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Polonium Radiohalos: Still "A Very Tiny Mystery"

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It is now almost two decades since the then Assistant Chief Geologist of the US Geological Survey, Dr. G. Brent Dalrymple, described polonium radiohalos as "a very tiny mystery."[1] An expert geochronologist, Dalrymple was being cross-examined in the Federal District Court in Little Rock at the Arkansas "creation trial" of December 1981.

Radiohalos (or radioactive halos) are minute spherical zones of color or darkening surrounding tiny mineral crystals, all included in larger grains or crystals of host minerals in certain rocks. Alpha-particles produced by radioactive decay of U, Th, and their decay products in the tiny mineral inclusions penetrate the surrounding host minerals, damaging their crystal lattices and discoloring them. The distances traveled by the α-particles are related to their energies, and where the α-particles stop they do the most damage, leaving spherical shells of intense discoloration. Because the α-particles emitted by the radionuclides in the U and Th decay chains have different energies, it is therefore possible to identify which radionuclides were responsible for producing the radiohalos. The minerals containing these radiohalos are usually studied in thin sections, so the radiohalos are viewed in cross-sections and thus exhibit ring structures.

Radiohalos produced by the ^{238}U and ^{232}Th decay chains are thus easily explained. However, there are also radiohalos found that only exhibit rings produced by the three Po (polonium) radionuclides of the ^{238}U decay chain (Figure 1), and it is these Po radiohalos that are enigmatic.[3] Examination of the tiny central mineral inclusions (or radiocenters) in these Po radiohalos reveals that only the respective Po radionuclides were present at the time the Po radiohalos formed, but their half-lives are very short—^{218}Po (3.1 minutes), ^{214}Po (164 micro-seconds) and ^{210}Po (138 days). After 10 half-lives of decay the original quantities of radionuclides are essentially exhausted, so these Po radiohalos rings would seem to have formed very quickly, in approximately 31 minutes (^{218}Po), 1.64 milli-seconds (^{214}Po) and 1,380 days (^{210}Po).

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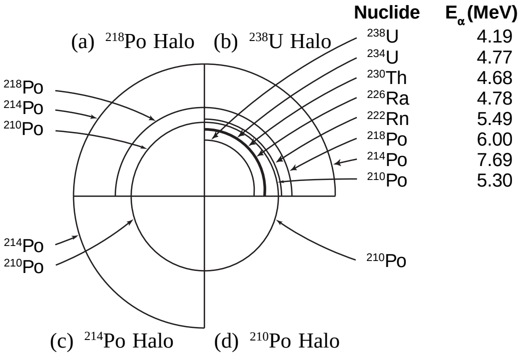

Figure 1. *Composite schematic drawing of (a) a ^{218}U halo, (b) a ^{238}U halo, (c) a ^{214}Po halo and (d) a ^{210}Po halo with radii proportional to the ranges of α-particles in air. The nuclides responsible for the α-particles and their energies are listed for the different halo rings [after Gentry[2]].*

Now these Po radiohalos have been found primarily in the mineral biotite, a mica—at 20 out of 22 reported localities.[4] The rocks hosting these Po-radiohalo-bearing biotites at 17 of the 20 localities are probably granites or granitic pegmatites. According to conventional uniformitarian geology, such granitic rocks formed over millions of years by cooling from hot magmas intruded into the upper levels of the earth's crust.[5] However, the radiohalos could only have formed after the biotites had crystallized around the tiny Po-bearing inclusions and cooled. Thus, assuming the Po was in the tiny inclusions when they first crystallized, it can be concluded that the biotites, and therefore the granites, had to crystallize and cool in less time than it would have taken for the Po radiohalo rings to form[6]—1.64 milli-seconds for the ^{214}Po radiohalo rings! If this implies that these granitic rocks were instantly created, then it is no wonder that the conventional geologist Dalrymple relegated Po radiohalos to being "a very tiny mystery"!

Of course, such incredible implications have not gone unopposed. Some observers have claimed that many Po radiohalos occur along cracks and cleavage planes in biotites, and that fluids may therefore have transported the Po into the biotites after the granitic rocks had formed.[7] In a relatively few instances this is obviously true, but only ^{210}Po radiohalos are found along such cracks, which are sometimes also bordered by discoloration with a width equivalent to the ring diameter of ^{210}Po. This implies that only the longer-lived ^{210}Po was transported in the fluids. Secondary ^{210}Po radiohalos have also been found in coalified wood associated with sandstone-hosted U orebodies formed by groundwater flow.[8] The Po was concentrated from the U-transporting fluids into the Se-rich radiocenters because of the geochemical affinity of Po with Se.

Critics also point to the apparent association between the occurrence of Po radiohalos and concentrations of U—16 out of 20 Po-radiohalo-bearing biotite localities have reported U in the rock or in an orebody.[9] Thus it has been suggested that the fluids responsible for concentrating the U may have also transported the Po and concentrated it in the tiny radiocenters. ^{210}Po is present in groundwaters,[10] and in volcanic gases[11] and fluids,[12] and has been reported in submarine hydrothermal vent fluids and chimney deposits on the East Pacific Rise,[13] where the ^{210}Po appears to have been transported over distances of up to several kilometers in 20–30 days.

However, if Po radiohalos formed secondarily from fluid-transported U-decay products, the expected amounts of the ^{218}Po, ^{214}Po and ^{210}Po radiohalos would be directly proportional to their different half-lives.[14] Thus, for example, there should be 67,000 ^{210}Po radiohalos for each ^{218}Po radiohalo. Yet in a Norwegian biotite there are more than 1,000 ^{210}Po radiohalos, 90 ^{218}Po radiohalos and only one ^{214}Po radiohalo,[15] but in other biotites the abundance ratios are ^{218}Po>^{210}Po>^{214}Po, and even ^{214}Po>^{218}Po or ^{210}Po.[16] Also, there may be as many as 20,000–30,000 ^{218}Po and ^{210}Po radiohalos per cubic centimeter,[17] or 5,000–10,000 ^{218}Po and ^{214}Po radiohalos per cubic centimeter.[18] The seeming impossibility of this secondary transport explanation is highlighted by the fact that the 5 x 10^9 atoms of ^{218}Po initially needed to produce each very dark ^{218}Po radiohalo had to be concentrated in the tiny radiocenters in less than the ^{218}Po's three minute half-life.[19] But experimentally-measured diffusion rates are just too slow,[20] and close to radiocenters there is no large excess of a-recoil tracks left by decay of the fluid-transported Po and Po-precursors.[21]

Another puzzle is that at five of the 20 Po-radiohalo-bearing biotite localities the host granitic rocks intrude apparently older rocks arguably produced during the Flood.[22] If these granitic rocks therefore also formed during the Flood, then how were the Po radiohalos produced in them? On the other hand, most of the Po radiohalos occur in Precambrian granitic rocks, many of which might be related to the events of the Creation Week, as might the one occurrence of Po radiohalos in a Precambrian high-grade metamorphic rock.

Thus the Po radiohalos still remain "a very tiny mystery." There can be no doubt, though, that they are significant as clues for unraveling earth history within the Biblical framework, so further research is warranted. If the Po radiohalos are indeed "fingerprints of creation," [23] then they provide the means of identifying Creation Week rocks. Similarly, they may indicate accelerated radioactive decay in the past and/or suspension of normal geological processes and process rates, including fluid transport, during the Flood. Whatever these Po radiohalos are "telling us," we are only going to find out by further "reading the rocks" to seek a better understanding of the geological distribution and occurrences of these Po radiohalos at both known and new localities. Such research is now being pursued.[24]

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