GENERAL SCIENCE NOTES

THE IMPLICATIONS OF THE OKLO PHENOMENON ON THE CONSTANCY OF RADIOMETRIC DECAY RATES

By C. L. Webster, Jr., Geoscience Research Institute

Unless there are unusual (external and/or internal) pressures compelling an individual to question the constancy of radiometric decay rates, they are considered to be constant, with little reason for questioning.

The usual source of pressure causing an individual to question the constancy of the decay rates is one's own personal philosophy. Scientifically speaking, radiometric decay constants, once measured, remain unchanged except for minor adjustments due to the refinement of measurement techniques. However, a candid question to ask would be: "Is there any hard physical evidence that would corroborate the large magnitudes of the decay rates apart from laboratory studies?" I believe that the answer is "Yes!" In addition to the radiohalo evidence found in various rock formations throughout the world (Brown 1990), the Oklo Natural Reactor Phenomenon, found in Gabon, Africa, contributes meaningful insight into the evaluation of radiometric decay rate constancy.

In June, 1972, a routine isotope analysis for U-235 content of uranium ore from Gabon, Africa, revealed a significant deviation from the standard $0.7202 \pm 0.0006\%_a$ U-235 (atom per cent). The initial atypical analysis was $0.7171 \pm 0.0010\%_a$ U-235. Further analyses revealed U-235 concentrations as low as $0.621\%_a$, with one core analysis exhibiting a low of $0.440\%_a$. These analyses were systematically traced to the Oklo mine of the Franceville Uranium Mines Company in Gabon, Africa. Once the deviant ore was traced to its source, additional analyses produced one sample with a phenomenal low of $0.292\%_a$ U-235 (Naudet 1974). The only reasonable explanation for this depletion of U-235 was an ancient sustained nuclear chain reaction within the ore formation. The possibility of a natural reactor occurring had been proposed as early as 1956 (Kuroda 1956).

If uranium containing the natural $0.7202\%_a$ concentration of U-235 is used as the fuel, a sustained nuclear chain reaction is possible only under severe artificial geometric constraints of alternating uranium and

moderator, or with unique neutron moderation by deuterium (Canadian natural-uranium "CANDU" power reactor). Neither of these conditions are possible under the normal conditions found in nature, nor has evidence for such conditions been found at the Oklo site. Therefore, the conditions of criticality there must have been different from those currently present. The most probable set of conditions for a sustained nuclear reaction attainable under natural conditions at Oklo would involve neutron moderation by ordinary light water.

Before a sustained nuclear chain reaction with moderation by light water is possible, there must be an enrichment of U-235 to about $3\%_a$. Operating under the assumption that the decay constants for uranium have remained constant over geologic time, the U-235 concentration would be approximately $3\%_a$ about 1.45×10^9 years ago (less than three half-lives of U-235). In other words, if the present laws and constants of nature had extended throughout the past, the Oklo uranium deposit could have become critical about 1.45 billion years ago, if all other necessary conditions were met at that time. Is there any physical evidence to suggest that such might have been the case?

The natural fission reactor problem has been approached from three different perspectives: 1) Rb-Sr techniques for determining the age of the formation in which the Oklo deposits are located; 2) determination of the radiogenic lead in the Oklo deposits; 3) measurement of the ratio of fission products to the present concentration of U-235, and comparison of these ratios with the neutron flux that would have been associated with any decrease in U-235 by natural fission.

The Oklo uranium deposit is located in the middle Precambrian Francevillian formation. Associated pelites (clay-like rocks), microsyenites (igneous type of minerals) and volcanic rocks were dated using both Rb-Sr and K-Ar techniques. Interstratified rhyolitic tuffs (also volcanic) were also analyzed. Concordance was found for all techniques and all materials at 1,740±20 million ($1.740\pm0.020\times10^9$) years B.P. (Naudet 1974). Such concordance for independent radiometric methods and non-related mineralogy cannot be lightly dismissed.

Difficulty was experienced when attempts were made to date the ore deposit within the reactor sites by lead/lead and uranium/uranium isotope ratios. However, for the ore zones outside the natural reactor sites the majority of analyses by these same techniques resulted in ages between 1,750 and 1,800 million years B.P. Ion microprobe analyses of individual uranium mineral grains from these ore zones revealed an age

on the order of 1,700 to 1,800 million years B.P. (Naudet 1974). It should be emphasized that all of these ages are exclusively dependent upon radiometric half-life data and the presumed constancy of radiometric half-lives throughout time.

Fission products exhibit unique isotopic signatures that are entirely different from the naturally occurring isotopic signatures. Utilizing these differences researchers have not only identified the isotopes undergoing fission, but also the determined percentages of each that has been fissioned. In addition to isotopic signatures, the relative initial abundances of each element present before the nuclear reactions occurred have also been determined.

Application to the Oklo data of the isotopic systematics developed from current reactor theory reveals a remarkable fit of theory with field data. In almost every elemental isotopic signature analyzed, with respect to a U-235 concentration at the present value of $0.7202\%_a$, the fission products were found in concentrations exceeding the predicted values by a factor of about six (5.8). On the other hand, if the initial concentration of U-235 is assumed to be about six times greater than its present concentration, the concentrations of fission products found within the Oklo reactor closely match theoretical values, within experimental error (Naudet 1974).

The isotopic studies of neodymium provide strong supporting evidence for a natural occurring self-sustained nuclear-fission reactor at Oklo. Figure 1 illustrates the isotopic signature of the seven stable isotopes of naturally occurring neodymium. The isotopic signature of neodymium from U-235 fission is illustrated in Figure 2. Note the distinct absence of the Nd-142 isotope and the relative abundances of the 143, 144, and 145 isotopes as compared to those of the natural neodymium. The isotopic signature for the neodymium found at the Oklo reactor site is illustrated in Figure 3. The presence of a 142 isotope is indicative of the existence of natural neodymium prior to the reactor going critical. In order to compare the Oklo reactor neodymium with that of fission neodymium, the Oklo signature must be corrected for the presence of the natural neodymium. This is done by calculating the absolute abundances of each isotope 143, 144, 145, 146, 148, and 150, based on the absolute abundance of the Nd-142 isotope, and subtracting these from the Oklo signature. Once this is completed the corrected isotopic signature can be determined (illustrated in Figure 4). Without a doubt, the corrected

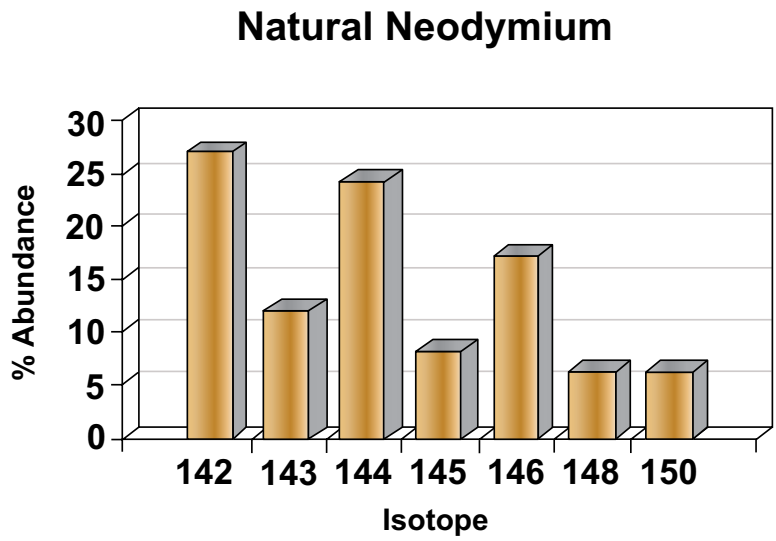
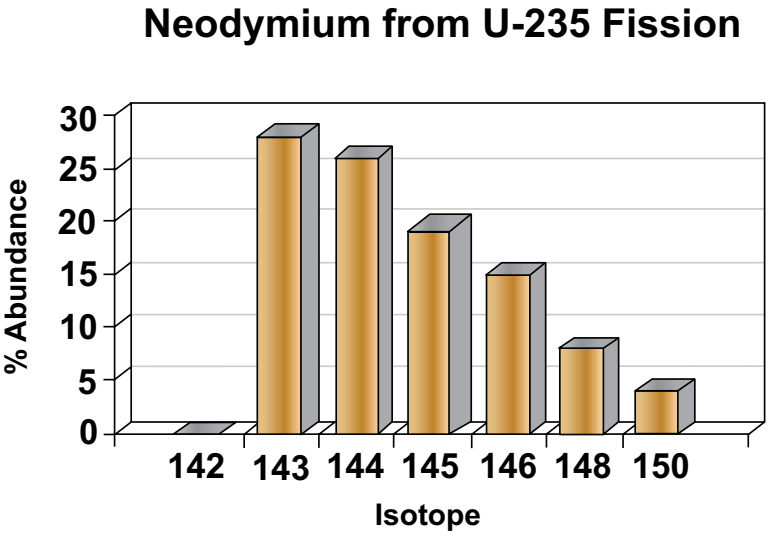


FIGURE 1. Isotopic signature for naturally occurring neodymium.

FIGURE 2. Neodymium isotopic signature from the reactor fission of U-235.



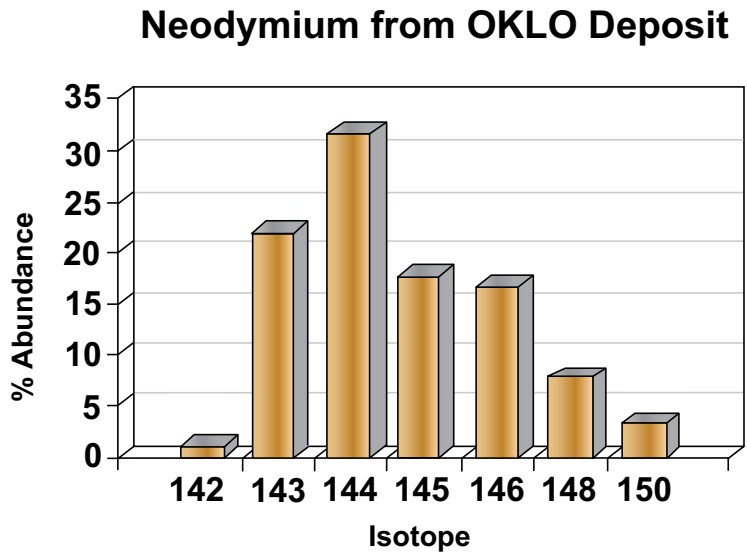
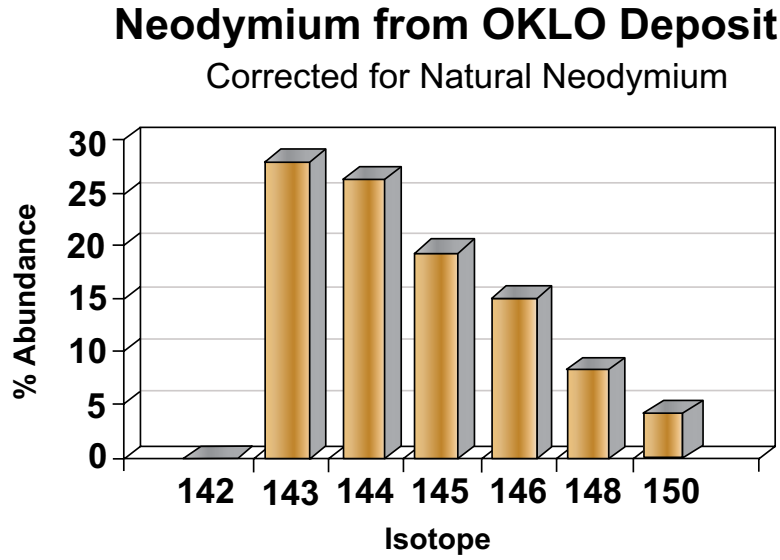


FIGURE 3. Isotopic signature for neodymium isolated from the Oklo natural reactor site in Gabon, Africa.

FIGURE 4. Oklo reactor neodymium isotopic signature corrected for the presence of naturally occurring neodymium.



Oklo neodymium signature is the signature for that of neodymium from the fission of U-235.

In addition to corroborating the fact that the Oklo deposit did become a natural reactor, the absolute abundances of the neodymium isotopes also substantiate the fact that the U-235 concentration, at the time of criticality, had to be on the order of $3\%_a$ (Naudet 1974). This is the hard non-radiometric decay data needed to support the large magnitudes and constancy of the radioactive decay rates.

Initial modeling suggests that the Oklo reactor went critical, during the Precambrian, approximately 1.7 to 1.9×10^9 yr ago, and that the period of duration was at least 2×10^5 yrs (Naudet 1974, Cowen et al. 1975).

A question that now arises in the face of these strong data supporting long ages for the existence of abiotic matter is, "Can these data be accepted within the Scriptural framework of a literal seven-day creation as described in Genesis?" I personally believe that the answer is "Yes!"

One of the immediate consequences of accepting these long ages for the abiotic material of the earth is the assumption that this matter existed on planet Earth before the creation of life. This assumption is supported by interpreting Genesis 1:1-2 as identifying God as the Creator of the "foundations" of the Earth, regardless of when that creation process took place. The creation of life and living processes, as we know them, begins with verse 3 of Genesis 1. In addition, one can add the fact that there is no specific reference in the scriptural account of Creation week that addresses the creation of water or the mineral components of dry land ("earth" that was created on day three). The only reference made to their creation is "in the beginning." It seems possible then that the elementary abiotic matter is not bound by the limited age associated with living matter.

The implications of this approach would suggest that the radiometric clocks are not reset to zero whenever the minerals are transported by igneous or erosional processes. This approach also strongly suggests that the radiometric age assigned to the inorganic minerals associated with a fossil is more a reflection of the characteristics of the source of this inorganic material than an indication of the age of the fossil.

Conflicts between scientific and biblical interpretations are minimized with these assumptions. However, not all of the questions are answered, and areas that call for the exercise of faith remain.

In seeking to harmonize the revelation of God through Scripture and natural science, we must find a model that is consistent with *both* sources of revelation. Where such consistency is not found, we need to seek a better understanding of both sources through the guidance of the Holy Spirit.

REFERENCES

Brown RH. 1990. Radiohalo evidence regarding change in natural process rates. Creation Research Society Quarterly 27:100-102.

Cowan GA, Bryant EA, Daniels WR, Maeck WJ. 1975. Some United States studies of the Oklo Phenomenon. International Symposium of the Oklo Phenomenon, Libreville, Gabon, l'Agence Internationale de l'énergie Atomique SM-204(5):341-356.

Kuroda PK. 1956. On the nuclear physical stability of the uranium minerals. Journal of Chemical Physics 25:781-1295.

Naudet R. 1974. Commissariat á l'Energie Atomique (France), Le Phénomène d'Oklo. Commissariat á l'energie Atomique, Bulletin d'Informations Scientifiques et Techniques 193(June):7-45.