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CRATER RETENTION AGES OF PLANETARY SURFACE PROCESSES: NEW PROGRESS

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Introduction: Impact crater densities (craters/km^2) have allowed successful estimate of planetary surface ages and survival times of topography on modified surfaces [1–3]. Malin et al. recently reported a breakthrough observation: formation rate of small (~20 m) Martian craters [4]. If correct, this will allow even more direct age measurement.

History of Technique: The technique was introduced in the 1960s when Canadian impact craters were used to predict the ~3.6 Ga age of lunar lava plains [5], and an "early intense bombardment" prior to 3.6 Ga [6], confirmed by Apollo. In the 1970s, cratering rates were extended to Mars by scaling arguments [1]. This led to age estimates of a few hundred Ma for Mars' broad lava plains [1], supported in the 1980s by ages of Martian basaltic meteorites [7, 8]. My 2005 "isochron" plot [2] shows expected crater densities on Martian surfaces of different age, in the absence of erosion. The new Malin et al. data [4] agree with the isochrons within a factor 3 [9]. This opens the door to direct Martian age measurements without scaling arguments. It also negates most recent critiques of the technique [10].

Example: Debris Aprons, Ice Flow, and Climate/Obliquity Cycles: A striking application illustrates the power of the method. Martian features attributed to ice deposition include debris aprons, mantles, and possible glaciers [2, 11, 12]. Measurements of ages of decameter-scale structure on these surfaces repeatedly give ages in the range ~3–50 Ma, measured either by my isochrons, Neukum's isochrons, or the new Malin et al. measurement [2–4, 9]. These ages are in the range of the last few high-obliquity episodes, and support suggestions that Mars is undergoing ~10 Ma cycles of climate change in which ice deposition occurs [2, 12–14].

Conclusions: The technique offers great promise for further work on Mars and extension to other planetary bodies.

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LIGHT NOBLE GAS COMPOSITION OF DIFFERENT SOLAR WIND REGIMES: RESULTS FROM GENESIS

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Introduction: The Genesis mission provided samples of solar wind (SW) from different regions on the Sun. These SW regime samples are important in understanding fractionation processes upon formation and acceleration of the SW to ultimately deduce solar composition from SW values. We present He and Ne isotopic and elemental compositions of the bulk SW (SW of entire collection period) and the 3 major SW regimes: slow (from the ecliptic plane, emanating from above streamers), fast (emanating from coronal holes), and coronal mass ejections (CME). At the conference we will also present Ar data.

Experimental: Noble gases were analyzed in targets composed of amorphous, diamond-like C on Si. The low atomic mass of C minimized backscatter losses and thus isotope fractionation. Backscatter loss was corrected for He and was negligible for Ne based on SRIM [1]. Gases were extracted by UV laser ablation (213 nm). The main focus of this work is to detect differences between SW regimes. Therefore, He and Ne isotopes and ^{4}He/^{20}Ne were analyzed in 3 separate runs, using standard-sample bracketing. The bulk SW target served as "standard" and the other regime targets as "samples." Experimental details are given in [2].

Results: The preliminary ^{4}He/^{3}He of the bulk SW is 2081 ± 17. He isotopes are fractionated between slow and fast SW by 6%, ^{3}He being enriched in the former. The ^{20}Ne/^{22}Ne and ^{21}Ne/^{22}Ne of the bulk SW are 13.80 ± 0.03 and 0.0328 ± 0.0001, respectively, in excellent agreement with reported SW values [3, 4]. In contrast to He, fractionation of the ^{20}Ne/^{22}Ne between slow and fast SW is only marginally significant ($\leq$1%), ^{20}Ne tending to be enriched in the slow SW. The enrichment of light isotopes in the slow SW is in accordance to the Coulomb drag theory, postulating isotope fractionation upon acceleration of SW species in the lower corona [5]. The preliminary ^{4}He/^{20}Ne of the bulk SW is 669 ± 6. The slow SW is depleted by 1% in He relative to Ne and fast SW either due to inefficient Coulomb drag [6] or fractionation upon ionization in the chromosphere (although first ionization potentials of He and Ne are similar, ionization times are very different [7]). In contrast to the quasi-stationary slow and fast SW, transient CME events are known to vary in composition. The Genesis CME targets collected many events, providing an average CME composition. He isotopic composition is similar to bulk SW, thus an enrichment of ^{3}He over ^{4}He as observed in many single events could not be detected. Most prominent is, however, the ^{4}He enrichment over ^{20}Ne of ~10% in CMEs relative to quasi-stationary SW, in accordance with the He over O enrichment detected with the ACE spacecraft [8].

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