# Terrestrial atmospheric nitrogen in lunar soils?

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Surface-correlated N in lunar soils and breccias exhibits an obvious but mysterious effect that was evident essentially from the first analyses of samples returned by the Apollo missions: The isotopic ratio $^{15}N/^{14}N$ is variable, by up to 30%. For some time this was interpreted in terms of variation in the solar wind isotopic composition, perhaps reflecting solar nuclear processes and perhaps even reflecting a secular trend (e.g. Kerridge, 1993). This would be very difficult to understand (Geiss and Bochsler, 1982) in terms of the standard model of the Sun, however, and more recently Hashizume *et al.* (2000), among others, have championed an alternative interpretation that the isotopic variations reflect N in extralunar, extrasolar particle infall mixing with the solar wind N.

Most recently, Ozima *et al.* (2005) have suggested another interpretation: That the isotopic variations in lunar soil N reflect admixture of solar wind N with an "Earth wind" flux of atmospheric N. An Earth wind flux is quantitatively insufficient under present circumstances, but might have been quantitatively effective very early in the history of the Earth-Moon system, before the development of the global geomagnetic field. Although viable this seems a quite unlikely hypothesis, but one laden with important consequences if valid.

The Ozima *et al.* (2005) hypothesis is also subject to simple test: If the isotopic variations are due to a contribution of Earth wind they should be essentially absent in lunar farside samples, since the Moon is thought to have been spin-locked essentially throughout the history of the Earth-Moon system, and an Earth wind would not reach the farside. The purpose of this work is to apply this test.

There are no samples returned from documented farside locations, but there are numerous lunar meteorites, half of them presumed to originate on the farside. We analyzed N in nearly all eleven soil and fragmental breccias known among Antarctic lunar meteorites. By the Earth-wind hypothesis, half should display essentially constant isotopic composition of N, at the solar wind value. This expectation is not realized in our observations, so we conclude that the Earth-wind hypothesis for the origin of N isotopic complexity in lunar soils is not tenable.

## References

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# The rim structure of simple craters as an indicator for an impact vector

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The rims of two simple impact craters, Wolfe Creek, Australia, and Meteor Crater, AZ, USA, were examined. New methods of analysis were devised to display structural features that may be indicative of oblique impacts. Data from the two craters are compared.

Although the majority of craters are formed by oblique impacts, crater shapes remain circular for impact angles >30° and thus normally do not give any implications for the direction of impact. However, the ejecta blanket is the most sensitive indicator for impact angle and direction, and can show a “forbidden zone” on other terrestrial bodies.

The ejecta trajectories forming asymmetric or bilaterally symmetric ejecta blankets of oblique impacts may deviate from a radial orientation with respect to the final crater center and could probably be traced at the rim and overturned flap of simple craters, which represent the most proximal part of the ejecta. We therefore systematically analyzed strike and dip of strata in the crater rims of two young, simple impact craters, Wolfe Creek Crater and Meteor Crater.

Wolfe Creek Crater is located in Western Australia, was formed 300 ka ago and has an average diameter of 880 m. It was formed in sub-horizontal Devonian sandstones that are overlain by a layer of Miocene laterites. Meteor Crater in Arizona is 50 ka old and 1200 m in diameter. Pre-impact target rocks are sub-horizontal Permo-Triassic sandstones and limestones.

The strike data collected in both craters is translated from a geographic to an azimuthal referece scheme with the point of origin situated in the crater center. The strike of rock layers in the rim is examined for deviations from a hypothetical concentric orientation with regards to the crater center. The deviation can be expressed as an angular value for each measurement.

*Results*: When displayed in a polar plot, which gives a better sense of the spatial relationship, the values reveal a bilaterally symmetric orientation of the bedding and potential “forbidden zones”. These preliminary results contradict earlier propositions for an impact vector in both Wolfe Creek Crater (Shoemaker *et al.*, 2005) and Meteor Crater (Roddy & Shoemaker 1995). We intend to compare these results with other information, e.g. distribution of dip data, stereo plots and spatial relationships of bedding in three dimensions.

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## References

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