LUNAR VOLATILES: MORE THAN MEETS THE EYE? William N.
Agosto, Lunar Industries, Inc., Houston, TX 77239-0004

Because it may cost an average of $25,000 to deliver a pound
of terrestrial volatiles to the lunar surface, an economic
indigenous source of lunar volatiles will be in great demand for
future lunar base operations. While the moon is proverbially
volatile poor, 1000 ppm of combined absorbed volatiles of light
species like H, He, C and N have been released from bulk lunar
materials at 1000°C (1). A major source of the volatiles is
believed to be the solar wind which is predominantly hydrogen
(2,3). Recalculated data of Gibson and Johnson (4) on lunar soil
fines reveals that approximately 81% of the hydrogen is released
below 600°C (5). Accordingly, lunar fines may prove to be a
significant source of volatiles for space industrial utilization
(6).

Just in terms of the known hydrogen abundance of 150 ppm
absorbed in the sub 20 micrometer size fraction of lunar soil
(7), there is enough hydrogen, at 75% recovery from the top meter
of regolith over the entire lunar surface, to make (when combined
with lunar oxygen) an all-lunar water lake of over 1000 square
kilometers at ten meters depth. The question of the most
efficient method of extracting lunar soil volatiles has to be
addressed in the context of concentrating other valuable lunar
surface materials like oxides, metals, glasses and ceramics
(8,9).

Lunar volatiles may, in fact, be much more abundant than is
generally believed. Frank et al. (10), in a very controversial
paper, have interpreted transient holes appearing at the rate of
20 per minute in the ultraviolet day glow of the earth as due to
low density ice comets (0.1 g/cm^2) each approximately 100 tons in
mass and consisting primarily of water, carbon and dust that
impact the earth's upper atmosphere. The authors predict
relatively low speed impact (<10 km/sec) of these bodies on the
moon. If they are correct, their estimate of the lunar infall of
such comets at the rate of 300 per day (11) amounts to about 10^4 tons of impacting volatiles on the lunar surface every year. If
only one part per million of that material random walks to the
lunar poles and is trapped in permanently shadowed craters it
would amount to a volatile deposit of ten tons per year. Such a
continuous influx could, of course, add up to billions of tons of
volatiles at the lunar poles over geologic time. This radical
hypothesis has naturally attracted a storm of criticism (12,13,14)
chiefly to the effect that it increases the extraterrestrial
material influx many orders of magnitude above what has been
traditionally observed in the cislunar environment and that
lighter masses at far lower impacting energies like the spent
Saturn IV booster (14 tons at 2.5 km/sec) have been detected by
lunar seismometers while nothing like the proposed comet influx
has been detected by the same instruments. In response to the
objections Frank et al. have pointed out that the mechanical
competence (tensile/compressive strength, elastic limit, etc.) of
the postulated comets is orders of magnitude below the stony
meteoroid and Apollo hardware influx that have been seismically

© Lunar and Planetary Institute • Provided by the NASA Astrophysics Data System
LUNAR VOLATILES: MORE THAN MEETS THE EYE?

Agosto, W. N.

detected and that, as a consequence, the thermal/mechanical partitioning and mechanical modes of the impacting comet energies are outside the detection limits of the lunar seismometers. They also point out that lunar seismic detection of the influx of bodies >1 ton is four orders of magnitude below that inferred from the frequency of incoming fire balls detected on earth by the Prairie Network (11). From the lunar volatiles perspective, it might also be noted that transient gas bursts, traditionally ascribed to volcanism, have been detected with some regularity on the moon without corresponding seismic records (15,16,17). Accordingly, the hypothesis of Frank et al. is still very much an open question.

REFERENCES: