IMPACT DRIVEN SUPPLY OF SODIUM AND POTASSIUM TO THE ATMOSPHERE OF MERCURY: T. H. Morgan NRC/NASA JSC, Houston, TX 77058; A. E. Potter and H. A. Zook Space Science Branch/NASA JSC, Houston, TX 77058.

Sodium and potassium have recently been detected in the atmosphere of Mercury [1,2], and sodium is found to be the most abundant of the five atmospheric species known to exist on Mercury. On average, there are a total of approximately $3.7 \times 10^{+28}$ atoms of sodium and approximately $4 \times 10^{+26}$ atoms of potassium in the sunlit atmosphere. Atmospheric sodium and potassium can be removed from the planet by several physical processes [3,4], and observations indicate that the loss rate is at least $2.5 \times 10^{+22}$ atoms/sec, and probably larger. The rate of source processes for sodium must be at least this large. Three source mechanisms have been proposed: (1) Solar wind sputtering of the surface [1]; (2) Photo-sputtering [5], and (3) Meteoritic infall [1]. Sputtering by the solar wind is not a significant source process, since the solar wind is known to reach only a very small portion of the surface of Mercury. Early estimates of the contribution due to photo-sputtering were a few times 10^{+25} atoms/sec [5], but this result has been challenged [6]. Here we estimate the flux of atoms to the atmosphere of Mercury due to meteoritic infall.

The amount of vapor produced by a meteorite striking the surface of a planet depends on the mass of the meteorite, the material properties of both the projectile and the target surface, and the impact velocity. For very small velocities, 2-3 km/s, or for very small masses, experiments indicate that the mass of vapor formed at impact may be only a few percent of the projectile mass [6,7]. At larger velocities, in excess of 30 km/s, the mass of vapor formed at impact may be many times the impact mass [8]. Available data [9] indicate that impact generated vapor temperatures range from 2500 to 5000 K. Under these conditions it can be shown that the bulk of the sodium present in the vapor will be atomic sodium.

We assume that the density of material in the plane of the the ecliptic depends on distance from the Sun, r, as $r^{-1.3}$ [10]. The meteoritic infall rate at the Earth corrected for differences in geometric focusing and orbital velocity between the two planets, then yields the meteoritic infall rate onto the planet Mercury. Proposed velocity distributions for meteoritic material at 1 AU [11] can be scaled to the orbit of Mercury, and these predict an average impact velocity at the surface near 30 km/sec. The amount of ejecta from these impacts which remains on the planet depends on the impact angle. In the case of meteoroids which impact the surface at large angles to the local normal (greater than 45 degrees), much of the ejecta will leave the impact site with velocities approaching the local escape velocity. Taking these factors into account, conservative assumptions (0.40 kg/sec infall onto the planet; fraction of sodium by mass, 0.13 percent;

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average relative vapor yield, 1 gm/gm) yield sodium at the rate of 1.4x10+22 atoms/sec. Less conservative, and perhaps more realistic values for the infall rate and average relative vapor yield (0.80 kg/sec and 2 gm/gm, respectively) lead to $5.6 \times 10^{+22}$ atom/s for the sodium supply rate due to meteoritic impact. Thus, we conclude that meteoric infall can supply sodium at a sufficient rate to account for the observed sodium abundance. We anticipate that this same process can also account for the potassium abundance.

Paradoxically, the sodium and potassium vapor contained in the hot ejecta cloud may be preferentially removed from the planet over those portions of the orbit for which the solar radiation pressure on the atoms is high. Losses due to radiation pressure are enhanced by the elevated temperature of the impact vapor cloud, since the high velocity atoms in the ejecta cloud are exposed to solar radiation pressure for a longer time than low velocity atoms at near-surface temperatures.

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