperature, and since the temperature in the granite cores increases significantly from near the top (105°C) to the bottom (313°C) of the granite portion of the drill hole, calculations show that 50 micrometers-size zircons taken from the bottom of the drill hole (313°C) should have lost 1% of their Pb content in about 300,000 years. Since the zircons were in cores taken from a Precambrian granite that is estimated to be 1.5 billion years old by conventional geochronology (29), the prediction based on uniformitarian geochronology would be that most of the Pb would have long ago diffused out of the zircons extracted from the deepest cores at 313°C. But the results of the experiments did not agree with this prediction; rather they showed equally high retention of Pb in zircons taken from all depths. In fact no Pb loss from zircons at 313°C would appear to place an upper limit to the age of this Precambrian granite, which, on the presumption that these granites are primordial rocks, in essence places the same limit on the age of the earth.

The Age of the Earth: Limited by Helium Retention in Deep Granite Cores

Another approach which seemed to hold greater prospects for more closely defining an upper limit for the age of these Precambrian granites (and hence of the earth) was the differential analysis of similar size zircons from these same cores for helium, the second most volatile chemical element known. The helium accumulates in these zircons in a manner similar to the radiogenic Pb, viz., from the alpha particles emitted from trace amounts of U and Th. However, the extreme volatility of this gas means that it diffuses out of the zircons at a far greater rate than Pb. On a purely uniformitarian basis the search for helium in these zircons would quite possibly never have been done because conventional geological wisdom suggests negligible helium retention in zircons subjected to even 100°C for the presumed 1.5 billion year age (29) of those granites. But having already discovered that the Pb retention in these zircons contradicted the age estimates determined by radiometric dating techniques, I decided that, from a creationist perspective, the search might just reveal something of exceptional interest. Groups of zircons from six different depths were repeatedly analyzed for helium using an extremely sensitive gas mass spectrometric system. The results (30) showed a helium retention of about 58% in the tiny 50 micrometers zircons from 960 meters depth (105°C), about 27% in zircons from 2170 meters (151°C) and a phenomenal 17% retention of helium even at 2900 meters where the temperature is 197°C. These results show a creation-based perspective of science does possess predictive capabilities which can be scientifically tested.

It is difficult to understand how such high retention (30) of helium can be accounted for except by restricting the age of these granites (and hence the earth) to something of the order of several thousand years. These results are consistent with an approximate 6000-year age of the earth and moreover are in direct conflict with the presumed 4.5-billion-year age of the earth determined by radioactive dating techniques. Evolutionary colleagues can prove this deduction for a young age of the earth is wrong if they can show just how this unusually high retention of helium can be deduced from the accepted 1.5-billion-year age (29) of those zircons by using only uniformitarian principles.

REFERENCES

1. Gentry, Robert V. 1973. ANNUAL REV. NUCL. SCI. 23: 347.
2. Gentry, Robert V. 1974. SCIENCE 184: 62.
3. Gentry, Robert V. et al. 1974. NATURE 252: 564.
4. Joly, J. 1917. PHIL. TRANS. ROY. SOC. London , Ser. A. 217: 51-79; Idem., 1917. Nature 99: 457-58, 476-78; Idem. 1923. PROC. ROY. SOC. London, Ser. A 102: 682-705; Idem. 1924.NATURE 114: 160-64.

Table 1. Comparison of sizes of induced bands (columns 1 to 5) with halo radii (columns 8 to 21). Column 6 gives the ^4He ion energies at which the induced bands were formed, or the α-particle energies corresponding to the nuclides in column 7. Thus, the nuclide or α-particle energy that produced any halo ring in columns 8 to 21 can be found from column 6 or 7. The letters K-L, H, S, M, and G represent halo measurements by Kerr-Lawson (*15*), Henderson (*1, 6, 7*), Schilling (*9*), Mahadevan (*10*), and Gentry. Subscripts L, M, and D indicate light, medium (dose 10 to 20 times coloration threshold), and dark (dose about 50 times coloration threshold) induced bands; L→D and L→M indicate light to dark and light to medium; these were visually determined. Gentry's measurements were made with a filar micrometer readable to 0.07 μm. The estimated overall uncertainty was ± 0.3 μm. Other abbreviations: N.M., not measured; N.R., not resolved; N.P., not present.

Coloration band size (μm)						U halo radius (μm)									Po halo radius (μm) in								
Biotite			Fluorite	Cordierite	E (Mev)	Nuclide	Biotite			Fluorite		Cordierite	Biotite							Fluorite	
													^{210}Po		^{210}Po					^{210}Po	^{210}Po
1. G_L	2. G_M	3. G_D	4. G	5. G	6.	7.	8. K-L	9. H	10. G	11. S	12. G	13. M	14. H	15. $G_{L\to D}$	16. H	17. $G_{L\to M}$	18. H	19. G_M	20. G	21. G
13.4	13.8	14.2	14.1	16.2	←4.2	$^{238}U\to$	12.3	12.7	12.2→13.0	14.0	14.2	16	N.P.	N.P.	N.P.	N.P.	N.P.	N.P.	N.P.	N.P.	N.P.
N.M.	16.7	N.M.	17.3	19.2	←4.77	$^{226}Ra\to$	15.4	15.3	14.8→15.8	16.9	17.1	19	N.P.	N.P.	N.P.	N.P.	N.P.	N.P.	N.P.	N.P.	N.P.
N.M.	N.M.	N.M.	N.M.	N.M.	←4.66	$^{232}Th\to$	N.R.	N.R.	N.R.	15.8	N.R.	N.R.	N.P.	N.P.	N.P.	N.P.	N.P.	N.P.	N.P.	N.P.	N.P.
N.M.	16.7	N.M.	17.3	19.2	←4.78	$^{238}U\to$	15.4	15.3	14.8→15.8	16.9	17.1	19	N.P.	N.P.	N.P.	N.P.	N.P.	N.P.	N.P.	N.P.	N.P.
N.M.	19.3	20.0	19.6	22.5	←5.3	$^{210}Po\to$	N.R.	N.R.	N.R.	19.3	19.5	N.R.	19.8	18.3→19.9	20.0	18.1→19.1	19.9	19.3	19.8	19.8	19.8
N.M.	20.5	21.1	N.M.	N.M.	←5.49	$^{222}Rn\to$	18.6	19.2	18.1→19.0	20.5	20.5	23.5	N.P.	N.P.	N.P.	N.P.	N.P.	N.P.	N.P.	N.P.	N.P.
N.M.	23.0	23.9	23.6	26.7	←6.0	$^{210}Po\to$	22.0	23.0	21.5→22.7	23.5	23.5	26.5	N.P.	N.P.	N.P.	N.P.	N.P.	24.0	23.3	N.P.	23.7
33.1	33.9	34.4	34.6	38.7	←7.69	$^{210}Po\to$	33.0	34.1	30.8→33.0	34.5	34.7	38.5	N.P.	N.P.	34.5	32.5→33.8	34.0	34.0	34.0	N.P.	34.9

5. Kerr-Lawson, D. E. 1928. UNIV. TORONTO STUD. GEOL. Ser. No. 27:15
6. Henderson, G. H., C. M. Mushkat, D. P. Crawford. 1934. PROC. R. SOC.
7. Henderson, G. H., and L. G. Turnbull. 1934. PROC. R. SOC. Lond. Ser. A. Math. Phys. Sci. 145: 582.
8. Henderson, G. H., and S. Bateson. Ibid., PROC. R. SOC. Lond. Ser. A. Math., Phys. Sci. 145: 573.
9. Schilling, A., 1926. NEUES JAHRB. MINERAL. Abh. 53A: 241.; See also ORNL Rep. ORNL-tr-697.
10. Mahadevan, C., 1927. INDIAN J. PHYS. 1: 445.
11. Gentry, Robert V. 1968. SCIENCE 160: 1228.
12. Gentry, Robert V. 1971. SCIENCE 173: 727.
13. Gentry, Robert V. et al. 1973. NATURE 244: 282.
14. Gentry, Robert V. 1978. Are any unusual radiohalos evidence for SHE?, PROC. INTERNATIONAL SYMPOSIUM ON SUPERHEAVY ELEMENTS. Lubbock, March 1978. Pergamon Press, New York, Oxford.
15. Gentry, R. V., W. H. Christie, D. H. Smith, J. W. Boyle, S. S. Cristy, & J. F. McLaughlin. 1978. NATURE 274: 457.
16. Gentry, R. V. 1970. SCIENCE 169: 670.
17. Gentry, R. V., W. H. Christie, D. H. Smith, J. E. Emery, S. A. Reynolds, R. W. Walker, S. S. Cristy, & P. A. Gentry. 1976. SCIENCE 194: 315.
18. Henderson, G. H. and F. W. Sparks 1939. PROC. R. SOC. Lond. Ser. A Math. Phys. Sci. 173: 238. Henderson, G. H., ibid., p. 250.
19. Lind, S. C., and C. F. Whittemore. 1915. U. S. Bureau. Mines Tech. Pap. 88:1. Stern,T.W.,and L.R. Stieff, 1959. U.S. Geol. Surv. Prof. Pap. 320:151., Rosholt, J. N., 1958. PROCEEDINGS OF THE SECOND U. N. INTERNATIONAL CONFERENCE ON THE PEACEFUL USES OF ATOMIC ENERGY, Geneva. United Nations, New York, vol. 2, p. 321.
20. Gentry, Robert V. 1975. NATURE 258: 269.
21. Fremlin, J. H. 1975. NATURE 258: 269.
22. Hashemi-Nezhad, S.R., et al, 1979. NATURE: 178: 333-335.
23. Moazed, C., R. M. Spector, and R. F. Ward. 1973. SCIENCE 180: 1272.
24. Feather, N. 1978. ROY. SOC. EDINBURGH COM. 11:147.
25. Gentry, Robert V. 1979. EOS 60: 474. Idem. 1980. EOS 61: 514.
26. Gentry, Robert V. 1982. PHYSICS TODAY 35: No. 10, 13. Ibid., 36: No. 4, 13.
27. Ramdohr. P. 1957. Abb. der Deutsch. Adad. d. Wiss., Berlin, Kl. f. Chem., Geol. u. Biologie, no.2: 1. Also ORNL Translation (ORNL-Tr-755).
28. Gentry, Robert V., T. J. Sworski, H. S. McKown, D. H. Smith, R. E. Eby, W. H. Cristie. 1982. SCIENCE 216: 296. (See also Gentry, R. V. 1984. SCIENCE 223: 835.)
29. Zartman, R. E. 1979. Los Alamos Sci. Lab. Rep. LA-7923-MS.
30. Gentry,R. V., G. Glish, & E. R. McBay. 1982. GEOPHYS. RES. LETT. 9:1129.

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DISCUSSION

Attempts to find radiohalos in meteorites and moon rocks have been unsuccessful, although both galactic cosmic ray and solar cosmic ray tracks have been found in appropriate crystals from each of these sources. The limitation of radiohalos to earth minerals of hydrothermal classification suggests that water may be essential to the process(es) by which radiohalos are formed. The location of radiohalo centers in mica along conduit paths and cleavage planes supports this inference.

The existence of mature uranium halos in association with unsupported polonium halos presents a problem for a view that limits the real time ages of all minerals to less than 10,000 years. A 5 micron radius sphere of pure uraninite as a radiohalo center would require in the order of 3 million years to produce sufficient alpha particles to develop the minimum crystal disordering for a detectable 33 micron radius radiohalo (Polonium - 214). A 3 micron radius sphere of monagite with one uranium impurity atom per unit monagite lattice element would require about 190 million years to develop a minimally detectable 3 micron radius radiohalo in mica. Thus the in situ creation of polonium impurity centers for unsupported polonium radiohalos and uranium impurity centers for mature uranium radiohalos at any time within the last million years also requires the uranium centers and are in every way indistinguishable from halos that would be produced by the uranium decay series as presently observed. For many individuals such a scenario requires the Creator to produce unnecessary "evidence" for events that did not occur in reality.

In presenting to the public at large, or any segment thereof such as the scientific community, the Biblical creationist interpretations set forth in this paper, it is desirable to recognize that Polonium halos are definitive evidence of instantaneous, in situ creation only if one has perfect and complete knowledge concerning all other possibilities. Such knowledge may be possessed only by deity. The present limits to human knowledge do not justify asserting that there are no possible circumstances under which the regular processes maintained by the Creator could have progressively deposited Polonium within some samples of granite, comparable to the much more readily understandable accumulation at Polonium centers in "coalified" wood.

If the polonium for unsupported polonium radiohalos in granite was an in situ primordial creation at halo center sites, it would be the only known primordial appearance of an element with other than a complete spectrum of isotopes. Polonium has 26 isotopes, all of which are radioactive. The 5 longest half-life members of this family, together with their half-lives and stable end products are:

Polonium 209	103 years	Thallium 205
Polonium 208	2.93 years	Lead 204
Polonium 206	8.8 days	Lead 206, Mercury 202
Polonium 207	5.7 hours	Lead 207
Polonium 204	3.6 hours	Lead 204
Polonium 205	1.8 hours	Thallium 205

According to the well-established empirical relationships between isotope abundance, half-life, and binding energy per nucleon, primordial polonium would be composed largely of its longer-lived isotopes, and its residue would be principally thallium 205 and lead 204. However thallium has never been reported as a polonium radiohalo center constituent, and lead 204 may be absent also [Robert V. Gentry, Nature 252 (Dec. 13, 1974), pp. 564-566; Annual Review of Nuclear Science 23 (Dec. 1973), pp. 347-362, specifically page 360]. Why is only lead 206 featured, the end product of uranium daughter products polonium 218, 214 and 210? The presence in uranium and polonium radiohalo centers of selenium, which would be precipitated also under conditions favoring the precipitation of uranium and polonium, favors explanation of radiohalos with processes involving solution transport of uranium and its daughter products, even though the details of such processes cannot be elaborated at the present lack of knowledge concerning hydrothermal environments and crystal formation [Norman Feather, Communications to the Royal Society of Edinburgh, No. 11, 1978, pp. 147-158].

Synthesis of a hand-sized piece of granite would prove that at least one laboratory procedure may be successful; it would be only suggestive, not definite, with respect to the actual processes that have determined the characteristics of a specific sample of natural granite.

It is unsound to assert (p2, ¶3), without firm theoretical or observational support, that large variations in alpha decay rate were associated with alpha particles of unvarying penetration range. An explanatory model that contains such a requirement suffers a severe loss in credibility.

The suggestion attributed to Gentry, et al., in the quotation from Norman Feather (p5, ¶1, reference 24) accounts for unsupported Polonium halos by radiation from daughters of hypothetical, extremely long-lived, extinct isomers of Polonium parents, not in terms of the fiat, in situ creation explanation given in this paper.

A critical reader of the paper may wonder why Pb atoms are expected to be less tightly fitted into a Zr_2SiO_4 lattice than U and Th atoms.

Since the He content of He-producing gas wells increases with well depth, it would be desirable to clarify the relationship between temperature, ambient He pressure, and expected He retention in zircons with U and Th impurity.

In conclusion, this reviewer wishes to express appreciation for the discussion of Polonium halos in "coalified" wood that is given in this paper.

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Dr. Gentry's years of excellent experimental work and observations on radiohalos make him without doubt the world's leading authority on them. However, I have a problem with his view that the "orphan" Polonium halos (the ones unaccompanied by halos from parent nuclides) must be primordial. Why (as Dr. Robert Brown has suggested) are the only orphan halos from Polonium isotopes in the Uranium decay series? Shouldn't there be some halos or daughter products from the other Polonium isotopes as well? It seems to me that there are other possible creationist explanations for the orphan halos. One which John Baumgardner, myself, and others have discussed has the following features:

1. *Uranium decays at an early stage of earth history (for example, after the Fall), producing Polonium 210, 214, and 218.*

2. *Decay stops for a period (say from the Fall to the Flood), during which time the Polonium is physically or chemically separated from the Uranium.*

3. *Decay restarts (say during the Flood), producing halos in already-existing granite crystals.*

This model is new and not well thought out yet. I cite it merely as a contrasting illustration. If someone rises to Dr. Gentry's famous challenge and synthesizes granite, it might prove that the halos are not primordial. But it would not prove that the halos were formed by natural processes working at present rates.

D. Russell Humphreys, Ph.D.
Albuquerque, New Mexico

My essential criticisms of Dr. Gentry's halo interpretations have been published in more detail elsewhere (Physics Today, April 1983, 11-13). The main problems with his thesis are:

(1) The inclusion minerals at the centers of halos are nearly always minerals that are known U or Th-bearing minerals like zircon or monazite. These minerals are not geochemically compatible with Group VI elements like Po and there is no reason to believe they would have Po except from decay of U or Th.

(2) The only isotopes of Po that Dr. Gentry reports finding are those that form by alpha decay of U and Th. There are 26 isotopes of Po, and the 22 that are not alpha decay products of U and Th have not been reported. These two points strongly indicate that the Po Dr. Gentry finds is due to conventional U and Th decay and is not primordial, unresolved problems notwithstanding.

(3) Dr. Gentry alternates between uniformitarianism and non-uniformitarianism as it suits his hypothesis. He accuses orthodox geologists of circular reasoning for assuming that the halos imply constant nuclear decay rates without direct proof, but he assumes (without direct proof) that his halos are due to alpha radiation in the past and (again without direct proof) that he can identify the halos with specific elements. I believe Dr. Gentry is correct when he identifies his halos, but he is correct only because uniformitarianism is valid. Finally, he gratuitously assumes that, if decay rates change, they must slow down with time; couldn't they just as easily be speeding

up so that rocks are older than radiometric ages indicate?

Assuming uniformity of physical laws is neither arbitrary nor circular: We live in a universe of patterns, and once a pattern is known to exist, the burden of proof is on someone who asserts that the pattern can change. When our checkbooks fail to balance, we do not assume lightly that someone has tampered with our account; we look for errors in our accounting instead. Similarly, we assume that unresolved problems in science will turn out to have a conventional explanation and only when the evidence becomes incontrovertible do we postulate changes in the laws of nature. As points (1) and (2) above indicate, Dr. Gentry's halos do not come anywhere close to this level of urgency. There is every reason to believe the halos have a conventional origin. In addition, there is no observational evidence that decay rates can change as drastically as they must to accommodate the creationist time scale; there is no theoretical basis for believing that they can change (Barry Setterfield makes a game try, but his treatment is full of errors). The paltry few percent change in electron-capture decay rates that creationists cite fall far short, in degree and in kind, of the million or so times that all forms of decay would have to speed up to reconcile creationist chronology and the radiometric time scale. Until creationists can demonstrate such enormous accelerations of decay beyond any doubt, and that probably means in the laboratory, most geologists will continue to be unrepentant uniformitarians.

Steven Dutch
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CLOSURE

Reviews of scientific papers by competent scientists are of inestimable value in probing weaknesses and inconsistencies of a another scientist's work, and thus are essential in the determination of scientific truth. By their very nature, reviews must be critical, even to the point of being highly critical, so that the scientific community will not be left in doubt concerning possible flaws in the work being reviewed. As many scientists can testify, the referee process required by scientific journals has saved many a reputation by exposing errors in technical papers prior to publication. At other times, however, that same process has also acted to prevent unpopular scientific truth from being published.

Indeed, even these ICC Proceedings may contain things which would not pass muster in the open literature, and it might be said that in many cases the reason would be prejudice against the creation perspective. On the other hand, there is the possibility that some papers may have genuine flaws which need to be identified. This is all the more reason why creation scientists need to have their work examined and scrutinized by their peers. The history of Christianity has amply demonstrated that much done in the name of God bears little or no resemblance to the teachings of the Bible, or to the progress of truth.

With this in mind I must--if I am really interested in the scientific truth as it relates to creation and evolution--have my findings, discoveries, and conclusions reviewed by those scientists who would be most critical of my work. This I have endeavored to do over the past twenty years as I have submitted my results to the secular scientific community for review and publication. The results of those endeavors have been recounted in detail in my recent book Creation's Tiny Mystery. There I attempted to provide a basis for laymen and scientists to arrive at an intelligent decision about the scientific validity of my discoveries of evidence for creation and a young age of the earth.

As necessary as it has been for my work to go through the referee procedures mandated by the secular scientific community, I consider it just as necessary for it to be scrutinized by the reviewers chosen by the organizing committee of the ICC. The article I submitted for these ICC Proceedings is part of a paper originally published in 1984 in the Proceedings of the Sixty- Third Annual Meeting of the Pacific Division of the AAAS. At that time I requested a vigorous response to the evidences for creation and a young age of the earth summarized therein. None was forthcoming; so I am pleased that critical reviews have now been given by three respected scientists and even more pleased that one is an evolutionist. My intent in responding to those reviews is again to provide a basis for laymen and scientists to evaluate the scientific validity of my discoveries of evidence for creation and a several-thousand-year age of the earth.

At the outset I wish to emphasize my personal esteem for all the reviewers. This is needful because in order to clarify matters it has been necessary to take strong exception to parts

of some reviews. In certain instances, ideas and assumptions are introduced which differ considerably from my views and my creation model, and then these ideas are used to raise questions about the scientific implications of my research for creation. Some background information on halos is given below so that the reader can intelligently evaluate my responses to these ideas.

Experimental results published over the last 20 years show that polonium halos exist in Precambrian granites independently of any other type of radioactivity; thus I have said they are evidence of primordial polonium--meaning polonium that was created independent of, and separate from, any decay products in the uranium decay chain. The existence of primordial polonium halos in Precambrian granites identifies these rocks as part of the primordial Genesis rocks of our planet. In other words, primordial radioactivity and primordial rocks were created simultaneously when God called the earth into existence during creation week. In contrast, the evolutionary theory of the origin of the Precambrian granites supposes that these rocks crystallized from a slowly cooling magma over eons of geological time. Fortunately, there is an experimental test by which the origin of the granites can be settled. It is also a test which has devastating consequences for the theory of evolution.

The basic premise of the entire theory of evolution is the uniformitarian principle, which is the assumption that the cosmos, including the earth, came to its current state solely through the action of known and unchanging physical laws. (Some readers may be more familiar with the term principle of naturalism.) The practical application of the uniformitarian principle to evolutionary geology implies that the Precambrian granites repeatedly formed naturally throughout billions of years of geologic time--and by naturally I mean with nothing more than known physical laws to govern their crystallization. But if this theory of granite origin is actually true, then it should be possible to reproduce this type of rock today by melting a piece of granite and allowing it to cool under suitable laboratory conditions. The end product should be another piece of granite similar to the original. If this could be done, evolutionists would be able to claim that the basic premise of their theory has some basis in fact, and I would withdraw my claim that the Precambrian granites were the Genesis rocks of our planet. In addition, if polonium halos could then be produced in that synthesized granite, I would also withdraw my claim that polonium halos in granites are primordial.

After waiting almost eight years for the scientific community to respond to this falsification test, there still has been no demonstration of granite synthesis. It is certain that evolutionists would have performed this critical test long ago if it were possible for them to have done so. This impossibility can be traced to the fact that the fundamental premise of their theory--the uniformitarian principle--is not now, nor has it ever been, a sufficient basis for the Precambrian granites to form. In other words, both the Precambrian granites and the enclosed primordial halos required supernatural power to bring them into existence. Thus, irrespective of how many pieces seem to fit into the evolutionary scenario, the truth is that the uniformitarian principle is a false, hypothetical assumption. This background information is essential because parts of the reviews of Brown and Dutch rely heavily, either directly or indirectly, on this erroneous principle.

For example, paragraph 1 of Brown's review implicitly utilizes the uniformitarian principle in an attempt to support a secondary origin of polonium halos in earth rocks. Before discussing how this is done, I note first that the mention of cosmic ray tracks in this paragraph is irrelevant to the topic under discussion, because cosmic ray tracks have no connection whatsoever with halos. Second, Brown omits some pertinent information when he refers to the absence of halos in meteorites and lunar rocks. For the benefit of the non-scientist who may not understand what this is all about, I should explain that in referring to meteorites and lunar rocks Brown is attempting to correlate the absence of halos with the absence of water. True, as far as we know, meteorites and the lunar rocks returned to earth do not contain water. What Brown does not say, however, is that most of these lunar rocks are not primary rocks, but surface rocks which recrystallized from molten material produced by meteorite impact. The absence of halos in lunar surface rocks is expected because any halos that might have existed in the original (pre-impact) lunar rock would have been destroyed by melting. Likewise, because of the vacuum on the moon, any water which might have existed in original lunar rock specimens would certainly have been lost during the high temperature phase of the impact process. Thus the general absence of halos in recrystallized lunar rocks is a natural consequence of the mode of formation of those rocks, and only incidentally related to the absence of water.

In this context I should add that there is reason to continue the search for halos in lunar rocks. I think it is conceivable that halos may still exist in tiny, unmelted fragments of certain primary minerals contained within those rocks. Whether such fragments do exist in the lunar rocks now on earth will not be known until all those rocks are sectioned and carefully examined.

Before discussing Brown's assertion about minerals of hydrothermal classification, I will discuss his evaluation of halos in mica, a mineral that is generally considered to be of this type. In his first paragraph Brown suggests, without any supporting evidence, that halo centers along conduits and cleavage planes in mica support a hydrothermal origin of halos in this mineral. (In other words, halos which developed from radioactivity captured out of a solution containing significant concentrations of radioactive elements.) This suggestion was initially made by some early investigators who worked on halos about a half a century ago. There were serious problems with this hypothesis then, and even more difficulties with it now.

First, to associate halos in mica with a hydrothermal origin because their centers are along cleavage planes is meaningless because the crystal structure of mica is such that every center is situated along some basal cleavage plane. Secondly, there are numerous uranium and thorium halo centers in mica, such as monazites and zircons, which are not considered to be of hydrothermal origin (in the conventional usage of that term). Thirdly, Brown fails to say that the perfect cleavage properties of mica provided me with the opportunity over 20 years ago of examining the microscopic distribution of alpha radioactivity around polonium halo centers, and those studies showed no evidence for a secondary origin of polonium halos in this mineral. In fact, the report describing those results is cited in my ICC paper.

I now turn attention to my respected colleague's comment about halos being found in earth minerals of hydrothermal classification. This comment is a clear reference to the standard uniformitarian supposition that many primary minerals formed over geological time by very slow crystal growth either in a magma containing water, or in aqueous solutions laden with the chemical elements of which the mineral is composed. Uniformitarian geologists adopted this belief long ago mainly because: (1) it is possible to use aqueous solutions to slowly grow crystals of some minerals in the laboratory, and (2) there was evidence that many secondary minerals in sedimentary deposits had formed in this fashion. Geologists merged these two observations together with the uniformitarian principle and went on to assume that the vast number of primary minerals found in the earth--here I refer to the minerals found in crystalline rocks such as the Precambrian granites and pegmatites--achieved their large size through a slow growth process.

In my recent book, Creation's Tiny Mystery, I challenge the assumption that large crystals of primary minerals grew from small crystals over evolutionary time, and in particular refer to the existence of polonium halos as unambiguous evidence that these minerals were created. I also note in my book that evolutionary geologists should long ago have seen the falsity of this supposition both from the huge size of some natural crystals and from their inability to synthesize even reasonable size specimens of certain minerals such as biotite, an iron-rich mica which often contains radiohalos.

Summarizing, the term "minerals of hydrothermal classification" does represent a correct description of origin when applied to secondary mineral formation in sedimentary deposits. On the other hand, it is incorrect when applied in the conventional geological sense to describe the origin of primary minerals. Thus, Brown's argument for a water-related origin of halos in those minerals is invalid because it is based on the erroneous assumption that primary (or primordial) minerals developed through slow crystal growth over geological time.

For further clarification of the preceding paragraph, I should emphasize that, as might be expected, in the context of my creation model certain terms have a different meaning. With this new meaning there may be a definite relation between primary minerals and "minerals of hydrothermal classification." In my book, Creation's Tiny Mystery, I referred to the creation of earth's primordial rocks in the context of an instantaneous crystallization of a primordial liquid. More precisely, I envision there were a variety of primordial liquids called into existence on Day 1 (and perhaps Day 3) which gave rise to various types of primordial rocks. In my opinion, 2 Peter 3:5 strongly suggests that these primordial liquids must have included water at some instant in time within the creation process. In this sense the primordial (primary) minerals created on Day 1 (and perhaps Day 3) of creation week could also be viewed as "minerals of hydrothermal classification."

Skipping over paragraph 2 momentarily, paragraph 3 expresses some of my colleague's philosophical views, and he is certainly entitled to those opinions. Moreover, any scientist has a right to formulate any hypothesis he chooses about creation, and he is entitled to use the data published in my reports in this endeavor. However, if my data are used, then that scientist should be careful to state just where his own assumptions are introduced into his interpretation of my data, and in addition, he should make it quite clear that the conclusions obtained with these different assumptions are separate and distinct from my views. Unfortunately, that distinction is not clear in several places in Brown's review of my ICC paper, hence the need for extensive clarification on my part. Paragraph 2 is one place where such clarification is essential.

Brown introduces his second paragraph by stating that the existence of well-developed uranium halos in association with polonium halos presents a problem for a view that limits the age of all minerals--or equivalently, the age of the earth--to less than 10,000 years. In Figure 1(a) and 1(b) I show two examples of the specific association of halos to which my colleague refers in the above statement. (Readers desiring further information about these halos should refer to the photos in my ICC paper.)

FIGURE 1

Both (a) and (b) show a polonium-218 halo adjacent to an overexposed uranium halo in the Wolsendorf fluorite. (Scale is about 1 cm = 29 micrometers).

Given the above information, we need to understand why Brown asserts the association of uranium and polonium halos presents a problem for a young age of the earth, and then determine whether the reasons for that assertion are scientifically valid.

The basis for his assertion is found in the second sentence of paragraph 2. There the claim is made that it would take from 3 million to 190 million years to produce well-developed (mature) uranium halos. In other words, Brown attempts to call into question a young age of the earth by saying that it must have taken millions of years for uranium halos to form in the minerals in which they are found. He fails to say, however, that the millions of years that he claims are needed for uranium halos to develop is neither a scientific fact, nor a part of my creation model, but is instead a deduction at which he arrives by assuming a uniform radioactive decay process throughout geological time. But as discussed in my book, the assumption of uniform decay is just a corollary of the fallacious uniformitarian principle. In other words, the millions of years which Brown assigns to the development of uranium halos are imaginary because they are computed on the basis of a false assumption.

Paragraph 2 of Brown's review concludes with a reference to the Creator producing unnecessary "evidence" for events which did not occur in reality. With all due respect, the reader should understand that here my colleague is arguing against a straw man of his own devising, for the scenario described in his second paragraph is completely foreign to my creation model. Specifically, he mentions the in situ creation, sometime within the past million years, of polonium centers for polonium halos, and uranium halo centers for well-developed (mature) uranium halos. At first glance this statement may seem to fit into my creation model, but this is an illusion. One irreconcilable difference between my creation model and the above comment is the reference to the <u>in-situ</u> creation of uranium impurity centers for well-developed (mature) uranium halos. In Brown's own words this "requires the uranium centers and halos are in every way indistinguishable from halos that would be produced by the uranium decay series as presently observed." But since the "the uranium decay series as presently observed" is undergoing uniform radioactive decay, then it seems that Brown is referring to the creation of uranium centers with characteristics which he interprets as evidence of uniform radioactive decay over an extended period of time.

This whole idea is foreign to my creation model. Nowhere do I propose that uranium halo centers were created with the characteristics associated with uniform radioactive decay over an extended period of time. Such a scenario implies, first, that the uranium centers were created with artificial characteristics, and second, that uranium halos in granites were not

produced by alpha-particle interaction with those rocks, but instead are just colorations which were directly imprinted into them.

This view is conceptually, philosophically, and scientifically at variance with two major tenets of my creation model--namely, (1) that polonium halos are genuine evidence of an instantaneous creation of the Precambrian granites precisely because alpha particles emitted from rapidly decaying primordial polonium atoms did produce polonium halos in those rocks (in other words, polonium halos are truly autographs of radioactivity that had only a fleeting existence), and (2) that uranium and thorium halos likewise resulted (via an accelerated decay process) from the interaction of alpha particles from uranium and thorium centers that were created simultaneously with the granites.

In my model uranium and thorium halos are post-creation entities which formed via an enhanced radioactive decay process during one or more of the three biblically-based singularities described in my ICC paper. On this basis, I can easily account for the close association of uranium and polonium halos, such as shown in Figure 1. I must conclude, therefore, that the problems cited in the second paragraph of Brown's review concerning the association of uranium and polonium halos are due primarily to his use of the erroneous uniformitarian principle and the associated uniform decay rate assumption, and secondarily to the introduction of an idea which is completely foreign to my creation model.

In paragraph 4 Brown argues for a secondary rather than a primordial origin of polonium halos in granites, but unfortunately he overlooks nearly all the scientific evidence which negates this hypothesis. Through many experiments over the past two decades I have shown the unequivocal differences between the secondary polonium-210 halos in coalified wood--meaning those that resulted from water transport of uranium daughter activity-- and the several types of primordial (independently created) polonium halos in granites. Brown does not at all deal with the vast differences in uranium content and transport rate between granites and gel-like wood (the early stage of coalified wood), nor in any way attempt to provide experimental evidence for a secondary origin of polonium halos in granites. Instead, he argues against a primordial origin of polonium halos in granites using arguments which appear to be based on scientific fact. The following discussion presents another view of those arguments.

In the beginning of paragraph 4 Brown argues against primordial polonium halos using an idea initially proposed several years ago by one of the other reviewers (Dutch). His main line of argument utilizes a particular concept of the isotopic composition of primordial polonium. Using this concept Brown arrives at what he feels should be the composition of halo centers at present, and then notes that I have not reported such compositions. All this leaves the impression that something must be wrong with my conclusion that polonium halos in granites are primordial. Unfortunately, some very important information was omitted from Brown's discussion. We shall see that the picture changes considerably when all the pieces of the puzzle are included.

Readers should understand first that I have never said, or even remotely suggested, that primordial polonium would be composed of the isotopes cited in paragraph 4 of Brown's review. His definition of primordial polonium is quite different from mine, and the reader is entitled to know the reasons why the two are fundamentally different.

What my colleague has done--apparently unwittingly--is to combine two results from experimental physics together with a theoretical result of the evolutionary Big Bang model, and then lumped everything together as if it is based on experimental nuclear physics. In particular, Brown claims "well-established empirical relationships between isotope abundance, half-life, and binding energy per nucleon..." establish the composition of primordial polonium as he states it. If all parts of this statement were true, there would be some scientific justification for Brown's version of primordial polonium. The problem is, however, that one crucial part of the above statement is not true.

Specifically, while nuclear physics has established empirical relationships between half-life and binding energy per nucleon, it definitely has not established a pattern of primordial isotope abundances as Brown claims is the case. The pattern of isotope abundances to which Brown refers--which also forms the basis of his definition of primordial polonium--is in reality the end result of theoretical calculations pertaining to the Big Bang theory of the evolution of the universe.

To understand Brown's version of primordial polonium the reader needs to understand how cosmologists view the origin of matter. First, because modern cosmologists believe only the two lightest elements--hydrogen and helium--were made in the Big Bang, they must find some way to account for all the heavier elements in the universe--including those composing the earth, sun and planetary system. Their theory is that these heavier elements were formed billions of years ago in fusion reactions deep inside certain stars. As explained in my

book, they also believe interstellar space became sprinkled with heavier elements as more and more stars exploded through eons of time. Then, through processes which have never been clearly defined, supposedly the remnants of these violent explosions somehow reaccumulated to form other stars, one of which is assumed to have been the proto-sun, the forerunner of both our sun and the earth.

Here we must pause to separate fact from assumption. It is doubtless true that some chemical elements are produced in stellar fusion reactions--by charged particle reactions, or by slow neutron capture (the s-process), or by rapid neutron capture (the r-process)--but it is just sheer fiction to assume that all the heavier elements in the universe were produced by such reactions. But this is what modern cosmologists do, and on this basis they proceed to theoretically calculate the primordial isotopic abundances of all the heavier elements.

Such patterns of isotope abundances are only theoretical patterns because they involve several unverified assumptions about the exact path by which fusion build-up of the heavier elements is thought to have occurred. I should add that what correspondence there is between the most commonly accepted theoretical abundance pattern and the actual abundance pattern as measured on earth is the result of varying the parameters in the theoretical calculations to fit the measured abundances. (Readers desiring more details on how isotope abundance calculations are linked to various aspects of the Big Bang theory may consult an older publication, Nuclear Astrophysics, authored by Nobel laureate William A. Fowler, and published by the American Philosophical Society, Philadelphia, 1967, or a more recent one, "Nucleosynthesis and its Implications on Nuclear and Particle Physics", Proceedings of the NATO Advanced Research Workshop on Nucleosynthesis and Its Implications on Nuclear and Particle Physics, Les Arcs, France, March 17-23, 1985, D. Reidel Publishing Company, 1986.)

The above discussion shows that the theoretical isotope abundance pattern used by Brown to formulate his version of primordial polonium and its most prominent decay product, thallium-205, is hinged on the assumption that the heavier chemical elements on earth--specifically including polonium--originated in stellar nucleosynthesis. Using that assumption Brown interprets the absence of thallium-205 in halo centers as indicating the absence of primordial polonium, hence implying that something is wrong with my identification of primordial polonium halos.

Here a most important point needs to be emphasized. There is another explanation for the absence of thallium-205 besides the one Brown has mentioned, namely: Instead of the missing thallium- 205 indicating something is wrong with my identification of primordial polonium halos, what it actually shows is that the Big Bang version of primordial polonium is without any scientific basis. We should ever remember that the validity of a theory is determined on the basis of whether it agrees with the relevant experimental facts, and in this case it is abundantly clear that the Big Bang version of primordial polonium does not agree with the experimental facts.

Therefore, I reaffirm that polonium halos in granites did form from the decay of primordial polonium-218, polonium-214 and polonium-210, and this is why halo centers feature the decay product lead-206. (Halos from bismuth-212/polonium-212 also exist but are much rarer than those just listed.) I believe these types of polonium halos are evidence that the true isotopic composition of primordial polonium--meaning the polonium God created when He called the earth into existence--was irreconcilably different from that expected on the basis of the Big Bang model. In other words, when God called the earth into existence He left unambiguous evidence of His creative power which could never be confused with the Big Bang scenario. (Readers interested in knowing other reasons why the Big Bang model is wrong should consult the more extended discussion given in my book.)

On a different subject in paragraph 4, Brown refers to the presence of selenium in both uranium and polonium radiohalo centers, and the assertion is made that this is evidence for the explanation of halos involving solution transport of uranium daughters. The first problem with this view is that selenium is definitely not a constituent of uranium radiohalo centers, and it is not clear why such a claim would be made. (In fact, one of the other reviewers, Dutch, correctly notes that Group VI elements, which includes selenium, are not geochemically compatible with the U- and Th-bearing minerals that normally constitute U and Th halo centers.) Secondly, only in a very few cases have I observed selenium in the centers of polonium halos in granites. Possibly Brown generalized the results given in my 1974 Science report and incorrectly inferred that selenium in polonium halo centers in granites is the rule rather than the exception. Thus, all the arguments cited in this paragraph in support of a secondary origin of polonium halos in granites are based either on ideas or suppositions which are foreign to my views, or on incorrect interpretations of my published data.

In paragraph 5, my respected colleague does not directly comment on the implications of the falsification test as I have defined them, but instead generates his own interpretation

predicated on the assumption of a successful outcome of that test. Brown is entitled to his views, but he fails to mention the evidence which contradicts the assumption of a successful outcome--namely, that, according to conventional theory, the conditions for reproducing granite from a granite melt have existed in nature countless times, yet the end result is rhyolite, a fine-grained, non-halo- containing rock that is quite different from granite, a coarse- grained rock which does contain halos. Additional explanation is given in my book, Creation's Tiny Mystery (page 130).

In paragraph 6 of his review, Brown claims my model of enhanced alpha decay suffers a severe loss of credibility. But this conclusion is obviously based on his acceptance of uniform radioactive decay rates--a direct consequence of the uniformitarian principle. Thus, this particular criticism results from his acceptance and use of a fallacious assumption.

Paragraph 7 could easily be interpreted as a correction to an erroroneous claim on my part, but the fact is that my comments about Feather's evaluation are correct as they stand.

In answer to paragraph 8, U and Th atoms are more tightly bound because they are part of the zircon lattice structure. The Pb atoms, on the other hand, being the radiogenic end-products of U and Th decay, are rather loosely bound primarily because they have been displaced about 100 angstroms (by recoil from a series of alpha emissions) from the original U and Th lattice sites into a region where lattice disruption has occurred.

Paragraph 9 refers to the helium content of helium-producing wells. These may have their source in secondary uranium deposits, that is, uranium which has been separated from primary uranium-bearing minerals and widely dispersed via solution transport. A prime example of secondary uranium deposits are those of the Colorado Plateau. Helium migration occurs without difficulty from such deposits because of the dispersed state of uranium and its daughters.

There are two reasons why helium migration from zircons in granites is much lower than from helium escape from these secondary deposits. First, there is the difference in uranium content. Zircons, which may contain only about 100 ppm (parts per million) of uranium, are encased within granites containing an even smaller concentration of uranium, usually about several ppm. These concentrations are generally much lower than the uranium concentrations found in many secondary uranium deposits. Secondly, migration (or diffusion) from zircons has been found to be relatively slow at ambient temperatures, a fact which is attributable to the crystalline structure of this mineral. These two factors account for helium effusion from helium wells being significantly higher than helium diffusion from zircons. Thus nothing in this paragraph contradicts my claim that helium in zircons taken from deep cores is very strong evidence for a several-thousand-year age of the earth.

About paragraph 10, I appreciate the compliments about my work on halos in coalified wood. Of course, the analytical techniques that were used to investigate polonium halos in coalified wood were the same as those used to investigate primordial polonium halos in granites.

In summary, I thank Dr. Brown for presenting his detailed objections in print, thus enabling me to clarify to the scientific community some issues that have long been misunderstood. And in closing my response to his review, I again express my respect and admiration for him personally.

Turning to Dutch's review, part (1) reveals how easy it is to arrive at erroneous conclusions when reading someone else's reports. It is true that U and Th halo radiocenters are generally known U- and Th-bearing minerals, but Dutch displays a lack of knowledge of radiohalos by erroneously assuming these minerals also form the centers of polonium halos. The data I have published, especially in my 1974 Science and Nature reports, show that polonium halo radiocenters in granites are quite distinct from the usual U- and Th-bearing minerals found at the centers of U and Th halos. Other unpublished results of mine are in agreement with these findings. Thus, when Dutch argues against polonium being in U- and Th-bearing minerals, he is arguing against a straw man of his own invention.

Part (2) in essence disputes the conclusion that polonium halos in granites are primordial on the basis that halos from other polonium isotopes should also be present if this were the case. Dutch has produced no scientific evidence to contradict the existence of primordial polonium halos in granite. Instead he has introduced a hypothetical phenomena into the discussion--namely, of what he thinks primordial polonium should consist--and then claims that my model must be wrong because it doesn't include his hypothetical component. This is, of course, exactly the same argument that Brown used in paragraph 4 of his review. As I showed in my lengthy response to Brown's paragraph 4, the fallacy in this whole idea is the assumption that the Big Bang version of primordial polonium is correct. Indeed, as I indicated in the conclusion of my response to Brown's paragraph 4, the isotopic composition

of lead in polonium halos in granites provides unmistakable evidence that the Big Bang version of primordial polonium is fictitious.

As mentioned previously, I have provided abundant scientific evidence that some polonium halos in nature are secondary-- referring to the polonium-210 halos found in uranium rich coalified wood specimens from the Colorado Plateau--and have shown in detail how these halos differ from the primordial polonium halos in granites. For some reason Dutch omits any mention of these differences from his review.

In part (3) Dutch attacks my creation model because it includes elements of uniformity and nonuniformity. It should be noted that his attack is based on philosophical rather than scientific grounds. I make no apologies for proposing a model that includes both uniformity and nonuniformity because this is what the scientific evidence dictates. What Dutch avoids saying is that my model can account for both primordial polonium halos in granites as well as secondary polonium halos in coalified wood, which is something the standard evolutionary model can never do. What is most interesting in this paragraph is the way Dutch first raises questions about the identification of polonium halos using the uniformitarian aspect of my model, but then admits my identification of polonium halos is correct after all! The last point in this paragraph concerns whether decay rates may have speeded up or slowed down. My response is that the evidence from the U/Pb ratios in coalified wood, as well as the results from both the Pb and helium retention in zircons taken from deep cores, provides strong evidence that the earth's age is very young. This implies an enhancement in the decay rate in the past.

The last paragraph of Dutch's review starts out as a philosophical defense of the uniformitarian principle, with the implication that evolutionists have the truth. With this mind-set Dutch then proceeds to relegate all my discoveries for creation to the category of "unresolved problems in science." He claims that scientists will only revise their beliefs after they are confronted with incontrovertible evidence to the contrary. But somehow he fails to see that evolutionists have been confronted with just that kind of evidence for a long time--the falsification test was proposed almost eight years ago. Clearly, when the issue between creation and evolution was reduced to the outcome of an experimental test, evolutionists signally failed-- and are continuing to fail--to meet the challenge of creation.

Dutch's comments about variable decay rates reveal again, unfortunately, that he continues to utilize the straw man approach--this time erecting two of them--as a means of attacking my work. As just noted (two paragraphs ago), the evidence cited for a change in the decay rate is based on the U/Pb ratios in coalified wood and the results of Pb and He retention in zircons taken from deep granite cores. I also cite the existence of primordial polonium halos in Precambrian granites of presumably varying geological ages as prime evidence that the different radiometric ages of those granites are fictitious. But I oppose the idea that it is possible to produce significant decay rate changes at present. Dutch must surely realize that this is my position because the creation model I have proposed--and about which he comments--pictures significant decay rate changes only in the context of supernatural intervention into the affairs of this planet during such periods as creation week and the time of the flood. From this it can be seen that the whole idea of inducing significant decay rate changes at present is diametrically opposed to the basic tenets of my creation model.

Near the end of his review Dutch begins to critique other creationists' views of radiometric dating, including a reference to changes in electron-capture decay rates. I do not understand why these remarks are included in his review because all the views that Dutch comments on here are quite different from mine, and in fact are completely disassociated from my results.

Finally, I again express my personal esteem for Dutch. And in response to his last sentence, I would hope that he--and for that matter all who hold a purely uniformitarian view of earth history--would carefully consider that God left scientific evidence of creation to help those who doubt Genesis come to a full knowledge of the truth of His Word.

In considering Russ Humphreys' review, aside from the question about other polonium halos--to which I have already responded in the preceding reviews--it appears to be mainly an outline of a tentative model conceived by Russ and John Baumgardner. There are some similarities between their model and mine--we both incorporate some form of change in the radioactive decay rate into our models. This means that we both recognize the uniformitarian principle is not a valid premise for reconstructing earth history. The significant differences between our models, as I understand them, are as follows:

(1) In their model radioactive decay doesn't start until some time such as the Fall, whereas in mine it begins during creation week. The reason I include radioactive decay processes

within the pristine framework of creation week is that, from my understanding, luminous stars were in existence during this time, which was of course before the Fall. It is my belief those stars radiated energy through essentially the same nuclear reactions that are now operative, and that some of those reactions involved radioactive decay processes as well as nuclear fusion.

(2) In their model radioactive decay ceases from the Fall to about the time of the Flood, whereupon it begins again. In my model, there are several special periods of decay rate enhancement such as creation week, the Fall, and the Flood, to name the major ones. My model includes the possibility of an enhanced decay rate during creation week for the generation of heat, thus causing an expansion or uplift of land masses, resulting in the appearance of dry land. At the time of the Flood I see the possibility that an enhanced decay rate was again operative, this time perhaps for the primary purpose of initiating violent upheavals within the earth through rapid melting.

(3) In their model radioactive decay restarts after the Flood, whereas in my model there is an enhancement in the decay rate during the period of the Flood.

Without further discussion about the differences between our models, the most important question is whether their model can account for the existence of polonium halos in granites. The first problem is of course to identify the source of uranium for the polonium. For polonium halos embedded within a large granite formation it is in many cases difficult, if not impossible, to find a significant concentration of uranium nearby.

Then comes the question of transporting polonium through the solid rock. The movement of radioactivity via solution transport is certainly valid for gel-like wood, but quite difficult to justify for movement through granite. Ordinarily this must be done by diffusion, an exceedingly slow process, which when considering the time between the Fall and the Flood, would imply only small distances would be traversed.

Perhaps the most difficult obstacle to the formation of polonium halos in this tentative model seems to be inherent in the model itself. That is, if decay stops after the Fall, then polonium is a stable element with the ratios of the various polonium isotopes fixed in the proportion that existed at the time decay ceased. Thus all isotopes of polonium would move in unison (chemically speaking) and there would be no isotopic separation at all. The same is true for the lead and bismuth beta-precursors of polonium. This means that, if decay restarted at the Flood, there would be only one type of polonium halo (polonium-210) from the uranium series rather than the three types which actually exist.

The reason for this becomes apparent when it is realized that during the period of decay the isotopic abundances of polonium- 218, -214, and -210, bismuth-214 and -210, and lead-214 and -210, are determined by the half-lives. For all three elements the 210 isotope has a half-life that is several hundred times greater than the 214 or 218 isotope. This means that in every case where polonium, bismuth, or lead may be separated as an element in a radiocenter, the 210 isotope of that element will be in vastly greater abundance than the 214 or 218 isotope, and thus lead to the formation of polonium-210 halos in every instance. In other words, there would be no possibility of halos originating solely with polonium-218 or polonium-214 to produce either a balanced- coloration three-ring polonium-218 halo or a two-ring polonium- 214 halo. Examples of these balanced-coloration polonium-218 and polonium-214 halos are shown in the radiohalo catalog in my book.

Finally, since Russ ends his review with comments about the falsification test, it is appropriate to relate two new items about this topic. In the first instance a friend recently informed me that a California geologist had claimed one of the geology films distributed by Ward's Natural Scientific Establishment, Inc. showed granite synthesis. Subsequently, I contacted the producer of the film, Mr. Silas Johnson, now retired, of Coronado, California. According to Johnson this film is mainly an overview of geologic history explaining in general terms the conventional view of the origin of igneous rocks. The film was designed for the high school level and contains nothing relating to the experimental synthesis of granite.

Another report is far more interesting. A Canadian evolutionist wrote me, and sent copies to a number of prominent evolutionists, that the geology course, Understanding the Earth, offered on TV- Ontario, features a film on igneous rocks that shows granite synthesis. I obtained a videotape of that film, which is program 3 in the Understanding the Earth series. The purpose of the series is to educate students in the conventional, uniformitarian view of earth history, including the idea that granites cooled slowly from a melt. As a means of accomplishing that purpose, program 3 shows a laboratory experiment that claims to duplicate conditions under which granite is thought to have formed. In the film granite powder is melted under pressure and then allowed to cool. The resulting specimen is said to show a resemblance to granite. The film does not claim that the cooled specimen is actually a

granite. It states only that the experiment can be interpreted as being suggestive of how granites formed. To say the specimen resulting from a granite synthesis experiment just resembles granite, instead of actually being a granite, is exactly what the falsification test is all about. Thus, the Canadian evolutionist, who wrote to me about this TV program illustrating granite synthesis, erroneously equated an imitation granite with the genuine article.

From my viewpoint the results of this experiment have been one of evolution's best kept secrets--the experiment itself was done over twenty years ago--and it is now time for this particular secret to be given the widest possible exposure.

As this response goes to press I am checking to see what, if any, additional details about this interesting experiment may be determined at this late date. In my opinion creation science is about to move into a new era. There are exciting possibilities!

Robert V. Gentry