

# MYSTERY OF THE RADIOHALOS

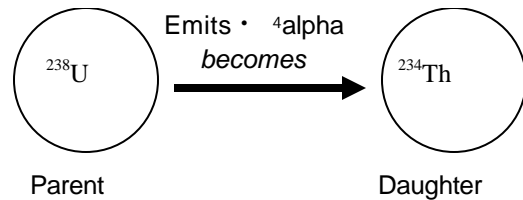
- Current physical laws may not have governed the past.
- Earth's primordial crustal rocks, rather than cooling and solidifying over millions or billions of years, crystallized almost instantaneously.
- Some geological formations thought to be one hundred million years old are in reality only several thousand years old.

Grant these propositions and—any researcher will tell you—the entire structure of the historical natural sciences would dissolve into formlessness. Few certainties would remain. Yet these very possibilities (and others equally disintegrative) have been suggested in a remarkable series of papers published over the past several years in the world's foremost scientific *Journals*—*Nature*, *Science*, and *Annual Review of Nuclear Science*, among others. Nor has this assault upon orthodoxy elicited a vigorous counterattack: the research results published to date have been so cautiously and capably elaborated, and evidence so thoroughly piled upon evidence, as to forestall any outcry by those whose scientific sensibility may have been outraged. While some investigators appear finally to be arming themselves for combat, the issue has not yet been joined.

It was over a decade ago that Robert V. Gentry, puzzling over questions about the Earth's age, directed his attention to an obscure and neglected class of minute discolorations in certain minerals. He has since examined more than 100,000 of these "radiohalos," and without doubt stands as the world's leading authority on the subject. As an assistant professor of physics at Columbia Union College (Takoma Park, Maryland), he has brought to bear upon the halos an array of sophisticated instrumentation such as few researchers ever have the privilege to wield. As a result, he has converted the entire field of radiohalo research into an exact science, transmuting the microscopic spheres of mystery into rich mines of exciting and challenging information.

**RADIOACTIVE HALO (or RADIOHALO):** "In some thin samples of certain minerals, notably mica, there can be observed tiny aureoles of discoloration which, on microscopic examination, prove to be concentric dark and light circles with diameters between about 10 and 40mm [one micrometer is one-millionth of a meter] and centered on a tiny inclusion. The origin of these halos (first reported between 1880 and 1890) was a mystery until the discovery of radioactivity and its powers of coloration; in 1907 Joly and Muggge independently suggested that the central inclusion was radioactive and that the alpha-emissions from it produced the concentric shells of coloration... halos command attention because they are an integral record of radioactive decay in minerals that constitute the most ancient rocks" (1).

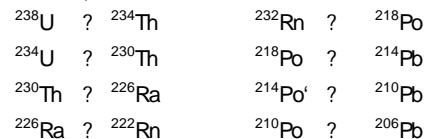
## Glossary of Technical Terms



A parent radioactive atom decays into a daughter atom in various ways, one of which is by the emission of an alpha particle from the parent atom's nucleus. Numerous types of radioactive atoms occur in nature, but only three are the initiators of a decay series: uranium-238 ( $^{238}\text{U}$ ); uranium-235 ( $^{235}\text{U}$ ); and thorium-232 ( $^{232}\text{Th}$ ).

(The numerical superscript signifies how heavy the element is. Isotopes of the same element have different weights but nearly identical chemical behavior—as for example ( $^{238}\text{U}$ ) and ( $^{235}\text{U}$ ). An alpha particle has a weight of 4.)

Each of the three decay-series initiators decays, by a chain of steps, into lead. For example, the alpha-decay steps in the  $^{238}\text{U}$  series are the following (steps not involving alpha-decay are not shown here):



Similarly,  $^{235}\text{U}$  decays by a different series of steps to  $^{207}\text{Pb}$ , and  $^{232}\text{Th}$  decays to  $^{208}\text{Pb}$ . Note that while all the series end up with lead, each one results in a different isotope of lead.

The half-life of a given type of radioactive atom is the time during which half the atoms in any collection will decay. The half-life of  $^{238}\text{U}$  is  $4\frac{1}{2}$  billion years. Half-life, decay rate, and decay Constant are closely related quantities. If we assume that the decay rate has not changed over geologic time\*, and if we measure 1) how much of a parent in a rock has decayed into its daughter; and 2) the current rate of this decay, then we can, it is generally believed, assess the date when the parent was incorporated into the rock—that is, the date when the rock was formed. In the case of Earth's oldest rocks, this date (some  $3\frac{1}{2}$  billion years ago) is thought to be the time when the molten Earth first cooled down sufficiently for rocks to solidify from the primordial magma.

\*Numerous other assumptions and technicalities also come into play.

\*This renewal is based upon a series of telephone interviews with Robert V. Gentry, as well as the available technical literature.

Gentry's studies have led him to the following conclusions:

1) Some halos ("polonium" halos) imply a nearly instantaneous crystallization of Earth's primordial rocks: and this crystallization must have occurred simultaneously with the synthesis/creation of certain elements.

2) Some halos correspond to types of radioactivity are unknown today.

3) Whereas radiohalos have been thought to afford the strongest evidence for unchanging radioactive decay rates throughout geological time (and these rates enable scientists to determine rock ages), in actuality the overall evidence from halos requires us to question the entire radioactive dating procedure: something appears to have disrupted the radioactive clocks in the past.

4) Halos in coal-bearing formations that are conventionally thought to be 100 to 200 million years old suggest these strata to be only several thousand years old. Further, the time required for coal formation is much less than previously thought.

5) Taken together, these conclusions point to one or more great "singularities" in Earth's past—events or processes that are discontinuous with the rest of history, unique occurrences that critically affect the data we now have. If we attempt to interpret these data solely in terms of current processes, we go astray.

In this report we will discuss only those researches leading to conclusion (1), reserving the rest for a subsequent report.

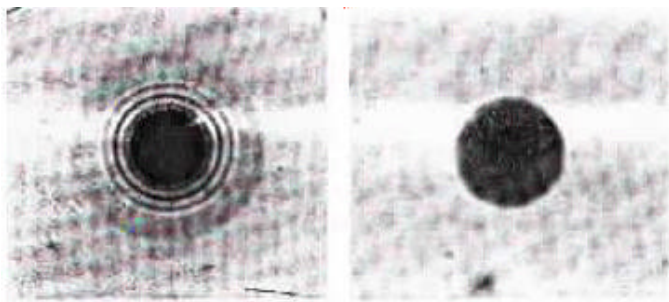
chaos, and makes it possible to extend currently reigning theories as far as they can bear before replacing them with other theories yet more embracing. A successfully modified, "tested" theory is preferable to a new "untried" theory. And so scientific knowledge advances in an orderly fashion, with as few wrong turns as possible.\*

Gentry has so far avoided clashing with this conservatism, chiefly by concentrating his efforts on publication of data rather than discussion of their implications—and also by the good fortune that his work has been slow to draw widespread attention. That is beginning to change, however. But perhaps the reaction of a number of prominent physicists to Gentry's work on polonium halos (see insets on this and the following page) is the most significant gauge of

## THE CONSERVATISM OF SCIENCE

Many have noted a conservatism in science essential to its orderly advance: skepticism toward radically new ideas enables scientific journals to retain focus, prevents anarchic descent into theoretical

*\*This conservatism—and its deceptive advantages—will receive continuing discussion in these newsletters.*



*A uranium-238 halo (left) and a polonium-210 halo in biotite. Scale is 1 cm equivalent to 45 m m.*

As we will learn in a subsequent review, the evidence from halos has led Gentry in a direction quite opposite from Struve's. But more than that, Gentry's halo research appears to strike at the roots of virtually all contemporary cosmologies, posing a fundamental problem which has so far resisted every effort to solve it in conventional terms. This is the problem of the polonium halos.

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## Comments by Leading Scientists

*Before the demise of the journal, Pensée, the editor—in preparation for a planned article on Gentry's work—approached a number of leading scientists for their assessment of polonium halos. The following responses were received during the first month or so of 1975.*

**PROFESSOR TRUMAN P. KOHMAN**, Department of Chemistry, Carnegie-Mellon University, Pittsburgh. "I do not believe that 'Gentry's contentions' can be regarded as of 'rather startling nature.' However, some of his experimental findings (like those of his predecessors) are quite difficult to understand, and the ultimate explanations could be interesting and even surprising. Many persons probably do not take them seriously, believing either that there is something wrong with the reported findings or that the explanations are to be found in simple phenomena which have been overlooked or discarded. . . . I believe it can be said that Gentry is honest and sincere, and that his scientific work is good and correctly reported. It would be very hard to believe that all, or any, of it could have been fabricated

**PROFESSOR EDWARD ANDERS**, Enrico Fermi Institute, University of Chicago. "His [Gentry's] conclusions are startling and shake the very foundations of radiochemistry and geochemistry. Yet he has been so meticulous in his experimental work, and so restrained in his interpretations, that most people take his work seriously. . . . I think most people believe, as I do, that some unspectacular explanation will eventually be found for the anomalous halos and that orthodoxy will turn out to be right after all. Meanwhile, Gentry should be encouraged to keep rattling this skeleton in our closet for all it is worth."

**PROFESSOR EUGENE P. WIGNER**, Department of Physics, Rockefeller University, New York. "Even though I know Dr. Gentry personally, I am not sufficiently familiar with his scientific results to be able to judge them. Personally, however, I have a very high regard for him."

**DR. EMILIO SEGRE**, Istituto Di Fisica "Guglielmo Marconi," University Degli Studi, Rome. "The photos [of radiohalos] are remarkable, but their interpretation is still uncertain."

**PROFESSOR FREEMAN DYSON**, Institute for Advanced Study, Princeton. "Supposing that the results of Gentry are confirmed, what will it mean for theory? I do not think it will mean any radical changes in geology or cosmology. It is much more likely that the explanation will be some tricky point in nuclear physics or nuclear chemistry that the experts have overlooked. That is of course only my personal opinion and I am accustomed to being proved wrong by events. (I just lost a \$10 bet that Nixon would be in office till the end of 1974. I will be glad to lose this one too.)"

**DR. PAUL RAMDOHR**, Emeritus Professor of Mineralogy, Heidelberg University, Heidelberg. "The very careful and timetaking examinations of Dr. Gentry are indeed very interesting and extremely difficult to explain. But I think there is no need to doubt 'currently accepted cosmological models of Earth formation'. Anyhow, there is a very interesting and essential question and you could discuss it, perhaps with cautious restrictions against so weighty statements like the one above in quotes. It would be interesting and good if more scientists would have more knowledge of the problems."

**ACADEMICIAN G. N. FLEROV**, Joint Institute for Nuclear Research, Moscow. "We made sure that [Gentry] carried out his investigations very thoroughly. . . . Therefore his data deserve serious attention. . . . It is not excluded that [polonium halos] have been formed as a result of the extremely rare combination of geochemical, geological and other conditions, and their existence does not contradict the logically grounded system of concepts involved in the history of Earth formation."

**DR. E. H. TAYLOR**, Chemistry Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee. "I can attest to the thoroughness, care and effort which Gentry puts into his work. In a general way these puzzling pieces of information might result from unsuspected species or phenomena in nuclear physics, from unusual geological or geochemical processes, or even from cosmological phenomena. Or they (or one of them) might arise from some unsuspected, trivial and uninteresting cause. All that one can say is that they do present a puzzle (or several puzzles) and that there is some reasonable probability that the answer will be scientifically interesting."

## POLONIUM HALOS

The last three alpha decay steps in the uranium-238 decay series (see glossary above) involve the successive decay of polonium-218 ( $^{218}\text{Po}$ ), polonium-214 ( $^{214}\text{Po}$ ), and polonium-210 ( $^{210}\text{Po}$ ). In contrast to the decay of the parent uranium, these steps occur very quickly; the half-lives of the three forms of polonium are 3.05 minutes, 164 microseconds, and 140 days, respectively. Polonium, therefore, is not thought to be observed in nature except as a daughter product of uranium and thorium decay.

That is where the enigma begins. For Gentry has analyzed numerous polonium halos possessing, in some cases, the rings for all three polonium isotopes; in other cases the rings for  $^{214}\text{Po}$  and  $^{210}\text{Po}$ ; and in other cases, the ring for 210 alone— *but none of these halos exhibits rings for the earlier uranium-238 daughters*. These halos are evidence for parentless polonium, not derived from uranium.\*

But the question then arises, How did the polonium inclusions ever become embedded in the host rocks (more specifically, in Earth's oldest—Precambrian—rocks)? On the conventional view, these rocks slowly cooled and crystallized out of the primordial magma (molten rock) over millions of years. Under such circumstances, any polonium (with its extremely short half life) that was incorporated into the solidifying rocks would have completely decayed long before the crystalline rock structure was established. No halos could have formed, for they consist precisely of radiation damage to this crystalline structure. Polonium rings should exist only *in conjunction with* the other uranium series rings. But since the actual halos were caused by parentless polonium, they require nearly instantaneous crystallization of the rocks, simultaneously with the synthesis or creation of the polonium atoms.

Gentry, well aware that this conclusion is unthinkable to most, has buttressed it with impressive experimentation: fission track and neutron flux techniques (3) reveal no uranium in the inclusions that could have given rise to the polonium—a conclusion more recently confirmed by electron microscope x-ray fluorescence spectra (4); fossil alpha recoil analysis (3) demonstrates that neither polonium nor other daughter products migrated from neighboring uranium sources in the rock, which agrees with calculations based on diffusion rates (5); ion microprobe mass spectrometry yields extraordinarily high  $^{206}\text{Pb}/^{207}\text{Pb}$  isotope ratios that are wholly inconsistent with normal decay nodes (6), but which are exactly what one would expect as a result of polonium decay in the absence of uranium.

To date there has been only one effort (7) to dispute Gentry's identification of polonium halos. As it turned out (4), that effort might better never have been written, the authors having been impelled more by the worry that polonium halos "would cause apparently insuperable geological problems," than by a thorough grasp of the evidences. Challenges to Gentry's interpretation of the polonium halos have been more noteworthy. English physicist J. H. Fremlin wrote in *Nature* (November 20, 1975) that "The nuclear geophysical enigma of the  $^{310}\text{Po}$  halos is quite fascinating, but the explanation put forward . . .

is not easy either to understand or to believe." Fremlin proposed two possible explanations:

**Geologic transfer.** If there are uranium inclusions reasonably close to polonium halos, then it is possible that one or more of the uranium daughter products migrated from the uranium site to a new location, where subsequent decay gave rise to the polonium halo. Since the daughter products have much shorter half-lives than uranium, we would not expect to find any quantity of them remaining at the site of the halo. The polonium would therefore appear to be "parentless." The difficulty with this view is that transfer of uranium daughters in minerals occurs so slowly that the daughters would decay long before they could migrate any significant distance (3, 5).

If the sophisticated experimentation cited above proved telling against the transfer hypothesis, Gentry and several co-workers delivered a yet more conclusive blow in a very recent paper: polonium halos derived by geologic transfer from uranium sources have now actually been found in coalified wood deposits (8). Their presence here was to be expected: prior to coalification the wood was

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\*Gentry has also found halos with rings from polonium -218, -214, or -210, combined with a ring from polonium -212 which is in the thorium decay series. This last form of polonium is also parentless—that is, there are no halo rings for thorium itself or its other daughters.

**BREAKTHROUGH REPORT**

with primordial  $^{238}\text{U}$  and  $^{232}\text{Th}$  atoms. . . Carried to its ultimate conclusion, this means that polonium halos, of which there are estimated to be  $10^{15}$  [one million billion] in the Earth's basement granitic rocks, represent evidence of extinct natural radioactivity, and thus imply only a brief period between 'nucleosynthesis' [creation - of elements] and crystallization of the host rocks" 5).4

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