Woodmorappe's Shotgun Attack on 40Ar-39Ar Dating: Many Misses and Few Hits

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Dr. David Plaisted is a computer scientist and another creationist critic of radiometric dating (see The Radiometric Dating Game). Many creationists, including Dr. Plaisted, argue that argon in minerals and rocks may be extraneous (that is, incorporated into the samples during or after crystallization because of open system behavior) rather than accumulating in crystals from radioactive decay over millions of years. Obviously, YECs generally believe that excess argon was 'incorporated' into rocks and minerals during the 'Creation Week' or 'Noah's Flood' rather than over millions of years and that the ancient dates that result from these samples are entirely 'fictitious'.

In many cases, the presence of excess argon in a sample can be identified by the presence of a U- or saddle-shaped Ar-Ar spectrum rather than a flat distribution of steps (McDougall and Harrison, 1999, p. 123-125). If excess argon can be identified and distinguished from argon that accumulates in minerals and rocks over long periods of time (radiogenic argon, McDougall and Harrison, 1999, p. 11), then YECs cannot use 'undetected' excess argon as a blanket excuse to attack the reliability of Ar-Ar and K-Ar dating.

Using a 'shot gun' approach, YEC Woodmorappe (1999, p. 76) lists many references (Maluski, 1978; Hanes, 1991; Hyodo and York, 1993; Renne, 1995; Ruffet et al., 1995, 1997; Broecker and Franz, 1988; Foster et al., 1989; Harrison, 1990; Maluski et al., 1990; Seidemann et al., 1984; 'Landoll and Foland, 1989' [Landoll et al., 1989]; Blanckenburg and Villa, 1988; etc.), which he claims provide examples of minerals that are believed to contain excess argon, yet provide deceptively flat Ar-Ar spectra instead of the expected 'U-shaped' distribution. Admittedly, there are examples in the literature where samples with excess argon produce flat Ar-Ar spectra (e.g., Hyodo and York, 1993). Nevertheless, as discussed below, the amount of excess argon is often trivial or other methods are available to detect and even quantify the excess argon.

Most YECs want us to believe that Ar-Ar dating commonly produces ancient dates that appear trustworthy, but really aren't because of 'hidden' excess argon. According to Woodmorappe (1999, p. 76), the shape of the spectra cannot be trusted to detect the excess argon. Relying on Woodmorappe (1999), creationist Dr. David A. Plaisted at Reply Number 4 to Dr. Henke also expresses skepticism that excess argon can be readily detected. Nevertheless, what do Woodmorappe's references REALLY say and how well do they support his accusations? Do these references really support the YEC agenda that Ar-Ar and K-Ar dating methods are worthless? Can extraneous argon be distinguished from radiogenic argon?

Maluski (1978) studied the effects of tectonism on the 40Ar-39Ar compositions of minerals in the Variscan granites of Corisca. Woodmorappe (1999, p. 76) claims that Maluski (1978) contains examples of biotites with excess argon that produce deceptively flat Ar-Ar spectra rather than the traditional U-shaped (also called 'saddle-shaped') spectra. In reality, Woodmorappe's (1999, p. 76) claims are incorrect. The biotites have disturbed spectra (that is, they're not flat) and most of them have saddle or U-shapes (Maluski, 1978, p. 1619, 1624, 1623). Nevertheless, Maluski (1978) argues that all of the biotites have LOST argon over time. That is, contrary to Woodmorappe's (1999, p. 76) claims, NONE of the biotites have excess argon (Maluski, 1978, p. 1623-1624).

Overall, the Ar-Ar results in Maluski (1978, p. 1619) provided some valuable and reliable results that Woodmorappe (1999, p. 76) ignores. Specifically, the Ar-Ar dates correspond very well to the intensity of deformation that the biotites had experienced since their formation (Maluski, 1978, p. 1619, 1623-1624).

Despite the disturbed spectra, Maluski (1978, p. 1619) was able to obtain confident Ar-Ar dates from amphiboles at high temperature steps. Maluski (1978, p. 1627) is also optimistic that the application of the Ar-Ar method on K-feldspars will be useful in dating mylonites (that is, determining when the rocks were deformed by faulting).

Hanes (1991, p. 46), which is cited by Woodmorappe (1999, p. 76), admits that if excess argon is uniformly distributed throughout a sample or if the radiogenic and excess argon are homogenized, a flat, deceptive spectrum may result. However, Hanes (1991, p. 42) also states that excess argon in biotite may be detected if cogenetic muscovite and hornblendes provide consistently younger dates. In the following quotations, Hanes (1991, p. 43) further claims that excess argon may be detected:

'Fortunately, the shape of a 40Ar/39Ar age spectrum can OFTEN signal the presence of excess argon. [my emphasis]

'Laser spot-dating may help map out the distribution of such excess-argon contamination in a mineral grain...' [reference omitted].

Hanes (1991, p. 44) continues:

'A more complicated version of excess-argon spectra are those that yield a marked "saddle" shape...[reference to figure omitted] in which anomalously high dates are obtained at both low and high temperatures of gas release. The trough of the "saddle", representing minimum contamination by excess argon, may provide an upper limit for the cooling age of the sample... [reference omitted]. In the case of alkali feldspars, this trough may be a plateau-segment providing a VALID age... '[reference omitted] [my emphasis]

'The nature of non-radiogenic, trapped argon can, in some cases, be determined by the isochron approach...[reference omitted] a technique that is analogous to the Rb-Sr isochron method.'

Hyodo and York (1993) is also on Woodmorappe's (1999) shotgun list. Indeed, Hyodo and York (1993, p. 62) shows a fairly flat plateau for a biotite with excess argon. However, rather than abandoning Ar-Ar dating for YEC sunday school stories involving talking snakes and forbidden fruit, Hyodo and York (1993, p. 63) recommend that a laser system be used to detect excess argon in individual grains.

According to Woodmorappe (1999, p. 76), Renne (1995) contains examples of biotites with excess argon that produce deceptively flat Ar-Ar plateaus. Renne (1995) discusses the presence of excess argon in biotites and hornblendes from one pluton, the Noril'sk #1 Intrusion in Siberia. However, the amount of excess argon and its effects on the radiometric dates are trivial. Flat 40Ar-39Ar plateau dates of biotites gave slightly older dates of 251-254 Ma when compared with Ar-Ar whole-rock and plagioclase results (Renne, 1995, p. 165). The whole-rock and plagioclase 40Ar-39Ar dates, which are considered more accurate by Renne (1995), were only 247-250 Ma. A previous U/Pb zircon date was 248.0 **+/-** 3.7 Ma (Renne, 1995, p. 175). Isochron plots of the 40Ar-39Ar data indicate the presence of minor amounts of excess argon in the biotites and hornblendes. The isochron date of the biotites was reasonable, 250.1 **+/-** 1.5 Ma (2 sigma) with an excess Ar component of 40Ar/36Ar = 565 **+/-** 39. The hornblendes also yielded a reasonable isochron age of 249.3 **+/-** 1.6 Ma with excess argon of 40Ar/36Ar = 327 **+/-** 10. Recall that if the samples are exposed to modern atmospheric argon, 40Ar/36Ar = 295.5 (McDougall and Harrison, 1999, p. 11).

Clearly, Woodmorappe (1999, p. 76) exaggerates the amount of excess argon associated with the Ar-Ar flat plateaus of the biotites in Renne (1995). Furthermore, he (1999, p. 76) utterly fails to mention that the isochron plots DETECTED AND MEASURED the excess argon. Because the disputed ranges of dates are very close (247-250 Ma versus 251-254 Ma) they are too trivial to undermine the reliability of radiometric dating and serve the needs of young-Earth creationism.

Woodmorappe (1999, p. 76) cites another article, Ruffet et al. (1995), which contains examples of biotites and phengites with excess argon that nevertheless produce flat Ar-Ar plateaus. Ruffet et al. (1995, p. 327) collected and dated some of these minerals from high-pressure metamorphic rocks in the western Alps of northern Italy. Although they obtained a clear U-shaped Ar-Ar spectrum indicating excess argon from one of their biotites (Ruffet et al., 1995, p. 341), they (1995, p. 327) also recognized from the literature that biotites with excess argon could produce deceptively flat spectra. As part of their efforts to evaluate the validity of the spectra, they (1995, p. 328) state:

'One way to test the validity of plateau ages on HP [high-pressure] phengites is to perform detailed 40Ar-39Ar analyses on phengites either on different rocks from the same outcrop, or on different parts of the same crystal, in order to compare the reproducibility of the plateau ages.'

After carefully studying the chemistry, textures and other properties of biotites and phengites in their samples and considering various explanations, Ruffet et al. (1995) concluded that excess argon was present in some of their specimens. Ruffet et al. (1995, p. 343) conclude:

> **'This work shows that in case of "undetectable" excess argon with meaningful wrong plateau ages, a very detailed study of single grains allows to identify excess argon whereas this is impossible with bulk sample analyses.'**

The extent of the excess argon in the samples was later CONFIRMED by 40Ar-39Ar laser probe analyses and comparisons with Rb-Sr results (Ruffet et al., 1997, p. 16).

Woodmorappe (1999, p. 54) also states that 'concordant' Ar-Ar and Rb-Sr isochron results on high-pressure phengites were rejected as 'meaningless' by Ruffet et al. (1997), presumably because the 'concordant' results simply did not coincide with the expected ages of the rocks. The abstract of Ruffet et al. (1997, p. 291) shows that the dates are not as 'concordant', 'subjective' or 'meaningless' as Woodmorappe (1999, p. 54) would have us believe:

> **'The combined use of Rb-Sr and 40Ar-39Ar laser probe methods allows confirmation of the existence of excess argon in phengites from eclogites from the Sesia zone (Western Alps) despite systematic 40Ar-39Ar plateau ages. 40Ar-39Ar phengite ages from two different areas shows integrated age spreads between 65.4 +/- 0.3 and 109.5 +/- 0.4 Ma. The youngest 40Ar-39Ar plateau age (65.9 +/- 0.4 Ma) is concordant with two Rb-Sr phengite-whole rock isochron ages from the same outcrop which display a mean age of 64.2 +/- 2.5 Ma and older than a Rb-Sr biotite-whole rock isochron age at 53.0 +/- 1.0 Ma. This age concordance, being incompatible with the concept of isotopic closure temperature, is probably fortuitous and probably results from an excess argon contamination. However, the concordance of the Rb-Sr phengite isotopic closure temperature with the temperature reached during the eclogite-facies event suggests that the age at 64.2 +/- 2.5 Ma could be a crystallization age probably contemporaneous with the eclogite-facies event in the Sesia zone.'**

That is, Ruffet et al. (1997, p. 1) states that a Rb-Sr date of 64.2 **+/-** 2.5 Ma on the phengites could represent a valid age for the high temperature and pressure ecologite facies metamorphism.

Woodmorappe (1999, p. 76) also cites Broecker and Franz (1998), which mentions that metamorphic phengites with excess argon may produce deceptively flat Ar-Ar spectra. Broecker and Franz (1998) studied the geology of Tinos Island, Greece, which included some very complex rocks that had experienced several metamorphic and deformational events. The rocks include fault breccias and mylonites, as well as greenschist and relict blueschist metamorphic minerals (Broecker and Franz, 1998, p. 370-373). Considering the extreme complexity of the rocks, it's not surprising that the Ar-Ar and Rb-Sr radiometric dates provide ambiguous results, where the Ar-Ar dates may involve excess argon. The Rb-Sr results of some of the samples were so scattered that no isochrons could be derived (Broecker and Franz, 1998, p. 379). Broecker and Franz (1998, p. 370, 379) also cite the literature and admit that seemly good Ar-Ar plateaus may still be substantially affected by excess argon. Nevertheless, they (1998, p. 380) conclude:

> **'The RELATIVELY SMALL age difference obtained for [our] high-pressure samples suggests that contamination with excess argon, IF AT ALL, IS ONLY OF LIMITED IMPORTANCE.' [my emphasis]**

Foster et al. (1989) is another interesting article that mostly contains positive information about radiometric dating that Woodmorappe (1999, p. 76) chooses to ignore as he sieves through it looking for 'dirt' on radiometric dating. Foster et al. (1989, p. 236) identified four K-feldspars that contained excess argon. However, contrary to Woodmorappe's (1999, p. 76) claims, the entire spectra for each of the four samples are NOT flat, but generally have 'saddle' shapes (Figure 6, Foster et al., 1989, p. 236). Ar-Ar isochrons were successfully used to quantify the excess argon in one of the feldspars (Foster et al., 1989, p. 236). Foster et al. (1989, p. 232) conclude:

> **'We present analyses here that bear on the age of the Old Woman-Piute batholith [Mojave Desert of California] which in turn allow CLEAR interpretation of the 40Ar/39Ar systematics of K-feldspars containing excess argon. [my emphasis]**

Foster et al. (1989, p. 232) also obtained consistent dates for both the peraluminous and metaluminous portions of the Old Woman-Piute batholith, including zircon dates of 74 **+/-** 3 Ma for both portions, 40Ar/39Ar dates of 73 **+/-** 2 Ma on hornblendes from the metaluminous portion, and 40Ar/39Ar dates of 70 **+/-** 2 Ma on micas from both portions. 40Ar-39Ar spectra were obtained from K-feldspars, which had initial steps of 60 - 67 Ma, but rose to consistent plateau dates of 70 **+/-** 2 Ma (Foster et al., 1989, p. 232).

According to Woodmorappe (1999, p. 76), Maluski et al. (1990) includes examples of 'igneous' plagioclases with excess argon that supposedly produce deceptively 'flat' Ar-Ar spectra. However, Maluski et al. (1990) studied minerals from a granulite (metamorphic) rock from Algeria and not 'igneous' samples. Contrary to Woodmorappe (1999, p. 76), analyses of the plagioclases produced the characteristic U- or saddle-shape Ar-Ar spectra (Maluski et al., 1990, p. 200), and were not anomalously flat. Furthermore, Woodmorappe (1999, p. 76) neglects to mention that Maluski et al. (1990, p. 193) used electron microprobe and laser probe analyses to SUCCESSFULLY IDENTIFY and LOCATE excess argon within biotite, pyroxene, garnet, and other metamorphic mineral grains. Unlike most other minerals, the excess argon in the metamorphic plagioclases could not be pinpointed to specific areas in the grains and Maluski et al. (1990, p. 193) concluded that the excess argon was distributed throughout the minerals.

Seidemann et al. (1984) performed conventional K-Ar and 40Ar-39Ar dating on basalt flows from the Hartford Basin of Connecticut and the Newark Basin of New Jersey. Woodmorappe (1999, p. 76) claims that Seidemann et al. (1984) contains examples of igneous plagioclases with anomalous flat spectra that fail to detect excess argon. In reality, Seidemann et al. (1984, p. 595-597) found that the Talcott Flow produced a nice plateau with no indication of excess argon. The 187 +/- 10 Ma date was reasonable. The Hampden flow probably contained excess argon, but the Ar-Ar spectrum did not have an ideal saddle- or U-shape. However, the Hampden spectrum was not flat either. Clearly, the non-flat spectrum indicates a disturbance of some kind in the argon concentration (Seidemann et al., 1984, p. 595-597). From their study, Seidemann et al. (1984, p. 594) confidently concluded that the basalts of the Hartford and Newark Basins ranged from 185 +/- 4 to 194 +/- 4 Ma, which are consistent with fossil assemblages in associated rocks.

According to Woodmorappe (1999, p. 76), Landoll et al. (1989) (mislabeled as 'Landoll and Foland, 1989' by Woodmorappe, 1999, p. 76) obtained deceptive Ar-Ar spectra from igneous hornblendes. Landoll et al. (1989) studied excess argon in amphiboles from an igneous-metamorphic rock complex in Zimbabwe. Average 40Ar/39Ar dates on 11 minerals (amphiboles and biotites) ranged from 177.6 +/- 0.3 (1 sigma) to 181.3 +/- 0.4 (1 sigma) Ma (Landoll et al., 1989, p. 4060). The samples included three amphiboles (their dates were 180.8 +/- 0.2, 180.9 +/- 0.3 and 181.3 +/- 0.4 Ma, 1 sigma), whose chemistry, textures, and fluid inclusions suggested the presence of excess argon (Landoll et al., 1989, p. 4060, 4064-4066). In particular, the three samples were zoned (Landoll et al., 1989, p. 4053). The zoning and excess argon could have easily resulted from late magmatic or early subsolidus reactions involving fluids (Landoll et al., 1989, p. 4053). The spectra of the three amphiboles do NOT have the characteristic saddle-shape (Landoll et al., 1989, p. 4065, 4061).

The amounts of excess argon in the three amphiboles were too small to be detected with Ar-Ar isochrons (Landoll et al., 1989, p. 4065). Nevertheless, Rb-Sr analyses of two of the biotites and their host whole rocks provided very consistent results of 178.1 +/- 1.3 and 177.1 +/- 1.3 (1 sigma) Ma (Landoll et al., 1989, Table 5, p. 4062). Not surprisingly, Woodmorappe (1999, p. 76) fails to mention how minor the differences really are between the three amphiboles with excess argon and the other samples, which have no evidence of excess argon.

Blanckenburg and Villa (1988) investigated the argon retentivity and the presence of excess argon in amphiboles from schists (metamorphic rocks) from the eastern Alps on the border of Italy and Austria. Among the amphiboles that were dated by K-Ar and Ar-Ar, 20 tschermakitic hornblendes had dates that ranged from 17-37 Ma (Blanckenburg and Villa, 1988, p. 1). However, two nearly potassium-free cummingtonite-rimmed hornblendes gave K-Ar dates of 118 -/+ 22.0 and 120 +/- 86 Ma (note the high errors!!). (Blanckenburg and

Villa, 1988, p. 3). The variations in the composition and textures of the cummingtonite-rimmed hornblendes when compared with the tschermakitic hornblendes suggest that they had different origins and growth histories. Therefore, the very different dates are not entirely surprising. Evidence that the 120 Ma dates are due to excess argon includes traceable trails of fluid inclusions, which represent the remnants of fluids that once flowed through microscopic fractures (Blanckenburg and Villa, 1988, p. 1). Such fluids are known to carry excess argon (Blanckenburg and Villa, 1988, p. 9). Blanckenburg and Villa (1988, p. 10) also state:

> **'Excess-Ar is DETECTED by (1) K-Ar measurements in the nearly K-free cummingtonites, (2) the scatter of K-Ar ages of larger number of samples from a single location, or (3) by 39Ar-40Ar release spectra of type c and d.' [my emphasis]**

Blanckenburg and Villa's type c curve resembles a logarithmic decay curve and their type d curve has the classic U- or saddle-shape (Blanckenburg and Villa, 1988, p. 8). Therefore, contrary to what Woodmorappe (1999, p. 76) would have us believe, Blanckenburg and Villa (1988, p. 8) found the spectra shapes to be useful in identifying excess argon in amphiboles. In particular, Blanckenburg and Villa (1988, p. 8) carefully studied the cores and rims of different amphiboles from Lanshuter Huette in the Alps along with their Ar-Ar spectra. They conclude:

'Ar-Ar analysis DEMONSTATES that all three LH [Lanshuter Huette] hornblendes contain excess argon.' [my emphasis]

Blanckenburg and Villa (1988) clearly demonstrate that excess argon may be distinguished from radiogenic argon and, in some cases, quantified through the use of Ar-Ar and other analyses.

Woodmorappe (1999, p. 68) also quotes the following section from Blanckenburg and Villa (1988, p. 6):

'Of course, K-Ar isochrons are not claimed to give accurate solutions for every confusing K-Ar age pattern affected by excess Ar... Thus, the systematics of the data array in Fig. 4 may well be an effect of pure coincidence.'

By quoting this section, Woodmorappe (1999, p. 68) wants us to believe that K-Ar isochron dating is 'subjective' and based on 'selective acceptance of the evidence'. However, when we review Blanckenburg and Villa (1988, p. 6), we see that the reason why the K-Ar isochron discussed in the above quotation is 'confusing' is that it has bad scatter. Obviously, the samples had suffered from open system behavior, including excess argon. In other words, contrary to Woodmorappe's diatribes, this example is self-checking and is far from being an ideally suitable K-Ar isochron. Specifically, Blanckenburg and Villa (1988, p. 6) state:

'The complex pattern [in the isochrons] can be resolved in the key sample Ze 4, from which planar hornblende (17.9 Ma), a linear hornblende (24.4 Ma) and a cummingtonite (118 Ma) coexisting with both hornblendes yield three different apparent ages. A rough calculation shows that by subtracting of equal amounts of excess Ar (6.6 x 10 to the -8 ccSTP/g 40Ar*) from both cummingtonite and linear hornblende we obtain an age of ~ 18 Ma for all three amphiboles.'

Because the dates of approximately 18 Ma are based on the assumption that the three amphiboles have equal concentrations of excess initial argon, the dates may just be a coincidence in this particular case. Indeed, considering the high errors on the corrected dates (**~ +/-** 2 Ma), Blanckenburg and Villa (1988, p. 6) are justified in arguing that these dates may just be a coincidence. Specifically, here is part of Woodmorappe's quotation of Blanckenburg and Villa (1988, p. 6) in context:

> **'Thus, the systematics of the data array in Fig. 4 may well be an effect of pure coincidence. The mobility of excess 40Ar is INDICATED by the SCATTER of the data points with respect to the best fit lines; especially samples Ze 2, Ze 5 core and rim seem to indicate higher excess 40Ar-concentration in comparison to other samples. Their ages of 19-20 Ma might therefore still be too high.' [my emphasis]**

Again, Woodmorappe (1999, p. 68) fails to mention these details because they refute his agenda. By using badly scattered data from Blanckenburg and Villa (1988), Woodmorappe (1999, p. 68) has erected an invalid strawperson argument to attack K-Ar isochron dating.

Harrison (1990) is a review of the literature on the interpretation of 40Ar/39Ar results from feldspars. According to Woodmorappe (1999, p. 76), Harrison (1990) supposedly contains examples of igneous K-feldspars with excess argon that fail to provide the characteristic U-shaped Ar-Ar spectra. On the contrary, Harrison's (1990) examples demonstrate how non-flat 40Ar-39Ar spectra from feldspars may be understood and rationally interpreted. Specifically, Harrison (1990, p. 220-222) states that U-shaped Ar-Ar spectra OFTEN indicate the presence of excess argon in K-feldspars and that Ar-Ar isochron plots of the data may further confirm the presence of excess argon. In stark contrast to the notes of caution from several researchers and the persistently unrealistic attacks on 40Ar-39Ar dating by Woodmorappe (1999, p. 75-76), Harrison (1990) sees widespread strengths in the 40Ar-39Ar method. Harrison (1990, p. 227) even argues that investigators would not have the tendency to be overcritical of the 40Ar-39Ar method if they would simply avoid faulty assumptions and not try to 'find global consequences in the failure of particular samples to yield straightforward results'. In particular, Harrison (1990, p. 219) states:

'In matters related to excess Ar, anomalous age spectrum shapes, slow cooling effects and radiogenic 40Ar (40Ar*) loss, internally CONSISTENT, TESTABLE models are AVAILABLE which appear to WELL describe end-member phenomena. Simultaneously, however, criticisms have appeared which challenge the very basis of the method in providing chronological data, let alone thermal histories. The resolution appears not to lie in differing experimental approaches, but rather in the PERSISTENCE OF ARGON FOLKLORE AND A TENDENCY FOR SOME TO ENDOW A SIGNIFICANCE TO THEIR RESULTS BEYOND THE SCOPE OF THE SAMPLING.' [my emphasis]

Harrison's warnings about extrapolating unusual results to other samples and believing in 'argon folklore' are particularly relevant to Woodmorappe's common tendency to comb the literature to find unusual and difficult samples and then to misapply them to all other samples!

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