Lunar Exploration (3)
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# STRATEGIC PARADIGM SHIFTS ABOUT INESCAPABLE FINE DUST ON THE MOON: GROUND-TRUTH MEASUREMENTS FROM APOLLO 11 TO CHENG'E-4

**Abstract**

Although many magnificent technological and scientific achievements were made by Apollo astronauts and geophysical observatories they put on the Moon, low priority was given to risk management of inescapable lunar dust as fine as talcum powder. The final Apollo 17 astronaut, Gene Cernan reported "we can overcome other physiological or physical or mechanical problems except dust". The dust adhered 'to everything, no matter what kind of material" with a "restrictive, friction-like action to everything ...". The 7 experiments chosen by NASA in 1965 for Apollo observatories included our Charged Particle Lunar Environment Experiment (CPLEE). To improve its engineering risk-management of dust, on 12 January, 1966 we invented and quickly proposed an eighth experiment, our minimalist 270g Apollo Dust Detector Experiment (DDE). From 1969 to 1976, Apollo 11, 12, 14 and 15 DDEs made the only measurements to date of movements of fine dust on the surface of the Moon. Here we show key recent discoveries with Apollo 12 DDE of sunrise-driven dust storms and dust levitation to the experiment height of 100cm. Our measurement-based simple 5-step model of sunrise effects begins with the cohesive forces between dust particles, unreferenced and unacknowledged since 1972 and ends with explaining why surfaces of the Moon are normally smooth and dust-covered. The vertical East-facing solar cell of Apollo 12 DDE measures changes in brightness of the dawn horizon caused by levitated dust clouds while the horizontal cell measures dust deposition, amounting over the first 3 days to about 30In 2015 we suggested sunrise-driven dust storms caused immobilisation after its first sunrise, of the moving parts of Cheng'e-3 Yutu, the first lunar rover in 40 years. In May 2016, a major revision of scientific priorities will make Chang'e-4 lunar rover in 2018 the first spacecraft on the Moon with top priority on studies of lunar surface moving dust. We anticipate that the strategic new emphases by Chang'e-4 in 2016 on lunar surface dust might cause re-examination of Apollo-era low priorities of risk management of dust movements in the international plans of a Moon Village and the engineering designs of Google Lunar XMedal competitors.