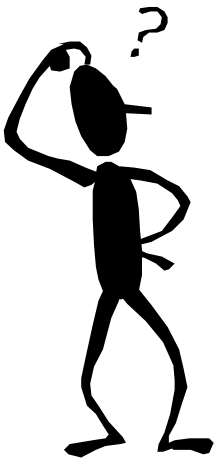

SOLAR-WIND HYDROGEN AT THE LUNAR POLES

H. H. Schmitt, G. L. Kulcinski, J. F. Santarius,
J. Ding, M. J. Malecki, and M. J. Zalewski

University of Wisconsin

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INTRODUCTION

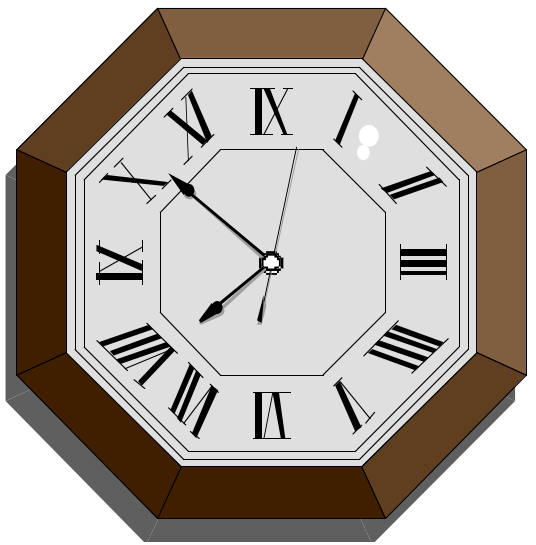
- APOLLO SAMPLE DATA
  - UP TO 146 wppm HYDROGEN
  - SOLAR-WIND ORIGIN
- EPITHERMAL NEUTRON DATA
  - AVERAGE ~50 wppm HYDROGEN
  - ~150 wppm IN POLAR REGIONS
  - 1500 ± 800 wppm IN DEEP POLAR CRATERS
- CLEMENTINE 750nm ALBEDO VS. NEUTRON DATA (DING)
  - 36 wppm NEARSIDE VS. 28 wppm FARSIDE

INTERPRETATION?

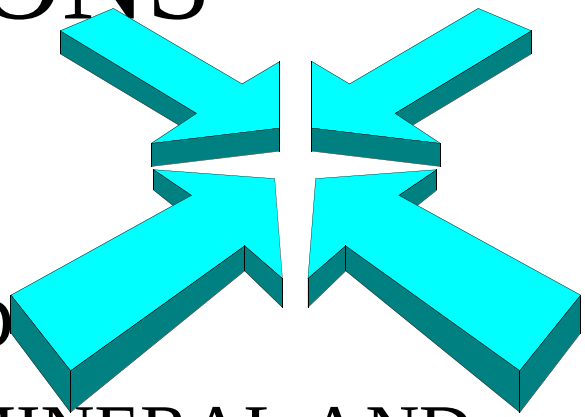
- PROSPECTOR TEAM
  - LARGE QUANTITIES OF POLAR ICE WITH SOME SOLAR-WIND HYDROGEN
- THIS PAPER
  - LARGELY CONCENTRATED SOLAR-WIND HYDROGEN

REGOLITH MATURATION

- BEGINS WITH SURFACE STABLIZATION
  - MODIFICATION BY:
    - PRIMARY IMPACTS
    - SECONDARY IMPACTS
    - SPACE RADIATION
    - INTERNAL VOLATILE MIGRATION
- SPACE RADIATION
  - COSMIC RAYS
  - SOLAR-WIND IONS

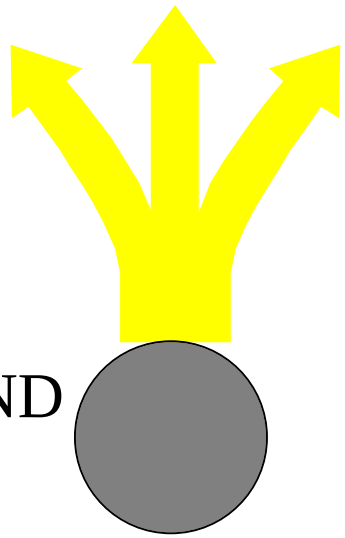


SOLAR-WIND IONS



- HYDROGEN (PROTONS)
  - ~ 96% OF THE SOLAR-WIND
  - INITIALLY IMBEDDED IN MINERAL AND GLASS CONSTITUTENTS
  - PARTIALLY RELEASED AS <u>PICKUP IONS</u>
    - MICROMETEORIOD IMPACT
    - DIURNAL HEATING
  - PARTIALLY RETAINED BY BURIAL

PICKUP IONS



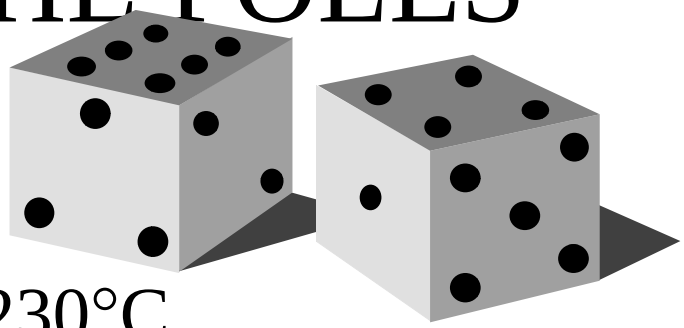
- RELEASED REGOLITH VOLATILES
  - IONIZED AND ENTRAINED IN SOLAR-WIND
  - LOST ENTIRELY OR RE-IMPLANTED

- DEFINITIVE MODEL OF HISTORY OF PICKUP IONS NOT YET AVAILABLE
  - APOLLO, CLEMENTINE AND PROSPECTOR DATA DEFINE ~STEADY-STATE IN REGOLITH

STEADY-STATE HYDROGEN CONCENTRATION

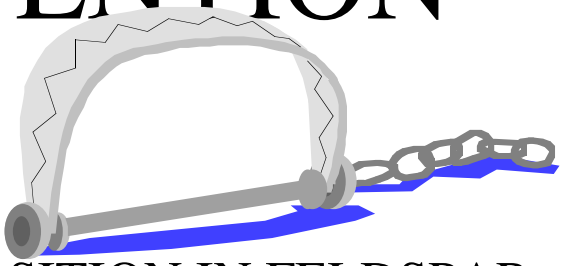
- APOLLO SAMPLES: 1OO ± 50 wppm
  - MAY BE LOW DUE TO HANDLING LOSSES
- PROSPECTOR DATA FOR REGIONS WITH PERMANENT SHADOW
  - ~150 wppm (HIGH END OF APPOLLO DATA)
  - X3 THAT SEEN FOR LOWER LATITUDES
  - GRADUAL DECREASE ACROSS PERMANENT SHADOW BOUNDARIES
  - 1500 ± 800 wppm IN DEEP POLAR CRATERS

CONDITIONS AT THE POLES

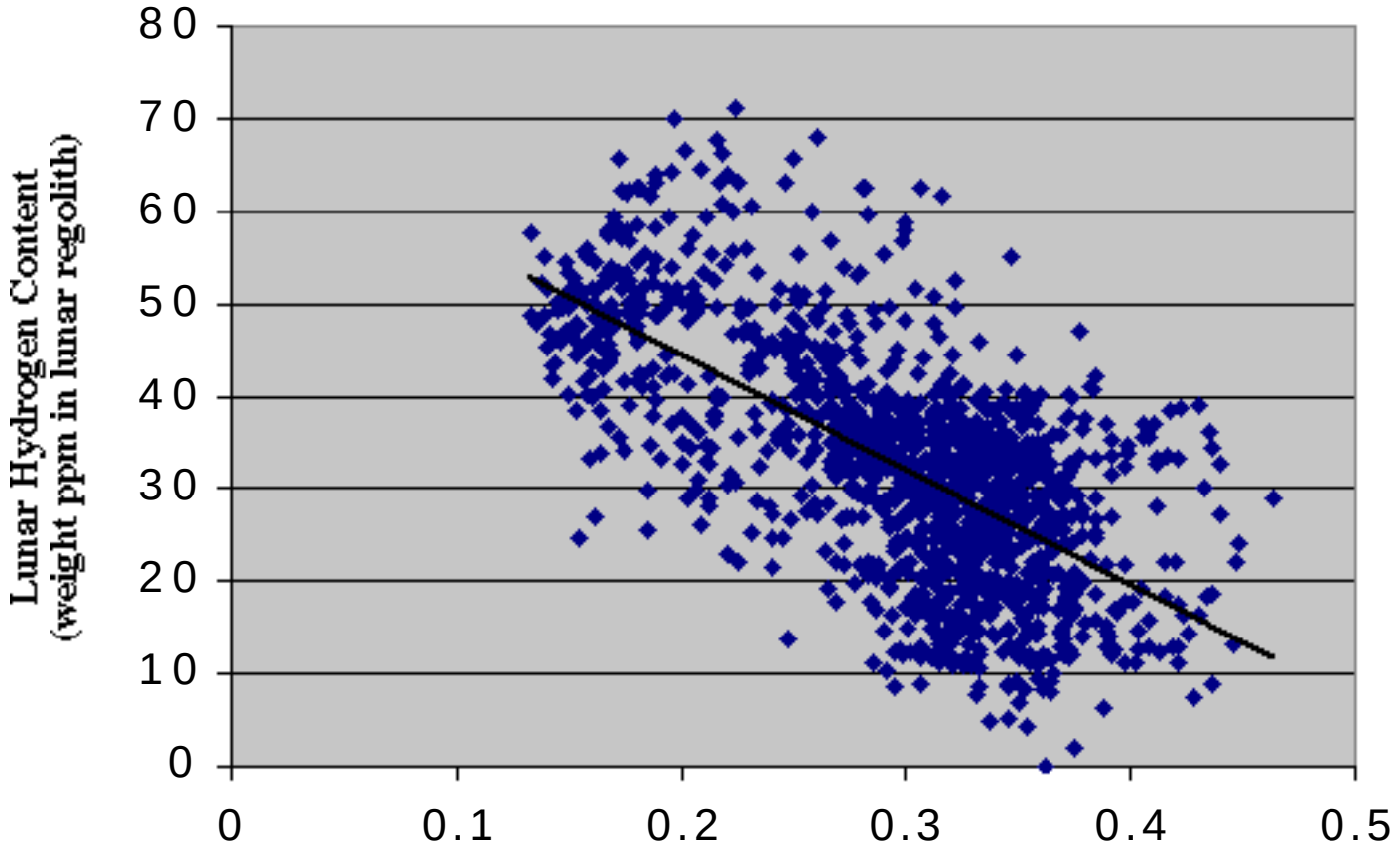


- PERMANENT SHADOW - ~ -230°C
- OUTSIDE PERMANENT SHADOW
  - AVERAGE TEMPERATURE INCREASES WITH DECREASING LATITUDE
- MAXIMUM CONTRAST BETWEEN EQUATOR AND PERMANENT SHADOW
  - ~350°C

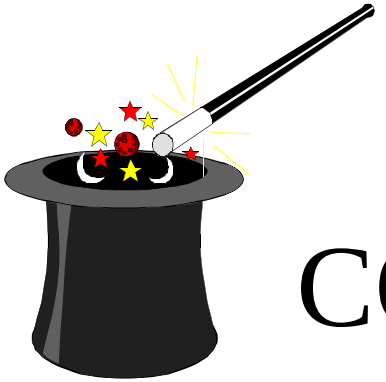
HYDROGEN RETENTION



- PLAGIOCLASE FELDSPAR
  - KNOWN TO ASSUME A CATION POSITION IN FELDSPAR - SODIUM SUBSTITUTE?
    - NOTE TRANSIENT SODIUM ATMOSPHERE
  - SUGGESTED BY CONCENTRATION NEAR LARGE, YOUNG HIGHLAND CRATERS
  - SUGGESTED BY CONCENTRATION IN KREEP-RICH ANNULUS AROUND IMBRIUM
- ILMENITE
  - CLEMENTINE-PROSPECTOR COMPARISON BY CO-AUTHOR DING



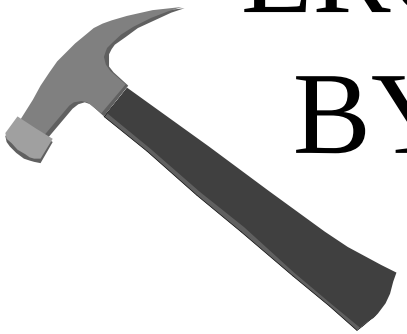
AVERAGE TRAPPED LUNAR HYDROGEN IS HIGHEST IN REGIONS HAVING THE LOWEST AVERAGE ALBEDO VALUES.



SOLAR-WIND CONSIDERATIONS

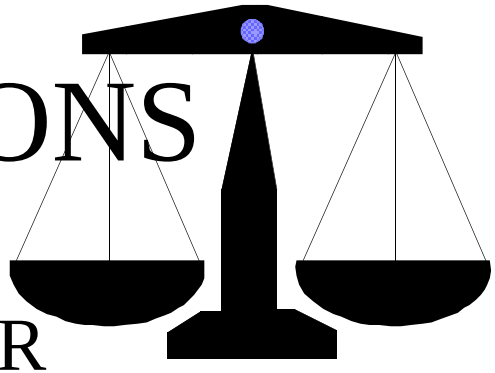
- VARIABLES AFFECTING ADDITIONS AND LOSSES OF HYDROGEN NEAR THE POLES
  - SOLAR-WIND FLUX VS. LATITUDE AND LONGITUDE
  - TILT OF MOON'S AXIS RELATIVE TO ECLIPTIC
  - NON-ECLIPTIC COMPONENT OF SOLAR-WIND
  - DIURNAL TEMPERATURE VARIATION VS. LATITUDE AND LONGITUDE
  - PICKUP ION REDEPOSTION RATES VS. LATITUDE AND LONGITUDE
  - ABUNDANCES OF RETENTIVE MINERALS
  - MOON'S INTERACTION WITH THE MAGNETOSPHERE
  - FLUX OF MICRO-METEORITES IMPACTING THE MOON

EROSION OF WATER ICE BY MICROMETEROIDS



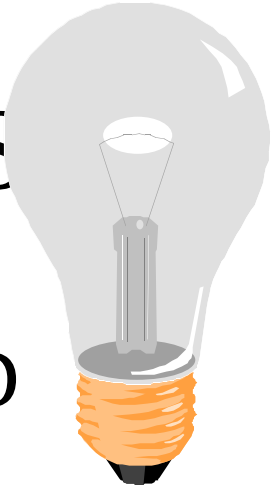
- REGOLITH TURNOVER (GARDENING)
  - FEW CM EVERY 10 MILLION YEARS
- BLANKET OF COMETARY ICE WOULD ERODE AT COMPARABLE RATE
  - SPUTTERING DUE TO SOLAR-WIND WOULD ADD TO EROSION
  - SOME PROTECTION POSSIBLE IN DEEP CRATERS OR BY FORTUITOUS EJECTA

SCIENCE CONCLUSIONS



- THE HYDROGEN SIGNAL IN POLAR REGIONS IS LARGELY A CONCENTRATION OF SOLAR-WIND HYDROGEN BY COLD-TRAPPING
  - WATER ICE MAY BE PRESENT IN DEEP CRATERS WHERE PARTIALLY PROTECTED FROM EROSION
  - WATER ICE MAY BE LOCALLY MIXED WITH SOLAR WIND HYDROGEN WHERE INITIALLY PROTECTED FROM EROSION BY IMPACT EJECTA

HELIUM-3 CONCLUSIONS



- CONCENTRATION OF SOLAR-WIND HYDROGEN IN POLAR REGIONS IMPLIES THE SAME FOR HELIUM-3
  - MORE INFORMATION ON ACUTAL GRADE IS REQUIRED BEFORE THE POLES BECOME MORE INTERESTING THAN TI-RICH MARE WHERE HELIUM-3 GRADE IS WELL-DEFINED BY APOLLO AND CLEMENTINE DATA

LUNAR BASE CONCLUSIONS

- WATER CAN BE PRODUCED FROM THE REGOLITH ANYWHERE ON THE MOON THAT OPERATIONS REQUIRE
  - SPECIFIC LUNAR BASE TRADE STUDIES MUST DEMONSTRATE THAT WATER PRODUCED AT THE POLES, AND TRANSPORTED TO THE BASE, IS LESS COSTLY THAN LOCAL PRODUCTION