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Lunar Polar Areas of Water-Rich Permafrost According to LEND/LRO Data

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Introduction: Discovery of "New Polar Moon". The main signature of "New Polar Moon" is the presence of rather high content of water and another volatiles in the polar regolith. The first possible detection of water ice in polar craters has been claimed by the radar team of Clementine mission. Non-direct evidence for the presence of water ice in polar regolith was provided by Lunar Prospector Neutron Spectrometer (LPNS), as extended suppressions of neutrons emission around lunar poles. The first direct detection of H2O and/or OH in the top layer of polar regolith was performed by IR mapping spectrometer M3 onboard Chandraiaan-1 mission, but IR data characterizes the upper most layer of few microns only.
The final proof for the presence of local areas with high content of water and another volatiles at lunar poles has been recently provided by direct measurements of NASA's LRO and LCROSS missions: orbital neutron telescope LEND of LRO has identified the crater of Cabeus, as the most promising impact site with high content of hydrogen, and instruments onboard LRO and LCROSS have measured direct signatures of water, H2 and another volatiles in the plume material from the artificial impact crater.
Observations: local water-rich areas at lunar poles, as Neutron Suppression Regions (NSRs). Currently available neutron data from LEND allowes identification of several local areas around both lunar poles, which might have rather high content of water ice about several percent by mass within 1 meter of the subsurface. They are detected as Neutron Suppression Regions, or NSRs.
Questions to be addressed about "New Polar Moon": There are several questions about water-linked processes at recently found NSRs, which shall be addressed in the presented talk:
(1) Which combination of physical conditions is necessary for a local area at lunar pole to become NSR with permanent water ice in the shallow subsurface? Initially one thought that permanent shadow could be a sufficient condition for deposition and preservation of water ice in regolith. Current experimental data does not support such a simple idea; many PSRs do not manifest suppression of epithermal neutrons, and there are cases, when NSR have illuminated surface.
(2) What is the origin of water in NSRs? One hypothesis assumes that water was delivered to the Moon by comets. The hypothesis of "comet water" was generically related with the model of PSRs, as "cold traps" for water vapor from the post-impact transient atmosphere. "Comet water" was delivered in separate impact episodes, and one has to explain current location of water in NSRs by time history of these events. The second hypothesis proposes that lunar water is continuously produced in chemical reactions in regolith between implanted protons of solar wind and oxygen of the soil.
(3) Which process could transport water molecules over the surface

from the place of initial release to the site of deposition? Detection of local NSRs with enhancement of hydrogen and/or water points out that there should be some mechanism of “horizontal migration”, which delivers molecules toward some particular places of deposition on the lunar surface..

(4) How could water propagate down to lunar subsurface? The presence of water in the regolith in sun-lit conditions points out that ice is the most likely preserved in the permanently cold layer of permafrost, which is covered by dry regolith, which temperature varies according to diurnal cycle of solar irradiation. Some kind of “vertical migration” transport should be considered for explanation of NSR formation, which brings water from the surface down to cold layer of permafrost.