



# REPORTS OF THE

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DEFENDING THE TEACHING OF EVOLUTION IN THE PUBLIC SCHOOLS

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Polonium Halos and Helium Diffusion

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Creationist  
Magazine

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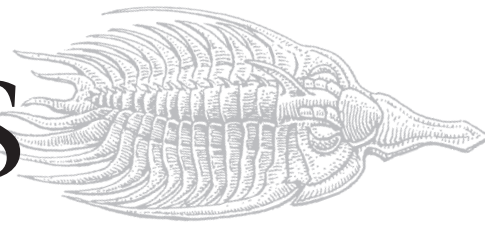
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For more information on Ray's work explore his website at <[www.trollart.com](http://www.trollart.com)>.

"Do you seek the Rock of Ages, or the ages of the rocks?"

This is the classic conundrum for young-earth creationists. If the earth is really only a few thousand years old, then everything we know about the physical sciences (and all the science that depends on them), from astronomy to oil exploration to volcanology, is in jeopardy. Indeed, this is the rationale for the "yeahbut-whatabout" strategy of many creationists. If one creationist objection to naturalistic models is refuted, their proponents are quick with another question: "Yeah, but what about ... ?" The presumption is that one instance of an unanswered question or disputed conclusion will pull the whole structure of science down. But of course, this is a characteristic of biblical literalism (the whole is completely and absolutely true or none of it can be) and not of modern science.

It is probably no surprise that YECs fret about the physical sciences, since there are so many data sets that independently reinforce a very old age of the earth. Although the exact details vary somewhat, none of these data sets estimates an age of the earth that is significantly less than 4.5 billion years (and certainly nothing even close to the 6000 years that YECs seek). Still, creationists at the RATE (Radioisotopes and the Age of The Earth) Project have been toiling away for over a decade to find scientific support for a young earth. Two of their targets are the production of radioisotope "halos" in geologic formations and diffusion of helium (which is the chief product of one type of radioactive decay).

In this issue, Lorence G Collins and Barbara J Collins offer a primer on how halos are formed by polonium isotopes and how those halos appear in geologic deposits. Next, Thomas A Baillieu explores the use of polonium halos by Robert Gentry and his colleagues to argue for a young earth. And completing our rock suite is a treatment by Kevin R Henke on the work by Russell Humphreys and his colleagues on the diffusion of helium as evidence for a young earth. Their conclusions show that YECs are quick to pick and choose geologic data that



suit their conclusions, but, as Henke points out, even using their own models to calculate the age of the earth gives estimates orders of magnitude older than 10 000 years!

## IN THE NEWS

More polling information tells us two things: (1) acceptance of evolution is still unacceptably low around the world; and (2) it is even worse in the US. We also see a smattering of school boards and politicians toying with the idea of introducing creationism into the science curriculum under various guises. Some people never learn!

## BOOK REVIEWS

Our reviewers examine two books on "intelligent design": *The Panda's Black Box* critiques ID from a variety of disciplinary perspectives, and *Signature in the Cell* claims to show that the information content in DNA could not have arisen naturally.

We also have reviews of a book of poetry by Philip Appleman and a graphic adaptation of *On the Origin of Species*. And Daniel K Brannan reviews *Creationism and the Conflict over Evolution*, which considers the philosophical and theological implications of ID.

## PEOPLE & PLACES

In his regular column on the people and places of evolution, Randy Moore provides a profile of Jean-Baptiste Lamarck. Lamarck is one of the important figures in the history of science, particularly evolution, but what most people know about him is either wrong or incomplete.

RNCSE 30 (5) was printed in November 2010.

## ERRATUM

In "Americans' scientific knowledge and beliefs about human evolution in the year of Darwin" (RNCSE 2010 May/Jun; 30 [3]: 16-8), the first name of the second author was misspelled, and the name of the fourth author was omitted. The authors were George F Bishop, Randall K Thomas, Jason A Wood, and Misook Gwon.

# UPDATES

**Georgia, Carroll County:** At its July 22, 2010, meeting, the Carroll County Board of Education was asked “to consider researching, evaluating and taking a position on the issue of teaching evolution compared to creation in the schools,” according to the *Times-Georgian* (2010 Jul 23). Bob Staples told the board:

Evolution is a theory in crisis and harmful to our progress ... We have been either created by God or are the result of naturalistic evolution. ... There is no evidence of evolution happening in the past. ... Evolution is not a fact, but is taught as a fact in many educational settings.

The assistant superintendent of teaching and learning for the district explained that evolution is part of the state science standards, but the superintendent offered to prepare a chart showing “what is required compared to what is offered” for the board’s benefit.

**Louisiana, Livingston Parish:** “The Livingston Parish School Board will begin exploring the possibility of incorporating the teaching of ‘creationism’ in the public school system’s science classes,” the Baton Rouge *Advocate* (2010 Jul 24) reported. The director of curriculum for the district reportedly told the board that, under the Louisiana Science Education Act, schools are allowed to present “critical thinking and creationism” in science classes. The response from the board was enthusiastic, with David Tate asking, “Why can’t we get someone with religious beliefs to teach creationism?” Clint Mitchell added, “Teachers should have the freedom to look at creationism and find a way to get it into the classroom.” Keith Martin, the president of the board, agreed, “Maybe it’s time that we look at this,” and proposed the formation of a committee to study the possibility.

Marjorie Esman, executive director of the American Civil

Liberties Union of Louisiana, told the *Advocate*, “They would be wasting a huge amount of taxpayer money on a battle they can’t win.” The board’s attorney confirmed that it would be unconstitutional for the schools to teach creationism. Meanwhile, Tate, who broached the possibility of teaching creationism at the previous board meeting, commented, “We don’t want litigation, but why not take a stand for Jesus and risk litigation.”

**Oklahoma, Oklahoma City:** Michael Talkington, Adjunct Professor of Biology at Oklahoma City Community College, will not be returning. In April 2010, Bryan Jaden Walker, a student at OCCC, commented in his blog:

He closed the classroom’s door. Once the door was closed, he glossed over the scientific explanation very quickly (less than 20 seconds), then explained creationism for about five minutes (5000 year-old-earth, no evolution, etc). ... After he finished his creationism lecture, he opened the classroom door again.

Walker subsequently complained to a dean at OCCC, who, he said, told him that Talkington was entitled to his opinion and reproached Walker for intolerance. Nevertheless, Walker’s report was quickly noted by popular bloggers. The attention resulted in a story in the OCCC student paper, the *Pioneer*, which reported (2010 Jul 18) that OCCC was investigating Walker’s allegations. Talkington — described as “a doctor of veterinary medicine who worked at Mid-America Christian University, a south Oklahoma City seminary” — told the paper:

I have things inside my mind, as a scientist and a man of faith, that prove to me that intelligent design is true ... I don’t emphasize evolution. There are no test questions

regarding evolution and I don’t discuss it at length.

Although no disciplinary action was taken against Talkington by OCCC, he will not return; the decision, he told *The Oklahoman* (2010 Aug 8), was his own.

**Texas:** The Institute for Creation Research is apparently conceding defeat in its lawsuit over the Texas Higher Education Coordinating Board’s 2008 decision to deny the ICR’s request for a state certificate of authority to offer a master’s degree in science education from its graduate school. The United States District Court for the Western District of Texas granted summary judgment to the defendants in a June 18, 2010, ruling (see *RNCSE* 2010 Jul/Aug; 30 [4]: 4–6).

Information about the graduate school vanished from the ICR’s website over the summer of 2010, and Chris Ashcraft reported in *Creation Ministries International’s Journal of Creation* (2010; 24 [3]: 54–5), “On 25 June 2010 the ICR board of directors voted to close the Grad School,” citing a June 30, 2010, e-mail from Henry Morris III. Replacing it, apparently, is the ICR’s School of Biblical Apologetics, which offers a Master of Christian Education degree; Creation Research is one of four minors. The Texas Supreme Court’s decision in *HEB Ministries, Inc et al v Texas Higher Education Coordinating Board* (235 SW 3d 627 [Tex 2007]) established that THECB does not have oversight over institutions that offer exclusively religious education and training.

**Texas:** In a decision issued on July 2, 2010, the United States Court of Appeals for the Fifth Circuit upheld a lower court’s decision that the Texas Education Agency’s policy requiring “neutrality” of its employees when “talking about evolution and creationism” is not unconstitutional. The case, *Comer v Scott*, was filed by Chris Comer, the former director of science for the Texas Education



Agency, who was forced to resign from her post in November 2007 after she forwarded a note announcing a talk by Barbara Forrest. In June 2008, Comer filed suit, arguing that the agency's neutrality policy violates the Establishment Clause. Her lawsuit was dismissed in March 2009, but she appealed the decision, and oral arguments were heard in April 2010.

Writing for a three-judge panel of the Fifth Circuit, Fortunato Benavides explained:

Upon review of the record and applicable law, we cannot conclude that TEA's neutrality policy has the "primary effect" of advancing religion. The fact that Comer and other TEA employees cannot speak out for or against possible subjects to be included in the curriculum ... serves to preserve TEA's administrative role in facilitating the curriculum review process for the Board. ... Thus, we find it hard to imagine circumstances in which a TEA employee's inability to publicly speak out for or against a potential subject for the Texas curriculum would be construed or perceived as the State's endorsement of a particular religion.

Documents from the case are available on NCSE's website at <<http://ncse.com/creationism/legal/chris-comer-docs>>, and a brief video is on NCSE's YouTube channel (<<http://www.youtube.com/user/NatCen4ScienceEd>>).

**Australia:** A national survey reveals that one in ten Australians does not believe in evolution — and three in ten think that humans lived at the same time as dinosaurs. The survey, conducted by Auspoll for the Federation of Australian Scientific and Technological Societies and the Australian Academy of Science, was intended to assess the level of science literacy in Australia.

Jenny Graves of the Australian Academy of Science told *The Age* (2010 Aug 1):

None of us [is] all that surprised because we have been aware for a few years that Australia is losing ground in science and maths but it's a real wake-up call that ... a very sizeable number of people ... really don't understand some of the absolute basics of our lives.

The survey was conducted on-line July 20–22, 2010; the report is available on-line at <<http://www.fast.org/images/News2010/science%20literacy%20report%20final%20270710.pdf>>.

**Australia, Queensland:** "Primary school students are being taught that man and dinosaurs walked the earth together and that there is fossil evidence to prove it," according to the *Brisbane Courier-Mail* (2010 Aug 1). About 80% of primary school students in Queensland attend religious classes conducted by volunteers — including, apparently, some from local Pentecostal churches, who often teach creationism in the religious instruction classes. Education Queensland told the *Courier-Mail* that parents can opt their children out of Religious Instruction classes, noting that creationism is part of certain religious faiths. Jim Ferguson, president of the Buddhist Council of Queensland, said that he planned to raise the issue at the next meeting of the Religious Education Advisory Committee, part of Education Queensland.

**Ireland:** According to the *Irish Times* (2010 Sep 13), Conor Lenihan, who represents Dublin South West for Fianna Fáil in Dáil Éireann (the lower house of the Irish parliament) and serves as Minister of State for Science, Technology, Innovation, and Natural Resources, was billed as launching John J May's *The Origin of Specious Nonsense* (Dublin: Original Writing, 2010) at a

September 15, 2010, event in Dublin.

In a sample provided on the book's website (<<http://www.theoriginofspeciousnonsense.com/>>), May writes:

It is sacrificing reason on the altar of treason to accept that the greatest construction of all time — a human being with a brain [—] is the result of chance, random selection and destructive mutations. It is the irrational 3-legged chair of hopeless speculation that bears no resemblance whatsoever to reality and observable functioning perfect order.

Later, the *Times* (2010 Sep 14) reported, "Lenihan will not now launch a book in Dublin which describes evolution as a fantasy and a hoax." May told the newspaper that he asked Lenihan not to participate in the event "because I am so embarrassed that the Minister for Science has been so insulted" by those critical of his involvement in the event. Lenihan said that he "remained to be convinced" by May's arguments — while insisting that "diversity of opinion is a good thing."

**United Kingdom:** A creationist attraction — Noah's Ark Farm Zoo, in Wraxall, near Bristol — was awarded with the Quality Badge from the Council for Learning Outside the Classroom, and the British Humanist Association is protesting. In a press release dated July 22, 2010 (available on-line at <<http://www.humanism.org.uk/news/view/605>>), a BHA spokesperson was quoted as saying:

This is an appalling decision. It is entirely inappropriate that the Council should support an establishment that advances creationism and seeks to discredit a wide variety of established scientific facts ... Teachers and parents look to the Council for assurance that children will expe-



rience high quality educational visits that meet the relevant government guidelines. Awarding this particular zoo a Quality Badge risks exposing hundreds of children to anti-scientific dogma.

In 2009, the BHA called upon the British and Irish Association of Zoos and Aquariums, as well as a number of government and tourism agencies, to dissociate themselves from Noah's Ark Farm Zoo (see *RNCSE* 2009 Nov/Dec; 29 [6]: 6-9).

**International:** A new poll indicates that public acceptance of evolution is significantly higher in Great Britain and Canada than in the United States. The poll, con-

ducted by Angus Reid Public Opinion, asked, "Which of these statements comes closest to your own point of view regarding the origin and development of human beings on earth?" and offered the choices "Human beings evolved from less advanced life forms over millions of years" and "God created human beings in their present form within the last 10 000 years." (For the report, see <<http://www.visioncritical.com/wp-content/uploads/2010/07/2010.07.15-Origin.pdf>>.)

In the United States, there was no statement commanding the assent of the majority of respondents: 35% of respondents preferred the evolution statement and

47% preferred the creationism statement. In Canada and Great Britain, however, evolution was the majority view. In Canada, 61% of respondents preferred the evolution statement and 24% preferred the creationism statement. In Great Britain, 68% of respondents preferred the evolution statement, and 16% preferred the creationism statement.

The results varied by region. Acceptance of evolution in the United States was lowest in the South (27%, with 51% accepting creationism) and highest in the Northeast (43%, compared to 38% accepting creationism). In Canada, acceptance of creationism was highest in prairie provinces (about

## Popular "Scientific" Magazine Distributed by Young-Earth Creationists in the Netherlands

Coen Brummer

As of March 2010, people in the Netherlands can subscribe to *Weet*, a popular "scientific" magazine written and distributed by young-earth creationists. The magazine is put together very professionally and is printed on shiny paper, in full color, which raises the question of who is funding the luxury layout.

The launch of this magazine is not the first attempt of creationist movements to gain ground in the Netherlands. In 2007, the Evangelical Network broadcast an edited version of BBC's *The Life of Mammals*, a natural history program produced by David Attenborough, leaving out the scenes on the theory of evolution and the age of the earth. In 2009, an impressive list of Christian orthodox organizations distributed millions of eight-page leaflets door to door containing creationist arguments against the theory of evolution (see my article "Darwin year in the Netherlands: A time to reflect," *RNCSE* 2009 Jul/Aug; 29 [4]: 4-5).

Coen Brummer lives in Utrecht, the Netherlands. He is currently finishing his MA in history and is pursuing an MSc in history and philosophy of science at Utrecht University. His personal website is <<http://www.coenbrummer.nl>>.

The magazine launches an all-out campaign against the scientific worldview and contains numerous articles questioning the conventional theories about the age of the earth, the theory of evolution, climate change, and genetic engineering. Editor-in-chief Jan Rein de Wit states in his editorial that the Bible is the basis for their argumentation: "Not to prove that the Bible is literally true, because that goes without question, but to show the greatness of God" (*Weet* 2010 Feb; 1: 5; my translation).

The articles in *Weet* recycle standard creationist argumentation that has been falsified over and over during the last decades. For example, in "Darwins broodje aap" ("Darwin's urban legend"), an interview with biologist Peter Borger tells us about his "great discovery": "random mutations in DNA could never result in useful biological information" and that because of this, the theory of evolution by natural selection has no solid basis (*Weet* 2010 Feb; 1: 23; my translation).

This type of reasoning is classic creationist argumentation and has been proven wrong on multiple occasions. Even creationists typically accept research showing that mutations in bacteria can result in antibiotic resistance, which is very

useful for the organism. In the evolutionary history of humans, there are plenty known cases of useful random mutations as well. For example, some 2.7-2.1 million years ago the pseudogenization of the MYH16 gene by one simple mutation caused looser masseter muscles, which resulted in a greater possibility to develop larger brains (see Sean Carroll, *Endless Forms Most Beautiful* [New York: WW Norton, 2005], p 272-4).

Another *Weet* article questions the age of the earth, based on the discredited account of a World-War-II-era war plane that crashed in Greenland, but is now covered by 250 feet of ice. It argues that if 250 feet of ice can accumulate in just 60 years, then ice layers at the poles could have come about in just a few millennia. Of course the plane was embedded in *glacial* ice, which accumulates in different ways than the ice layers at the poles. (Read more about this claim at the Index to Creationist Claims of the TalkOrigins Archive at <<http://www.talkorigins.org/indexcc/CD/CD410.html>>.)

Articles on other subjects, such as climate change and genetic engineering, are also based on similar shoddy research and questionable reports.

It is not very likely that the cre-



50%, with only 31-39% accepting evolution). In Great Britain, acceptance of creationism was highest in London (25%, compared to 58% accepting evolution).

The choices offered by Angus Reid are similar, but not identical, to Gallup's, which offers two versions of the evolution statement, specifying "God guided this process" and "God had no part in this process." In 2008, 36% of Gallup's respondents preferred the "God guided" statement and 14% preferred the "God had no part" statement, for a total of 50% accepting evolution, compared to 44% accepting the creationist statement. Gallup's results are more or less consistent from 1982 to 2008.

ationist campaign is gaining ground simply by offering subscriptions to magazines such as *Weet*. However, since the main target group of the magazine obviously consists of orthodox and not-so-orthodox Christian teenagers with an interest in the sciences, it is likely that initiatives as this add to the confusion or even strengthen their creationist base. Considering the world's present day challenges that demand scientific answers (such as the energy crisis and the food crisis), this is highly regrettable.

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# NCSE NEWS

News from the Membership *Glenn Branch*

From time to time we like to report on what our members are doing. As the following list shows, they — and we — have a lot to be proud about!

**Andrew Alden** received the accolade "Best blog about East Bay rocks" for his Oakland Geology blog (<<http://oaklandgeology.wordpress.com>>) from the alternative weekly *East Bay Express* (2010 Jul 14-20). The newspaper wrote, "Alden succinctly describes headscarps, wacke, and serpentine with an obvious passion for his chosen field." Alden also maintains a general geology blog at About.com: <<http://geology.about.com/b/>>.

**Tim Berra**, along with Gonzalo Alvarez and Kate Shannon, contributed "The Galton-Darwin-Wedgwood Pedigree of HH Laughlin" to the *Biological Journal of the Linnean Society* (2010; 101: 228-41). As they explain in the abstract:

A pedigree of the Galton-Darwin-Wedgwood families that was exhibited as a poster at the Third International Congress of Eugenics in 1932 at the American Museum of Natural History has been located in the archives of Truman State University in Kirksville, Missouri. ... The poster of the Galton-Darwin-Wedgwood pedi-

gree is published here, together with a tabular version providing ready access to the information contained in the pedigree.

Berra is Professor Emeritus of Evolution, Ecology, and Organismal Biology at the Ohio State University, Mansfield, and the author of *Charles Darwin: The Concise Story of an Extraordinary Man* (Baltimore: Johns Hopkins University Press, 2009; reviewed in *RNCSE* 2010 Jan-Apr; 30 [1-2]: 37-8) and *Evolution and the Myth of Creationism* (Palo Alto [CA]: Stanford University Press, 1990).

**Paul S Braterman** spoke to the Dundee Skeptics about "'Intelligent design', creationism, and the assault on science education" on September 14, 2010. From a description of his talk: "Creationism is evolving. Its promoters now disguise it as up-to-date biological science. Well-financed groups such as the Discovery Institute in the US, and Truth in Science in the UK, are trying to introduce their own materials into the classroom, under the guise of correcting alleged biases in current teaching." Braterman is honorary Senior Research Fellow in Chemistry at the University of Glasgow.

**Jean-Pierre Cavigelli** replied to a creationist's letter to the editor of the *Casper Tribune* by noting



that the creationist “proves to be a wonderful example of why evolution should be taught in schools” and proceeding to explain speciation, using the local example of red crossbills: “the variation in their songs has led the isolated populations to have different songs, preventing the males and females from ever getting together, even if they were to get blown into each others’ mountain ranges.” His letter appeared in the September 3, 2010, issue of the newspaper.

With Jack W Szostak, who shared the 2009 Nobel Prize in Physiology or Medicine, **David Deamer** coedited *The Origins of Life* (Cold Spring [NY]: Cold Spring Harbor Laboratory Press, 2010). The publisher writes:

Written and edited by experts in the field, this volume provides a comprehensive account of the environment of the early earth and the mechanisms by which the organic molecules present may have self-assembled to form replicating material such as RNA and other polymers. The contributors examine the energetic requirements for this process and focus in particular on the essential role of semi-permeable compartments in containment of primitive genetic systems.

Deamer himself contributed a paper, coauthored with Arthur L Weber, on “Bioenergetics and life’s origins,” and **Norman Sleep** of Stanford University contributed a paper on “The Hadean-Archaeon environment.” Deamer is Professor Emeritus of Chemistry at the University of California, Santa Cruz.

**Raymond Eve** contributed “Wiccans v creationists: An empirical study of how two systems of belief differ” to eSkeptic, the e-mail newsletter of the Skeptics Society (2010 Aug 25; available on-line at <<http://www.skeptic.com/eskeptic/10-25-18/>>). Finding that each group tended to have its own set of consistent and reinforcing beliefs, he concluded, “we began with the question of whether pseudoscientific beliefs are the result of ignorance and mental aberration, or are they the end product of a way of thinking

embedded in a worldview ... The data here support the latter.” Eve is Professor of Sociology at the University of Texas, Arlington, and coauthor, with **Francis B Harrold**, of *The Creationist Movement in Modern America* (Boston: Twayne, 1991).

Writing in the *Shreveport Times* (2010 July 18), **Barbara Forrest** blasted the Louisiana Science Education Act, which opened the door for creationism to be taught in the state’s public schools. Responding to the executive director of the Louisiana Family Forum, who in a previous column praised “the courage of our policy writers,” she replied, “The LFF announced on their website that they wrote the bill. They were assisted by the Discovery Institute.” She also noted the anomaly of the bill’s including a disclaimer prohibiting “discrimination for or against religion or non-religion.” “But,” she explained, “legislation that is about real science education need not include religion disclaimers.” Forrest, a member of NCSE’s board of directors and of Louisiana Coalition for Science’s board of directors, is Professor of Philosophy at Southeastern Louisiana University and the coauthor with **Paul R Gross** of *Creationism’s Trojan Horse* (revised edition: New York: Oxford University Press, 2007).

NCSE Supporter **Douglas J Futuyma** of Stony Brook University, along with Michael A Bell, Walter F Eanes, and Jeffrey S Levinton, edited *Evolution Since Darwin: The First 150 Years* (Sunderland [MA]: Sinauer Associates, 2010), based on Stony Brook University’s “Darwin 2009” symposium. The publisher writes:

Thirty-nine authors from 22 universities and two museums in five countries wrote on areas of evolutionary biology and related topics on which their research focuses. Their essays cover the history of evolutionary biology, populations, genes and genomes, evolution of form, adaptation and speciation, diversification and phylogeny, paleobiology, human cultural and biological evolution, and applied evolution.

NCSE members and Supporters were abundantly represented in the volume. Futuyma himself contributed “Evolutionary biology: 150 years of progress”; **Robert L Millstein** of the University of California, Davis, contributed “The concepts of population and metapopulation in evolutionary biology and ecology”; **Günter P Wagner** of Yale University contributed “Evolvability: The missing piece of the neo-Darwinian synthesis”; **Jonathan B Losos** of Harvard University contributed “Adaptive radiation: The interaction of ecological opportunity, adaptation, and speciation” (coauthored with D Luke Mahler); **David M Hillis** of the University of Texas, Austin, contributed “Phylogenetic progress and applications of the tree of life”; NCSE Supporter **Joel Cracraft** of the American Museum of Natural History contributed “Thinking about diversity and diversification: What if biotic history is not equilibrial?”; and NCSE Supporter **Tim D White** of the University of California, Berkeley, contributed “Human evolution: How has Darwin done?”

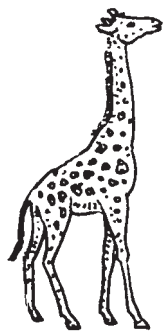
**Scott Hatfield’s** visit to the Galápagos was reported in *The Fresno Bee* (2010 Sep 3):

Hatfield traveled ... with a group of 16 people, including Fresno City College science instructors, a psychologist and graduate students. The group traveled 500 miles in a boat with national parks officials and took eight plane rides over 10 days.

He plans to give talks in the classroom and in the community about his experience.

Hatfield is a science teacher at Bullard High School in Fresno, California.

The fifth edition of **Art Hobson’s** *Physics: Concepts & Connections*, a non-technical physics textbook for non-science college students, which devotes significant attention to evolution and creationism, was published (San Francisco: Addison-Wesley, 2010). Hobson writes, “The underlying theme ... is that science is based on evidence and reason.” Hobson is Professor Emeritus of



Physics at the University of Arkansas; *Physics: Concepts & Connections* is used on more than 130 campuses.

After a visit from NCSE's **Eugenie C Scott** to Fort Wayne, Indiana, **Al Kuelling** took the opportunity to contribute a guest column to the Fort Wayne *News-Sentinel* (2010 Sep 17), debunking misconceptions and myths about evolution. He wrote:

rejection of evolution is a dangerous anti-science attitude. That attitude puts at risk the high level of scientific achievement that has helped to propel the United States to an economic, technological and political leadership position in the world.

A retired engineer, Kuelling was the author of two statements on evolution that were adopted by the United Methodist Church in 2008, one amending a statement on science and technology to include "We find that science's descriptions of cosmological, geological, and biological evolution are not in conflict with theology," and one endorsing the Clergy Letter Project founded by **Michael Zimmerman**.

In a column for the *Gainesville Sun* (2010 Aug 19), **Gregory Mead** presented "The case against teaching creationism in public schools," responding to a recent spate of coverage of and letters to the editor about the views of candidates for the Alachua County, Florida, school board. "Evolutionary theory has been through the crucible of 150 years of 'peer reviewed' research," Mead explained, while "[c]reationists want their ideas placed before our school children without actual research."

**Richard Milner's** *Darwin's Universe* (Berkeley [CA]: University of California Press, 2009) was reviewed by **Donald R Prothero**, Professor of Geology at Occidental College, for eSkeptic, the e-mail newsletter of the Skeptics Society (2010 Aug 18; available on-line at <<http://www.skeptic.com/eskeptic/10-08-18/>>). Prothero writes:

the book seems to reach a

readership that might never touch any other book on evolution, because it is so charming and entertaining as well as informative. ... [T]his book is a valuable addition to the popular science bookshelf, since it reaches people sitting on the fence of evolution vs creationism by entertaining and amusing them as it gently instructs them.

**Doren Recker** contributed "How to confuse organisms with mousetraps: Machine metaphors and intelligent design" to the journal *Zygon* (2010; 45 [3]: 647-64). The abstract:

Why do design arguments — particularly those emphasizing machine metaphors such as "Organisms and/or their parts are machines" — continue to be so convincing to so many people after they have been repeatedly refuted? In this essay I review various interpretations and refutations of design arguments and make a distinction between *rationally* refuting such arguments ... and rendering them *psychologically* unconvincing. ... Unless people are cued to "look again" at what initially makes perfect sense, they are not inclined to apply more sophisticated evaluative procedures.

Recker is Associate Professor and Head of the Philosophy Department at Oklahoma State University; he also serves on the board of governors of Oklahomans for Excellence in Science Education.

The journal *Science and Education* recently devoted not one but two special issues, edited by David W Rudge and Kostas Kampourakis, to Darwin and Darwinism, and members and Supporters of NCSE were represented. NCSE Supporter **Michael Ruse** of Florida State University contributed "Darwinism then and now: The divide over form and function" (19 [4-5]: 367-89), **William F McComas** of the University of Arkansas coauthored "Charles Darwin and evolution:

Illustrating human aspects of science" (19 [6-7]: 637-54), and **C Mackenzie Brown** of Trinity University contributed "Hindu responses to Darwinism: Assimilation and rejection in a colonial and post-colonial context" (19 [6-7]: 705-38). *Science and Education* is published for the International History, Philosophy, and Science Teaching Group (on the web at <<http://www.ihpst.org>>).

NCSE's executive director **Eugenie C Scott** was profiled by Phil Haslanger in the Madison, Wisconsin, *Capital Times* (2010 Jul 1). "In a place like Madison, it's easy to think about the battles over teaching evolution in schools as something from another time and place," Haslanger writes. But — as Scott, who was born and raised in Wisconsin, told him — "You don't have to go far to find a teacher afraid of teaching evolution or who is teaching creationism." Haslanger, a regular columnist for the *Capital Times*, is pastor of Memorial United Church of Christ in Fitchburg, Wisconsin.

The latest issue of *Evolution: Education and Outreach* (volume 3, number 2) was in honor of the 65th birthday of NCSE's executive director **Eugenie C Scott**. Edited by NCSE's deputy director **Glenn Branch**, it contains essays by **Nicholas J Matzke**, **Robert T Pennock**, **Barbara Forrest**, **Raymond Arthur Eve** with Susan Carol Losh and Brandon Nzekwe, **Lawrence M Krauss**, Robert M Hazen, **Kevin Padian**, Jay D Wexler, **Kenneth R Miller**, **Brian Alters**, and **Carl Zimmer**. Plus there's a biographical appreciation by **Andrew J Petto**, a bibliography compiled by Adam M Goldstein and **Glenn Branch**, and a reflection on the importance of "Listening to Teachers" by Scott herself.

NCSE's Scott and **Louise S Mead** also contributed "Problem concepts in evolution part II: Cause and chance," to NCSE's regular feature column in *Evolution: Education and Outreach*. In it, they discuss how the concepts of cause and chance are often confusing to students and suggests "how to address these specific challenges to understanding evolu-



## George C Williams Dies

The eminent evolutionary biologist George C Williams died on September 8, 2010, at the age of 84, according to *The New York Times* (2010 Sep 13). Born in Charlotte, North Carolina, on May 12, 1926, Williams served in the US Army from 1944 to 1946, and then studied at the University of California, Berkeley, where he received his AB in zoology in 1949, and the University of California, Los Angeles, where he received his PhD in biology in 1955. During his academic career, mostly at the State University of New York, Stony Brook, he published a string of important work, including the books *Adaptation and Natural Selection* (1966), *Sex and Evolution* (1975), *Natural Selection* (1992), *Why We Get Sick* (coauthored with Randolph M Nesse, 1994), and *Plan and Purpose in Nature* (1996). His honors include induction in the National Academy of Sciences (1993) and the Crafoord Prize in Biosciences (1999).

A long-time member of NCSE, Williams was concerned about creationism. In a brief 1996 article in *Biology and Philosophy*, he defended his treatment of genetic information in *Natural Selection* against "intelligent design" advocate Phillip Johnson's misrepresentations of it. In 1999, he reviewed the early "intelligent design" anthology *Mere Creation* for the *Quarterly Review of Biology*, writing that the contributors:

reject the idea that a strictly trial-and-error process of natural selection can account for the functional design of organisms, and propose that a creator's wisdom has been directing evolution. They make no attempt to deal with the many examples of egregious unwisdom seen in functionally arbitrary and sometimes maladaptive historical legacies, which suggest a creator with no understanding or concern with what he was imposing on organisms.

tion in light of recent research." And NCSE's **Steven Newton** reviewed Ralph O'Connor's *The Earth on Show: Fossils and the Poetics of Popular Science, 1802-1856* (Chicago: University of Chicago Press, 2007), which, he writes, "presents a wide-ranging view of how geology, in its earliest days, appealed through drama and spectacle to an exclusive portion of the public."

In this issue of *Evolution: Education and Outreach*, **Niles Eldredge** and Gregory Eldredge also explain in their editorial, "After a temporary hiatus, ... we are poised to come back free online — the better to serve our educational outreach mission." Past issues will soon begin to appear on-line at the National Institutes of Health's PubMed Central. Articles by **Nick Matzke**, **Kevin Padian**, and **Eugenie Scott** were published through Springer's Open Access program and are already freely available via the journal's website <<http://www.springer.com/life+sciences/evolutionary+%26+developmental+biology/journal/12052>>. Moreover, NCSE members will have the opportunity to receive a printed copy of the issue, which will be offered as a gift premium in the fall fundraising letter.

**Douglas Theobald** published "A formal test of the theory of universal common ancestry" in *Nature* (2010; 465 [7295]: 219-22). From the abstract (omitting notes):

As first suggested by Darwin, the theory of UCA [universal common ancestry] posits that all extant terrestrial organisms share a common genetic heritage, each being the genealogical descendant of a single species from the distant past. ... Although UCA is widely assumed, it has rarely been subjected to formal quantitative testing, and this has led to critical commentary emphasizing the intrinsic technical difficulties in empirically evaluating a theory of such broad scope. ... I test UCA by applying model selection theory to molecular phylogenies, focusing on a set of ubiqui-

tously conserved proteins that are proposed to be orthologous. Among a wide range of biological models involving the independent ancestry of major taxonomic groups, the model selection tests are found to overwhelmingly support UCA irrespective of the presence of horizontal gene transfer and symbiotic fusion events. These results provide powerful statistical evidence corroborating the monophyly of all known life.

In the same issue, Mike Steel and David Penny commented "Theobald's work is unlikely to be the last word on common ancestry. ... In the meantime, there is now strong quantitative support, by a formal test, for the unity of life." Theobald is Assistant Professor of Biochemistry at Brandeis University; his review of Richard Dawkins's *The Greatest Show on Earth* appeared in *RNCSE* 2010 May/June; 30 (3): 37-8.

**David R Vinson** spoke on "Creation or Evolution: Foes or Friends?" at Fuller Theological Seminary in Sacramento on July 9, 2010. A flyer for the event explained, "It's Creation versus Evolution, right? Or do we have to choose? Can these divergent ideas be reconciled? ... Grappling with these very questions, our speaker, David Vinson, MD, began a long journey of exploration." A clinical researcher and emergency physician, Vinson maintains a website devoted to science-and-religion issues at <<http://sites.google.com/a/drvinson.net/home/>>; his review of Denis Alexander's *Creation or Evolution: Do We Have to Choose?* will appear in a future issue of *RNCSE*.





# Origin of Polonium Halos

Lorence G Collins

Barbara J Collins

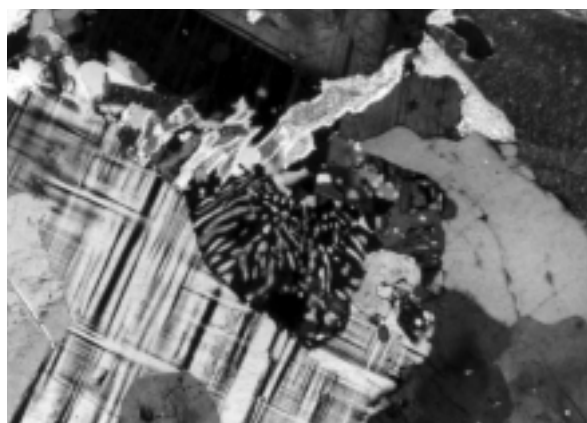
## INTRODUCTION

It has been more than twelve years since we (Collins 1988, 1997b; Hunt and others 1992) discussed Robert Gentry's hypothesis proposing that polonium (Po) halos and granite were created nearly instantaneously on Day Three of the Genesis Week (Gen 1:9–10; Gentry 1965, 1970, 1974, 1983, 1988). It is worth examining new information pertinent to the origin of polonium halos. Gentry points out that most granite petrologists believe that all granite bodies of large size are formed deep in the earth's crust from magma (molten rock) and that as much as 5 million years are required for this magma to be cooled sufficiently for biotite mica to begin to crystallize (*see sidebar on p 13 for descriptions of these minerals*).

Polonium halos occur in biotite in granites of supposed magmatic origin, and the half-lives of the polonium (Po) isotopes are short ( $^{218}\text{Po}$ , 3.05 minutes;  $^{214}\text{Po}$ , microseconds; and  $^{210}\text{Po}$ , 140 days). Gentry claims, therefore, that no matter how much original polonium may have been present in the granite magma, all would have decayed to stable lead ( $^{206}\text{Pb}$ ) in 5 million years, long before the biotite in which polonium halos are found could have formed. He asserts on that basis that polonium halos can be used to support the literal interpretation of the Bible that granite in the earth was created during Day Three of the Genesis Week and not over a period of ~4.6 billion years (Dalrymple 1991). This rapid formation of granite during Day Three and supposed disappearance of polonium isotopes during 5 million years are ideas that are also promoted by Snelling (2008a, 2008b). [Thomas A Baillieu's detailed summary and critique of Gentry's views begins on p 17.]

Gentry and Snelling's claims are without validity (Collins 2008). These creationists ignore the fact that uranium in the original magma would be continuously supplying polonium isotopes during the 5 million years of cooling. The problem is not the disappear-

ance of polonium through 5 million years, as Gentry and Snelling suggest, but the inability of polonium ions produced during this time to migrate from scattered uranium atoms in very viscous magma to precipitate as polonium atoms in a localized place in a growing biotite crystal lattice so that polonium halos can form. The question to ask, therefore, is: how has it been possible for uranium to concentrate in local sources so that polonium, which is derived from the decay of this uranium, could nucleate in growing crystals of biotite or fluorite? There are two possible mechanisms to make this concentration happen. The first is by the formation of either vein-dikes or pegmatites containing uranium minerals that are associated with chemical replacement processes (metasomatism). The second is by the formation of pegmatites containing uranium minerals that result from magmatic processes. Both mechanisms are examined in this article.

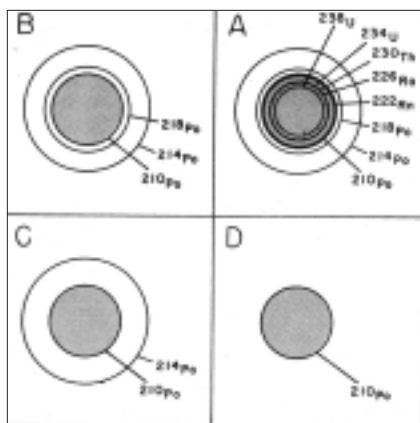


**FIGURE 1.** Myrmekite (center; white vermicules [quartz]; black [plagioclase feldspar]) adjacent to potassium feldspar with grid twinning (bottom; black and white) with cross-polarized light.

## POLONIUM HALOS IN VEIN-DIKES AND PEGMATITES ASSOCIATED WITH CHEMICAL REPLACEMENT PROCESSES

Collins found that in many places where polonium-halo-bearing biotite and fluorite crystals are present, the adjacent granitic rocks were microfractured and contained myrmekite (the intergrowth of plagioclase and vermicular quartz) (Collins 1988, 1997a; Figure 1). The granitic rocks in these places were produced

*Lorence G Collins is a retired professor of geology at California State University, Northridge, who has written extensively to promote general knowledge about geology and to counter arguments by anti-evolutionists, including four other articles for RNCSE, which can be found at <<http://www.csun.edu/~vcgeo005/creation.html>>. Barbara J Collins has taught biology at California Lutheran University for 47 years. She has a PhD in geology from the University of Illinois and was the first woman to earn a PhD in geology at this university.*



**FIGURE 2.** A. Schematic drawing of  $^{238}\text{U}$  halo with radii proportional to ranges of alpha-particles in air. B. Schematic drawing of  $^{218}\text{Po}$  halo. C. Schematic drawing of  $^{214}\text{Po}$  halo. D. Schematic drawing of  $^{210}\text{Po}$  halo. (From Collins 1988.)

by chemical replacement processes (metasomatism) of previously solidified igneous rocks at temperatures below those required for melting (350–550°C).

The evidence that such granite is formed by metasomatism consists of detailed thin section studies, electron microprobe analyses, and cathodoluminescence images of undeformed diorite through a transition of deformation into granite where calcium, sodium, iron, magnesium, and aluminum were subtracted as potassium and silica were introduced (Collins 2002). The resulting metasomatic granite that is formed at temperatures below melting conditions looks like granite that has crystallized from magma because the newly formed granite inherits the mineral textures and structures (dikes into wall rocks and inclusions of foreign rocks) of the original igneous rock (for example, diorite), but now the rock's mineral and chemical compositions have been changed into what occur in granite. The process is similar to the formation of petrified wood in which silica atoms are brought in and exchanged for carbon atoms, preserving the cellular structure of the wood, except that in the metasomatic granite, potassium is exchanged for sodium and calcium, converting plagioclase feldspar into potassium feldspar while preserving the original shapes of the plagioclase crystals. Some of these same myrmekite-bearing microfractured granitic rocks contained scattered but relatively abundant uranium ( $^{238}\text{U}$ ) in crystals of uraninite and zircon, so a nearby source for radioactive radon gas ( $^{222}\text{Rn}$ ) was readily available, as were polonium  $^{218}\text{Po}$ ,  $^{214}\text{Po}$ , and  $^{210}\text{Po}$ , the three daughter isotopes of  $^{222}\text{Rn}$ .

Fracturing of the rock that is intense enough produces open spaces that became filled with the dissolved elements that ultimately formed calcite vein-dikes containing biotite (and fluorite) with polonium halos (Wakefield 1987–8, 1988). Coarse-crystalline pegmatites were produced in other places in this same area when closely spaced microfractured rocks were converted to granite by replacement processes. Uranium continued to supply large amounts of radioactive radon and polonium once it became concentrated in, or was in route to, these lower-pressure microfractured places. This accumulation of radioactive elements in the lower pressure sites enabled polonium to nucleate in growing or recrystallizing crystals of biotite mica (and fluorite).

Polonium ions nucleate in biotite and fluorite because these ions are large and can fit only in large sized holes in a mineral lattice. Such holes occur in biotite and fluorite but not in the other kinds of minerals commonly found in granite. The polonium ions nucleating on the faces of growing biotite crystals and fluorite subsequently became enclosed inside these

crystals. The enclosed polonium ions would then begin to decay and emit alpha particles. The alpha particles, shot out in random patterns, would cause damage to the crystal lattice producing spheres with different radii, destroying the lattice structure and producing a disordered pattern, known as a glass, which appears as a black circular spot under the petrographic microscope. Rings of these different radii of damage can be seen if these spheres are cut through in the plane of the equator. Such rings are referred to as halos — hence,  $^{218}\text{Po}$ ,  $^{214}\text{Po}$ , and  $^{210}\text{Po}$  halos. From 9 to 10 billion atoms of polonium are needed at a nucleation point before individual halos can be seen (Gentry 1988). This means that vast numbers of polonium atoms were once present in the crystals of biotite before these atoms all eventually decayed to stable lead ( $^{206}\text{Pb}$ ).

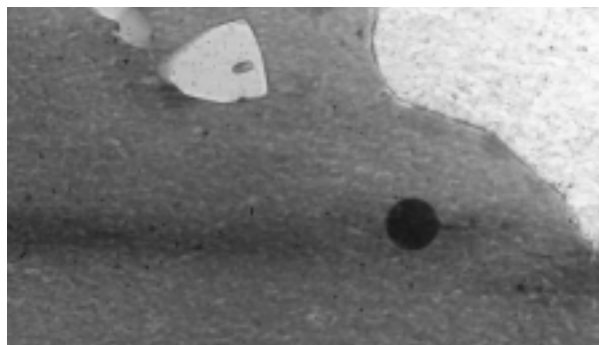
Examples of the three types of polonium halos can be seen below the geologic map of Wakefield (1987–8; <<http://www.csun.edu/~vcgeo005/gentry/tiny.htm>>). Figure 2 shows schematic diagrams of the rings (halos) of damage for the three polonium halo types and for a uranium halo. The uranium-halo schematic shows that the three polonium isotopes are the last three daughter isotopes in the eight-step decay of  $^{238}\text{U}$ , each step losing a mass of 4. On that basis, the  $^{218}\text{Po}$  halo with its three rings, the  $^{214}\text{Po}$  halo with its two rings, and the  $^{210}\text{Po}$  halo with its one ring are isolated (separate) from any immediate uranium source, but, of course, the polonium ions that nucleate to produce these halos are derived from some nearby uranium source.

Numerous polonium halos occur per cubic centimeter in the biotite “books” in the calcite vein-dike of the Silver Crater Mine (figure 14 of Wakefield 1987–8). (Numerous could mean 20–30 thousand polonium halos per cubic centimeter in biotite as reported by Gentry [1968] in a Norwegian mica.) Biotite at the Silver Crater Mine and fluorite in calcite vein-dikes in the Wilberforce area show no evidence of any fracturing that would provide avenues along which radon gas and ions of polonium could move to nucleation points. The growing crystals of biotite and fluorite would be inside large volumes of hot gaseous fluids occupying the open fracture and would not be expected to be fractured or deformed. The Wilberforce area can be seen on the edge of the geologic map in Wakefield (1987–8) west of the Fission Mine where the last four letters “orce” appears.

After crystallization in the calcite vein-dikes, ongoing replacements can continue to occur, involving multiple deformations in the adjacent granitic rocks that allow more fluids to come into the vein-dikes. Both biotite and apatite are reported to replace calcite in some of the vein-dikes in the Bancroft area (Wakefield 1987–8, 1988). These second growth biotite crystals also contain polonium halos, indicating that the hydrous fluids causing these additional replacements carried  $^{222}\text{Rn}$  and polonium isotopes.

Because the location where Gentry (1988) reported some of his best polonium halos in biotite (and fluorite) was not in granite but in a calcite vein-dike near the Silver Crater uranium mine in the Bancroft area of Ontario, Canada (Gentry 1971, 1974; Wakefield

1987-8, 1988), his claim for nearly instant crystallization of granite is immediately nullified. In his model, all biotite containing polonium halos crystallized in granite formed from magma. Calcite vein-dikes, however, do not form from granite magma at any stage of

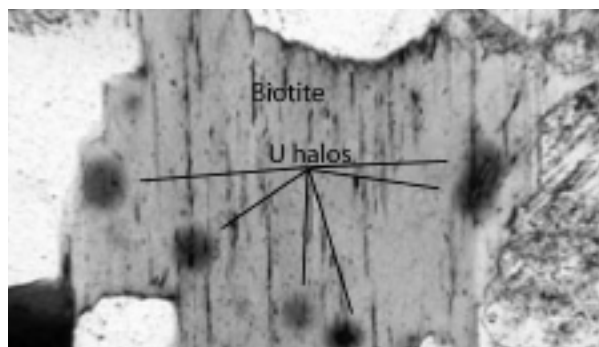


**FIGURE 3.** Biotite with a band of lattice damage along a microfracture by radiation from  $^{222}\text{Rn}$ ,  $^{210}\text{Po}$ ,  $^{214}\text{Po}$ , and  $^{218}\text{Po}$  atoms; black circular dot is a  $^{210}\text{Po}$  halo; from Buckhorn pegmatite in plain light.

its crystallization. Such vein-dikes fill fractures (a meter or more wide) in previously solidified granitic rock and are, therefore, later than the crystallization of the granite (Wakefield 1987-8, 1988).

#### FRACTURES IN BIOTITE WITH POLONIUM HALOS IN PEGMATITES

Gentry claimed that biotite (and fluorite) crystals containing polonium halos always lacked any microfractures through which radioactive radon or polonium ions could penetrate to produce the polonium halos. This is not true. The adjacent granitic rocks have microfractures where pegmatites were formed by recrystallization and replacement, such as the Buckhorn pegmatite in the Bancroft area. The crystals of biotite crystals in such places that contain polonium halos show evidence of microfracturing or evidence that they had microfracturing prior to recrystallization (Collins 1997b). For example, in Figure 3, a band of alpha-particle damage can be seen where radioactive inert  $^{222}\text{Rn}$  gas and  $^{210}\text{Po}$  and  $^{218}\text{Po}$  ions were once migrating in fluids along a fracture in the crystal of biotite. These three isotopes produce radii of damage that are almost the same distance from the



**FIGURE 4.** Circular and oval dark U-halos of alpha-particle lattice damage in biotite surrounding tiny U-bearing zircon crystals in granite in cross-polarized light. The thin section showing these halos are too thick to show the eight rings of damage.

center line of the fracture so they are not distinguishable from each other in the band of continuous overlapping damage which produces a smeared-out band of damage to the lattice of the biotite. Billions of radioactive isotopes once moved along this fracture, shooting out alpha particles as the fluids progressed through the fracture. Sufficient  $^{210}\text{Po}$  (9 billion atoms or more) nucleated at one place along the fracture to create the isolated black  $^{210}\text{Po}$  spherical halo of damage. Another example of a fracture containing a  $^{210}\text{Po}$  halo in biotite is shown in figure 4 of Collins (1997b). The assertion by Gentry that polonium halos are never found along fractures in biotite is not true.

#### RATE AT WHICH BIOTITE CRYSTALS OF LARGE SIZE GROW

Gentry believes that granite and polonium-halo-bearing biotite had to form nearly instantly on Day Three of the Genesis Week. He argued, therefore, that the rate of crystallization of granite must be exceedingly fast. Snelling (2008b) suggested that the granite formed in 6-10 days. In contrast, silicate crystals (quartz, mica, feldspars, and so on) in deep-seated magma normally grow exceedingly slowly (over thousands and millions of years) because (1) the heat in molten rock at great depth escapes only very slowly to the earth's surface so that the rate of cooling is very slow, (2) the high viscosity of the silica-rich melt (like a hot, thick, molten, silica glass) prevents metallic ions from diffusing quickly to nucleation and growing-crystal-sites, and (3) water (steam) that would facilitate rapid diffusion of such ions is generally absent.

However, the rate at which silicate crystals grow in granite pegmatites

## GLOSSARY

**$^{210}\text{Po}$**  — an isotope of polonium, element number 84, having 84 protons in its nucleus and 126 neutrons for a total mass of 210

**alpha particle** — a helium atom with a mass of 4

**biotite** — black mica, a sheet-structure silicate mineral

**calcite** — calcium carbonate

**diorite** — a dark-colored, coarsely crystalline igneous rock commonly containing hornblende, biotite, and plagioclase

**fluorite** — calcium fluoride

**half-life** — the time for half the quantity of a radioactive element (isotope) to decay to a daughter isotope

**hornblende** — a black silicate mineral rich in iron and magnesium

**ion** — an atom with a negative or positive charge

**isotopes** — variants of the same element with the same number of protons in the nucleus but differing numbers of neutrons so that the total mass of the element is different

**magma** — melted igneous rock

**myrmekite** — an intergrowth of two minerals (plagioclase and quartz). It is commonly wartlike (<1 mm wide) and projects into potassium feldspar while attached to quartz-free plagioclase and generally is less than 1 volume percent of a rock. The quartz is tiny, tapered, curved, shaped like worm tubes, and circular to oval in cross section

**pegmatite** — a coarse silicate igneous rock containing crystals generally larger than 2 centimeters long. Some pegmatite crystals may be more than a meter long

**phenocryst** — a crystal formed from magma and much larger than surrounding ground mass crystals

**plagioclase** — a feldspar that ranges from sodium-rich varieties to calcium-rich varieties. In granite this feldspar contains much more sodium than calcium

**radon** — a neutral gaseous element with no ionic charge

**vein-dike** — a former open fracture that cuts across the rock structure and is filled with various minerals, such as calcite, quartz, and biotite

**uraninite** — uranium oxide

**vermicules** — quartz shaped like curved worm tubes

**vermicular** — having the shape of worm tubes

**volcanic porphyry** — a volcanic rock containing phenocrysts

**zircon** — zirconium silicate; large crystals can be gemstones, but tiny crystals commonly form in granite

(where large crystals several centimeters wide may form) can be rapid because of the local great abundance of water (steam). The abundant water occurs because water tends to concentrate in localized volumes in late stages of crystallization of magma because most minerals crystallizing in granite lack any water in their lattices, and it is where abundant water is present that pegmatites form. Crystals in pegmatites can grow to large sizes in a matter of a few days or weeks (London 2008; Nabelek and others 2009; Sirbescu and others 2008; Webber and others 1999).

The rate of growth of calcite and biotite in fluids where calcite vein-dikes form must be even faster than the rate of growth for silicate minerals crystallizing in pegmatites in a granite body. The fluids that produce the calcite vein-dikes would have a high water content and notably low silica so they would have low viscosity. The growth of large crystals of biotite (and fluorite) crystals could, perhaps, be in a matter of hours or less, and, therefore, the growth of superposed lattice layers would also surround nucleating polonium ions on the faces of the growing crystals. Thus, thousands of polonium halos per cubic centimeter in crystals of biotite and fluorite are possible lacking any evidence for microfractures.

#### FORMATION OF GRANITE BY CHEMICAL REPLACEMENT PROCESSES CONFIRMED

Gentry rejected the model for granite's being formed by chemical replacement processes because there was no publication in refereed geology journals of a large-scale chemical-replacement model for the origin of some granitic masses. However, several recent studies have indicated the presence of large scale metasomatic (replacement) processes. Andrew Putnis and colleagues, using microprobe studies on an atomic scale, have confirmed that a chemical replacement model for the origin of some granite masses is correct (Putnis and others 2007; Engvik and others 2008; Plummer and Putnis 2009). The evidence for this replacement is the presence of numerous tiny pores in plagioclase feldspar crystals in primary igneous rocks that were deformed and microfractured. Fluids moved through these pores and brought in potassium and/or sodium while depositing tiny rosettes of red hematite crystals along the walls of the pores. The introduction of the potassium and/or sodium converted large masses of igneous rocks into granitic rocks (with surface areas several kilometers in diameter) in Finland, Sweden, Brazil, and California. Where potassium was introduced, myrmekite (similar to that in Figure 1) locally borders the potassium feldspar in these rocks (Collins and Collins 2002). The presence of myrmekite alone can indicate that the rock system was open to ready movement of fluids that could have contained dissolved radioactive radon and polonium ions (if available). Myrmekite is formed locally where chemically altered lattices of relatively calcic plagioclase are incompletely replaced by potassium feldspar, leaving residual calcium, sodium, aluminum, and silica atoms in the lattice which are not in proper balance to recrystallize only as more sodic plagioclase; so some silica is left over to recrystallize as quartz vermicules (Collins 1997a). During metasomatism the reactions do not occur in balanced mass-for-mass exchanges, as one is

taught in chemistry classes, but by volume-for-volume exchanges of elements (ions) in minerals that have different densities.

Other published examples of large-scale chemical replacements by potassium feldspar come from economic geologists. For example, Doucette (2000) reports that such replacements occur in volcanic porphyry where gold and copper enrichments are found, converting plagioclase phenocrysts into potassium feldspar (see figure 27 in Doucette 2000). Large-scale potassium-feldspar replacements, extending over hundreds of square kilometers, are reported by Liu and others (2003) in the uppermost Precambrian rocks underlying Paleozoic sedimentary rocks in the North American mid-continent.

#### POLONIUM HALOS FORMED BY MAGMATIC PROCESSES

Uranium halos are commonly found throughout a granite mass; isolated polonium halos are rare or absent (Figure 2). Uranium in magma is incorporated into crystals of zircon or uraninite as the magma cools and solidifies. The element preferentially enters into zircon's crystal structure because uranium's ionic charge ( $4^+$ ) is the same as that of the zirconium ion. Cooling magma is normally too viscous for large amounts of uranium or zirconium ions to diffuse. Most uranium and zirconium ions, therefore, move only very short distances, precipitating in tiny crystals of uraninite or zircon, or the uranium is precipitated only in crystals of zircon, which are scattered throughout the granite mass. These tiny zircon or uraninite crystals are then enclosed in, or fill spaces in between, other silicate minerals that are crystallizing in the granite mass, such as quartz, feldspars, and biotite. Once the crystals in the granitic mass have formed, any polonium that would be produced must be derived from the decaying uranium in the zircon crystals that had already nucleated and been incorporated in the crystallized biotite and could not then nucleate in later-formed biotite to create visible isolated polonium halos. Only  $^{238}\text{U}$  halos including eight spheres of damage surrounding the zircon (or uraninite) crystals would be produced following the solidification of granite magma. These eight spheres have a common center where the uranium is concentrated, and each sphere has a different radius that corresponds to the energies of emissions of alpha particles from each of the eight daughter isotopes in the  $^{238}\text{U}$  decay series until stable lead  $^{206}\text{Pb}$  is formed (Collins 1997b). The last three isotopes in the  $^{238}\text{U}$  decay series are  $^{218}\text{Po}$ ,  $^{214}\text{Po}$ , and  $^{210}\text{Po}$ , so their halos are part of the eight produced in the adjacent biotite bordering the uranium source and do not occur as separate isolated halos (Figure 2). The damage in biotite surrounding  $^{238}\text{U}$ -bearing zircon crystals in granite can be seen as circular or oval black halos outlining the shapes of the zircon (or uraninite) crystals under the petrographic microscope (Figure 4). The thin section is too thick, however, to see the eight separate halos.

It is also important to point out that the ratio of the amount of lead  $^{206}\text{Pb}$  to the amount of the remaining uranium  $^{238}\text{U}$  in zircon crystals is used by geochronologists to determine the age of the crystallization of



the granite. Because the age determined by this method is consistent from place to place in the same granite (within experimental error), this consistency indicates that the decay process for  $^{238}\text{U}$  obeys natural laws that are not arbitrary, which in turn validates the use of this method for determining the age of a granite body (Dalrymple 1991). This applicability in two (or more) places of the results of a single principle based on the observation of natural processes in a way that is consistent with findings from other models and methods of analysis, such as rubidium-strontium (Rb-Sr) and potassium-argon (K-Ar) age determinations, reinforces the validity of the uranium-lead (U-Pb) age determinations.

The formation of isolated polonium halos in magmatic pegmatites, on the other hand, is possible because of the very large atomic size of the uranium atom (ion), which causes some uranium atoms to be concentrated in both zircon crystals and in residual hydrous fluids during last stages of crystallization of granite magma. Atoms (ions) that are either too small or too large to fit in stable arrangements in holes in the lattices of such silicate minerals as biotite, plagioclase feldspar, and potassium feldspar that are common in magmatic granite are left over in the residual fluids of the last stages of solidification of granite magma (Klein and Hurlbut 1985). For example, small-sized atoms (ions) of lithium, beryllium, and boron (elements numbers 3, 4, and 5) are commonly crystallized in late-forming pegmatites in gem minerals. Atoms that are too large include gold (element number 79) and uranium (element number 92). Uranium is commonly found in scattered zircon crystals in granite (as noted above), but some uranium may also be concentrated in late stages of granite crystallization in pegmatites in the mineral uraninite because of its very large atomic size. Biotite and fluorite crystallizing near this uraninite could plausibly contain Po-halos because the concentrated uranium atoms in this uraninite and in fluids bringing this uranium to the pegmatites would be an abundant source of radon  $^{222}\text{Rn}$  and polonium isotopes.

Gentry (1988) actually includes an illustration of a large biotite crystal containing polonium halos in a pegmatite from Murray Bay, Canada. This pegmatite contains crystals of beryl, zircon, and uraninite (Spense 1940). The association of the gem mineral beryl with biotite probably indicates an origin by crystallization of this pegmatite from magma. The biotite would not be microfractured in such an environment, and the presence of abundant steam would permit rapid growth of large crystals. This mineral association in no way indicates that the pegmatite had to crystallize nearly instantaneously. Furthermore, biotite crystals in pegmatites that lack uraninite also lack polonium halos. The presence or absence of polonium halos in biotite in magmatic pegmatite is directly related to the presence or absence of nearby uranium in uraninite or zircon and not because of instant cooling.

## CONCLUSIONS

The absence of microfractures in some polonium halo-bearing biotite and fluorite is plausibly explained

where these minerals grew in former large, open fractures that were ultimately filled mostly by calcite. In microfractured granitic rocks that were modified by metasomatic processes, polonium halos can form along microfractures in biotite. The rapid rates at which crystals can grow in calcite vein-dikes or pegmatites in the presence of steam and the rapid rates at which radioactive isotopes can diffuse from areas of relatively high pressures into possible large open fractures are important factors in the formation of polonium halos. The coexistence of uranium-bearing minerals in calcite vein-dikes or pegmatites which release abundant amounts of radioactive radon  $^{222}\text{Rn}$  and the easy transport or diffusion of uranium and polonium ions and neutral radon gas in surrounding microfractured rock are also necessary. Also important is the relatively long half-life of  $^{222}\text{Rn}$  (3.82 days). All these factors provide the means by which polonium halos are formed in biotite and fluorite by natural processes.

The absence of microfractures in biotite (or fluorite) where these minerals grew in pegmatites that were crystallized during the last stages of the solidification of granite magma is plausibly explained because crystals forming in magma are generally not microfractured. Moreover, it is plausible that polonium halos can form in pegmatites of magmatic origin because of the transport or diffusion of uranium and polonium ions and neutral radon gas in steam that is concentrating in local places during the last stages of crystallization of granite magma.

Granite bodies of both primary magmatic and secondary chemical replacement origins are not created during a single young age in the Genesis Week but are among a continuum of ages that range from early in the Precambrian to the late Cenozoic. The one essential requirement for polonium halos to form in biotite and fluorite in calcite vein-dikes or granite (either produced by chemical replacement processes or by magmatic processes) is the nearby presence of uranium-bearing minerals that supply the large quantities of radon  $\text{Rn}^{222}$  and polonium.

If polonium halos truly had a nearly instantaneous origin as suggested by Gentry (1988), then even more examples of other polonium halo types would be expected to occur, such as (1) halos of  $^{215}\text{Po}$  and  $^{211}\text{Po}$  that are derived from radon gas  $^{219}\text{Rn}$  in the radioactive uranium ( $^{235}\text{U}$ ) decay series or (2) halos of  $^{216}\text{Po}$  and  $^{212}\text{Po}$  that are derived from radon gas  $^{220}\text{Rn}$  in the radioactive thorium ( $^{232}\text{Th}$ ) decay series. But they are not found (Collins 1997b). The reason is that the radon gas atoms ( $^{219}\text{Rn}$  and  $^{220}\text{Rn}$ ) in these two decay series which are the precursors for the other radioactive polonium isotopes have half-lives in seconds, and their daughter polonium isotopes have half-lives in seconds and microseconds instead of 3.05 minutes for  $^{218}\text{Po}$  and 140 days for  $^{210}\text{Po}$  in the  $^{238}\text{U}$  decay series (Collins 1997b). However, Gentry found only one kind of Po-halo sequences among three possible kinds in biotite and fluorite of supposed instantaneous origin.

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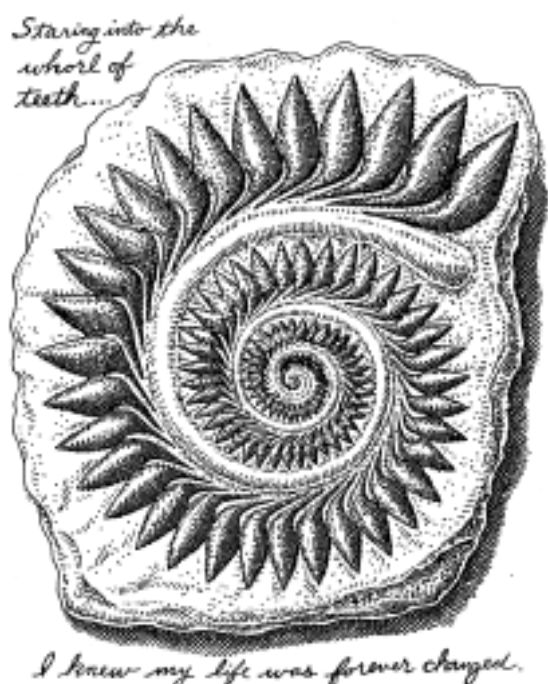
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# “Polonium Halos” Refuted

## A Critique of “Radioactive Halos in a Radiochronological and Cosmological Perspective” by Robert V Gentry

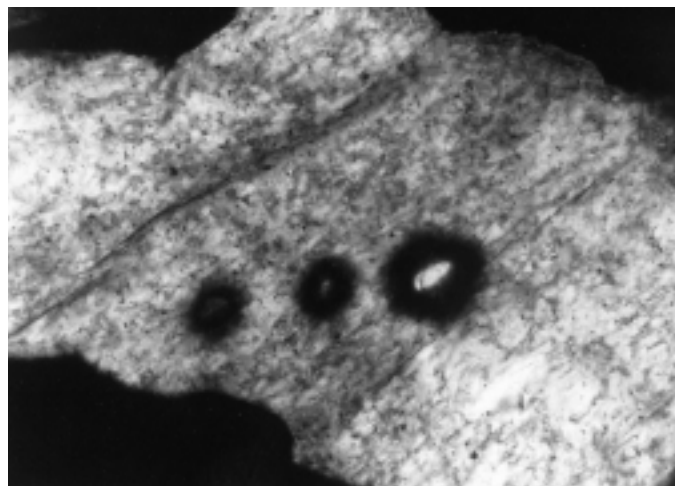
Thomas A Baillieul

*[This article is an extract of a longer treatment of these issues posted on-line at <<http://earthfriendarts.tripod.com/evolve/gentry.html>>. Readers are encouraged to consult the extended version.]*

### INTRODUCTION

As the creationism/evolution debate continues, there has been an increasing sophistication of certain creationist arguments and publications. In the early days of “scientific creationism”, its proponents sought to challenge the scientific view of the natural world by simply adopting scientific-sounding terminology. However, these poorly cloaked Bible-based assertions about the history of the earth (and the universe) were continually rejected by the courts as being inappropriate for public school classrooms. Continuing to evolve, modern creationists produce highly technical and sophisticated reports that have all the trappings of scientific research. Refuting these pseudoscientific reports can be an especially difficult challenge when creationist authors have professional credentials and have published in mainstream scientific journals. One such individual is Robert Gentry, who holds a master’s degree in physics (and an honorary doctorate from the fundamentalist Columbia Union College). For nearly two decades he held a research associate’s position at the Oak Ridge National Laboratory, where he was part of a team that investigated ways to neutralize nuclear waste. Gentry has spent most of his professional life studying the nature of very small discoloration features in mica and other minerals, and has concluded that they are proof of a young earth. To understand Gentry’s hypothesis, a basic background in geology, mineralogy, and radiation physics is helpful. (Readers may refer to sidebars on p 18 and 19.)

Gentry’s thesis has several components. First is his contention that the granitic rocks from which his samples reportedly came constitute the “primordial” crust of the earth. Within these rocks are biotite (an iron-



**FIGURE 1:** Radiation damage haloes around zircon inclusions in pyroxene (160X magnification). Author’s collection.

bearing form of mica) and fluorite crystals which bear a relatively uncommon class of tiny, concentric discoloration “halos” (Figure 1). These halos were considered to be the result of damage to the crystal structure of the host minerals caused by high energy alpha particles (*see the article by Collins and Collins beginning on p 11*). In numerous papers published in scientific journals in the 1970s and 1980s, Gentry built the case that the different alpha decay energies of various naturally occurring radioactive isotopes resulted in distinctly different halo diameters. Thus, Gentry concluded that he could distinguish halos resulting uniquely from the radioactive decay of various isotopes of the element polonium, which is part of the decay chains of natural uranium and thorium. Because polonium has a very short half-life (from a few microseconds to days, depending on the specific isotope), Gentry argues that concentric halos associated with polonium decay — but without any rings corresponding to any other uranium decay series isotopes — were evidence that the host rock had formed almost instantly, rather than by the slow cooling of an original magma over millions of years. Gentry extrapolates that all Precambrian granites — his primordial crustal rock — must have formed in less than three minutes, and that polonium halos are therefore proof of the young-earth creation model according to Genesis.

*Thomas A Baillieul received his master’s degree in geology (mineralogy) from the University of Massachusetts in 1976, and has worked in academia, the private sector, and government across the US and in southern Africa. His areas of specialization include modeling the formation of uranium ore bodies, and studying the migration of radionuclides in the natural environment.*

## ABOUT THE ROCKS

Geologists classify rocks into three main categories — sedimentary, igneous, and metamorphic — based on the way in which they form.

Igneous rocks form from molten material, and are further subdivided into two main categories: the volcanic rocks, which form from lava extruded at or near the surface; and plutonic rocks, which form from magma, deep within the crust. Both types of igneous rocks comprise a mixture of different minerals. As igneous rocks cool, mineral crystals form following a specific sequence. The crystals develop an interlocking texture with some of the trace minerals, becoming completely surrounded by later forming crystals. Volcanic rocks, because they are able to cool and crystallize rapidly, have a very fine-grained texture; the individual mineral grains are too small to see easily with the naked eye. Plutonic rocks, on the other hand, cool very slowly, on the order of a million years or more for some deeply buried and insulated magmas. The mineral grains in these rocks can grow very large and are readily distinguished in hand samples.

Granite is a well-known type of plutonic igneous rock, but there are many others as well. Geologists distinguish these types of rock based on their chemical and mineralogical composition. Granites, for example, have more than 10% quartz and abundant potassium feldspar. Other plutonic rocks have less quartz and potassium, and different ratios of calcium and sodium feldspar minerals. True granites are relative latecomers on the geologic scene, as they require recycling of crustal materials several times to differentiate and concentrate potassium. In an earlier issue of *RNCSE*, Lorence Collins (1999 Mar/Apr; 19 [2]: 20–2, 27–9) provided a thorough overview of the origin and nature of granitic rocks.

Metamorphic rocks represent alterations of precursor sedimentary, igneous, or other metamorphic rocks. Through the cycles of burial, folding, faulting, and subduction of crustal plates, rocks get pushed and dragged down to depths where — under heat and pressure — changes take place. In metamorphic rocks, new minerals form that are more stable at higher temperatures and pressures. Sometimes the minerals segregate into distinct bands. When burial pressures and temperatures get too great, the rocks melt completely, becoming new igneous rocks.

Sedimentary rocks are secondary in formation, being the product of precursor rocks (of any type).

— Tom Baillicul

Fortunately, several components of Gentry's thesis allow us to pose questions that can be answered by looking at the evidence from the natural world:

1. Do the rocks from which Gentry drew his samples represent the "primordial" basement rocks of the originally created earth?
2. Are the concentric halos observed by Gentry actually caused by alpha particle damage to the host crystal structure?
3. If the concentric halos are indeed caused by alpha radiation damage, is polonium decay the only possible cause?
4. Is Gentry's hypothesis consistent with, or does it explain, all other evidence pointing to a *great* age for the earth?

A "yes" answer to each question would significantly strengthen Gentry's arguments. Of course, a "no"

answer would invalidate any inference or proposition based on that component.

## ANSWERS IN NATURE

Do the rocks from which Gentry drew his samples represent the "primordial" basement rocks of the originally created earth?

Gentry is a physicist, not a geologist. Contrary to accepted geologic reporting practice, he consistently fails to provide the information that a third party would need to collect comparable samples for testing. For his research, Gentry utilized microscope thin sections of rocks from samples sent to him by others from various places around the world. Thus, he is unable to say — and others are unable to confirm — how his samples fit in with the local or regional geological setting(s). He also does not provide descriptive information about the individual rock samples that make up his studies — that is, the abundance and distribution of major, accessory, or trace minerals; the texture, crystal size and alteration features of the rocks; and the presence or absence of fractures and discontinuities.

Because Gentry does not acknowledge that the Precambrian time period represents fully 7/8 of the history of the earth, he does not recognize the wide diversity of geologic terranes that came and went over that enormous time span. In Gentry's model, any rock looking vaguely like a granite and carrying the label Precambrian is considered to be a "primordial" rock — a claim that is patently incorrect. True granites are themselves evidence of significant crustal recycling and elemental differentiation (see for example, Taylor and McLennan 1996) and cannot be considered primordial. A little detective work by Wakefield (1988) showed that at least one set of rock samples studied by Gentry are not from granites at all, but were taken from a variety of younger Precambrian metamorphic rocks and pegmatite veins in the region around Bancroft, Ontario. Some of these rock units cut or overlie older, sedimentary, and even fossil-bearing rocks.

Furthermore, polonium halos are found only in rocks that contain myrmekite — a replacement mineral intergrowth — which is a clear indication that the rock is not "primordial" but one that has undergone significant change over an extended period of time. Collins (1997) has noted these and several other contradictory situations between the polonium halo hypothesis and observed geological relationships in the field.

## ARE THE CONCENTRIC HALOS OBSERVED BY GENTRY ACTUALLY CAUSED BY ALPHA PARTICLE DAMAGE TO THE HOST CRYSTAL STRUCTURE?

Reviewing Gentry's early research (Gentry 1968, 1971; Gentry and others 1973), it is apparent that the association of concentric colored halos with polonium is actually speculative. Gentry adopts and expands on the work of Joly (1917) that polonium isotopes were the most likely cause of the circular patterns observed in certain rocks. Joly did most of his work with discoloration halos in the first decade of the 20th century — a time when the structure of the

atom was just being discovered and before the crystal structure of minerals had been unraveled. This was also the period when the nature of radioactivity was just being uncovered. Joly made the very speculative assumption that if alpha particles could travel 3–7 centimeters in air, then they would only travel 1/2000 of that distance in biotite mica.

From this generalization, and without considering variability in the density and the crystal structure of the host mica (or even the variable density of air), Joly attempted to correlate the size of the radius of concentric ring halos with the alpha particles of specific isotopes (he was first to suggest polonium). He also tried to develop an age dating technique based on the diameter of the halo features — the larger the halo, the longer the radiation had been affecting the host mineral grain. Henderson (1939) carried Joly's work further, developing a classification scheme for the different patterns of discoloration halos he observed, and deriving hypotheses for how short-lived polonium could find its way into the host crystal structure. Gentry followed Joly's approach of defining an idealized model based on the average distance traveled in air by alpha particles of different energy. He then measured concentric ring halos in mica (or fluorite, or cordierite) to see which ones matched his model.

How can alpha particle emissions result in discrete colored rings? Gentry's (1992) explanation is that "alpha particles do the most damage at the end of their paths." This would appear to be a reference to the "Bragg Effect" — the phenomenon whereby charged particles lose energy during penetration of different media. When charged particles (a proton or an alpha particle) pass through matter, they lose energy primarily by ionizing the atoms of material they pass through and different atoms require different amount of energy to ionize. In general, the lower the energy of the impacting charged particle, the faster it loses energy. As the particle loses energy, it slows down, and as it slows down, it interacts more strongly with surrounding atoms, causing it to decelerate even more rapidly. Finally, the particle loses all of its kinetic energy and comes to rest, at which time it can capture electrons and become a neutral atom (Knoll 1979). In a uniform medium, the amount of energy loss — and thus the degree of disruption — is greatest at the end of the particle's path of travel (although energy will have been given up and ionization of surrounding atoms will have occurred along the entire path).

The effects of alpha particles in crystalline materials, the physical properties of which vary depending on orientation, are complex. Gentry's own attempts to duplicate alpha particle damage in minerals using a helium ion beam illustrates this problem.

The pattern produced by Gentry through ion beam bombardment was a zone of discoloration, faintest near the source, and increasing in intensity up to a relatively sharp termination. Gentry's ion-beam work, however, was not able to produce multiple bands or the sharply defined concentric ring structure of certain halos. It is likely that intense alpha particle bombardment disrupts the crystallinity of the target mineral (a well-known natural radiation effect), changing its physical properties along the particle

## RADIOACTIVITY

Radioactivity is a phenomenon of the nuclei of atoms. You may recall from high school chemistry class that atoms are composed of protons, which carry a positive charge; neutrons, with no charge; and negatively charged electrons. The protons and neutrons together form the nucleus of the atom, surrounded by a swarm of electrons in distinct orbits. In neutral atoms, the numbers of protons and electrons always match, their charges balancing. It is the number of protons (and hence the number of electrons) that give an element its unique chemical characteristics.

Atoms, however, can have different numbers of neutrons without changing their chemical behavior. For example, the simplest atom, hydrogen, has one proton and one electron. Two additional varieties of hydrogen exist: one which has one neutron in addition to the proton (called deuterium); and one with two neutrons (known as tritium). Different varieties of the same element are known as isotopes. Uranium has 92 protons, but has different isotopes with 141, 142, 143, 144, 145, and 146 neutrons.

Radioactivity is a complex phenomenon, but it can be thought of simply as the consequence of the imbalance caused in an atomic nucleus by an overabundance of neutrons. Isotopes that have too many neutrons try to become more stable by getting rid of neutrons through a number of means, the most common being the emission of high-energy alpha and beta particles. An alpha particle comprises two protons and two neutrons and is chemically indistinguishable from a helium nucleus (as a matter of fact, all the helium gas sold commercially comes from the radioactive decay of uranium, the gas occasionally being trapped in oil deposits that overlie uranium ore bodies). Emission of an alpha particle creates a new chemical element with two fewer protons than its parent atom. The radioactive isotope  $^{238}\text{uranium}$  (92 protons) decays by giving off an alpha particle to become an atom of  $^{234}\text{thorium}$  (90 protons).

Beta particles are created when a neutron breaks down into a proton and an electron — the beta particle thus is an electron, only in this case it comes from the nucleus. In beta decay, the proton remains in the nucleus, also causing the atom to adopt a new chemical identity.  $^{87}\text{Rubidium}$  (37 protons) decays to become  $^{87}\text{strontium}$  (38 protons). Other types of radioactive decay schemes are known to exist, but are much less common than alpha and beta particle emission — and are not really relevant to the subject at hand.

One last point — radioactivity is a statistical phenomenon. Not all the radioactive atoms within a mass decay at the same time. For example, an amount of  $^{238}\text{uranium}$  decays at a rate such that after 4.5 billion years half of the original mass has been converted to other atoms. Several of the "daughter" atoms in the decay series of  $^{238}\text{uranium}$  are themselves radioactive and decay at their own statistical rates until eventually the stable, non-radioactive isotope of  $^{206}\text{lead}$  is reached.

— Tom Baillieul

path. This would tend to broaden the Bragg Effect rather than creating a narrow zone of disruption that produced a simple ring.

Gentry himself (1970, 1974) notes a number of aspects about concentric halos that cannot be explained by the alpha decay hypothesis. Dwarf and giant halos cannot be reconciled with any known alpha decay energies. Gentry postulates that these



anomalous size halos represent new elements or new forms of alpha decay. Neither explanation seems likely given the current state of knowledge of radioactive elements (ICRP 1983; Parrington and others, 1996). Other halos show “ghost” rings that do not correspond to any measured alpha decay energy and remain unexplained. Finally, there are “reversed coloration” halos, supposed uranium halos in which the gradation of color intensity in the circular band is opposite to, and the ring diameters offset from, those in a “normal” uranium pattern. Other exceptions to Gentry’s energy-versus-ring diameter model have been noted by Odom and Rink (1989) and Moazed and others (1973). Gentry speculates on the cause(s) of some of these anomalous features, but provides no empirical data to support any explanation. Indeed, Gentry appears to be more willing to question the evidence provided by the physical samples than to question the validity of his model.

Perhaps the most damaging challenge to Gentry’s hypothesis comes not from what has been observed, but from what is missing. Of the three major naturally occurring radioactive elements, uranium, thorium, and potassium, two — uranium and thorium — demonstrate decay series involving alpha particle emissions. Thorium is between three and four times more abundant than uranium in the earth’s crust. Gentry attributes polonium halos to alpha particle decay of the polonium isotopes  $^{210}\text{Po}$ ,  $^{214}\text{Po}$ , and  $^{218}\text{Po}$ , all part of the  $^{238}\text{U}$  uranium decay chain. However, the decay series of  $^{232}\text{Th}$  thorium to stable  $^{208}\text{Pb}$  lead also includes two polonium isotopes:  $^{212}\text{Po}$  and  $^{216}\text{Po}$ . These polonium isotopes from thorium decay series have alpha decay energies well within the range documented for uranium-series polonium decay. Thus, polonium isotopes which result from the decay of naturally occurring  $^{232}\text{Th}$  thorium should also produce characteristic halos. However, as Collins (1997) points out, Gentry has identified only halos for those isotopes of polonium associated with the decay of  $^{238}\text{U}$  uranium; halos attributable to  $^{212}\text{Po}$  polonium and  $^{216}\text{Po}$  polonium are not found. Additionally, halos attributable to the two polonium isotopes in the decay series of  $^{235}\text{U}$  uranium ( $^{211}\text{Po}$  and  $^{215}\text{Po}$ ) are also missing.  $^{235}\text{U}$  uranium currently comprises 0.71% of naturally occurring uranium ( $^{238}\text{U}$  uranium makes up 99.3%); 3 billion years ago,  $^{235}\text{U}$  uranium accounted for greater than 3% of natural uranium isotopes. If Gentry’s model is valid, halos associated with all of these other polonium isotopes should be observed, some in even greater abundance than the ones he reports. The failure to understand and confirm the full range of a model’s predictions suggests that the model is flawed, and conclusions based on that model are unreliable. Clearly, more work is required to resolve all of these questions. The association of ring-type halos with any specific energy of alpha decay must be considered speculative.

#### IF THE CONCENTRIC HALOS ARE INDEED CAUSED BY ALPHA RADIATION DAMAGE, IS POLONIUM DECAY THE ONLY POSSIBLE CAUSE?

Even if we accept that concentric ring halos actually are due to alpha radiation damage, an immediate problem arises from the short half-life of the polonium iso-

topes themselves. Under Gentry’s model, in order to leave a visible radiation damage halo, the affected mica or fluorite grains would have to crystallize before the polonium decayed away to background levels — about 10 half-lives. For polonium isotopes, this correlates to between a fraction of a second ( $^{212}\text{Po}$ ,  $^{214}\text{Po}$ ,  $^{215}\text{Po}$ ) and 138.4 days ( $^{210}\text{Po}$ ). Gentry’s hypothesis calls for literally millions of atoms of isotopically pure, polonium to be concentrated at the center of each ring. His model makes no distinction between which polonium isotopes should be present — thus there should be equal likelihood for all. He points out that there is no known geochemical process by which such concentrations can occur during crystallization of a magma, concluding therefore that polonium halos are indicative of some non-natural or supernatural occurrence.

Polonium isotopes are produced in the radioactive decay chain of naturally occurring  $^{238}\text{U}$  uranium,  $^{232}\text{Th}$  thorium, and  $^{235}\text{U}$  uranium.

**TABLE 1: DECAY SERIES OF URANIUM AND THORIUM ISOTOPES**

Decay Series	Polonium Isotopes	Particle Energy (MeV)
$^{238}\text{U}$ Uranium	$^{218}\text{Po}$ Polonium	6.00
	$^{214}\text{Po}$ Polonium	7.69
	$^{210}\text{Po}$ Polonium	5.3
$^{235}\text{U}$ Uranium	$^{215}\text{Po}$ Polonium	7.38
	$^{211}\text{Po}$ Polonium	7.45
$^{232}\text{Th}$ Thorium	$^{216}\text{Po}$ Polonium	6.78
	$^{212}\text{Po}$ Polonium	8.78

Gentry’s studies identify concentric ring structures correlated with each of the three polonium isotopes in the  $^{238}\text{U}$  uranium decay series. Ring halos correlated with polonium isotopes from the  $^{235}\text{U}$  uranium or the  $^{232}\text{Th}$  thorium decay series are not reported, although they would have to be present under Gentry’s primordial origin hypothesis.

Gentry does not provide a conclusive argument for demonstrating the relationship between concentric halos and polonium decay. Brawley (1992) and Collins (1997) note, however, that many concentric ring halos line up along visible fractures within the host mica. Such fractures are very common in mica crystals. Microfractures and cleavage planes could provide conduits for the rapid movement and concentration of  $^{222}\text{Rn}$  radon, a gaseous daughter product of  $^{238}\text{U}$  uranium which forms part way along the decay chain leading to polonium.  $^{222}\text{Rn}$  radon, itself an alpha emitter, has a half-life of 3.82 days and is produced continuously in the decay of the parent uranium. Radon, one of the noble gases, is chemically inert and is known to migrate rapidly through large thicknesses of rock. Indeed, radon emanometry (measurement at the surface of radon being released from buried rock formations) is a well-developed technique in the exploration for uranium ore bodies.

*continued on page 25*

# Thinking of Writing for the New *RNCSE*?

## INSTRUCTIONS FOR AUTHORS

Andrew J Petto, *RNCSE* Editor

**R**eports of the National Center for Science Education (*RNCSE*) welcomes contributions from its readers and any one interested in issues related to evolution as the foundation of the biological sciences, to the place of evolution in the science curriculum, or to the public perception of scientific method and practice. These contributions may be submitted in one of three categories.

**Articles** include scholarly articles and formal essays. These may explore specific arguments raised by anti-evolutionists, relate new information that may be helpful in promoting evolution, or present original research related to the public understanding of evolution. We also welcome case reports and classroom action research that assess the outcomes of strategies for strengthening the understanding of evolution in educational practice. Articles undergo formal peer review prior to publication.

**Features** describe events or experiences of interest to *RNCSE*'s readers and members. These may include reports of school board elections or local organizing by parent and teacher groups, political or governmental decisions and policies, first-person accounts of experiences with anti-evolutionist speakers, curricula, or organizations, other reports and information related to our primary concerns of promoting good science in education and public life, and, of course, humor related to creationism/evolution issues.

**Reviews** are reviews of books, films, and other media that deal with evolution, evolution education, and the creationism/evolution controversy.

All contributions should be written for a general audience, and authors should provide definitions or descriptions for technical terms and concepts that might not be understood by a nonspecialist. Submissions should be previously unpublished and not under consideration elsewhere (or an explanation should be provided to the editor). Contributions are evaluated on their merits, and not on the academic qualifications or position of the author.

Query letters from prospective authors are encouraged. For articles or features, contact the editor, Andrew J Petto (editor@ncse.com); for reviews, contact the review editor, Glenn Branch (branch@ncse.com).

Beginning with the first issue of *RNCSE* in 2011, articles, features, and reviews will appear in their entirety only on-line at <<http://ncse.com>>. The printed edition of *RNCSE* will carry short summaries of these items.

## STYLE AND FORMAT

**1. Manuscripts** should be prepared electronically, in Microsoft Word, Rich Text, or plain Text format, and submitted to *RNCSE* via <http://ncse.com>. Send file format questions to editor@ncse.com.

**2. The text** should be single-spaced; use a 12-point font; employ italics, rather than underlining (except with URL addresses); and all illustrations, figures, and tables should be placed within the text at the appropriate points, rather than at the end.

**3. Manuscripts** should be accompanied by a brief biographical statement identifying the author and giving an address (postal and, if desired, e-mail) where interested readers may contact the author. In the case of multiple authors, give biographical statements for each, and select one author as the corresponding author. Authors wishing to protect their privacy may use "c/o NCSE, PO Box 9477, Berkeley CA 94709-0477, info@ncse.com" as their corresponding address.

### Example of a biographical statement:

Andrew J Petto is Senior Lecturer in Anatomy and Physiology at the University of Wisconsin, Milwaukee. With Laurie R Godfrey, he edited *Scientists Confront Creationism: Intelligent Design and Beyond* (New York: WW Norton, 2008).

**4. Citations** within text should be limited to author, date, and (when necessary) page. Page references are required for verbatim quotations of sentences and longer passages. Multiple references should appear in chronological order; references published in the same year should appear in alphabetical order; references published in the same year by the same author should be distinguished by lowercase letters ("a" for the first published, and so on.) Articles by more than two authors should be identified by the first author with "and others."

### Examples of in-text references:

(Branch and Scott 2004; Bottaro and others 2006; Numbers 2006:15–32; NAS 2008; Scott 2009a, 2009b)

**5. Reference** sections are alphabetical and should conform to the name-year format in *Scientific Style and Format: The CSE Manual for Authors, Editors, and Publishers*, 7th edition.

### Example of a reference section:

Bottaro A, Inlay MA, Matzke NJ. 2006. Immunology in the spotlight at the Dover "intelligent design" trial. *Nature Immunology* 7(5):433–435.

Branch G, Scott EC. 2004 Feb 15. Assaults on evolution have evolved as well. *San Jose Mercury News* Sect P:1.

[NAS] National Academy of Sciences. 2008. *Science, Evolution, and Creationism*. Washington (DC): National Academies Press.

Numbers RL. 2006. *The Creationists*, 2nd ed. Cambridge (MA): Harvard University Press.

Petto AJ, Godfrey LR. 2008. Why teach evolution? In: Petto AJ, Godfrey LR, editors. *Scientists Confront Creationism: Intelligent Design and Beyond*. New York: WW Norton. p 405–441.

Scott EC. 2009a. How creationist "Origin" distorts Darwin [Internet]. Washington (DC): *US News & World Report* [cited 2010 Oct 1]. Available from: <http://politics.usnews.com/news/blogs/god-and-country/2009/10/30/how-creationist-origin-distorts-darwin.html>.

Scott EC. 2009b. There you go again [Internet]. Washington (DC): *US News & World Report* [cited 2010 Oct 1]. Available from: <http://politics.usnews.com/news/blogs/god-and-country/2009/11/03/scientist-genie-scotts-last-word-to-creationist-ray-comfort-there-you-go-again.html>.

Do not abbreviate names of publications. Include location of book publishers and (if possible) website publishers; use "[place unknown]" if necessary. Use "nd" for "no date" if necessary.

**6. Material formatted** as footnotes or endnotes should be incorporated into the text or deleted.

**7. Text abbreviations** based on non-English terms should be translated into the appropriate English equivalent. For example, "e.g.," should be rendered as "for example."

**8. All measurements** in articles should be expressed in SI (or "metric") units.

**9. Figures, plates, and diagrams** should be submitted in high-resolution electronic form. Authors are responsible for obtaining permission to use copyrighted materials, and by submitting indicates that such permission has been obtained or is not necessary.

**10. All submissions are subject to editorial correcting** of grammar, spelling, punctuation, house style, and consistency with *Scientific Style and Format*. All manuscripts are edited prior to publication.

**11. Electronic proofs** will be available to authors to review before publication.

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# EO WILSON

Can there be any doubt about EO Wilson's importance, to evolutionary biology and beyond? Winner of the National Medal of Science and the Crafoord Prize, to say nothing of two Pulitzer Prizes and even the Thomas Jefferson Foundation Medal in Architecture, Wilson is a true renaissance figure, with important contributions in entomology, island biogeography, ethology, biodiversity, and environmental ethics. Evolution permeates his oeuvre: as he recently wrote in the preface to *Evolution: The First Four Billion Years* (Cambridge [MA]: Harvard University Press, 2009), "So solidly have the fields of biology built upon the Darwinian conception of evolution that it makes sense today to recognize it as one of the two laws (universal principles if you wish) that govern our understanding of life." (The other law, by the way, is "that all the elements and processes that define living organisms are ultimately obedient to the laws of physics and chemistry.") All of these books by Wilson are now available through the NCSE website: <<http://ncse.com/store>> — look in the "In the latest RNCSE" section. And remember, every purchase benefits NCSE!



Illustration by Dave Smith, used with permission of the University of California Museum of Paleontology.

## MEET WILSON

### *Anthill: A Novel*

by EO Wilson

A semi-autobiographical novel, *Anthill* combines a coming-of-age story with ruminations on nature from ants to the biosphere as a whole. "Melville gave us whales and obsessions, Orwell gave us pigs and politicians. Now Wilson suggests with winning conviction that in our own colonies, we proceed at our peril when we cast off mindful restraint in favor of unchecked growth. ... carries the reader down the ant-hole to describe life from the ants' point of view. No writer could do this better, and Wilson's passion serves him best here. His language achieves poetic transcendence," wrote Barbara Kingsolver in *The New York Times Book Review*.

### *Naturalist*

by EO Wilson

"Most children have a bug period," EO Wilson writes in his charming autobiography, *Naturalist*. "I never grew out of mine." He became a distinguished entomologist. But he also became a pioneer of sociobiology, a champion of biodiversity, and a graceful and elegant writer, winning the Pulitzer Prize twice. "In this exquisitely written mem-

oir," wrote the reviewer for *USA Today*, "the famed Harvard scientist looks back at his childhood in the South as well as his career as a groundbreaking thinker in the field of evolutionary biology. Truly, here is the irrefutable proof that scientists have souls."

### *Nature Revealed:*

*Selected Writings, 1949-2006*

by EO Wilson

A wide-ranging collection of Wilson's writing throughout his career, *Nature Revealed* contains sixty-one articles on ants and sociobiology, biodiversity studies (systematics and biogeography), and conservation and the human condition, plus a bibliography of his published work. "The papers collected here," Wilson explains in his preface, "are those subjects to which ants and my boyhood passions led me. Together they reflect, I hope faithfully, some of the broader events that have occurred in the disciplines they represent and the times in which they were written." Steven Pinker describes it as "[a] fascinating collection from one of the most influential thinkers of our time."

## ANTS

### *The Ants*

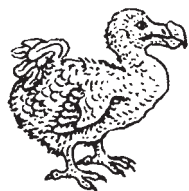
by Bert Hölldobler and EO Wilson

The bible of myrmecology, *The Ants* is not only a definitive guide to its subject but also a beautifully written study, winning a Pulitzer Prize in 1991. According to the reviewer for *Nature*, "*The Ants* is a stunningly attractive volume that belongs as much on the coffee table as it does on the lab bench. ... The 20 chapters are organized thematically, and they are written in a clear, accessible and engaging style... Only Hölldobler and Wilson could have written such a comprehensive and integrated treatment of ant biology. It represents a herculean labour of love, and it sets a new standard for synthetic works on major taxa."

### *Journey to the Ants*

by Bert Hölldobler and EO Wilson

If the 750+ pages of *The Ants* are too daunting, there's always *Journey to the Ants*, which provides a briefer treatment for a lay reader. Chapters include The Dominance of Ants, For the Love of Ants, The Life and Death of the Colony, How Ants Communicate, War and Foreign Policy, The Ur-Ants, Conflict and Dominance, The Origin of Cooperation, The



Superorganism, Social Parasites: Breaking the Code, The Trophobionts, Army Ants, The Strangest Ants, and How Ants Control Their Environment. "[A] bustling but well-organized ant heap, full of wonders natural and intellectual," wrote the reviewer for *Scientific American*.

*The Superorganism: The Beauty, Elegance, and Strangeness of Insect Societies*  
by Bert Hölldobler and EO Wilson  
From the publisher: "The Pulitzer Prize-winning authors of *The Ants* render the extraordinary lives of the social insects in this visually spectacular volume. *The Superorganism* promises to be one of the most important scientific works published in this decade. Coming eighteen years after the publication of *The Ants*, this new volume expands our knowledge of the social insects (among them, ants, bees, wasps, and termites) and is based on remarkable research conducted mostly within the last two decades. These superorganisms ... represent one of the basic stages of biological organization, midway between the organism and the entire species."

## SOCIOBIOLOGY AND BEYOND

*Consilience: The Unity of Knowledge*  
by EO Wilson

A provocative and controversial book, *Consilience* explains that "With the aid of the scientific method, we have gained an encompassing view of the physical world far beyond the dreams of earlier generation," and announces, "The great adventure is now beginning to turn inward, toward ourselves," as Wilson argues for all forms of inquiry — including ethics, art, and religion — to be based on and subsumed within science. Freeman Dyson writes, "The book is a major contribution to philosophy, whether you agree with it or not. ... This is a great and noble vision, portrayed with eloquence and passion."

*On Human Nature*,  
revised edition  
by EO Wilson  
From the publisher: "No one who cares about the human future can afford to ignore Edward O Wilson's book. *On Human Nature* begins a new phase in the most important intellectual controversy of this generation: Is human behavior controlled by the species' biological heritage? Does this heritage limit human destiny? With characteristic pungency and simplicity of style, the author of *Sociobiology* challenges old prejudices and current misconceptions about the nature-nurture debate. ... His goal is nothing less than the completion of the Darwinian revolution by bringing biological thought into the center of the social sciences and the humanities." *On Human Nature* won the Pulitzer Prize for general non-fiction in 1979.

*Sociobiology: The New Synthesis*,  
twenty-fifth anniversary edition  
by EO Wilson  
When it was first published in 1975, *Sociobiology* both offered a new biological synthesis, aimed at explaining social behaviors such as altruism, aggression, and nurturance in their evolutionary context, and provoked a fierce controversy, largely on account of its final chapter addressing the subject of human behavior. The publisher writes, "For its still fresh and beautifully illustrated descriptions of animal societies, and its importance as a crucial step forward in the understanding of human beings, this anniversary edition of *Sociobiology: The New Synthesis* will be welcomed by a new generation of students and scholars in all branches of learning."

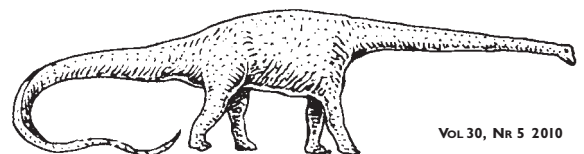
## BIODIVERSITY

*Biophilia*  
by EO Wilson  
In *Biophilia*, Wilson writes, "I will be so bold as to define as the innate tendency to focus on life and lifelike processes. ... I will make the case that to explore and affiliate with life is a deep and complicated process in mental

development. To an extent still undervalued in philosophy and religion, our existence depends on this propensity, our spirit is woven from it, hope rises on its currents." "Wilson's own empathy with things illuminates these essays with fresh perceptions of everyday matters," writes the reviewer for the *Los Angeles Times*. "They are masterpieces of prose style."

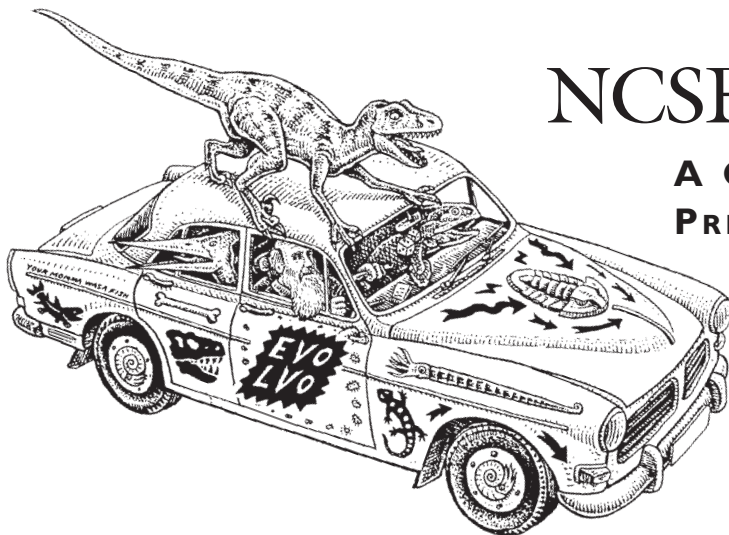
*The Creation: An Appeal to Save Life on Earth*  
by EO Wilson  
Composed as a series of letters to a Southern Baptist pastor, *The Creation* tries to rally the resources of both science and religion in the service of maintaining biodiversity. "I suggest that we set aside our differences in order to save the Creation," Wilson pleads. "The defense of living Nature is a universal value. It doesn't rise from, nor does it promote, any religious or ideological dogma. Rather, it serves without discrimination the interests of all humanity." The reviewer for *The New York Times Book Review* describes *The Creation* as "[t]he wise and lovely work of a truly learned man."

*The Future of Life*  
by EO Wilson  
"The central thesis of this elegant manifesto is not unfamiliar: the impact of human population growth and 'wasteful consumption' on the biological diversity of our planet has been nothing short of disastrous," writes the reviewer for *The New Yorker*. "What distinguishes Wilson's book, though, is its nuanced and evocative explanation of just why biodiversity matters, and its surprisingly optimistic diagnosis of how this natural balance might be preserved." "A civilization able to envision God and to embark on the colonization of space will surely find a way to save the integrity of this planet and the magnificent life it affords," Wilson concludes.



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REPORTS



# NCSE on the Road

## A CALENDAR OF SPECIAL EVENTS, PRESENTATIONS, AND LECTURES

**DATE** November 28, 2010  
**CITY** Sydney, Australia  
**PRESENTER** Eugenie C Scott  
**TITLE** TBA  
**EVENT** The Amaz!ng Meeting  
**TIME** 1:00 PM  
**LOCATION** Sydney Masonic Centre  
**CONTACT** The Amaz!ng Meeting Website:  
<http://www.tamaustralia.org/>

**DATE** February 18, 2011  
**CITY** Washington DC  
**PRESENTER** Joshua Rosenau  
**TITLE** Panel: The Challenge of Teaching Evolution in  
the Islamic World  
**EVENT** Annual Meeting of the American Association for  
the Advancement of Science  
**TIME** 3:00 PM  
**LOCATION** Walter E Washington Convention Center  
**CONTACT** Joshua Rosenau, [rosenau@ncse.com](mailto:rosenau@ncse.com)

**DATE** February 20, 2011  
**CITY** Washington DC  
**PRESENTER** Eugenie C Scott  
**TITLE** Panel: Aiming for Scientific Literacy by Teaching  
the Process, Nature, and Limits of Science  
**EVENT** Annual Meeting of the American Association  
for the Advancement of Science  
**TIME** 1:30 PM  
**LOCATION** Walter E Washington Convention Center  
**CONTACT** Jay Labov, [JLabov@nas.edu](mailto:JLabov@nas.edu)

**DATE** March 11, 2011  
**CITY** San Francisco CA  
**PRESENTER** Eugenie C Scott  
**TITLE** Science, Evolution, and Creationism  
**EVENT** NSTA National Conference on Science  
Education  
**TIME** 10:30 AM  
**LOCATION** Moscone Center  
**CONTACT** Dolores Howard, [dhoward@nsta.org](mailto:dhoward@nsta.org)

*Check the NCSE web site for updates and details — <<http://ncse.com/ncse-events>>.*

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TABLE 2: HALF-LIFE OF RADON ISOTOPES

Decay Series	Radon Isotope	Radon half-life
<sup>238</sup> Uranium	<sup>222</sup> Radon	3.823 days
<sup>235</sup> Uranium	<sup>219</sup> Radon	3.92 seconds
<sup>232</sup> Thorium	<sup>220</sup> Radon	51.5 seconds

Migration of radon along fractures with hold-up points at tiny structural traps would result in exactly the same concentric ring pattern assigned by Gentry to polonium alone (because polonium is an immediate daughter isotope of radon decay). Assigning a halo diameter to radon is difficult since the radon alpha decay energy is very close to that of <sup>210</sup>polonium; where measured accurately, the two ring structures commonly cannot be distinguished (Moazed and others 1973).

The development of fractures in the grains of mica after crystallization has occurred, and the migration of radon along these fractures over the course of millennia, are much more in keeping with current geologic models of rock formation. Thus, the radon hypothesis is more attractive than Gentry's model since it fits the observed evidence and does not require supernatural occurrences.

#### IS GENTRY'S HYPOTHESIS CONSISTENT WITH OTHER AGE DETERMINATIONS FOR THE EARTH?

Over the past six decades, geologists and physicists have developed numerous techniques for dating various types of rock and other natural materials. To reconcile his presumed young age for the earth with reported isotopic age dates for rocks around the world, Gentry (1992) argues that radioactive decay rates have varied over time. However, he is forced by his model to conclude that decay rates for his chosen polonium isotopes have *remained constant* in contrast to those of dozens of other radioactive isotopes that were greater by many orders of magnitude at the origin of the planet (6000 to 10 000 years ago). This of course gives rise to several major inconsistencies.

- Many rocks have been dated by a variety of techniques using different isotope pairs having very different decay mechanisms, and yet the results show remarkable consistency in measured ages. Gentry's hypothesis would require that in the course of these changes in rate, all of the different decay schemes for the different radioactive isotopes must have been accelerated by just the right, but very different amounts to give the consistent age dates we find for rocks today. For example, the decay rate for <sup>238</sup>uranium (half-life = 4.5 billion years) would have to be accelerated by nearly four times the rate for <sup>40</sup>potassium (half-life = 1.25 billion years.). Given the large number of different radioactive isotopes and decay schemes that have been used in dating rocks, the chance of this coincidence's taking place is essentially zero.
- A general principle of radioactive decay is that the more rapid the decay rate, the more energy

## WHAT CAUSES "HALOS"?

Certain minerals, such as zircon and monazite, which form as common trace constituents in igneous rocks, have crystal structures that can accommodate varying amounts of the naturally occurring radioactive elements uranium and thorium. When these minerals occur as inclusions in certain other minerals, most notably the mica family, they are often seen to develop discoloration, or "pleochroic" halos. The halos are caused by radiation damage to the host mineral's crystalline structure. The zone of damage is roughly spherical around a central mineral inclusion or radioactive source. Note that the halo has the highest intensity of discoloration near the source, gradually fading with distance in the host mineral to a "fuzzy" edge.

Radiation damage halos around mineral inclusions are well known from the geological literature. Discoloration halos in younger rocks tend to be smaller and less intense than in older rocks, indicating that the zone of crystal damage increases with time. From these observations, early attempts were made to use the dimensions of halos as an age dating technique. This was never fully successful since the size/intensity of an observed damage halo is also a function of the abundance of radionuclides present.

— Tom Baillicul

that is released. The slow radioactive decay of uranium, thorium, and <sup>40</sup>potassium has been identified as a primary source of the earth's internal heat. Speeding up the radioactive decay rates of these isotopes by many orders of magnitude to be consistent with a 6000–10 000-year age for the earth requires that the energies of decay 10 000 years ago would have been extreme, keeping the earth in a molten state to the present day. Obviously this has not occurred.

- Perhaps most critical: if one is going to propose that radioactive decay rates of all the other isotopes varied, and varied differently for each one over time, there is no reason why the decay rates of numerous polonium isotopes should not also have varied. Under a variable decay rate model, it can even be proposed that polonium decay rates might have been much longer than observed today. In fact, once the idea of variable decay rates is introduced, it becomes impossible to assign discoloration halos to any specific isotope or isotopic series, and Gentry's hypothesis falls completely apart.
- The decay rate and the energy of emitted alpha particles are both related to the imbalance of neutrons and protons in an atomic nucleus and are controlled by the strong nuclear force and the binding energy for the particular nuclide. Anything more than a fractional change in the decay rate over time would require variation in the fundamental forces of nature and the relationship of matter and energy. There is no evidence that anything of the sort has ever occurred.

There are many independent lines of reasoning beside radiometric age dating for concluding that the earth is far older than 6000 years. Other geologic processes, with completely independent mechanisms, that demonstrate a long period for earth history include:

- the slow crystallization and deposition of great thicknesses of limestones occurring over and over in the geologic record;
- the growth of salt domes in the Gulf Coast region of the US and beneath the deserts of Iran by slow, plastic deformation over millions of years of a deeply buried salt bed in response to the slow accumulation of overlying sediments;
- the spreading of the world's ocean basins, recorded in the symmetrical patterns of magnetization of the basalts on each side of the mid-ocean ridges. The current measured rate of spreading results in an age estimate for the western margin of the Pacific Basin of approximately 170 million years — an age which has been confirmed by radiometric dating.



Literally hundreds of other examples could also be presented. All of them lead to the same conclusion: Gentry's model requires assumptions that are not supported by observations of naturally occurring geophysical processes and when the model components are replaced by scientifically accepted values, there is no support for a young earth.

### SUMMARY/CONCLUSIONS

Gentry's polonium halo hypothesis for a young earth fails, or is inconclusive for, all tests. His samples are not from "primordial" pieces of the earth's original crust, but from rocks which have been extensively reworked. He is unable to demonstrate that concentric halos in mica are caused uniquely by alpha particles resulting from the decay of polonium isotopes. Finally, his hypothesis cannot contend with the many alternative lines of evidence that demonstrate a great age for the earth. In the end, Gentry's young-earth proposal, based on years of measuring discoloration halos, fails to generate a scientific model that is either internally consistent or consistent with generally accepted scientific understanding of geophysical processes and earth history.

Gentry rationalizes any evidence which contradicts his hypothesis by proposing three "singularities" — one-time divine interventions — over the past 6000 years. As with the idea of variable radioactive decay rates, once Gentry moves beyond the realm of physical laws, his arguments fail to have any scientific usefulness. If divine action is necessary to fit the halo hypothesis into some consistent model of earth history, why waste all that time trying to argue about the origins of the halos based on current scientific theory? Indeed, this is where most creationist arguments break down: when they try to adopt the language and trappings of science.

Creationists frequently point out that Gentry's research was published in mainstream, peer-reviewed

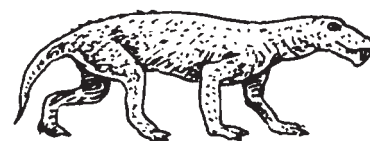
scientific journals. Like many creationist statements, this is partly true. Gentry published his research findings related to his hypothesis that circular halo features were caused by alpha particles from the decay of naturally occurring radioactive isotopes. However, Gentry never presented his hypothesis or conclusions regarding a young earth in these research articles. The closest he ever came to this type of statement is found in a cryptic question posed at the end of a 1974 article in *Science* (Gentry 1974): "... can they [polonium halos] be explained by presently accepted cosmological and geological concepts relating to the origin and development of the earth?" Based on the above analysis, the answer is a resounding *yes!*

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# Humphreys's Young Earth Helium Diffusion "Dates"

Kevin R Henke

[This article is an extract of a longer treatment of these issues available on-line at <http://www.talkorigins.org/jaqs/helium/zircons.html>. Readers are encouraged to consult the extended version.]

## INTRODUCTION

For decades, young-earth creationists (YECs) have desperately sought "scientific evidence" to attack radiometric dating and protect their religious views of earth history. Several years ago, a small group of YEC PhDs associated with the Institute for Creation Research (ICR), the Creation Research Society (CRS), and Answers in Genesis (AiG) formed the RATE (Radioisotopes and the Age of The Earth) committee (Vardiman and others 2000; Humphreys and others 2004: 3). Simply put, their activities included combing the scientific literature and designing laboratory "experiments" that would somehow verify what they have already concluded, namely that a "literal" interpretation of Genesis explains all the physical history of the universe and that anything that conflicts with their biblical interpretations is "wrong". As AiG personnel must affirm in Section 4, #6 of their Statement of Faith:

By definition, no apparent, perceived or claimed evidence in any field, including history and chronology, can be valid if it contradicts the scriptural record. (<<http://www.answersingenesis.org/about/faith>>)

In 2003, many Christian fundamentalists became very excited about a RATE project described in Humphreys and others (2003a), Humphreys and others (2003b) and Humphreys (2003). Humphreys and others (2003a) claim that zircons from the "Jemez granodiorite" of the Fenton Hill rock core, New Mexico, USA, contain too much radiogenic helium to be billions of years old. By inaccurately modeling the helium diffusion rates in the zircons, making numerous invalid assumptions, and assuming some unfounded miraculous increases in radioactive decay rates, Humphreys and others (2004) concluded that the zircons are only "6000  $\pm$  2000 years old." Not surprisingly, their results conveniently straddle Bishop Ussher's classical 4004 BCE "Genesis creation date" for the world. Loechelt (2008c; 2009a) argues that this is no coincidence.

Since 2005, a number of engineers, geologists, physicists, and other scientists (including at least one young-earth creationist and several old-earth creation-

ists) have criticized the validity of Humphreys and others' claims (for example, Loechelt 2008a, 2008b, 2008c, 2009a, 2009b, 2010; Whitefield 2008; Isaac 2007, 2008a, 2008b; Christman 2005). Humphreys's responses to his critics (such as Humphreys 2005a, 2006, 2008a, 2008b, 2010) have been superficial and have totally lacked suitable mathematical and technical details to defend his procedures and YEC conclusions. Most recently, Humphreys (2010) continues to dodge these critical questions from several very qualified specialists in physics, materials engineering, and geology.

Unfortunately for him, Humphreys's critics have shown overwhelming evidence that his study is flawed and useless, and perhaps even contrived to unfairly promote his creation model (Loechelt 2008c, 2009a). The vast majority of the errors in Humphreys's work are not the "mountain of minutiae" (as claimed by Humphreys 2005a), but serious mistakes that undermine any confidence in his work and claims. In particular, Loechelt (2008c) corrects many of the equations and parameters in Humphreys's documents. He further demonstrates that Humphreys's data actually support an age of about 1.5 billion years for the Fenton Hill zircons, which refutes Humphreys's claims for a "young" (6000-year-old) earth and his need for "accelerated" radioactive decay. Using his own equations and data, Humphreys's creation model actually provides a "creation date" of 90 000  $\pm$  500 000 years instead of 6000  $\pm$  2000 years. Loechelt (2008c: 8) also keenly points out:

The RATE radiohalo theory proposes the following mechanism for the formation of polonium radiohalos. Radon gas escapes uranium bearing minerals, such as zircon, which are embedded in biotite crystals, and migrates to accumulation sites where it decays into polonium, thereby forming a radiohalo. This theory requires that the heaviest of all noble gases, radon, have the ability to leave its host mineral and travel scores of microns between biotite plates, all within the time constraint determined by the 3.8235-day half-life of  $^{222}\text{Rn}$ . On the other hand, the helium diffusion theory requires that this same biotite trap helium, the lightest of all noble gases, and hold it for thousands of years. Clearly, the RATE researchers were focused on

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two isolated phenomena (helium diffusion and radiohalos) rather than solving a more general problem, such as noble gas migration in biotite. Ironically, the helium diffusion study and the polonium radiohalo study are published as consecutive chapters in the same book [that is, Vardiman and others 2005].

The vast majority of Humphreys's critical values that are used in his "dating" equations are either missing, poorly defined, improperly measured or inaccurate. (See my Internet essay at <<http://www.talkorigins.org/faqs/helium/zircons.html>> for more details.)

#### MISIDENTIFICATION OF FENTON HILL GNEISSES

Throughout their paper, Humphreys and others (2003a) claim to have studied biotites and zircons from samples of the "Jemez granodiorite" collected at a depth of 750 meters from the Fenton Hill borehole site. More recently, Humphreys and others (2004: 5) and Humphreys (2005b) continue to refer to their "granodiorite" samples from depths of 750 and 1490 meters. Granodiorites are igneous rocks that crystallize from melts (magmas) deep in the subsurface. As their name implies, they have intermediate chemical compositions between granites and diorites, which means that granodiorites tend to have more silica than diorites and more magnesium and iron than granites (Hyndman 1985: 46).

A review of the scientific literature on the subsurface geology of the Fenton Hill borehole site indicates that about 75% of the GT-2 and EE-1 cores consist of gneisses (Laughlin 1981: 308; Laney and others 1981: 2) and that granodiorite is not encountered in the cores until depths of 2591 meters (Figure 1) (Laney and others 1981: 1; Laughlin and others 1983; Burruss and Hollister 1979; Sasada 1989: 258). Information in Laughlin and others (1983) and other references clearly indicate that samples from 750 and 1490 meters are gneisses (Figure 1). Gneisses are former igneous or sedimentary rocks that have been metamorphosed under relatively high temperature and pressure conditions, but without melting (Hyndman 1985: 442; Chernicoff and others 2002: 128).

Even after being presented with evidence from the literature, Humphreys (2005a) still refused to admit that he and his colleagues misidentified gneisses as "granodiorites". He continued to insist that most of the Precambrian sections of the Fenton Hill cores are "granodiorites". In contrast, Robert Gentry readily admitted in Gentry and others (1982a) that the Fenton Hill cores consist of a large number of different rock types, including *gneisses* and other rocks that provided his zircon samples.

The misidentification of the rock types in the Fenton Hill cores is a serious problem. During their study, Humphreys and others (2003a: 6) agreed that any mixing of samples from different rock types would be inappropriate for their modeling efforts:

Measurements of noble gas diffusion in a given type of naturally occurring mineral often show significant differences from site to site, caused by variations in composition. For that reason it is *important* to get helium diffusion data on zir-

con and biotite from the *same* rock unit (the Jemez Granodiorite [*sic*]) which was the source of Gentry's samples. [emphasis added]

Of course, the sizes of zircons and biotites can vary considerably depending on the host rock. Because Humphreys and colleagues did not correctly identify the rocks they sampled and how the sizes of the minerals could vary, serious errors could easily be introduced into the values used in their age calculations (equations 13, 14, and 16 in Humphreys and others 2003a). Snelling and Austin are coauthors of Humphreys and others (2003a; 2004) with PhDs in geology, but non-geologist John Baumgardner was responsible for selecting and identifying the lithologies for this study. In defending this work, Baumgardner (quoted in Humphreys 2005a) argues:

Yes, there are occasional veins of material other than the coarse-grained granodiorite that forms the vast majority [*sic*] of the core. In making the selections I made of what samples to use, I purposely avoided these occasional veins. In fact I tried to select sections of the core well removed from such veins. So at least from my vantage point, the samples of core we used for the helium diffusion measurements were indeed coarse-grained granodiorite, not gneiss.

Baumgardner's statement that a "coarse-grained granodiorite" forms "the vast majority of the core" completely contradicts statements in Laughlin (1981: 308) and analytical data in Laughlin and others (1983) that approximately 75% of the cores consist of gneisses (not granodiorite). The dominance of gneisses in the Precambrian rocks of the Fenton Hill cores is also obvious from Figure 1. Because Baumgardner's conclusions are inconsistent with the results of professional geologists who have examined and analyzed the cores in great detail, I e-mailed him questions about the samples that he had collected for Humphreys's papers. In his gracious reply, Baumgardner described the core as consisting of dark gneissic "veins" surrounded by an "unaltered granodiorite" consisting of "large (typically, 2-3 mm) pinkish grains. Although I requested any mineralogical (such as petrographic or X-ray diffraction analyses) or chemical data (that is, major oxides, minor and trace element analyses) that Baumgardner might have to support his claims, he provided none.

By definition (Hyndman 1985: 442), gneisses consist of alternating dark- and light-colored bands and not "veins". If "dark gneiss veins" [*sic*: bands] were present in Humphreys's samples as Baumgardner claims, where are the light-colored bands of the gneiss? By the definition, how can the Fenton Hill samples have dark gneissic bands and no light-colored gneissic bands associated with them? Baumgardner seems to have misidentified the light-colored gneissic bands as "unaltered granodiorite". The light-colored layers of a gneiss often consist of blocky feldspar and quartz grains. Without detailed chemical and microscopic studies, feldspars and quartz in a light-colored gneissic band can readily appear "igneous" and "unaltered" to the unaided eye. Humphreys has yet to produce any



definitive chemical or microscopic evidence to challenge the metamorphic identifications of their samples in Laughlin and others (1983) and other documents. Despite these objections to his characterization of these samples, Humphreys (2008a, 2008b, 2010) continues to refer inaccurately to the relevant metamorphic sections of the Fenton Hill cores as “granitic rock”.

Faced with disagreement from professional geologists and even Gentry and others (1982a), Humphreys (2005a) argues that misidentifying a gneiss would not significantly affect their zircon diffusion studies or “dating” results:

The important point is that, regardless of the name we put on the rock unit [*sic*: rock units! see Figure 1], the zircons throughout it have been measured to contain essentially the same amounts and ratios of lead isotopes (Gentry and others, 1982b), and therefore have undergone the same amount of nuclear decay. The uranium, helium, and lead levels in our samples are perfectly consistent with the corresponding levels Gentry reported for his. The effect of variation from sample to sample is probably smaller than the 2-sigma error bars around our prediction. So here Henke is making a distinction without a difference.

Several of Humphreys’s assertions are flatly refuted by the chemical data in the very reference that he cites (Gentry and others 1982b), which shows that uranium and thorium concentrations in the Fenton Hill zircons can vary by more than an order of magnitude even within the same zircon! As Gentry and others (1982b: 296) admit:

Frequently, there were significant differences in the U and Th concentrations from two different locations on the same zircon.

These differences, of course, reflect the physico-chemical process that shaped the history of the rocks in the core sample.

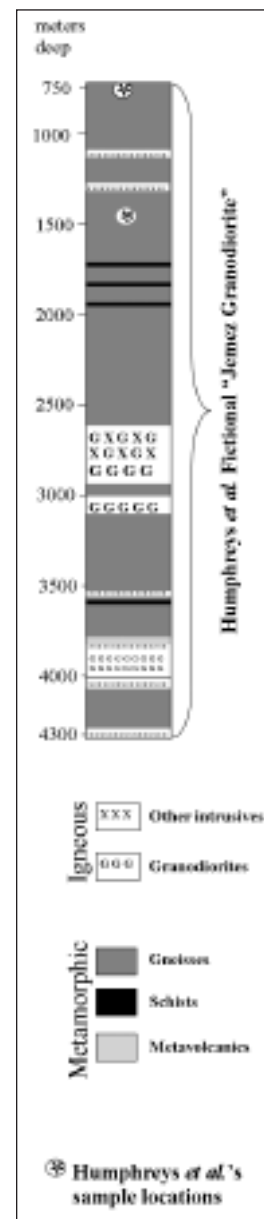
YECs might argue that because Precambrian granodiorites and gneisses were all zapped into existence during the six 24-hour days of the “Creation Week” (for example, Snelling and Woodmorappe 1998: 530), distinctions between Precambrian rocks really are not important. While these YECs invoke miracles to explain away most Precambrian intrusive rocks, Humphreys and others (2003a: 2) unintentionally admit that at least some intrusive rocks have significant histories when they claim that zircon crystals become imbedded in larger crystals as a magma “cools and solidifies”. So Humphreys has the impossible task of explaining why the numerous metamorphic and igneous rocks in the Fenton Hill cores (Figure 1) have complex structures and textures that indicate a long history (Laney and others 1981; Laughlin and Eddy 1977; Laughlin and others 1983; Sasada 1989; Loechelt 2008c) rather than a supposed rapid and miraculous formation in only six 24-hour days.

Because Humphreys collected his zircons from

gneisses and not granodiorites (Figure 1), he needs to recognize that thermodynamic and other laboratory studies indicate that gneisses and their metamorphic zircons form under much greater metamorphic pressures than could ever have existed at depths of only 750–4310 meters (Hyndman 1985; Winkler 1979). The gneisses at Fenton Hill were obviously uplifted from much greater depths. By definition, gneisses have gneissic banding, which requires minimum pressures of about 4000–6000 bars and temperatures of about 600–750°C to form. So Humphreys’s gneisses and their zircons were once at depths of at least 15–22 kilometers (Winkler 1979: 5), perhaps for a significant portion of their history. Loechelt (2008c) in his Appendix A also provides a detailed geologic history of the Fenton Hill cores. Considering that the metamorphic rocks of the Fenton Hill cores probably spent a lot of their history at depths greater than 15 kilometers, Humphreys’s modeling of helium diffusion in some zircons from current depths of 750 meters to 4.3 kilometers cannot yield valid information on the beginning of the earth’s geologic history.

Some additional data were likely lost when the rock samples were processed at the Institute for Creation Research (ICR) laboratory. Humphreys and others (2003a: 17) state that the biotites were extracted through “crushing, magnetic separation, and density separation with heavy liquids.” However, micas, including biotites, can lose much of their helium through crushing (Trull and Kurz 1993: 1314; Mussett 1969: 298). Therefore, grinding the biotite specimens could have resulted in substantial helium loss and significant errors in calculations based on the abundance of helium (Humphreys and others 2003a). Some researchers cut rather than crush micas for argon diffusion studies (Dalrymple and Lanphere 1969: 147–8).

According to Appendix B of Humphreys and others (2003a), the Fenton Hill biotites were impure, making adequate biotite separation difficult. Certainly, Humphreys (2005a) is correct when he states that different samples provide different degrees of difficulty in mineral separation. However, instead of confronting the problem, Humphreys (2005a) claims that the biotite separations are irrelevant (which invites the question why he should do them at all). In contrast, biotite and its helium diffusion properties have critical roles in some of the models described in Humphreys and others (2003a, especially their figure 7), in deriving data needed for age estimates (equations 12–14 and 17 in Humphreys and others 2003a), and in Humphreys’s invalid “Lyell uniformitarian” claim that *current* measurements of the diffusion of helium in his Fenton Hill biotites somehow rules out the possibility of extraneous helium contamination *in the past*.



**FIGURE 1.** Geology of the Fenton Hill GT-2 and EE-2 cores based on information in Laughlin and others (1983: 25–6) and Sasada (1989: 258). The zircons and biotites utilized in Humphreys and others (2003a; 2004) are from gneisses and not granodiorites.

## MYSTERIOUS MODIFICATIONS OF GENTRY'S HELIUM MEASUREMENTS

There are four important variables in the equations from Humphreys and others (2003a) that they use to date their Fenton Hill samples; these are referred to as  $Q$ ,  $Q_0$ ,  $a$ , and  $b$ .  $Q$  refers to the measured quantity of helium (presumably only radiogenic  $^4\text{He}$ ) in a mineral;  $a$  is a measure of the effective radius of the zircon; and  $b$  is the estimated effective radius of the biotite surrounding the zircon. (For the fictitious "Jemez Granodiorite", Humphreys and others [2003a] only supply one value each for  $a$  and  $b$  without providing any standard deviations.) Once a mineral cools below its helium closure temperature and remains below that temperature,  $Q_0$  is the maximum amount of  $^4\text{He}$  that is expected to accumulate in the mineral from the radioactive decay of its uranium and thorium. A certain percentage of alpha particles ( $^4\text{He}$  nuclei) will escape from the host mineral during radioactive decay and this loss is considered when calculating the  $Q_0$  values. Loechelt (2008c) and his references discuss how alpha particle loss may be estimated.

**TABLE 1:** *Information on the Fenton Hill, New Mexico, GT-2 and EE-2 well cores, including the original helium concentrations ( $Q$  in nano cubic centimeters of helium per microgram of zircon at standard temperature and pressure [STP], ncc STP/ $\mu\text{g}$ ) from Gentry and others (1982a: 1130). Samples 0–6 are from Gentry and others (1982a). Humphreys and others (2004) is the source of samples 2002 and 2003. Revised helium ( $Q$ ) values are from Humphreys and others (2003a: 3 [post-conference website version]) and Humphreys and others (2004: 3, table I). Depths are from Humphreys and others (2004: 3, table I). Gentry and others (1982a) identified the surface lithology as the Bandelier Tuff. The other lithologies are from Laughlin and others (1983). The ratios of measured helium to theoretical radiogenic helium ( $Q/Q_0$  values) are from Humphreys and others (2003a, 2003b, 2004) and Gentry and others (1982a). Humphreys (2005b: 30) indicates that the  $\pm 30\%$  for the  $Q/Q_0$  values are "very conservatively" one-sigma random errors.*

Even if the "dating" equations in Humphreys and others (2003a) were reliable, they still would need accurate and precise measurements of these variables before any of the equations would work. However, the data in Humphreys and others (2003a; 2004) are often poorly defined and inaccurate.

For example, Humphreys (2000) simply listed the helium measurements from Gentry and others (1982a), but after presenting Humphreys and others (2003a) at a creationist conference, Humphreys, in consultation with Gentry, concluded that the helium measurements (Gentry and others 1982a) had "typographic errors". Their undocumented "corrections"

to these measurements included lowering most of the  $Q$  values by 10 times (Table 1). As others (for example, Isaac 2008b) and I have noted, Humphreys has yet to reveal details on how these "typographic errors" were discovered and reliably corrected, while at the same time, the associated  $Q/Q_0$  values could remain unaffected. Humphreys (2005a) wrote: "Gentry's original calculations are no longer available." But, if they did not have Gentry's original calculations or laboratory notes, how do they know after more than 20 years that typographic errors had been made in Gentry and others (1982a)?

Using a series of questionable and vague assumptions, Gentry and others (1982a) derived a single maximum helium retention ( $Q_0$ ) value for their samples 1–6 and used it to calculate the amount of retained helium ( $Q/Q_0$  values) for the six samples. Humphreys and others (2003a; 2004) took the high  $Q/Q_0$  values from Gentry and others (1982a) and "corrected" the "typographic errors" in the helium measurements ( $Q$ ), which yield a  $Q_0$  of about 15 nano cubic centimeters (ncc) at standard temperature and pressure per microgram of zircon (ncc STP/ $\mu\text{g}$ ). Using the available information from Gentry and others (1982a) and ignoring the possibility of extraneous  $^4\text{He}$  and  $^3\text{He}$ , I was unable to derive a  $Q_0$  of 15 ncc STP/ $\mu\text{g}$  for the zircons. Instead, I found that the assumptions in Gentry and others (1982a) yield a  $Q_0$  of 41 ncc STP/ $\mu\text{g}$ . Loechelt (2008c: 5) also concluded that the assumptions in Gentry and others (1982a) would yield a  $Q_0$  of about 40 ncc STP/ $\mu\text{g}$  (detailed calculations are available on-line at <http://www.talkorigins.org/faqs/helium/zircons.html>) in appendices A and B).

Meanwhile, Humphreys (2005a) still does not adequately explain how he and Gentry and others (1982a) calculated a  $Q_0$  of only 15 ncc STP/ $\mu\text{g}$  (also see appendix A in <http://www.talkorigins.org/faqs/helium/zircons.html>) and why chemical data in Gentry and others (1982b) indicate that  $Q_0$  is typically much greater (perhaps as high as 800 ncc STP/ $\mu\text{g}$ ; see table B8 in appendix B at <http://www.talkorigins.org/faqs/helium/zircons.html>).

The problems with Humphreys's conclusion go far beyond whether the calculations are accurate. Even if Gentry and others (1982a) and I had obtained the same  $Q_0$  value, I would still argue that their approach

**Table 1:** Original and "Corrected" Data from Gentry and others (1982a).

Sample Number	Depth (meters)	Well Core Number	Actual Lithologies from Gentry and others (1982a) and Laughlin and others (1983)	He measurements ( $Q$ ) (ncc STP/ $\mu\text{g}$ ) from Gentry and others (1982a)	New or Revised He measurements in Humphreys and others (2004) ( $Q$ ) (ncc STP/ $\mu\text{g}$ )	$Q/Q_0$ ( $\pm 30\%$ , 1 $\sigma$ )
0	0	---	Bandelier Tuff	82	8.2	---
2002	750	GT-2	Gneiss	---	~12.1	~0.80
1	960	GT-2	Gneiss	86	8.6	0.58
2003	1490	GT-2	Gneiss	---	6.3	0.42
2	2170	GT-2	Gneiss	36	3.6	0.27
3	2900	GT-2	Granodiorite; Monzogranite	28	2.8	0.17
4	3502	EE-2	Gneiss; Monzogranite	0.76	0.16	0.012
5	3930	EE-2	Granodiorite	~0.2	~0.02	~0.001
6	4310	EE-2	Gneiss; Granodiorite	~0.2	~0.02	~0.001

and assumptions were flawed from the very beginning and that their  $Q_0$  and  $Q/Q_0$  values should be discarded because their samples 1–6 came from a variety of rock types, which means that the uranium concentrations in the zircons from these various igneous and metamorphic rocks ought to be very different, and so would the  $Q_0$  and  $Q/Q_0$  values at the different depths within the Fenton Hill rock cores. Indeed, Gentry and others (1982b) even show that the uranium and thorium concentrations of the Fenton Hill zircons are highly variable within single zircons (table B1 in appendix B at <<http://www.talkorigins.org/faqs/helium/zircons.html>>).

There are other problems with estimates from Humphreys's models. The equations estimating the age of the samples require accurate and well-defined values of  $a$  (radius of the zircons), which are currently unavailable. In their models Humphreys and others (2003a: 8) assume that helium diffusion in zircons is isotropic (that is, spherical) and could be represented by a single effective radius,  $a$ . In reality, zircons have tetragonal (anisotropic) crystalline structures, which affect the flow of helium through the minerals. Nevertheless, Loechelt (2008c: 6) cites Meesters and Dunai (2002):

A rigorous diffusion model would use a realistic 3-dimensional geometry. It has been demonstrated through direct computation, however, that a simpler spherical geometry is a reasonably good approximation *provided* the effective radius [ $a$ ] is chosen such that the surface-to-volume ratio of the sphere is the same as the geometry ... [Loechelt's emphasis]

Humphreys and others (2004: 15) address the issue of zircon anisotropy by claiming that switching the diffusion geometry of their zircons from an isotropic sphere to an anisotropic cylinder would change their results by less than a factor of two. This claim might be true, but Humphreys and others (2004) provide no calculations to support this claim. Furthermore, Humphreys (2005a) admits that the sizes of the zircons in his 750-meter (2002) sample were never determined. Instead, he simply assumed that  $a$  was 30 microns. Gentry and others (1982a) also does not contain adequate information on the lengths and widths of their zircons.

Equations 12–14 and 17 in Humphreys and others (2003a) require that  $b$  (the effective radius of biotite surrounding each zircon) must be known in order to obtain “helium diffusion dates” with these equations. Because of the well-developed and prominent cleavage planes between biotite layers, biotite is very anisotropic. Helium would tend to migrate through the planes rather than perpendicular or oblique to them. Clearly, an isotropic effective radius of  $b$  is inappropriate for this mineral. Yet, Humphreys and others (2003a) assumed that biotite is isotropic in their models (figure 7 in Humphreys and others 2003a). Even if the use of  $b$  was appropriate, Humphreys and others (2003a: 8) only list one  $b$  value — an “average” of ~1000 microns, which is from their 750-meter (2002) sample. Humphreys and others (2003a) also do not indicate how many grains were measured to obtain this average, they provide no standard deviations for this value, and they apply this one value (as he did with their  $Q_0$  value) to other sam-

ples from the Fenton Hill cores. Because descriptions in Laughlin and others (1983) indicate that samples 1–6 in Gentry and others (1982a) and samples 2002 and 2003 from Humphreys and others (2004) were from diverse metamorphic and igneous rocks (Table 1), it is likely that the sizes, and therefore the  $b$  values, of the biotites from these different rocks are very dissimilar.

If we overlook the problems with the data themselves, and use the “dating” equations from Humphreys and others (2003a), the currently best available  $a$ ,  $b$ , and  $Q/Q_0$  values yield an average age of  $90\,000 \pm 500\,000$  years (2 unbiased standard deviations) for the Fenton Hill zircons (see table 4 at <<http://www.talkorigins.org/faqs/helium/zircons.html>>). Now, Humphreys and other YECs might view the average “date” of 90 000 years to be recent enough to support young-earth creationism and refute “uniformitarianism”. However, the estimated dates that result from applying Humphreys's equations to the best available data scatter so widely that just one unbiased standard deviation easily exceeds the overall average date of 90 000 years.

This brief summary examines only a few of the many difficulties with the dating models that Humphreys used to generate his estimate of the age of the earth. More problems are discussed at length in the original article posted at <<http://www.talkorigins.org/faqs/helium/zircons.html>>, including evidence of manipulating data from Magomedov (1971) and the highly dubious “peer-review” system within the *Creation Research Society Quarterly*. Many YECs consider RATE to be the finest example of young-earth creationist research, but, in the end, the shortcomings of the research (missing or inaccurate data, imprecise or inconsistent application of models and computations, overlooking or minimizing confounding variables or contradictory data) say otherwise. If these shortcomings were corrected, the models would show a much older origin for the rocks in this sample than a young-earth creationist model could accept (see Loechelt 2008c). Yet YEC models and oaths of biblical allegiance cannot allow for these corrections. The critical issues in Humphreys's approach lie deeper than the known inaccuracies reported by Humphreys (Humphreys and others 2003a) or Gentry (Gentry and others 1982a), but whether Humphreys and his YEC colleagues will refine their conclusions based on improvements in data collection and mathematical models, or instead continue to adjust their models and data to fit their predetermined conclusions.

## ACKNOWLEDGMENTS

Internet comments on Humphreys and others (2003a, 2003b) and Humphreys (2003) by “WeHappyFew”, Joseph G Meert, and Jack DeBaun were exceptionally insightful. John Baumgardner kindly provided helpful information on Humphreys's samples. A number of scientists and other individuals peer-reviewed and provided valuable comments on various versions of this essay, including: Tom Baillieul, Tom Bridgman, John Brawley, Paul Heinrich, Mike Hopkins, Mark Isaak, Mark D Kluge, Ted Lawry, Frank Lovell and several anonymous scientists and other individuals.

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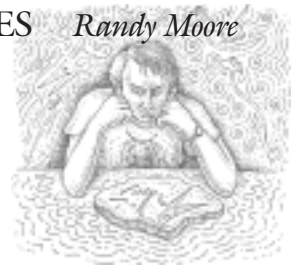
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## Jean-Baptiste Lamarck

### 1744–1829



**FIGURE 1.** Although Lamarck made enormous contributions to invertebrate biology, he is best known for proposing the inheritance of acquired traits. This monument to Lamarck was erected in 1908 near the entrance of Paris's Jardin des Plantes. The relief, which depicts an old, blind Lamarck being cared for by his daughter Aménaïde Cornélie, is accompanied by the inscription "Posterity will remember you. Posterity will avenge you, father."

Jean-Baptiste Pierre Antoine de Monet, Chevalier de Lamarck, was born into a military family on August 1, 1744, at Bazentin-le-Petit, Picardy, in rural northern France. He was the youngest of eleven children. Philippe, Lamarck's father, expected Jean to have a church-related career, and in 1756 Lamarck enrolled in a Jesuit seminary. However, when Philippe died in 1760, Lamarck quit the seminary, bought a horse, and joined the French army. In his first battle, Lamarck distinguished himself for bravery and was made an officer. However, an injury forced Lamarck out of the military, after which he worked as a bank clerk in Paris before studying botany and medicine.

At age 34, Lamarck published *Flore Française*, an acclaimed book about the plants of France. The following year — with the help of Georges-Louis Buffon, whose son Lamarck tutored — Lamarck was elected to the French Academy of Science. In 1793 (the

*Do we not therefore perceive that by the action of the laws of organization ... nature has in favorable times, places, and climates multiplied her first germs of animality, given place to developments of their organizations and increased and diversified their organs? Then ... aided by much time and by a slow but constant diversity of circumstances, she has gradually brought about in this respect the state of things which we now observe. How grand is this consideration, and especially how remote is it from all that is generally thought on this subject?*

year that King Louis XVI and Marie Antoinette went to the guillotine), Lamarck helped to reorganize the French Museum of Natural History and was appointed a professor there the following year. He was placed in charge of studying "insects, worms, and microscopic animals." Lamarck knew little about these organisms, but he later coined the word *invertebrate* (in 1815 in *Natural History of the Invertebrates*) to describe them. Today, a plaque at the museum's entrance notes that Lamarck lived there from 1795 until his death in 1829.

Lamarck first presented his ideas about evolution in a lecture on May 11, 1800. In 1809, Lamarck — a protégé of Buffon and Botanist to King Louis XVI — published his ideas about evolution in his most famous work, *Philosophie Zoologique*. Lamarck's theoretical book, which Darwin read while aboard the *Beagle*, shocked Cuvier and much of Europe by proposing "tendency to progression" and "tendency to perfection", and claimed that life is in a constant state of advancement and improvement that is too slow to be perceived except with the fossil record. Lamarck's claim required spontaneous generation of new species to replace those transformed to more

advanced species. Whereas contemporaries such as Buffon had hinted at evolution, Lamarck was its champion: "[S]pecies have only a limited or temporary constancy in their characters ... there is no species which is absolutely constant." Lamarck was confident of his conclusions, claiming that his model was a "permanent truth, which can only be doubted by those who have never observed or followed the operations of nature." Later, he was even more emphatic: "I am not submitting an opinion, but announcing a fact."

Lamarck, who coined the term *biology* (in 1802 in *Hydrogéologie*), was perhaps the world's premier invertebrate zoologist. He argued that organisms contained a "nervous fluid" that enabled them to adapt to their local environments. According to Lamarck, environmental changes alter the needs of organisms living in that environment. In turn, the organisms' altered needs change the organisms' behaviors, and these altered behaviors then lead to the greater or lesser use of different structures. The more an organism used a part of its body, the more developed that part would become (similarly, the disuse of a part would result in its decay). Lamarck referred to this idea — namely, that the use or disuse of a structure would cause the structure to develop or shrink — as his "First Law." This was followed by Lamarck's "Second

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Law”, which proposed that changes acquired as a result of the First Law would be inherited by the organism’s offspring. As a result, species would gradually change as they became adapted to their environment.

For example, Lamarck argued that wading birds evolved long legs as they stretched them to keep high and dry. Similarly, giraffes evolved long necks as they stretched their necks to reach leaves high in trees. When they stretched, Lamarck claimed, their “nervous fluid” would flow into their necks and over successive generations cause their necks to grow longer. This inevitable need-based change (that is, necks’ getting longer to get food) would give giraffes permanently longer necks, and these long necks would be passed to the giraffes’ offspring. Lamarck’s idea, which came to be known as “inheritance of acquired characteristics”, suggested that there was a drive toward perfection and complexity, analogous to species’ climbing a ladder. Lamarck rejected extinction, instead claiming that organisms evolved into different, more perfect species via a process he called “transmutation”. New, primitive organisms constantly formed from inorganic matter at the bottom of the scale. Although Lamarck’s idea is often depicted in textbooks as giraffes’ stretching to reach leaves atop trees (with the trait of longer necks being passed to offspring), *Philosophie Zoologique* included relatively little about giraffes.

Lamarck — an ardent materialist — was his era’s most renowned advocate of evolution, and his godless model for evolution was the first testable hypothesis to explain how a species could change over time. Many people — Erasmus Darwin among them — endorsed Lamarck’s idea. However, it was rejected (and sometimes ridiculed) by the leading scientists of his time (for example, his revered colleague Cuvier) and was later dismissed by other scientists. Nevertheless, Lamarck’s idea was popular with the public — so much so that Charles Darwin alluded to it in later editions of his *On the Origin of Species*. Darwin wrote to Joseph Hooker in 1844:

Heaven forfend me from Lamarck nonsense of a “tendency to progression”, “adaptations from the slow willing of animals,” etc.! But the conclusions I am led to are not widely different from his; though the means of change are wholly so. I think I have found out (here’s presumption!) the simple way by which species become exquisitely adapted to various ends.

Although Lamarck’s name is most often associated with his discredited “inheritance of acquired traits”, Darwin and many other scientists acknowledged him as a great zoologist and one of evolution’s early thinkers. Lamarck inspired Robert Chambers’s influential *Vestiges of the Natural History of Creation* (1844), a 390-page book that was the most controversial book of its time and which began public controversies about evolution. Although Darwin privately described Lamarck’s book as “veritable rubbish”, he explicitly admitted the possibility of inheritance of acquired traits (in Chapter VIII of *On the Origin of Species*) and conceded in 1861:

Lamarck was the first man whose conclusions on the subject excited much attention. This justly celebrated naturalist ... first did the eminent service of arousing attention to the probability of all changes in the organic, as well as in the inorganic world, being the result of law, and not of miraculous interposition.

Lamarck’s speculative suggestions regarding the origin of new traits continue to overshadow his otherwise important contributions to biology.

Lamarck married Marie Delaporte, the mother of his first six children, on her deathbed in 1792. He married at least twice more — there is no documentation for his rumored fourth marriage. In his 70s, Lamarck’s eyesight began to deteriorate. Despite his great contributions to biology, he

spent his last decade a blind, peniless man living in obscurity and cared for by his unemployed daughters (Figure 1).

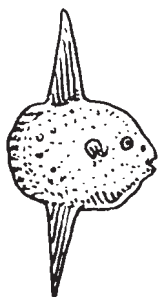
Lamarck died in Paris on December 18, 1829. His papers, books, and belongings were auctioned, and he was buried in a lime pit in Montparnasse cemetery with other paupers. Cuvier, who respected Lamarck’s studies of invertebrates but rejected his theory of evolution, used his eulogy to ridicule and discredit Lamarck. (Earlier, when Lamarck claimed that blind fish in caves lost their eyesight as a result of not using their eyes, Cuvier told Lamarck that “perhaps your own refusal to use your eyes to look at nature properly has caused them to stop working.”) Similarly, Lamarck’s obituary in the *Times* of London did not mention his many contributions to biology, focusing instead on the politics of finding his replacement at the museum. Although Lamarck’s daughter claimed that Lamarck would be remembered, his corpse was later excavated and piled with other nameless remains in the Paris catacombs.

Although Lamarck failed to present a persuasive mechanism for his conclusions, his ideas were popular with the public, for they reinforced the self-congratulatory Victorian emphasis on progress produced by persistence and hard work. After the publication of *On the Origin of Species*, there was a revival of Lamarckism, but the claims associated with the resurgence were based on flawed experiments and fraudulent data (for example, Paul Kammerer’s “midwife toad” fraud of 1919).

Today, Lamarck is memorialized with a large statue inscribed “Founder of the Doctrine of Evolution” at Jardin des Plantes in Paris. Far across the city is *rue Lamarck*, alongside which is the 86-meter *rue Darwin*.

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# BOOKREVIEWS

## CREATIONISM AND THE CONFLICT OVER EVOLUTION

by Tatha Wiley  
Eugene (OR): Cascade Books,  
2009. 154 pages

Reviewed by Daniel K Brannan

As a theologian at the University of St Thomas (St Paul, Minnesota), Tatha Wiley engages Darwinian thought in order to gain insight into the doctrines of Christianity. She emphasizes that the theological concept of creation contrasts with the anti-evolutionists' political definition of "intelligent design" (ID) creationism — a neo-Paleyan construct based in the teleological argument for God. She agrees that supernatural agency must be "bracketed" when doing science. Unless one misreads Genesis as offering an alternative scientific explanation, there is no conflict between Christianity and Darwinian science.

Fundamentalists see the Genesis stories as history and science. Wiley explains why the anti-modern and anti-intellectual fundamentalist movement in the US, with its idea of a "plain sense" reading of Scripture, is just flat wrong. Ever since the inception of *The Fundamentals* in 1909, fundamentalists have ignored a more informed biblical scholarship. Reading the creation stories as symbolic narratives, instead of history, transforms Adam and Eve into a metaphor for human experience; it is a *non sequitur* to claim that doing so makes Christ a metaphor as well. What impels this *non sequitur* is what Wiley calls the "fundamentalist anxiety." Understanding this anxiety, Wiley

suggests, should help us gently communicate the science of evolution to fundamentalist students.

The theological concept of creation and evolution address two different realities on both ontological and epistemological levels. They are complementary answers to different questions: whys versus hows. Wiley makes clear that theology, done properly, addresses metaphysical questions of human existence. Questions of an ultimate source of the universe (God) belong to metaphysics and outside the bounds of science. Taking what was meant to be a hymn of praise to encourage exiles to remain loyal to Yahweh (Genesis 1–3) and turning it into a science and history lesson is an incompetent exposition of scripture. Science, by its very nature, must limit itself to physical questions. Just as we wish to keep ID out of our classrooms, we must also keep out metaphysical claims that science proves a dysteleological or atheistic cosmos.

Wiley highlights the flaws of the teleological argument, which claims the order of the cosmos indicates a designer. Rather than ignore the dysfunctions and cruelties in nature, which Paley's natural theology failed to explain, Darwin solved the conundrum by proposing that whatever allows the better proliferation by an individual in a given environment is what truly counts, not how perfectly that individual serves a purpose in nature. More importantly, natural selection is an empirically based explanation amenable to testing and verification.

Wiley also explains how Roman Catholics have used evolution to inform theology. Both advances in evolutionary science and the work of biblical scholars continued to question the historicity of Adam and Eve and thus the doctrine of original sin. Developed primarily by St Augustine and given dogmat-

ic status by the Council of Trent in 1563, the doctrine reflected a medieval worldview. The Church began considering evolution and modern critical methods of biblical scholarship seriously in 1943. By 1950, Pope Pius XII cautiously accepted evolution but could see no apparent way to reconcile it with the doctrine of original sin.

By 1996, Pope John Paul II recognized evolution as "more than a hypothesis", noting that even if the body is brought into being by evolutionary processes, the soul is immediately created by God. By shifting to a mystical "ensoulment" of an "Adam" (humankind), he moved the discussion to one of metaphysics outside the purview of science. In 2004, a Vatican statement accepted evolutionary theory as compatible with divine purpose warning only that science should never engage in metaphysical claims that the cosmos has no purpose, humans have no ordained role to play, or God has no function in an evolving universe.

Fundamentalists never signed on. Some of them became a political movement focusing, via the Discovery Institute, on "irreducible complexity", requiring an "intelligent designer". Their "God-of-the-gaps" arguments make God dispensable when intelligible natural explanations eliminate the gaps in current knowledge. Consequently, ID does no favors for theology. Good theology prefers God to remain mysterious and ineffable rather than continuously shrinking as gaps are filled.

The insistence that science restrict itself to the study of natural causes is not a rejection of God's existence. It is a methodological approach to limit science to what is testable. The ID camp fails to understand that science is limited to discovering secondary causes of contingent events (such as laws of nature). Science must bracket a primary cause of those laws. Seeing God as the ultimate source of secondary causes allows theologians to understand him or her as the prime mover, the ground of being itself ... conceptions that belong to metaphysics. ID casts God as a tinkerer who could not get it right the first time — poor science but even worse theology.



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The final chapter focuses on the crux of the conflict: without a historical Adam and Eve in Eden, is Christ's atonement moot? I have to wonder why Wiley was not more forthright in answering with a resounding "no" since her previous publications do this quite well. If I can fault this work at all, it would be here. After all, the resolution of anti-evolution as pointed out by Wiley, echoing Eugenie C. Scott's position, is to educate both scientists and theologians: to allow both to become better informed about biblical scholarship and what scriptures are actually teaching regarding the doctrine of creation. Personal interpretation of Scripture without solid theological insight — so-called plain "sense" readings — must be rejected ... as the Ethiopian admitted when Philip asked him:

Do you know what you are reading?  
How can I, unless someone explains it to me? (Acts 8:30–31).

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## DARWIN'S ARK

by Philip Appleman, illustrations  
by Rudy Pozzatti  
Bloomington (IN): Indiana  
University Press, 2009. 112 pages

#### Reviewed by Cleo Fellers Kocol

When the National Center for Science Education asked me to review *Darwin's Ark*, I demurred, saying I was not a scientist and while a sometimes poet, certainly not Philip Appleman's peer. As for drawings, I only know what I like. The NCSE replied I was exactly what they wanted. Feeling somewhat ridiculous, I agreed. But as Appleman points out so aptly in his poems, *Homo sapiens* many times is ridiculous. Appleman is the Distinguished Professor of English Emeritus at Indiana University and author of eight volumes of poetry, three novels, and

six non-fiction books including the Norton Critical Edition of *Darwin*. Rudy Pozzatti is Distinguished Professor of Fine Arts Emeritus at Indiana University, whose art resides in museums and public and private collections worldwide.

I first became aware of Philip Appleman's ability to take seldom-addressed subjects, put them into poetic form, and subject them to public scrutiny in 1984 when his poem "The Skeletons of Dreams" hit me with the power of a hydrogen bomb. I sang its praises in freethought newsletters and read it to graduate students attending a talk at Guangxi Province Teachers' University in Guilin, China. I was awestruck the many times I have read the poem since.

The poem first appeared in *The New York Times* and was subsequently included in his 1984 collection of poems entitled *Darwin's Ark*. But "Skeletons" is only one star in a glittering galaxy of poems and illustrations (and excerpts from writings by Darwin and others) that add to this volume. Appleman illuminates his theme with empathy, understanding, wit, and humor that is often subtle or satirical. Pozzatti's illustrations, while often whimsical, are also realistic and memorable.

The words and drawings in *Darwin's Ark* brilliantly exhibit Darwin's theory of evolution, starting with "Skeletons of Dreams". In it Appleman includes these cautionary words,

Back home in his English garden  
Darwin paused in his pacing,  
writing it down in italics  
in the book at the back of his mind:

*When a species has vanished  
from the face of the earth,  
the same form never  
reappears ...*

The poem goes on to point out humanity's acquisition of an opposable thumb and an expanded cerebral cortex, and the millen-

*Cleo Fellers Kocol's poetry appears in many poetry journals. She is also the author of a historical novel, Fitzhugh's Woman (North Charleston [SC]: Booksurge, 2009), and of an article about women's rights in the July/August 2009 issue of The Humanist.*

nia linking us to our ancestral past, while pointing out that our species is still as mortal as mammoths.

All of the poems delineate, describe, or elaborate on Darwin's theory. The connections between *us* and *them*, humanity and the "lesser" animals, slide effortlessly into place, and the very earth we stand on oozes into our consciousness as we read these poems. Appleman blends the past with the present in an elegant fashion.

A sensitive, analytical writer, Appleman takes us into the scenes he paints with his words. We are the lions in the veldt. We feel the sense of urgency in the hunt, whether it is in grasslands in Africa or pews in churches, preachers "baying at sin." He uses metaphor in amusing ways as well, and we read about the evolution of automobiles, the passing of Cords and Duesenbergs, and "animals tame and animals feral." Rhymed or unrhymed, all the poems sing with the rhythm and the judicious choice of words.

The book is separated into four sections, Giants in the Earth, The Rust of Civilizations, Animals Tame and Animals Feral, and In the Caves of Childhood. The poems in each section tie the present to all that went before and at times point to the future. In an additional breakdown of the section highlighting animals, we find Phobias (fears) and Euphorias (joys), and these playful seeming titles end up, by the end of the poems, giving us very big challenges, making us look at ourselves and what we have wrought.

Open the book anywhere and you are apt to find an image that expands in your mind, becomes more because of the verbs used — "the concrete is veined with tar bubbling in the sun" or "the land is failing the horizons." Again a well-chosen adjective lifts a narrative above the obvious such as "to pray above our crippled brother seven raptured hours."

Darwin's observations and conclusions have been encapsulated and given back to us in poetic form expanding on the various concepts Darwin noted. We encounter the "survival of the fittest." We know what it means in a visceral, on-the-scene way in the

cold regions of Tierra del Fuego during the “spirit” years. We know what it is to be hungry, when food exists only in another like ourselves. We know what it is to be the hunted, to be the prey. Likewise Appleman makes clear that Noah’s Ark was “not floating on fact but was floating on faith”. *Darwin’s Ark* floats on word images and the underlying science as well as the social behavior that speaks and lives for all times.

The poem “Reading Our Times” contains the following end lines:

we push though the bars  
to Wall Street, promised land,  
land of silk and honey,  
bearing our Times  
into the screaming of  
monkeys,  
into the streaming baobab,  
ivory, apes, and peacocks,  
hacking at dripping lianas  
with our machetes, tracking  
the gamy spoor  
of Honor.

The prescient lines could have been written today.

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## THE PANDA’S BLACK BOX: OPENING UP THE INTELLIGENT DESIGN CONTROVERSY

edited by Nathaniel C Comfort  
Baltimore: The Johns Hopkins  
University Press, 2007. 165 pages

#### Reviewed by Glenn Sanford

For anyone interested in a wide-ranging and detailed treatment of the “intelligent design” (ID) controversy, a thorough reading of the transcripts from *Kitzmiller v Dover Area School District* would be recommended, except that it is extremely long, tedious, and often bogged down in the minutiae of legal proceedings. Nonetheless, a selective glimpse at the testimony is insightful. At issue in *Kitzmiller* was a statement directing students to “keep an open mind” “because

Darwin’s Theory is a theory” and informing those who were interested in an alternative view that the ID “reference book” *Of Pandas and People* was available.

In his introduction to *The Panda’s Black Box*, Nathaniel Comfort attempts to unpack the current teach-the-controversy strategy. He concludes that the controversy that exists between ID proponents and advocates of mainstream evolutionary theory “is not about the findings of science. Rather, it is about the place of science in society” (p 7). Comfort champions teaching the controversy, as long as it is taught in a humanities environment that is equipped to handle the rhetoric, dogma, values, and the political baggage that it entails.

Scott Gilbert, the only biologist among the contributors, provides an interesting look at what it would take for biologists to “teach the controversy”. Using his experience teaching developmental biology, he lampoons ID as “what science might be if it lost its respect for evidence and controls” (p 41) and adds that “the debate between evolutionary biology and ‘intelligent design’ is like a debate over whether the aerodynamics the Boeing 747 are superior to those of flying carpets” (p 43). These one-liners aside, Gilbert’s central theme — that it is important to separate the scientific content of a theory from its science-like packaging — provides a resonant theme.

Michael Ruse and Edward Larson provide histories of the design argument and teaching evolution in public schools, respectively. Ruse’s piece distills portions of his much more substantial *Darwin and Design: Does Evolution Have a Purpose?* (Cambridge [MA]: Harvard University Press, 2003) to provide a history of the design argument that stretches from the ancient Greeks to the contemporary ID movement. He rejects the claim that ID represents a breakthrough in scientific thinking.

Likewise, Larson, author of *Trial*

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*and Error: The American Controversy over Creation and Evolution* (third edition, New York: Oxford University Press, 2003) and *Summer for the Gods: The Scopes Trial and America’s Continuing Debate over Science and Religion* (New York: Basic Books, 1997) condenses substantial scholarship to trace the debates over evolution in the public schools from the 1920s into the 21st century. Beyond the abridged history, Larson touches on the role played by scientists’ attitudes toward religion in shaping the ongoing controversy and on the impotence of our court system when it comes to solving the public controversy.

Jane Maienschein uses the current controversy over human embryonic stem cells to illustrate how the public presentation of purported science-religion battles generally fails to capture the range of issues involved. Her discussion attempts to separate facts, on which there may be little disagreement (for example, that a fertilized egg contains a full complement of DNA), from values, on which there is generally little agreement (for example, “What rights or respect should be afforded to an embryo?”). She also separates metaphysical debates (that is, those about what exists) from epistemological debates (that is, those about how we know things). By citing the centrality of evolutionary theory to any hope of finding a competent response to threats such as the H5N1 strain of avian flu and the loss of biodiversity, she provides the most compelling case for choosing evolution over ID for our classrooms and policy-making arenas.

Robert Maxwell Young’s discussion of scientific reductionism, materialism and the fact-value distinction as sources of the science-religion divide illustrates at the often-ignored complexity of the science of human nature. Rather than attacking either ID proponents or evolutionists, he provides a useful examination of historical transitions that accompanied the shift from natural theology to materialist science. The centerpiece of his discussion casts Darwin’s theory as “arguably the most important idea in the history



of the natural or human sciences” (p 13).

*The Panda's Black Box* is an accessible reader that quickly and deftly surveys the current evolution-ID debates from a range of philosophical and historical angles. It provides a useful synopsis of considerable scholarship on the issues involved. Despite the considerable abridgment of several lines of argument owing to its brevity, it manages to convey a sense of the debates that is accessible and sufficiently footnoted to allow those who are so inclined to dig deeper into the quagmire of “the controversy” surrounding the place of science in our society.

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## CHARLES DARWIN'S ON THE ORIGIN OF SPECIES: A GRAPHIC ADAPTATION

by Michael Keller, illustrated by  
Nicolle Rager Fuller  
New York: Rodale, 2009. 192 pages

Reviewed by David B Richman

The idea of a graphic version of the *Origin of Species* is a good one, since many casual readers will never get through the original. This is perhaps unfortunate, but so much misinformation is available on evolution in the popular literature that any attempt to clarify Darwin's views on evolution by natural selection has to be welcomed. A graphic format might be easier to read and understood by those who have no time to read more deeply or are casually interested, but do not want to commit more time on it than a graphic format would require. Some of this audience would certainly include students, especially in high school. Years ago I found the book *Darwin for Beginners* by Jonathan Miller and illustrated by Borin Van Loon (New York: Pantheon, 1990) to be a rather

charming graphic account of Darwin's ideas, and it is still available and of use in this regard. In this same genre, Rodale Press has recently published Michael Keller's *Charles Darwin's On The Origin of Species: A Graphic Adaptation*.

I did not particularly like the illustrations, but tastes differ. When Nicolle Rager Fuller (the illustrator) concentrates on animals, she does very well, but her people sometimes are a bit strange. While I don't think the illustrations are up to more rigorous scientific standards, they are more than adequate for a book of this nature.

However, the main point is that the theory of natural selection is well covered and I think pretty well explained in Keller's book. Compared to Miller, Keller concentrates more on the basic ideas in each chapter of the *Origin* and less on the historical and philosophical background. His treatment of modern ideas in regard to evolution is also more up-to-date. Starting in part 2 on page 41, after 34 pages of background, Keller goes through each chapter of the *Origin*, briefly summarizing the evidence and arguments used by Darwin. These summaries are generally accurate and present the reader with at least the main ideas involved, although some topics get lesser treatments than others. The discussions of variation under domestication, the difficulties of the theory, geographical distribution, and mutual affinities of organic beings, are especially well done. The last chapter brings the reader up to the present with short panels on Mendel and genetics, the Synthetic Theory, genes and the discovery of DNA as the blueprint for life, jumping genes, and punctuated equilibrium, among others.

I have a few gripes, which primarily have to do with content. For some reason, Keller apparently used later editions of the *Origin* in which Spencer's phrase “survival of the fittest” was added. Darwin did not invent this phrase and it was not in the first edition. The phrase, while accurate if “fit” is

understood to apply to any adaptation that works to allow an individual to reproduce, does not necessarily mean that the strong overcome the weak; Spencer's phrase has unfortunately been used to imply that there are “inferior” peoples because they do not fit preconceived notions of superiority. It would have been wise for Keller to explain this if he was going to use a later edition of the *Origin*.

I can also quibble with the fact that while Keller abruptly introduces Emma Darwin as Charles's wife on page 26, he never really explains her background or the circumstances of their marriage (they were first cousins, which concerned him later because of problems that he perceived with inbreeding). Also unaddressed is her religious faith (she was a devout Unitarian) and how it affected their relationship. The death of Annie, their beloved daughter, discussed on page 31, apparently caused Emma to doubt her beliefs; when Darwin died, Emma refuted the rumor that he had recanted his agnosticism on his deathbed. These are important points to discuss if Emma and Annie are introduced, and I felt they were given short shrift.

There were several other places in the book where new subjects seemed to be introduced without much in the way of a connection to what went before, and some important points about modern theory were glossed over in my view, but in a book of this nature some information has to be omitted.

Finally, I found an unfortunate error on page 14: Robert Chambers's and John Henslow's occupations are reversed. Chambers was a journalist and author (*Vestiges of the Natural History of Creation*) and Henslow was a botanist and geologist, as well as mentor to the young Darwin. The reader should not expect an in-depth treatment in what is essentially a comic book, but these were errors that could have been easily avoided.

That said, Keller has produced a mostly accurate and reasonably complete book that introduces the intelligent layperson to the principles of and evidence for evolution

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by natural selection. It certainly will serve as a good introduction for high school students or for an introductory course for non-biology majors in college. Those who want more depth to the background information on Darwin's life would do well to read Janet Browne's two volumes on the subject, and those who would like more detail about Darwin's arguments should read a reprint of the first edition of the *Origin*. But the more casual reader will find a reasonably good synopsis of the theory and its more modern developments within the pages of this book. It is to these readers that I recommend this slim volume, with the minor reservations mentioned above.

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## SIGNATURE IN THE CELL: DNA AND THE EVIDENCE FOR INTELLIGENT DESIGN

by Stephen C Meyer  
New York: HarperOne, 2009.  
624 pages

Reviewed by David W Ussery

The main thesis of Stephen C Meyer's book *Signature in the Cell* — that DNA contains information and that this information could not have evolved but must have been created — is pretty much a warmed-over restatement of a claim that he has been making through his career over the past twenty years. But a lot has happened in that time. For the past ten years, I have been leader of the Comparative Microbial Genomics group in the Center for Biological Sequence Analysis (CBS) at the Technical University of Denmark, studying the flow of biological information in bacterial genomes. When I first started teaching my course on comparative genomics, there were only eight completely

sequenced bacterial genomes to compare. Now, there are over 1000 bacterial genomes to compare. I have been busy investing in building tools and technology to analyze this flood of data, and my small research group has published more than a hundred papers about comparative genomics — and the folks at the Discovery Institute, where Meyer is in charge of the Center for Science and Culture, what have they done? They have had lots of talks and lectures and written several books, and they claim to have produced a smattering of scientific publications, but they seem still to be stuck trying to revive Paley's early-19th-century argument from design.

As the subtitle of *Signature in the Cell* suggests, the book argues that DNA is evidence for the existence of a "mind outside of nature". (Meyer emphasizes repeatedly that this mind does not have to be *God* — just something supernatural and outside the physical universe.) How is DNA supposed to provide evidence for the existence this "mind"? According to Meyer, the most satisfactory explanation of the way in which DNA carries information appeals to the existence of an intelligent designer. But his account is wrong on many levels.

It would take a book at least the same length as Meyer's to explain how far he is from the current scientific consensus. For starters, the origin of the genetic code is not "irreducibly complex" as Meyer implies — in fact, since the 1960s, people have been toying with the idea that early versions of the genetic code contained fewer amino acids based on a two-letter code, and it is likely that ancient codes contained only a few stable, readily formed amino acids (Higgs and Pudritz 2009). Interested readers should visit PubMed (<<http://www.ncbi.nlm.nih.gov/sites/entrez>>) and type in the words "genetic code evolution". There were almost 7000 articles there in October 2010. Claiming that DNA was "intelligently designed" is as

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### AN INORDINATE FONDNESS FOR BACTERIA?

Where is most DNA found, and what does it code for? The human intestinal tract contains more than ten times as many bacterial cells than the total number of *human* cells in the whole body. Further, for every one human gene, there are at least 150 microbial genes. In a paper published this spring, we deposited to GenBank more than 3 *million* bacterial genes, just from the human intestinal flora (Qin and others 2010). The total number of bacteria on earth is more than a billion times as large as the number of stars in our universe. According to data in a wonderful table in a recent review article (Kyrpides 2009), if one were to take all the bacterial viruses on the earth, and stretch them out end-to-end, they would be about a hundred million light years in length — a thousand times the length of the Milky Way galaxy. And there is perhaps a thousand times as much bacterial DNA on the planet as viral DNA, meaning that the total length of bacterial DNA on earth is a million times the length of the Milky Way galaxy. So if a theologian were to ask me what I could say about the Creator, based on my knowledge of how DNA is distributed, I would probably paraphrase the response that JBS Haldane gave to a similar question and reply, "God must have an inordinate fondness for bacteria."

— David W Ussery

problematic as similar claims for whole organisms: the patterns and processes of evolution involve extinctions, inefficiencies, and similar features that it is awkward to explain on the "intelligent design" hypothesis.

The methodology of *Signature in the Cell* is based on William Dembski's "design filter": the information flow of DNA in the cell is contingent, complex, and specified. Therefore, Meyer concludes, it is the result of design: *supernatural* design, since "natural means" have been ruled out by the "explanatory filter"). This is presented subtly and intentionally, so as not to wave too many flags that this is actually a book advocating a disguised form of creationism. It is clear, nevertheless, that Meyer wants to convince his readers that if something cannot be explained by our current understanding of natural processes, then it is reasonable to assume a supernatural explanation. This is not how science has been done for centuries, and there is no reason to think that invoking supernatural forces will be a fruitful approach now.

Meyer is adept at disguising his

views as scientific, but in fact they are phrased in such a way as to be void of meaning. Take the first of the “dozen ID-inspired predictions” listed in the appendix of the book: “No undirected process will demonstrate the capacity to generate 500 bytes of new information starting from a nonbiological source” (p 496). As I was writing this review, an article in the *Journal of Genome Research* (Xing and others 2009) described how insertions from a common transposable element in humans (Alu, which makes up about 5% of the human genome) creates about 1 structural variant per 21 births in humans. That is, for every 21 humans born, there is a *new* protein structure created by *random* insertion of this element into the coding region of a gene. This sounds as though it should qualify as generating new information. Does it? I do not know, since what Meyer means by “500 bytes of new information” is left vague and ambiguous, so it is difficult to test.

Another recently published article describes how three new human genes have evolved from non-coding “junk DNA” (Knowles and McLysaght 2009). Again, new information has been generated, in this case from what appears to be random sequences, but without any rigorous, clearly applicable definition of “new information” on the table for all to see, one cannot tell whether Meyer’s prediction has been falsified.

Why would anyone regard Meyer’s arguments as persuasive? I suspect that the answer is the fear of the alternative — if life were not created directly by God, then (the argument goes) life is random, meaningless, and pointless. So much is at stake here. Meyer views “materialistic science” and religion as being at war with each other, and in this he agrees with Richard Dawkins (and many others). They *both* view the battle as between materialism and religion, with science deciding who wins — the only difference is that Meyer thinks that science can prove God did it, while Dawkins thinks science can prove there is no God.

But must we choose between Meyer (who in my opinion preaches bad science as well as teaches

bad theology) and Dawkins (who is an excellent scientist, but virulently atheistic)? Is there not a third alternative? Is it possible to be both a good scientist and also a good theist? You wouldn’t know it from *Signature in the Cell*, which is largely silent about the views of people like Francis Collins (2006). Indeed, the views of many scientists and theologians who have no problem reconciling evolution with theism are missing in this book of over 600 pages.

Meyer was slated to testify for the defendants in *Kitzmiller v Dover*, and I was looking forward to read his take on the trial, hoping for some sort of explanation for why Meyer and Dembski pulled out before the trial started. Instead, Meyer argues that the judge was a materialist (p 433). In contrast, the Dover Area School Board lost its case because Judge Jones paid careful attention to the evidence about the nature of science presented to him. He did not blindly accept the evidence one side presented; rather, he saw that it reflected the way that modern science is done. I am surprised that any scientist (as Meyer portrays himself) would have problems with the idea that supernatural explanations do not belong in science. Yet a large part of *Signature of the Cell* is a long argument that someone or something acting *outside* the laws of nature is responsible for DNA.

The scientific sterility of ID is evidence that Judge Jones was right. In “The theory of intelligent design: A briefing packet for educators” (Discovery Institute 2007), published after the *Kitzmiller* decision, it is claimed that the idea that ID has no publication record is wrong, and a list is given of “selected peer-reviewed publications that directly support intelligent design” — containing only six publications. To put this in perspective, there are more than 20 million papers listed in PubMed (over 276 000 on evolution alone). To argue that ID be taught as science, there must be at least some “science” to teach. It is as if the ID people want to put in five minutes’ work and get paid for a year!

Copy on a promotional website for the book (<<http://www.signatureinthecell.com/about-the-book.php>>) claims:

signatureinthecell.com/about-the-book.php>) claims:

unlike previous arguments for intelligent design, *Signature in the Cell* presents a radical and comprehensive new case, revealing the evidence not merely of individual features of biological complexity but rather of a fundamental constituent of the universe: information.

The claim for a “radical and comprehensive new case” is simply not truthful. In fact, there is *nothing* new here: the book contains little more than a rehash of old creationist arguments, many clearly borrowed from Meyer’s previous work. The argument from personal incredulity is the theme of this book, repeated *ad nauseam*. In science trust and integrity are important; in my opinion, the history of lies, error, and lack of scientific productivity from the ID movement does not inspire trust.

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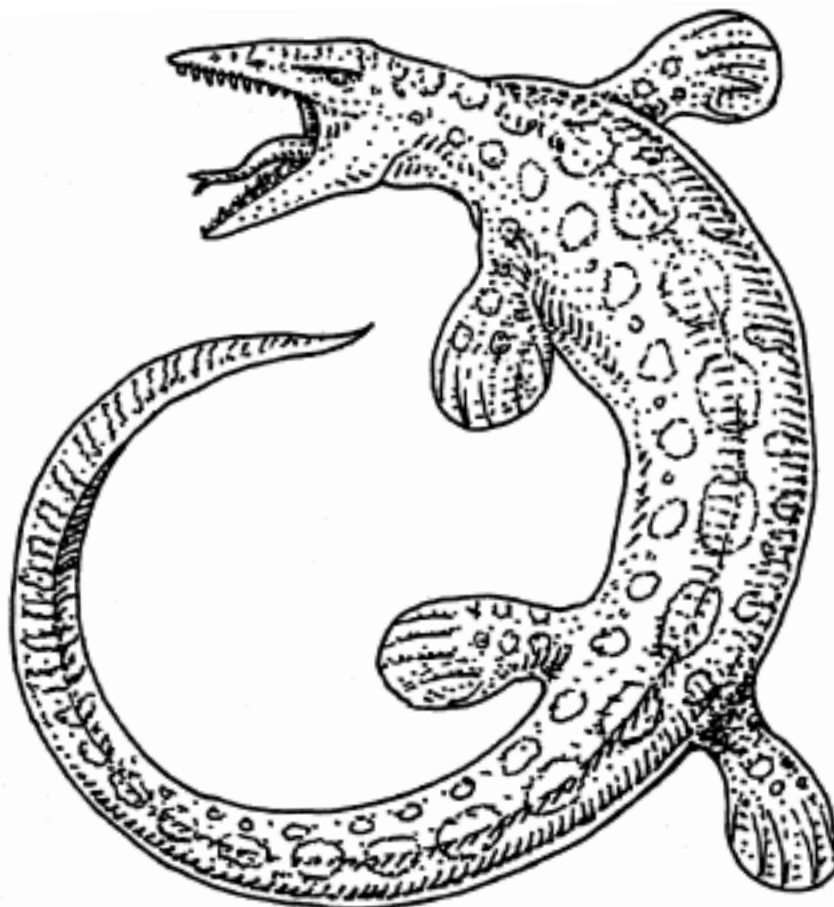
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