Long-Age Isotope Dating Short on Credibility

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Some time ago I was reading that the earth is 4.55 billion years old and I asked myself *'How do we know it is that old?'*. I found the answer in the isotope dating literature. But what else I found there convinced me that we don't know that the world is 4.55 billion years old. See what you think!

THE ISOTOPE AGE OF THE EARTH

According to Faure,[1] the age of 4.55 billion years was established by Patterson in 1956. Faure reproduced Patterson's graph to illustrate his method — it was a straight line (called an isochron) with 5 dots on it. Patterson had analysed three stone and two iron meteorites for lead isotopes and compared them with one sample of oceanic sediment. The results all fell approximately on one straight line so Patterson concluded that the age of the earth was the same as that of the meteorites at 4.55 billion years. Faure said that subsequent work on meteorites had confirmed Patterson's result so he used 4.55 billion years as the value required to calibrate other methods in his book.

Faure noted also that subsequent research had found that

> *'deep sea sediment contains lead whose isotopic composition varies regionally and not all of them fit the meteorite isochron as well as the sample analyzed by Patterson.'*[2]

Yet instead of updating Patterson's estimate using the new data, Faure chose to use Patterson's original number knowing that it was incorrect. I wondered why?

I further discovered that not all of the subsequent research on meteorites confirmed Patterson's result. Gale, Arden and Hutchinson[3] obtained more data on meteorite lead isotope ratios and they found a very different picture to that indicated by Patterson's sample. When they applied the same reasoning used by Patterson they came up with a **negative** age for the earth! They criticised Patterson's approach as *'naive'* and claimed that

> *'the whole of the classical interpretation of the meteorite lead isotope data is in doubt, and the radiometric estimates of the age of the Earth are placed in jeopardy'.*

When I looked back at Faure's textbook I then realised why he did not update Patterson's estimate using the data acquired since 1956. Patterson's method had relied on the set of points all falling on the straight line but the later research showed points all over the place. It was impossible for Faure to update Patterson's estimate because the data do not fit his model.

When I spoke to a colleague about this he said

> *'Well there have been many other results that confirm 4.5 billion years as the right age so it doesn't matter if the original result was wrong'.*

So I began to look for some of this 'other' work.

THE MOST ANCIENT ROCKS ON EARTH

If the earth is 4.5 billion years old then the oldest rocks should have been dated at something less than but close to this number. Sure enough I found that the most ancient rock crystals are 4.3 billion years old and come from Jack Hills in Western Australia. Compston and Pidgeon[4] obtained 140 zircon crystals from a particular rock type and subjected them to uranium/uranium concordia (U/U) and uranium/thorium concordia (U/Th) dating methods. One crystal showed a U/U date of 4.3 billion years and the editors of **Nature**[5] hailed it as the oldest rock crystal yet discovered.

I read this paper with great interest but once again found serious problems in the method. To understand what they were we have to look at the rules of measurement and statistical inference.

THE RULES OF MEASUREMENT

Measurement and statistical inference work as follows:

(1) one or more objects are defined for study
(2) samples are taken according to a defined method
(3) measurements are made on the samples
(4) properties such as means and variances are calculated from the measurements
(5) these properties are related back to the object(s) according to the method of sampling and the laws of probability.

If we wanted to compare the tail lengths between dogs and cats, for example, it is crucial that we decide **before we measure** what we are measuring is the tail of a dog or the tail of a cat. If for some reason we forgot to record which number belonged to which animal then we could not do the comparison we set out to do. We could only calculate the average length of dog-and-cat tails using all our numbers put together.

It would certainly not be appropriate to decide afterwards, just by looking at the results, which number must have come from a dog and which number must have come from a cat. This is called posterior reasoning. It does have a place in some types of data analysis but if we are not careful it can lead us badly astray.

THE CONCORDIA METHOD

Now consider the steps of logic followed by Compston and Pidgeon. The objects they defined were zircons from a particular rock type. In their sample of 140 zircons they found some colour and shape variations but were unable to distinguish any sub-groups related to age on these grounds. This is important to note because they later assumed that these zircons could have been formed at many different times over hundreds of millions of years. They had no evidence for this other than the dates they came up with so already we can see posterior reasoning coming in.

Isotope measurements were then made on the uranium-235, uranium-238 and thorium-232 decay chains. These isotopes all decay through a number of daughter products until they become stable isotopes of lead over millions of years. If the zircons had been closed systems over all that time (no exchange of contents with surrounding matter) then the parent-to-daughter isotope ratios would each separately indicate the time elapsed since the formation of the zircons. This works only if we also know how much of the lead isotopes were present at the time of formation. We don't know this of course but there are ways of guessing.

The 'concordia' method is based on the idea that if the parent/daughter ratios agree (are concordant) in any one crystal then it suggests that none of the contents have leaked away and the crystal has been a closed system. If so, then the indicated date is a reliable one.

Notice that the decision as to whether a crystal is datable or not is based on the measurements themselves — they are using posterior reasoning again.

Despite this, the criterion of agreement between three different decay chains should give some grounds for confidence because three independent processes are involved. This is only true however if the probability of leakiness is low (less than 5% is a commonly accepted chance of error). If it is high then there is a strong probability that 'concordant' results will just happen by chance. This is called a Type II error — saying something is so when it is not so. In Compston and Pidgeon's paper[6] far more than 5% of the zircons were leaky so there is a significant risk of making a Type II error.

A rather blatant weakness in the concordia method is that it recognizes agreement between ^{235}U and ^{238}U but plays down the result from the ^{232}Th decay chain. In this study nearly all the zircons were leaky according to the ^{232}Th data (and such a result is common with this method). In particular, grain 86, the one showing the oldest age, was one of the leakiest of all! If a crystal is leaky to the thorium chain then it is hard to believe it is not equally leaky to the uranium chains because they all decay through a similar set of chemical elements.

LEAD-LOSS

Compston and Pidgeon simply ignored the crystals that were leaky and concentrated on their 'best' results. But even amongst the 'best' results there were deviations from true concordance. To explain this away they invoked what is called 'lead loss'. They made up an imagined scenario to explain the deviations:

> *'the old zircons first formed at ~4,300 Myr, then lost lead during one or more early events . . . lead loss also occurred recently'.*

And this was what happened to their 'best' crystals! Note that the only evidence for 'lead loss' is the results themselves — posterior reasoning again!

It is standard practice in the concordia method to talk about lead loss rather than uranium gain because the results usually fall in a direction that is most easily explained by lead loss. However, all three of these decay chains go through a gas phase (radon gas) so it is most likely that it is radon gas, and not lead, that has leaked. The presence of a gas phase in all three decay chains therefore gives a bias toward what looks like lead loss but it could actually cover up indefinite amounts of lead loss or gain and/or uranium loss or gain. So how do we know what has happened? We don't, of course.

MULTIPLICATION OF METHODS

According to Faure, lead-loss explanations can be developed in as many stages as is needed to explain the results. This means that the research worker is able to 'massage' his data, using nothing more than posterior reasoning, until he finds a result that is consistent with his prior expectations.

Here is a fine example of how posterior reasoning can really lead us astray. When there are no objective criteria for measuring accuracy then all we end up with is the ideas that we started with. Science advances by testing ideas to show where they are wrong but methods like these only serve to entrench the status quo.

A similar weakness is inherent in the wide variety of isotope dating methods that a worker has to choose from. If one method gives unsatisfactory results he can just discard those results and use another method until he finds the result that satisfies his prior expectations. This is not objective science. In other fields of measurement a method is tested for accuracy against a standard substance of known purity. Long-age isotope dating could only become objectively accurate if we had a standard rock of known age to calibrate our methods. We do not have such a 'standard rock'.

OUTLIERS AND EXTREME VALUES

All measurement processes are subject to small systematic and random variations and, in addition, some measurement processes are subject to unpredictable gross errors. The systematic variations are usually dealt with by calibrating the method against a standard but, as we said above, in earth-age studies there are no standards of known age to calibrate against, only results from other equally fallible isotope methods. This is probably why Faure retained Patterson's outdated result — because he had no other standard to work from!

The random variations can be accounted for by statistical theory. But the gross errors (such as those caused by contamination or loss of sample in the measurement process) have an unknowable magnitude so they must be eliminated from the data. There are many techniques available for identifying such 'outliers' but they were not used in the papers referred to here.

Outlier rejection techniques are typically designed to identify those one or two 'odd' results that could perhaps be the result of a laboratory accident or some other unexpected event. However, in isotope dating a large proportion of the data is often rejected. For example, in the present case the isotope ratios in the 'oldest' crystal were measured seven times but the authors simply took the extreme value as the 'right' one, thereby rejecting the other 86% of the information which they had on that crystal. The statistical outlier rejection techniques were not designed to handle such situations — statisticians have assumed that if such a high proportion of the results are bad then they are all bad and it is a waste of time to study them further. There are legitimate statistical methods for estimating extreme values but these methods were not used here either!

THE WORST CASE

My search for the age of the earth had revealed many violations of the scientific method but the worst was yet to come. Podosek, Pier, Nitoh, Zashu and Ozima[7] found what might have been the world's oldest rock crystals but unfortunately they were too old!

They extracted diamonds from rocks in Zaire and found by the potassium-argon method that they were 6 billion years old. But the earth is supposed to be only 4.5 billion years old. So Podosek *et al.* decided they must be wrong. They admitted, however, that all the normal criteria for dating had been satisfied and if the date had not been contradicted by the 'known' age of the earth they would have accepted it as valid.

Here stands, openly revealed, the naked heart of isotope dating. The experimenters know only too well how tenuous is the foundation for their methods and when they get a 'wrong' answer they, without hesitation, discard their results. If such 'science' was carried out in a field related to human health the perpetrators would be sued for malpractice and deregistered from their professional association.

And then the ultimate Achilles heel. The potassium-argon ratios in these diamonds did not result from closed-system radioactive decay, otherwise they would have given the 'right' answer. Ozima, Zashu, Takigami and Turner[8] re-examined the diamonds and came up with an alternative explanation, unrelated to age, for the isotope ratios. This illustrates how it is impossible to tell, from the isotope information alone, when the dates are right and when they are wrong. In fact this is exactly what we would expect from a method which relies so heavily on posterior reasoning.

THE SILENT MAJORITY

As I searched the literature further I discovered something even more disturbing than this. The papers by Compston and Pidgeon and by Podosek *et al.* turned out to be rare gems because they laid out their data and their reasoning for critics to scrutinise. The majority of authors simply said that they used a particular isotope dating method and reported their final result. All the data 'massaging' is hidden. And the world is no wiser.

SUMMARY

From only three papers I have here listed seventeen flaws in isotope dating: failure to acknowledge contradictory results, using a model that is known to be wrong, unverifiable assumptions about initial isotope ratios, unverifiable assumptions about similar zircons having different ages, leaky crystals, high risk of Type II error, lack of standard rocks of known age to calibrate the methods, down-playing of inconvenient results, unconstrained reinterpretation of results, selection of methods to suit prior expectations, posterior reasoning, failure to use the correct statistical methods of outlier rejection and extreme value estimation, discarding large proportions of data, discarding whole data sets, finding non-dating explanations for isotope ratios only when it suits the authors, and not disclosing the data 'massaging'.

Any one of these flaws is enough to cast doubt on the results. Together? Well, perhaps you would like to make up your own mind.

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