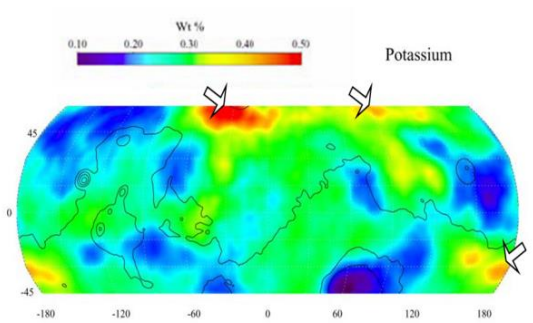
EVIDENCE FOR LARGE, ANOMALOUS NUCLEAR EXPLOSIONS ON MARS IN THE PAST.

J. E. Brandenburg, Morningstar Applied Physics LLC Vienna Va

Introduction: Previously, it had been hypothesized that Mars had been the location of large natural nuclear reactors[1,2], as are known to have occurred on Earth [3] This hypothesis was prompted by evidence of a large nuclear energy release in Mars past, and was considered the simplest hypothesis to explain the available data. Evidence of large scale nuclear activity on Mars comes from a variety of sources. It has been a long standing paradox that uranium, thorium and potassium, appear hyper-abundant on Mars surface when compared to Mars meteorites, which are believed to sample subsurface rocks. [4] This suggested a thin debris layer on the surface of Mars, enriched in Th, K and U , and dispersed by some impact or explosion. Thorium and radioactive potassium appear concentrated in the northern Mare Acidalium in the region of approximately 50 W 55N with a smaller concentration in Utopia Planum centered at approximately 90E and 55N with an additional small concentration at the approximate antipode of the Acidalium hot spot (see Figure 1and 2). This pattern suggested a massive explosion, such as the explosive disassembly of a large natural nuclear reactor, producing a global debris pattern , with a shock wave wrapping around the planet and colliding with itself at the approximate antipode.



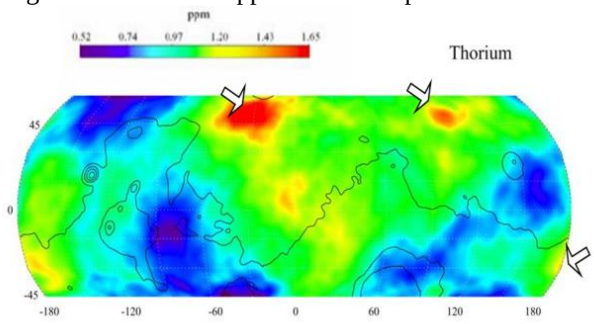


Figure 1. Distribution of radioactive K on Mars **Figure 2. Distribution of Th on Mars**

It is also known that xenon and argon components of Mars atmosphere are dominated by radiogenic isotopes when compared to Terrestrial , Jovian, Solar, or averaged Carbonaceous Chondrite standards. [5] However, the xenon 129 hyper-abundance in the Mars atmosphere is not consistent with the operation of a natural nuclear reactor, which requires moderation and slow neutrons to favor creation of fission on U235 nuclei rather than competing neutron capture processes[6] (Fig. 3) . The xenon 129 hyper-abundance is also not consistent with spontaneous fission of U238.(Fig. 3)

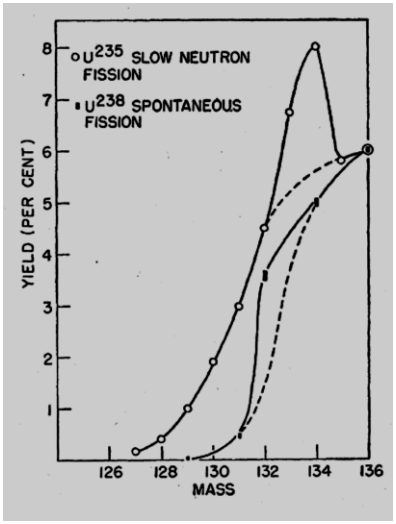
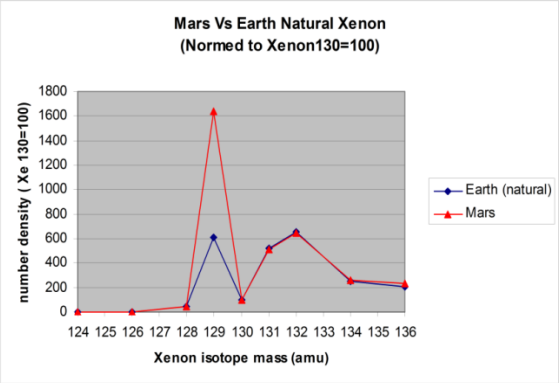


Figure 3. Distribution of Fission Xenon Isotopes

Other than the decay of large amounts of isolated Iodine 129,-half-life 15.7 million years. Xenon 129 hyper-abundance is caused by fast neutron fission and this is the source of its hyper abundance in the radiogenic component of xenon the Earth's atmosphere that has appeared since 1945 [5] (Fig. 4 and 5)



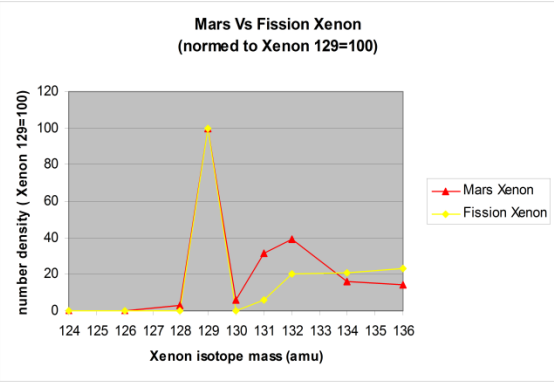


Figure 4. Xenon Isotopes in Earth and Mars Atmos. **Figure 5.Radiogenic Xe atEarth vs Mars Atmos.**

Mars meteorites show evidence of components being irradiated by neutrons with total flux of 10^{15}/cm^2 while on Mars [7] based on their Kr 80 abundance, a strong component of high energy neutron s E > 2.5 MeV has also been found. [8]. However, Eugster has argued for a cosmogenic origin of this irradiation [9]. Also arguing against the natural nuclear reactor source for these isotopic anomalies is the absence of large craters at either radiation hot spot. Instead, spectroscopic features of acid etched glass has been found at both sites, and no-where else[10]. Nitrates, possibly formed by fireballs chemistry, together , with signs of neutron irradiation, have been detected in ETA79001, [11,7,8] suggesting its possible source region in Mare Acidalium. This suggests large fireballs in the atmosphere such as Tunguska-like events , with mid-air explosions, but of much greater energy release than Tunguska. Calculations of the energy release [2] indicate similar energies as required to form the Lyot impact basin, of the order of 10^{24} J [12]

Alternative Hypotheses to a Natural Nuclear Reactor in Mars Past : The Natural Nuclear Reactor Hypothesis had the merit that it provided a known source for a large nuclear explosion that , in turn, explained the salient features of Mars isotopic anomalies with one or two events. However, deeper analysis-the xenon spectrum and absence of large craters- has shown this hypothesis is inadequate. Therefore, we must consider other hypotheses that are more complex. The first hypothesis that will be considered, is that nuclear explosions occurred in mid-air above both Mare Acidalium and Utopia Planum but that their cause is anomalous , this be called the **Anomalous Explosion Hypothesis**[13] We will also consider the hypothesis of explosions in mid-air of two large asteroidal bodies enriched in Iodine 129 and other fission products and fissional materials. We will call this the **TIFRA** (Tunguskoid Intrinsically -Fission Rich Asteroid) hypothesis. Finally the **Null Hypothesis** , will also be considered, which says that the isotopic anomalies-particularly the xenon 129 hyper-abundance, the K-Th –U enriched surface layer, the neutron irradiation in the Sherggotites and finally the acid-etched glass at both the radioactive hot spots, is simply due to variety of independent causes unique to the large and geologically active environment of Mars and its proximity to the asteroid belt.

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