Is Ozone Trapped in the Solid Carbon Dioxide Polar Cap of Mars?

Abstract. *Laboratory experiments show that solid carbon dioxide is an effective trap for ozone at temperatures as high as 156°K. Ultraviolet reflection-absorption spectra of ozone in solid carbon dioxide at 127°K indicate that the ozone observed over the polar cap of Mars may be trapped in solid carbon dioxide.*

The presence of ozone on Mars has been inferred (*1*) from the ultraviolet solar radiation scattered from the southern polar cap and measured with a scanning monochromator on the Mariner 7 spacecraft as it passed near the planet in August 1969. However, no ozone was detected over the desert regions. The amount of ozone observed was considerably greater than the steady-state, gas-phase concentration estimated from the abundance of major chemical species, temperature, pressure, and solar flux in the martian atmosphere (*2*). However, if ozone is "trapped" in the solid carbon dioxide cap, the "reflection-absorption" spectra would be expected to show the absorption feature of ozone.

In order to check this hypothesis, we have studied the trapping of O_3 in solid CO_2 at temperatures approximating the martian pole temperatures. The experimental system consisted of a Pyrex trap, in which solid CO_2 and ozone could be condensed, connected to an absorption cell in which ozone above the solid could be measured. The presence of ozone was measured by means of the absorption of the 2537-Å resonance line of a low-pressure Hg discharge (*3*). The trap was immersed in a slush of 2-methylbutane or 1-propanol, and O_3 was then either deposited simultaneously with CO_2 or deposited on CO_2 that had been previously condensed. With the trap in 1-propanol, the sublimation pressure of CO_2 was ~ 13 torr, corresponding to a surface temperature of about 156°K; the pressure of CO_2 with 2-methylbutane slush was ~ 0.10 torr, corresponding to a temperature of 127°K. However, during the experiments the temperatures may have dropped as much as 5°K when the pressure on the solid CO_2 was reduced.

In a typical experiment at 127°K, O_3 (at 0.1 torr) and CO_2 were passed through the trap until significant condensation had occurred. The trap and cell were then isolated from the supply, and the system was evacuated, the total pressure dropping to ~ 0.08 torr as the CO_2 cooled. Next the trap was isolated from the cell and pump while the absorption cell was pumped out. The cell in turn isolated from the pump and the trap opened to the cell. At this stage, the total pressure was ~ 0.16 torr, and the partial pressure of O_3 was 0.05 torr. This procedure was repeated until, after several cycles, the ozone began to be depleted.

These experiments indicate that O_3 was readily trapped when a mixture of O_3 and CO_2 was condensed in the trap, and it was also found that O_3 was trapped when it was passed over solid CO_2. At the higher temperature, 156°K, ozone was trapped but the partial pressures of ozone over the solid were substantially lower. No ozone was retained in the trap at these temperatures if O_3 alone was passed through the trap.

Absorption-reflection spectra of O_3 in solid CO_2 also have been obtained. Spectra of continuum light (2200 to 3200 Å) from a high pressure xenon arc scattered from mixtures of O_3 in solid CO_2 at temperatures between 127° and 156°K, as compared to that scattered from solid CO_2, show the broad Hartley band absorption of O_3 peaking near 2600 Å (*4*).

These laboratory measurements suggest that the ozone detected over the polar cap of Mars is not in the atmosphere but is trapped in solid CO_2. Moreover, other trapped molecules may possibly be observed. Oxygen might be detected by means of the Schumann-Runge absorption below 2000 Å or by means of the Herzberg absorption bands between 2400 and 2800 Å (*5*). In the infrared region water, methane, and ammonia might be detected (*6*).

H. P. Broida*
Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder 80302
O. R. Lundell, H. I. Schiff
R. D. Ketcheson
Department of Chemistry, York University, Toronto, Ontario, Canada

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* Visiting fellow at the Laboratory for Atmospheric and Space Physics, and the Joint Institute for Laboratory Astrophysics, University of Colorado, Boulder (1969–70), on leave from the Physics Department, University of California, Santa Barbara.

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Jurassic Sandstone from the Tropical Atlantic

Abstract. *The oldest sediment yet sampled from the abyssal margins of South America, late Jurassic (or possibly very early Cretaceous) shallow-water, coarse-grained, calcareous sandstone containing palynomorphs and mollusk prisms, was recovered from a depth of 4400 meters on the seaward scarp of the Demerara Plateau. The sandstone was deposited in a shallow, late Jurassic epicontinental sea after the initial stages of rifting when the newly created Atlantic began to founder.*

In October of 1968 (*1*) the steep eastern escarpment of the Demerara Plateau was investigated (Fig. 1A). Seismic reflection profiles (Fig. 1B) indicate that the plateau is capped by approximately 1500 m (1.5 seconds) of stratified, undeformed strata which appear to outcrop on the eastern escarpment. Fifteen bottom photographs obtained at the base of the escarpment at 4500 m reveal a bottom free of recent sediment, strewn with angular rocks and locally precipitous (Fig. 1, C and D).

We dredged near the base of the scarp at 4400 m at a point of over 2000 m below the outcrop of the deepest reflector recorded on the seismic reflection profile. The dredge became secured on the bottom and anchored the ship for 3 hours before the dredge broke loose.