high emission angles, i.e., near the planetary limb. The atmosphere is assumed to be optically thin in this model, so optical depths greater than 0.2 are not modeled using this formulation. Hapke's bidirectional reflectance function is used to model the surface scattering, assuming a phase function of the form $P(a) = 1 + b \cos(a)$, where a is the phase angle. Dust was assumed to be responsible for all the atmospheric scattering in this model (Rayleigh scattering in the martian atmosphere is insignificant in visible light).

The effects of turbulence in the terrestrial atmosphere ("seeing") upon groundbased Mars images were simulated by convolving a smearing function similar to that used by Lumme [5] with theoretical profiles. The results of this convolution indicate that changes in optical depth of 0.1 can be observed from Earth even with 2 arcsec seeing if the atmosphere is optically thin (small changes in opacity cannot be distinguished in the optically thick case). The shape of the photometric profile is not diagnostic of scattering in all cases, but the absolute reflectance can be used to infer the optical depth of dust in the atmosphere. Therefore, it should be possible to determine the optical depth of aerosols in an optically thin martian atmosphere using well-calibrated groundbased images of Mars. To test the viability of this method, we are comparing Viking data with nearly simultaneous groundbased photographs of Mars taken during the 1977–1978 apparition. The results of this comparison will be reported at the workshop.

References: [1] Martin L. J. and Zurek R. W. (1993) *JGR, 98*, 3221. [2] Zurek R. W. and Martin L. J. (1993) *JGR, 98*, 3247. [3] Arvidson R. E. et al. (1989) *JGR, 94*, 1573. [4] Herkenhoff K. E. and Murray B. C. (1990) *JGR, 95*, 1343. [5] Lumme K. (1976) *Icarus, 29*, 69. [6] Thorpe T. E. (1978) *Icarus, 36*, 204. [7] Thorpe T. E. (1982) *Icarus, 49*, 398. [8] Gierasch P. J. and Goody R. M. (1972) *J. Atmos. Sci., 29*, 400. [9] Haberle R. M. et al. (1982) *Icarus, 50*, 322. [10] Barnes J. R. (1990) *JGR, 95*, 1381. [11] Murray B. C. et al. (1972) *Icarus, 17*, 328. [12] Cutts J. A. et al. (1976) *Science, 194*, 1329. [13] Cutts J. A. (1979) *JGR, 84*, 2975. [14] Squyres S. W. (1979) *Icarus, 40*, 244. [15] Toon O. B. et al. (1980) *Icarus, 44*, 552. [16] Carr M. H. (1982) *Icarus, 50*, 129. [17] Howard A. D. et al. (1982) *Icarus, 50*, 161. [18] Plaut J. J. et al. (1988) *Icarus, 75*, 357. [19] Thomas P. et al. (1992) in *Mars* (H. H. Kieffer et al., eds.), 767–795, Univ. of Arizona, Tucson. [20] Martin L. J. et al. (1991) *Bull. A.A.S., 23*, 1217. [21] Clancy R. T. (1992) personal communication. [22] Ingersoll A. P. and Lyons J. R. (1991) *Bull. A.A.S., 23*, 1217. [23] Zurek R. W. (1982) *Icarus, 50*, 288. [24] Esposito L. W. et al. (1990) *Bull. A.A.S., 22*, 1076. [25] Thorpe T. E. (1977) *JGR, 82*, 4151. [26] Jaquin F. et al. (1986) *Icarus, 68*, 442. [27] Hillier J. et al. (1991) *JGR, 96*, 19203.

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MARS ATMOSPHERIC LOSS AND ISOTOPIC FRACTIONATION BY SOLAR-WIND-INDUCED SPUTTERING AND PHOTOCHEMICAL ESCAPE.

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We examine the effects of loss of Mars atmospheric constituents by solar-wind-induced sputtering and by photochemical escape

during the last 3.8 b.y. Sputtering is capable of efficiently removing all species from the upper atmosphere including the light noble gases; N is removed by photochemical processes as well. Due to diffusive separation (by mass) above the homopause, removal from the top of the atmosphere will fractionate the isotopes of each species with the lighter mass being preferentially lost. For C and O, this allows us to determine the size of nonatmospheric reservoirs that mix with the atmosphere; these reservoirs can be CO_2 adsorbed in the regolith or H_2O in the polar ice caps. We have constructed both simple analytical models and time-dependent models of the loss from and supply of volatiles to the martian atmosphere.

Both Ar and Ne require continued replenishment from outgassing over geologic time. For Ar, sputtering loss explains the fractionation of $^{36}Ar/^{38}Ar$ without requiring a distinct epoch of hydrodynamic escape (although fractionation of Xe isotopes still requires very early hydrodynamic escape). For Ne, the current ratio of $^{22}Ne/^{20}Ne$ represents a balance between loss to space and continued resupply from the interior; the similarity of the ratio to the terrestrial value is coincidental. For Ni, the loss by both sputtering and photochemical escape would produce a fractionation of $^{15}N/^{14}N$ larger than observed; an early, thicker CO_2 atmosphere could mitigate the N loss and produce the observed fractionation as could continued outgassing of juvenile N. Based on the isotopic constraints, the total amount of CO_2 lost over geologic time is probably of order tens of millibars rather than a substantial fraction of a bar. The total loss from solar-wind-induced sputtering and photochemical escape, therefore, does not seem able to explain the loss of a putative thick, early atmosphere without requiring formation of extensive surface carbonate deposits.

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SNC METEORITES AND THEIR IMPLICATIONS FOR RESERVOIRS OF MARTIAN VOLATILES.

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The SNC meteorites and the measurements of the Viking landers provide our only direct information about the abundance and isotopic composition of martian volatiles [1,2]. Indirect measurements include spectroscopic determinations of the D/H ratio of the martian atmosphere [3]. Here I present a personal view of volatile element reservoirs on Mars, largely as inferred from the meteoritic evidence. This view is that the martian mantle has had several opportunities for dehydration and is most likely dry, although not completely degassed. Consequently, the water contained in SNC meteorites was most likely incorporated during ascent through the crust. Thus, it is possible that water can be decoupled from other volatile/incompatible elements, making the SNC meteorites suspect as indicators of water inventories on Mars.

Multiple Reservoirs of Volatiles on Mars: The covariation of $^{129}Xe/^{132}Xe$ with $^{84}Kr/^{132}Xe$ among the members of the SNC suite strongly implies that there are at least two volatile element reservoirs on Mars [4]. The first, best associated with the Chassigny meteorite, has a solar $^{129}Xe/^{132}Xe$ ratio of ~1 [4]. The second, best associated with shock glasses from the EETA79001 shergottite, has $^{129}Xe/^{132}Xe$ ~2 [4] and is within error of the Viking measurement of martian air [1]. Because Chassigny is a cumulate igneous rock that appears to have experienced minimal weathering [5,6] and interaction with crustal materials [7] (but see below!), it is assumed here that Chassigny's anhydrous, volatile-element component is derived