## Impact #307
"Excess Argon": The "Archilles' Heel" of Potassium-Argon and Argon-Argon "Dating" of Volcanic Rocks

by Andrew A. Snelling, Ph.D.▼

For more than three decades potassium-argon (K-Ar) and argon-argon (Ar-Ar) dating of rocks has been crucial in underpinning the billions of years for Earth history claimed by evolutionists. Critical to these dating methods is the assumption that there was no radiogenic argon ($^{40}Ar^*$) in the rocks (e.g., basalt) when they formed, which is usually stated as self-evident. Dalrymple argues strongly:

> The K-Ar method is the only decay scheme that can be used with little or no concern for the initial presence of the daughter isotope. This is because ^{40}Ar is an inert gas that does not combine chemically with any other element and so escapes easily from rocks when they are heated. Thus, while a rock is molten, the ^{40}Ar formed by the decay of ^{40}K escapes from the liquid.[1]
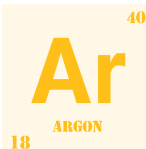
However, this dogmatic statement is inconsistent with even Dalrymple's own work 25 years earlier on 26 historic, subaerial lava flows, 20% of which he found had non-zero concentrations of $^{40}Ar^*$ (or excess argon) in violation of this key assumption of the K-Ar dating method.[2] The historically dated flows and their "ages" were:

Hualalai basalt, Hawaii (AD 1800–1801) .... 1.6±0.16 Ma; 1.41±0.08 Ma
Mt. Etna basalt, Sicily (122 BC) .... 0.25±0.08 Ma
Mt. Etna basalt, Sicily (AD 1972) .... 0.35±0.14 Ma
Mt. Lassen plagioclase, California (AD 1915) .... 0.11±0.03 Ma
Sunset Crater basalt, Arizona (AD 1064–1065) . 0.27±0.09 Ma; 0.25±0.15 Ma

Far from being rare, there are numerous reported examples of excess $^{40}Ar^*$ in recent or young volcanic rocks producing excessively old K-Ar "ages":[3]

Akka Water Fall flow, Hawaii (Pleistocene) .... 32.3±7.2 Ma
Kilauea Iki basalt, Hawaii (AD 1959) .... 8.5±6.8 Ma

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Mt. Stromboli, Italy, volcanic bomb (September 23, 1963) .... 2.4±2 Ma
Mt. Etna basalt, Sicily (May 1964) .... 0.7±0.01 Ma
Medicine Lake Highlands obsidian,
    Glass Mountains, California (<500 years old) .... 12.6±4.5 Ma
Hualalai basalt, Hawaii (AD 1800–1801) .... 22.8±16.5 Ma
Rangitoto basalt, Auckland, NZ (<800 years old) .... 0.15±0.47 Ma
Alkali basalt plug, Benue, Nigeria (<30 Ma) .... 95 Ma
Olivine basalt, Nathan Hills, Victoria Land,
    Antarctica (<0.3 Ma) .... 18.0±0.7 Ma
Anorthoclase in volcanic bomb, Mt Erebus,
    Antarctica (1984) .... 0.64±0.03 Ma
Kilauea basalt, Hawaii (<200 years old) .... 21±8 Ma
Kilauea basalt, Hawaii (<1,000 years old) .... 42.9±4.2 Ma; 30.3±3.3 Ma
East Pacific Rise basalt (<1 Ma) .... 690±7 Ma
Seamount basalt, near East Pacific Rise (<2.5 Ma) ... 580±10 Ma; 700±150 Ma
East Pacific Rise basalt (<0.6 Ma) .... 24.2±1.0 Ma

Other studies have also reported measurements of excess $^{40}Ar^*$ in lavas.[4] The June 30, 1954 andesite flow from Mt. Ngauruhoe, New Zealand, has yielded "ages" up to 3.5±0.2 Ma due to excess $^{40}Ar^*$.[5] Austin investigated the 1986 dacite lava flow from the post-October 26, 1980, lava dome within the Mount St. Helens crater, which yielded a 0.35±0.05 Ma whole-rock K-Ar model "age" due to excess $^{40}Ar^*$.[6] Concentrates of constituent minerals yielded "ages" up to 2.8±0.6 Ma (pyroxene ultra-concentrate).

Investigators also have found that excess $^{40}Ar^*$ is trapped in the minerals within lava flows.[7] Several instances have been reported of phenocrysts with K-Ar "ages" 1–7 millions years greater than that of the whole rock, and one K-Ar "date" on olivine phenocrysts in a recent (<13,000 year old) basalt was greater than 110 Ma.[8] Laboratory experiments have tested the solubility of argon in synthetic basalt melts and their constituent minerals, with olivine retaining 0.34 ppm $^{40}Ar^*$.[9] It was concluded that the argon is held primarily in lattice vacancy defects within the minerals.

The obvious conclusion most investigators have reached is that the excess $^{40}Ar^*$ had to be present in the molten lavas when extruded, which then did not completely degas as they cooled, the excess $^{40}Ar^*$ becoming trapped in constituent minerals and the rock fabrics themselves. However, from whence comes the excess $^{40}Ar^*$, that is, *^{40}Ar which cannot be attributed to atmospheric argon or in situ radioactive decay of ^{40}K*? It is not simply "magmatic" argon. Funkhouser and Naughton found that the excess $^{40}Ar^*$ in the 1800–1801 Hualalai flow, Hawaii, resided in fluid and gaseous inclusions in olivine, plagioclase, and pyroxene in ultramafic xenoliths in the basalt, and was sufficient to yield "ages" of 2.6 Ma to 2960 Ma.[10] Thus, since the ultramafic xenoliths and the basaltic magmas came from the mantle, the excess $^{40}Ar^*$ must initially reside there, to be transported to the earth's surface in the magmas.

Many recent studies confirm the mantle source of excess $^{40}Ar^*$. Hawaiian volcanism is typically cited as resulting from a mantle plume, most investigators now conceding that excess $^{40}Ar^*$ in the lavas, including those from the active Loihi and Kilauea volcanoes, is indicative of the mantle source area from which the magmas

came. Considerable excess $^{40}Ar^*$ measured in ultramafic mantle xenoliths from Kerguelen Archipelago in the southern Indian Ocean likewise is regarded as the mantle source signature of hotspot volcanism.[11] Indeed, data from single vesicles in mid-ocean ridge basalt samples dredged from the North Atlantic suggest the excess $^{40}Ar^*$ in the upper mantle may be almost double previous estimates, that is, almost 150 times more than the atmospheric content (relative to ^{36}Ar).[12] Another study on the same samples indicates the upper mantle content of $^{40}Ar^*$ could be even ten times higher.[13]

Further confirmation comes from diamonds, which form in the mantle and are carried by explosive volcanism into the upper crust and to the surface. When Zashu et al. obtained a K-Ar isochron "age" of 6.0±0.3 Ga for 10 Zaire diamonds, it was obvious excess $^{40}Ar^*$ was responsible, because the diamonds could not be older than the earth itself.[14] These same diamonds produced $^{40}Ar/^{39}Ar$ "age" spectra yielding a ~5.7 Ga isochron.[15] It was concluded that *the ^{40}Ar is an excess component which has no age significance* and is found in tiny inclusions of mantle-derived fluid.

All this evidence clearly shows that excess $^{40}Ar^*$ is ubiquitous in volcanic rocks, and that the excess $^{40}Ar^*$ was inherited from the mantle source areas of the magmas. This is not only true for recent and young volcanics, but for ancient volcanics such as the Middle Proterozoic Cardenas Basalt of eastern Grand Canyon.[16] In the mantle, this $^{40}Ar^*$ predominantly represents primordial argon that is not derived from in situ radioactive decay of ^{40}K and thus has no age significance.
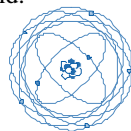
In conclusion, the fact that all the primordial argon has not been released yet from the earth's deep interior is consistent with a young Earth. Also, when samples of volcanic rocks are analyzed for K-Ar and Ar-Ar "dating," the investigators can never really be sure therefore that whatever $^{40}Ar^*$ is in the rocks is from in situ radioactive decay of ^{40}K since their formation, or whether some or all of it came from the mantle with the magmas. This could even be the case when the K-Ar and Ar-Ar analyses yield "dates" compatible with other radioisotopic "dating" systems and/or with fossil "dating" based on evolutionary assumptions. Furthermore, there would be no way of knowing, because the $^{40}Ar^*$ from radioactive decay of ^{40}K cannot be distinguished analytically from primordial ^{40}Ar not from radioactive decay, except of course by external assumptions about the ages of the rocks. Thus all K-Ar and Ar-Ar "dates" of volcanic rocks are questionable, as well as fossil "dates" calibrated by them.

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Note: "Ma" represents a million years (Mega-annum); "Ga" represents a billion years (Giga-annum).