# Landing on the Moon's farside: *What are the geochemistry, astrobiology and instrumental issues?*

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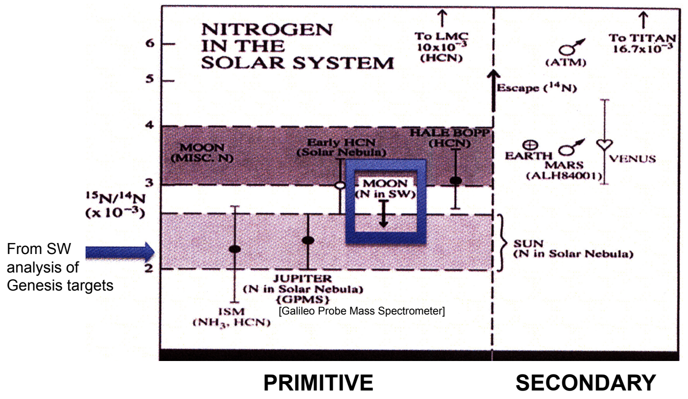
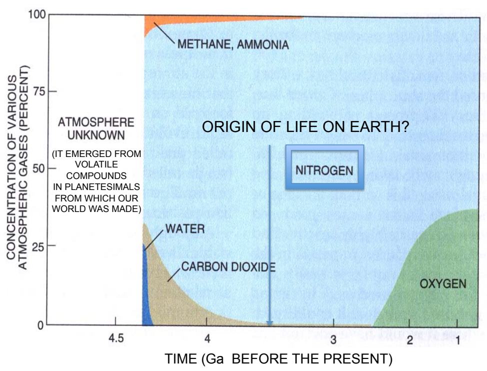
## 1. The lunar nitrogen problem in a cosmic context [1]




The isotopes of nitrogen in the Solar System, especially on the Moon's surface, do not always reflect those of the protosolar nebula.

## 2. What was the nitrogen concentration in the primitive terrestrial atmosphere?

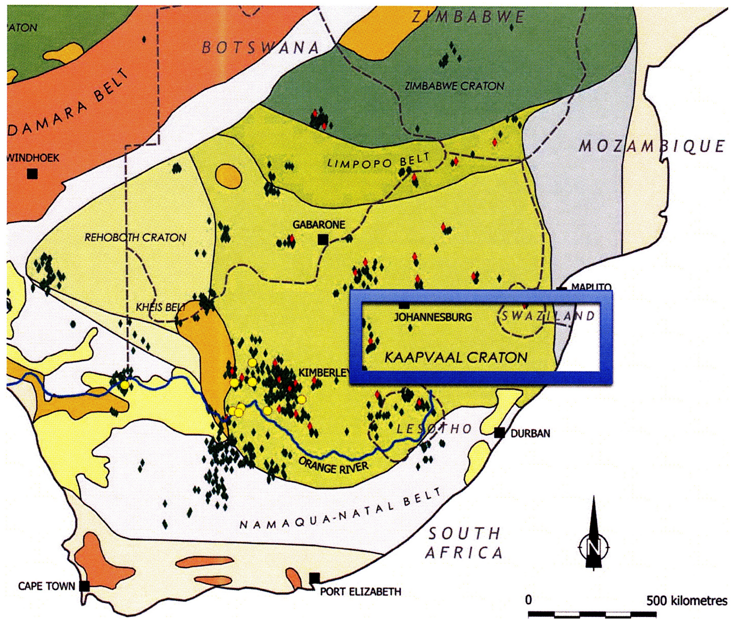
We have the opportunity to retrieve data from the early terrestrial atmospheric nitrogen at the time of the origin of life on Earth (to improve our chemical evolution scenarios).




Based on:
http://ircamera.as.arizona.edu/NatSci102/NatSci102/lectures/earth.htm

## 3. An issue in geochemistry: *the late onset of the geomagnetic field (GMF) and nitrogen isotopes*

In the past the analysis of ilmenite grains from the Kaapvaal craton has been interpreted in terms of a GMF that was null, or very weak, before about 3.8 – 3.9 Ga [2, 3].

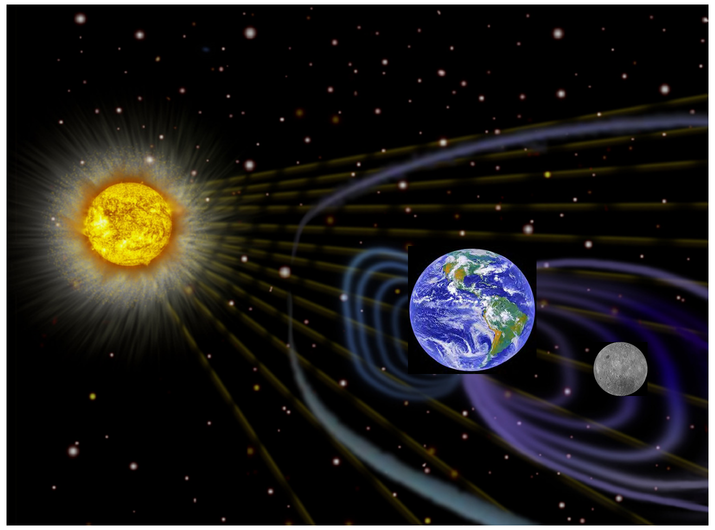



This craton (3.6 - 2.5 Ga) is one of the remaining areas of pristine crust on Earth. The current tests are compatible with the hypothesis of a null GMF in the early Archaean.

This raises the question that in the distant past the influx of terrestrial nitrogen to the Moon's surface might have been significant.

## 4 . An issue in astrobiology: *towards better models of chemical evolution* [4]

In the absence of a GMF the atmospheric nitrogen (Earth wind, EW) would be dragged by the solar wind to impinge exclusively on the lunar regolith on the early Moon's *nearside*.



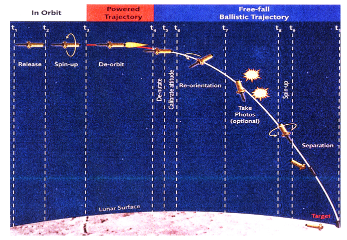
The EW implanted on the lunar soils during the Archaean is a tracer of both, the GMF and especially of the early atmosphere [5], which can lead to better models of chemical evolution.

This forces upon us measurements of possible anomalies of isotopic nitrogen ratios on both sides of the Moon.

Several cutting-edge technologies are available for such measurements.

## 5. An instrumental issue: *Using kinetic penetrators (KP) for probing the Moon' surface* [6]

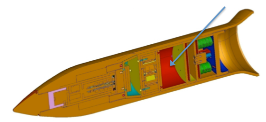
Exploring the lunar surface is feasible with KPs bearing a suite of instruments that could embed themselves underneath the lunar surface. Delivery could be from orbit with a dedicated descent module.




## 6. Conclusion: *Using kinetic penetrators for testing nitrogen anomalies on the Moon' s farside* [4]

From the point of view of astrobiology, a mass spectrometer (MS) is an appropiate instrument for identifying lunar geochemical asymmetries.

*Possible location of a MS in a KP*



## 7. References

1. Owen, T. *et al*. (2001) Nitrogen on the Moon: What does it tell us?. *Earth, Moon and Planets* **85-86**, 343-350.
2. Tarduno, J. A. *et al*. (2010) Geodynamo, Solar Wind, and Magnetopause 3.4-3.45 Billion Years Ago. *Science* **237**, 1238-1240.
3. Friese, A. E. W. *et al*. (2003) $^{40}Ar$-$^{39}Ar$ Dating of and Structural Information on Tectonite-Bearing Faults in the Witwatersrand Basin: Evidence for Multi-Stage, Tectono-Thermal Activity in the Central Kaapvaal Craton. *South African Journal of Geology* **106,** *41-70.*
4. Chela-Flores, J. (2012) A case for landing on the Moon's farside to test nitrogen abundances. *International Journal of Astrobiology* **11**, 61-69.
5. Ozima, M. *et al*. (2005) Terrestrial nitrogen and noble gases in lunar soils. *Nature* **436**, 655–659.
6. Smith, A. *et al*. (2011) Lunar Net —A proposal in response to an ESA M3 call in 2010 for a medium sized mission. *Experimental Astronomy* **23** (3), 711-740.

**Credits for the images: Sec. 4** *NASA and NOAA (for the solar wind image), and NASA for the Earth and the Moon's farside;* **Secs. 5 and 6:** *The UK Penetrator Consortium.*