Helium and Deep Time

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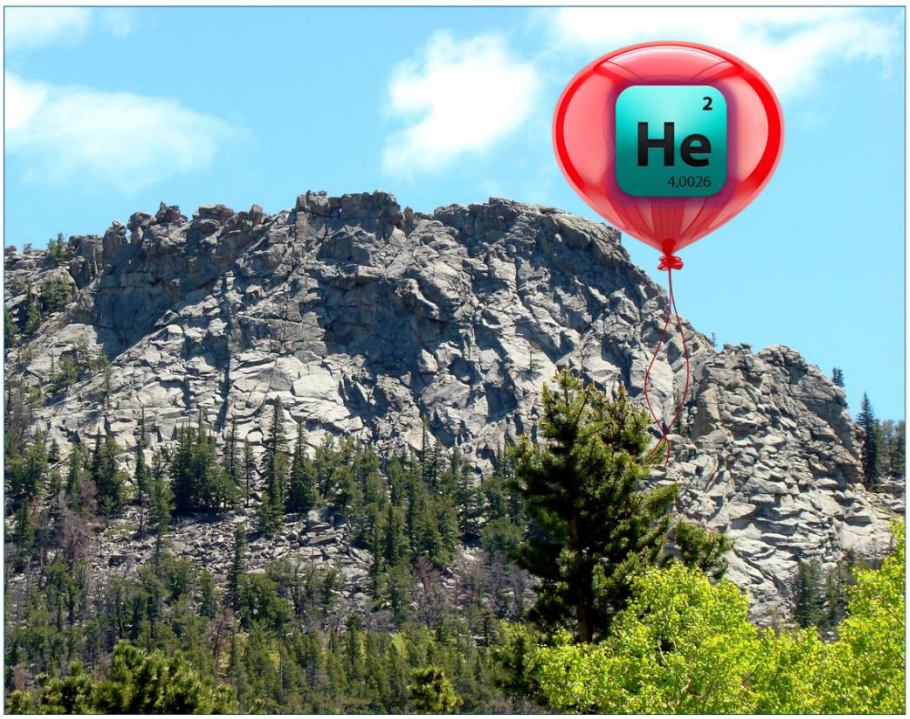

Are there "incontrovertible" reasons to affirm a young Earth? What does it mean to be incontrovertible? Some YEC seem to believe that this means that it is claimed by any YEC author that they appreciate. It is easy to list claims that might sound impressive. What happens if we dig into those claims? Can they stand up to analysis?

Helium is known as a "noble" gas. It is light and doesn't really chemically interact with other elements or compounds. You are probably familiar with the floating of helium ballons. Why do we even have it on Earth? Why hasn't it all just floated away. Scientists believe that it is being constantly formed by radiometric decay or elements like uranium, thorium, and some potassium often found in igneous rocks like granite. Some YEC claim that this process is to slow to account for the concentration found in some places. This is another one the "incontrovertible" evidences from Paul Humber's "Reasons to Affirm a Young Earth". (Humber 2013)

The reason given in this case is:

21. Helium Challenges Goliath

The reason was stated this way:

"Helium in deep granite challenges the conventional radiometric dating of rocks. Its leak-rate from zircon crystals points to an earth only thousands of years old, not billions. The nuclear decay products in the very same rock, therefore, must have devolved much more rapidly than conventionally assumed." (Humber 2013)

Origin of this reason:

Dr. Russell Humphreys and the YEC R.A.T.E. study (Radioisotopes and the Age of The Earth) had cores from near Los Alamos, New Mexico identified as from the **Jemez Granodiorite** processed and analyzed for radiometric measurements. The R.A.T.E. study was a well-funded study by top YEC geoscientists that set out to prove a young Earth and to support flood geology. Its RATE1 results were published in 2000. (Vardiman, Snelling, and Chaffin 2000)

Here are some key points from Humphreys' paper: (Humphreys 2005)

1. Uranium/Lead dating confirmed. Their analysis gave equivalent numbers to the accepted age of approximately 1.5 billion years. This points out that the R.A.T.E. recognized that this decay occurred, regardless of how much time it represents.

2. Significant amounts of radiometric helium (He4) are present.

    a. Everyone recognizes that helium escapes or diffuses from zircon and other minerals with uranium in them, such as are present in granites and granodiorites. Everyone agrees that the rate of diffusion increases as the temperature increases and Humphreys' data confirms this.

    b. Humphreys interprets his data as indicating that the amount of helium present in zircons should have diffused away if it had been generated over 1.5 billion years, the age that uranium-lead radiometric dating indicates for the rocks.

Humber and Humphrey propose that the helium in the zircons prove that the rocks are not as old as the uranium-lead data and in fact are actually consistent with an age of about

6,000 years. In order to make this case, they try to make the case that no alternative explanation could explain the concentration of helium in the zircons. If a reasonable alterative is found, then this reason would fail.

It is probably worth pointing out that I am not a nuclear physicist. My only nuclear physics class was a long time ago and it did not deal much with radiometric dating. Nevertheless, I can read the reports and try to assess the conclusions.

Here are some observations that I think are relevant:

- The cores are from a supervolcano with a very complex geologic history. (Budge 2014)
- Anomalously high helium concentrations are present in New Mexico, though not at the economic concentrations that are found in the Panhandle of Texas. (Lang et al. 2024)
- Helium measurements in zircon (and apatite, if available) are considered useful in reconstructing the thermal history of an area, not age dating. (Reiners 2005) The mobility or diffusion of helium means that there is always some loss of helium. Helium loss is sensitive to the temperature and pressure history of the minerals. As a result, an age calculated must be considered a minimum age estimate.
- Helium concentration varies widely within zircons from a single area (Zhang et al. 2020). It will be highest in areas within the crystals that have more uranium. The main reservoirs in crystals are fluid inclusions. We don't know how common they were in the zircons that were tested or what type of fracturing may have been present.
- Helium diffusion is not considered anomalous in other parts of the world but considered consistent with uranium dating. (Zhang et al. 2020)
- While Humphreys (and his colleague, John Baumgardner who actually selected the samples from the core), characterized the cores as all basically the same granodiorite, apparently consistent with the early descriptions of the cores, later more detailed work describes the cored interval as metamorphic rocks, gneisses and schists, and some granodiorites. (Henke 2010) Variability in the types of rocks sampled raises questions about the validity of the work.

Are there alternative ways to look at the data? Humphreys prepared a comparison to what he claims is the Jemez data analyzed from an old earth perspective. This is important because if the data fits reasonably well with an old earth model, then at most Humphreys data could be said to

show an alternative that would explain how some radiometric data could be modeled to fit a young earth model. It could not be said in any way to prove a young Earth.

Gary Loechelt's 2008 article, "Fenton Hill Revisited: The Retention of Helium in Zircons and the Case for Accelerated Nuclear Decay" provides a careful look at Humphrey's work. (Loechelt 2008) Although one can question the way the RATE team chose the samples and had them prepared, Loechelt focuses on 5 particular errors in the analysis of the data. One of the most significant of these regards the way Humphreys' old earth model handled the temperature history of the core. This is very important because as noted earlier, all recognize that helium diffusion is partly a function of the temperature of the zircons. Attached is Loechelt's figure showing with an orange line what Humphrey's assumed as an actual old earth model of what the temperature history was (**Figure 1**). Loechelt demonstrated that when this factor and the other errors in Humphreys' work are corrected, the old earth model matches the actual zircon data, while the proposal from Humphreys fails. Humphreys' old earth model is basically a strawman that does not represent a real assessment from geology.

Humphreys has responded to Loechelt but not in a forum that I have access to.

Loechelt wrote in his conclusions:

"This paper provides an answer to the RATE research at Fenton Hill. Not only does it expose the technical flaws in the RATE study, it also demonstrates that a model consistent with a conventional geologic framework can account for the observed amount of helium contained within these zircon crystals. Accelerated nuclear decay is not required to explain any of the observed phenomena. Rather, through careful attention to details and by applying rigorous mathematical methods, an alternative was found without invoking any exotic physics."

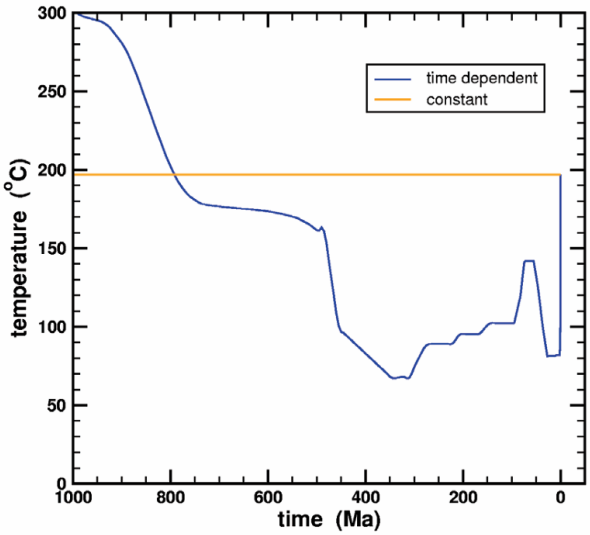

Figure 3. Comparison of the constant temperature profile used in the RATE uniformitarian model to a realistic time dependent profile for a well depth of 2900 m. The time convention uses zero for the present age and positive numbers for time before present.

***Figure 1**. from Loechelt (2000) showing that Humphrey's assumption of a constant temperature does not at all represent a geologic understanding. The much lower temperatures of the geologic model would mean that helium would have been retained to much higher levels.*

Regardless of the validity of Humphreys' model, a model that is at best questionable, it is true that an old earth model has been shown that explains the helium content. **Helium in zircon cannot be considered evidence for the accelerated radioactive decay that the RATE study used as their only explanation for all of the radiometric decay that is documented around the world.**

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Discussion:

Michael J Findley

All-star contributor

"Helium diffuses so rapidly that all the helium should have leaked out in less than 100,000 years. So why are these rocks still full of helium atoms?"

https://answersingenesis.org/.../6-helium-in-radioactive.../

ANSWERSINGENESIS.ORG

Helium in Radioactive Rocks

Michael,

Snelling's little article didn't really address any of the problems that Loechelt raised. He simply spouts what the RATE study claimed. He says, "These experimentally determined and repeatable results, based on the well-understood physical process of diffusion, thus emphatically demonstrate that these zircons are only a few thousand years old. The supposed 1.5-billion-year age is based on the unverifiable assumptions of radioisotope dating that are radically wrong."

Loechelt (2020) points out that the RATE study is using the same experiments and similar assumptions:

"Before considering the implications of the low temperature diffusion mechanism on the helium retention ability of zircon samples in the field, a couple of points need to be emphasized in order to avoid potential misconceptions. First, strictly speaking, none of the laboratory experiments cited in the previous section actually measured the helium diffusivity. Diffusivity is not a directly accessible material parameter. One does not have a "diffusometer" that can be placed in a sample like a thermometer. Instead, the directly accessible measurable quantity is the amount of gas released at a given temperature over a given time. Inferring a diffusivity from this gas release requires a model built upon underlying assumptions. If the assumptions of that model are not met, then the number that is calculated is not representative of the actual diffusion kinetics, regardless of how accurately

the experiment was performed. This point should not be overlooked. Second, any inference regarding the ability of a rock or mineral sample to retain helium over time scales on the order of the age of Earth requires the extrapolation of these laboratory measurements over time and temperature, often by orders of magnitude. Consider a simple example. If one wants to definitely know by direct observation if a mineral sample can retain a certain amount of helium for 6,000 years, the experimenter would have to put that sample in a laboratory instrument and wait that long. Clearly this is not practical. At best, a typical step-wise heating diffusion experiment will run over the course of many hours or perhaps even a few days in some instances. The challenge is how to best use data that were acquired over a relatively short period of time in the laboratory to predict the behavior that is expected over a longer period of time in the field. For this reason, a solid theoretical understanding of the underlying diffusion mechanism is invaluable."

I did find that one of Snelling's references goes to an interesting interchange between Loechelt and Humphreys. https://creation.com/images/pdfs/tj/j24_3/j24_3_34-39.pdf

Again we see that Humphreys has not proven that he can explain the helium content in 4000 years. His extrapolation of the laboratory measurements over that period has many problems and he has not resolved those. My bigger concern is that he misrepresents the old Earth understanding of the area. He ignores much of the geologic interpretation of the temperature history. The uplifts recognized by geologists lowered the temperature for long periods of time. Humphreys never presents a temperature history chart over geologic time but does describe some points. I tried and it is attached below. He says that "Regardless of how low the temperatures might have been before the volcanic eruption, the broad maximum of 250°C, lasting for hundreds of millennia, would wipe out most of the helium that might have accumulated in the previous 1.5 Ga".

At best, one could say that if we accept his particular view of the thermal history and incorporated his flawed modeling, the helium would not have been preserved. If however we use a more detailed analysis, his analysis failed. Has he proven that the earth is young because there is no explanation for the helium saturations.... Not at all.

Kevin Nelstead

All-star contributor

Michael J Findley Why are these rocks so full of helium?

Contrary to the claims of YECs, helium diffusion from zircon crystals does not provide compelling evidence for a young Earth. There are several serious problems with the RATE study of helium diffusion. The one I will focus on is the thermal history model the RATE researchers used in their calculations.

Helium, being a chemically-inert substance, is not chemically bound to the ions in the zircon ($ZrSiO_4$) crystal structure. Instead, helium atoms are physically trapped in the zircon crystalline cage. The helium atoms vibrate within their crystalline cage, and sometimes they have enough kinetic energy to move from one location to the next within the crystal. Eventually the helium atoms find their way to the surface of the mineral grain and escape. This process of movement through and escape from the crystal is what we mean by diffusion. The higher the temperature, the more kinetic energy helium atoms have, and the faster they are able to move through the crystal lattice. Below a certain temperature (the closure temperature), helium atoms essentially become trapped within the zircon crystals and diffusion ceases.

The zircon crystals analyzed for helium diffusion in the RATE study are from geothermal research wells drilled near the Valles Caldera in New Mexico. This area has experienced recent volcanism, with numerous Quaternary (ice age) volcanic events, including a significant caldera ("supervolcano") eruption. Because of this volcanism, the subsurface geothermal gradient (the rate at which temperature increases as one goes deeper) is much steeper than in most continental areas. For most of geologic history, however, the area has been non-volcanic. We should assume, therefore, that for most of the history of these zircon samples, temperatures were lower than at present. This would be the case in YEC flood geology models (if we ignore heat from accelerated nuclear decay) as well as for standard old-Earth models.

One of the emphases of the RATE zircon helium diffusion study is that these zircons hold much more helium than they should if they are indeed 1.5 billion years old. They determined this by extrapolating present high subsurface temperatures into the past, and then calculating how much helium should be in the samples if they were indeed that old. For example, the present temperature in the geothermal wells at a depth of 2900 meters is 197°C. The RATE researchers are correct to say that at this temperature, there should be almost no helium in the zircon crystals after 1.5 billion years. The problem is not with their calculation, but with their assumption that went into their calculation. The available geological evidence tells us that while the local volcanic field has been active in the Quaternary Period, the area has been non-volcanic for most of its history. This means that the subsurface temperatures have been considerably lower for most of the geologic history of the zircon samples.

If one does the helium retention calculations using a more realistic thermal history model, the age of the zircon grains comes out to be in the hundreds of millions of years, not thousands.

The RATE researchers claimed that by using current subsurface temperatures and extrapolating them into the past, they were merely applying uniformitarianism. This demonstrates a

misunderstanding of how geologists apply uniformitarian principles. We can apply the present laws of God's creation to the past, but that does not mean we should blindly extend present conditions (such as the geothermal gradient in a volcanic field) back into the past. By using the values for subsurface temperatures that they used, the RATE researchers claimed they were being somehow generous to uniformitarianists, but in reality they were being generous to themselves.

Here is an assessment of RATE from a Christian source which goes into some of the other problems with the RATE analysis of helium diffusion: **https://www.asa3.org/ASA/education/origins/helium-gl3.pdf**

Zhang reported the following regarding helium generated from granites:

"Dividing the preserved He quantities by the generated He amounts, it turned out that less than 10% of He produced since the formation of the granite is preserved in the rock over geological time, suggesting that more than 90% generated He can be transferred to the Weihe Basin."

"Based on the approximate calculation formula proposed by Lagerwall and Zimen (1963), the time required for a grain to lose 90% of its He were calculated, which is 1 Ma for minerals under lower temperature (<150ºC) when the He diffusion coefficient is approximately 10-18 cm2/s, and is 0.001 year (8.64 h) for granite grains (r = ~100 μm) at 700ºC (Fig. 6), suggesting that He can be closed in minerals under lower temperatures but cannot be trapped under high temperature over geological time."

- Most

Many parts of the world report radiation damage where due to decay of radioactive minerals. No such damage is reported in the Jemez samples as for most granites. If there were accelerated by a billion times, as interpreted by the RATE study, why is this not ubiquitous through the rocks, including the Jemez Granodiorite..

Zhang's comment suggests that if the

Can this analysis be duplicated in some other granite? Has argon data been collected? (How much K-spar is present?)

Jemez http://jemez.kgbudge.com/

Humber's conclusion:

Oil found in reservoirs at high pressure demonstrates that they did not form millions of years ago. He says that they must have either 1) be still forming or 2) not have been there for "the supposed millions of years"

His claim doesn't really seem to be that the pressured reservoirs prove that the Earth is young but that they do not prove that the Earth is ancient, just as was the case for his point 18 on oil formation. In support of this, he offers the analogy of modern fire extinguishers. We all know that they do lose some pressure over time. Does this mean that hydrocarbon reservoirs cannot have formed over deep time?

Loechelt (2008c) is a detailed report that argues that Dr. Humphreys' claims and his underlying assumptions are oversimplistic, inconsistent and erroneous, and that Dr. Humphreys' helium diffusion data are actually consistent with a date of about 1.5 billion years for the Fenton Hill zircons.

Another hypothesis to explain the helium diffusion data. Subsurface pressures on Dr. Humphreys' and R. V. Gentry's zircons in the Fenton Hill cores would have been about 200 to 1,200 bars. If the defect curve in Dr. Humphreys' diffusion studies resulted from voids, fractures and other openings in the zircons, then some of these openings could have been at least partially closed under subsurface pressures. If the openings were substantially closed, the defect curve of Dr. Humphreys' zircons, which is used to support his young-Earth creation model, would have been lower, aligned more with the intrinsic curve, and perhaps even approached the diffusion results for Dr. Humphreys' strawperson uniformitarian model. The intrinsic curve would be less affected by pressure. Humphreys (2006) argues that zircon is too "hard" to have its helium diffusion affected by subsurface pressures. However, laboratory studies in Dunai and Roselieb (1996) show that under 250 bars of pressure and at temperatures as high as 700°C, helium would take tens to hundreds of millions of years to just partially diffuse out of garnet, a "hard" silicate mineral like zircon. Dr. Humphreys has the responsibility to evaluate any pressure effects on his "dating" scheme before he can proclaim that the Earth is only 6,000 years old, "accelerated" radioactive decay is factual and that all radiometric dating methods must be discarded. Even without pressure effects, the best available a, b, and Q/Q0 data show that the "creation dates" from the equations in Humphreys et al. (2003a) provide ridiculous answers that range from hundreds to over one million years (an average and two standard deviations of 90,000 ± 500,000 years old, using only one significant digit; see below for details).

Issues raised by Henke

- The old Earth multi-domain model from Loechelt (2008c) better explains helium diffusion in the Fenton Hill zircons than Dr. Humphreys' young Earth RATE model.
- Subsurface pressures on Dr. Humphreys' and R. V. Gentry's zircons in the Fenton Hill cores would have been about 200 to 1,200 bars. If the defect curve in Dr. Humphreys' diffusion studies resulted from voids, fractures and other openings in the zircons, then some of these openings could have been at least partially closed under subsurface pressures. If the

openings were substantially closed, the defect curve of Dr. Humphreys' zircons, which is used to support his young-Earth creation model, would have been lower, aligned more with the intrinsic curve, and perhaps even approached the diffusion results for Dr. Humphreys' strawperson uniformitarian model.

- The "dating" equations in Humphreys et al. (2003a) are clearly based on many questionable assumptions (including: isotropic helium diffusion in minerals, constant subsurface temperatures over time, ignoring the possibility of extraneous helium, etc.).
- Gneisses are not "Granites", "Granodiorites" or other Igneous Rocks
- Questionable sample processing.
- MYSTERIOUS MODIFICATIONS OF THE HELIUM (Q) MEASUREMENTS FROM GENTRY ET AL. (1982a): MORE QUESTIONS THAN ANSWERS
- Equations in Magomedov (1970) Definitely Indicate the Use of Natural Logs