Helium in Rocks and in the Atmosphere

Uranium and thorium contained in rocks and minerals generate helium atoms as they are transformed by radioactive decay to lead. Helium is the second lightest element and is a noble gas, which means its atoms do not bond with atoms of other elements. So the small helium atoms in rocks and minerals easily fit between the atoms in crystal lattices and diffuse (leak) out of, and so escape from, the minerals and rocks. The hotter the rocks, the faster the helium escapes, and the deeper one goes into the earth, the hotter the rocks.

In a study of a deep, hot Precambrian granitic rock, drilled for potential geothermal energy, it was found that zircon crystals that contained uranium also contained large amounts of helium.[6] Even the deepest and hottest zircons (at 197°C or 387°F) contained far more helium in them than expected, given the uranium-lead radioisotope "age" for the zircon crystals of 1.5 billion years. At the time of that study, no experimental measurements of the leakage or diffusion rate of helium from zircons was available. But it was still possible to calculate that in some of the zircon crystals, up to 58 percent of the helium that would have been generated from uranium decay over 1.5 billion years was still present in them.

Now several experimental determinations of the helium leakage (diffusion) rate from zircons of several different rock units, including this Precambrian granitic rock, are available and are in agreement.[7] These experimental measurements all showed that helium diffuses so rapidly out of zircon crystals that it should have all but disappeared after about 100,000 years. Because the uranium-lead radioisotope decay system indicates that originally there would have been 1.5 billion years worth of helium generated in these zircon crystals, the amounts of helium left in them should have long since leaked out. The measured amounts of retained helium in these zircon crystals, combined with the measured diffusion rate of helium from zircon, can be used to calculate their helium diffusion age. Indeed, there is so much helium still left in these zircons that based on the measured rate of helium diffusion from zircons, these zircon crystals have an average helium diffusion age of only 6,000 (±2,000) years.

Helium starts diffusing out of zircon crystals as soon as it is produced by

6 R. V. Gentry, G. L. Glish and E. H. McBay, 1982, Differential helium retention in zircons: Implications for nuclear waste containment, *Geophysical Research Letters*, 9 (10): 1129-1130.

7 S. W. Reiners, K. A. Farley and H. J. Hicks, 2002, He diffusion and (U-Th)/He thermochronometry of zircon: Initial results from Fish Canyon Tuff and Gold Butte, Nevada, *Tectonophysics*, 349 (1-4): 297-308; D. R. Humphreys, S. A. Austin, J. R. Baumgardner and A. A. Snelling, 2003, Helium diffusion rates support accelerated nuclear decay, in *Fifth International Conference on Creationism*, R. L. Ivey Jr., ed., Pittsburgh, PA: Creation Science Fellowship, 175-196; D. R. Humphreys, 2005, Young helium diffusion age of zircons supports accelerated nuclear decay, in *Radioisotopes and the Age of the Earth: Results of a Young-Earth Creationist Research Initiative*, L. Vardiman, A. A. Snelling and E. F. Chaffin, eds., El Cajon, CA: Institute for Creation Research and Chino Valley, AZ: Creation Research Society, 25-100.

169669 ICR - Circle Folio 433 - 11/13/2009 - 14:13:13

radioactive decay. Therefore, the radioactive decay that produced the helium must have occurred within that timeframe of only about 6,000 years. Yet measurements of the uranium-lead radioisotope system in these same zircons indicate that 1.5-billion-years worth of uranium decay has occurred in these zircons. How then could 1.5 billion years worth of helium have been produced and accumulated in so little time? The best answer is that at some time in the recent past there had to have been an episode (or episodes) of grossly accelerated nuclear decay in which the radioactive decay timescale was enormously compressed, from 1.5 billion radioisotope years into 6,000 years of real time. Within the biblical framework for earth history, such an episode of accelerated nuclear decay logically occurred during Creation Week, during the year-long Flood cataclysm, or more likely both, when geological processes were also occurring at catastrophic rates.

Because this contradiction is so glaring and devastating to the uniformitarian long-ages timescale, attempts have been made to discredit this evidence. For example, it has been suggested that perhaps helium has instead diffused into the zircon crystals from outside sources, thus giving them this incorrect young diffusion age. However, such criticism ignores the experimental measurements of the helium concentration in the biotite flakes in which the zircon crystals were embedded.[8] The helium concentration in biotite flakes was actually much lower than the helium concentration in the zircon crystals, which means that according to the well-known fundamental diffusion law, the helium would have been diffusing from the higher concentration in the zircon crystals out into the lower concentration in the surrounding biotite flakes. In fact, the amount of helium in the biotite flakes was found to be exactly equivalent to the amount of helium that has leaked out of the zircon crystals. So any and every external source of helium cannot rescue the uniformitarian timescale, because the experimental evidence demonstrates conclusively that the helium generated by uranium decay in the zircon has been diffusing out into the surrounding biotite flakes in only about 6,000 years.

Another critic has suggested that there could have been resistance to the diffusion of helium out of the zircon crystals at the boundary or interface between the zircon crystals and the surrounding biotite flakes. This resistance would stop the helium from diffusing out of the zircon crystals and cause the retention of anomalous high helium concentrations. However, this desperate postulation was also easily refuted, because the zircon crystals are always found sitting in between the parallel stacked sheets that make up the biotite flakes. Therefore, there is an intrinsic weakness within the biotite flakes that would have in fact made it easier for the helium to leak out of the zircon crystals between the biotite sheets into the biotite flakes. Thus, all available evidence confirms that the true age of the zircon crystals, and the granitic rock containing them, is not 1.5 billion years, but only 6,000±2,000 years.

8 D. R. Humphreys, S. A. Austin, J. R. Baumgardner and A. A. Snelling, 2004, Helium diffusion age of 6000 years supports accelerated nuclear decay, *Creation Research Society Quarterly*, 41 (1): 1-16; D. R. Humphreys, 2005.

169669 ICR - Circle Folio 434 - 11/13/2009 - 14:13:13

The net result of the helium leakage from minerals and rocks is that ultimately this radiogenic helium (helium produced by radioactive decay) diffuses through the earth's crust to the earth's surface and leaks out into the atmosphere. More than 50 years ago, it was realized that there is not nearly enough helium in the atmosphere to correspond to the supposed age of the earth, and to the rate at which helium is escaping from crustal rocks into the atmosphere.[9] Indeed, it was in 1957 that the problem with helium in the atmosphere was forcefully brought to the attention of the scientific community. Estimates of the leakage rate of helium from crustal rocks into the atmosphere and the helium content of the atmosphere were highlighted, and then contrasted with the resultant question: "Where is the earth's radiogenic helium?"[10] In answer to the question, it was stated that the helium problem "… leads…to an 'anomalous' atmospheric chronometry."

Here then is the helium problem. The measured flux, or rate of introduction, of helium from the crust of the earth into the atmosphere is estimated to be 2×10^6 atoms per cm^2 per second (13 million helium atoms per square inch each second).[11] On the other hand, the estimated flux, or theoretical rate of escape, of helium from the atmosphere to space due to thermal escape is 5×10^4 atoms per cm^2 per second (about 0.3 million atoms per square inch each second). Other escape mechanisms such as the polar wind, solar wind sweeping, and hot-ion exchange have not been found to be important contributors to the loss of helium in space. Therefore, the helium in the atmosphere has been accumulating at a very rapid rate. The current measured column density of helium in the atmosphere is 1.1×10^{20} atoms per cm^2. If the earth's atmosphere had no helium when it formed, and the helium accumulated in the atmosphere at the current estimated rate, then the present density of helium in the atmosphere would have accumulated in less than only 1.8 million years. Of course, this is not to say that this is the age of the earth's atmosphere, but 1.8 million years is more than 2,500 times shorter than the presumed age of the earth of more than 4.5 billion years. Consequently, long-age atmospheric physicists admit that "…there appears to be a problem with the helium budget of the atmosphere,"[12] and that this helium escape problem "…will not go away, and it is unsolved."[13]

This estimate of less than only 1.8 million years for the atmosphere's helium to accumulate is, of course, based on the assumption that the earth's atmosphere contained no helium at its beginning. The second assumption is that the helium flux from the crustal rocks into the atmosphere has always been the same throughout

9 G. E. Hutchinson, 1947, Marginalia, *American Scientist*, 35: 118.

10 M. A. Cook, 1957, Where is the earth's radiogenic helium? *Nature*, 179 (4557): 213.

11 L. Vardiman, 1990, *The Age of the Earth's Atmosphere: A Study of the Helium Flux through the Atmosphere*, El Cajon, CA: Institute for Creation Research.

12 J. C. G. Walker, 1977, *Evolution of the Atmosphere*, London: McMillan.

13 J. W. Chamberlain and D. M. Hunten, 1987, *Theory of Planetary Atmospheres*, second edition, London: Academic Press.

169669 ICR - Circle Folio 435 - 11/13/2009 - 14:13:13

the earth's history. However, neither of these assumptions would be valid within the biblical framework of earth history. First, at the creation of the earth it is likely that God created the atmosphere with some helium in it, along with all the other atmospheric gases, because the helium in the atmosphere does serve a useful purpose. Second, and more importantly, as a result of the catastrophic geologic processes operating during the year-long Flood cataclysm, including accelerated nuclear decay that would have produced more helium at an accelerated rate, the rate of helium flux from crustal rocks into the atmosphere would have been far greater than at present. Thus, as a result of these two considerations, the time for the accumulation of the atmosphere's current helium content would have been much less than the estimated 1.8 million years. Therefore, the helium in the atmosphere is completely consistent with the earth and its atmosphere only being 6,000-7,000 years old, rather than the age of 4.5 billion years claimed by uniformitarians.

Two final considerations are worth noting. First, the usual method used by old-earth advocates, to avoid this helium evidence for a young atmosphere and earth, is to assume that the enormous quantities of helium generated during past eons somehow attained the required escape velocity, overcame gravity, and escaped from the atmosphere completely into space.[14] However, this requires temperatures in the outermost portion of the atmosphere that are extremely high, much higher than those required for all the necessary helium to reach escape velocity. Second, making this helium problem worse for uniformitarians is the discovery that there are large volumes of helium in the earth's crust that have not been derived by radioactive decay, but instead are considered primordial, that is, they have been present inside the earth since its beginning.[15] This means there is even more helium to escape through the earth's crustal rocks into the atmosphere than just the helium that has been generated by radioactive decay. It also means that if the earth is 4.5 billion years old there has been even more helium that has needed to escape into outer space from the earth's atmosphere by this postulated heating in the outermost atmosphere. On the contrary, the presence of this primordial helium only serves to suggest that the maximum age of the atmosphere measured by helium accumulation is much less than the calculated 1.8 million years.

14 L. Spitzer, 1949, The terrestrial atmosphere above 300km, in *The Atmospheres of the Earth and Planets*, G. P. Kuiper, ed., Chicago: University of Chicago Press, 211-247; D. M. Hunten, 1973, The escape of light gases from planetary atmospheres, *Journal of the Atmospheric Sciences*, 30: 1481-1494.

15 H. Craig and J. E. Lupton, 1976, Primordial neon, helium and hydrogen in oceanic basalts, *Earth and Planetary Science Letters*, 31: 369-385.

169669 ICR - Circle Folio 436 - 11/13/2009 - 14:13:13