No. 98 SULPHUR COMPOUNDS IN THE ATMOSPHERE OF VENUS II: UPPER LIMITS FOR THE ABUNDANCE OF COS AND H_2S

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ABSTRACT

Laboratory spectra of small amounts of carbonyl sulfide and hydrogen sulfide are discussed relative to their abundance in the Venus atmosphere. The upper limits to the mixing ratios relative to a two-way transmission in the Venus atmosphere, 4 km-atm of CO_2, are: COS $< 10^{-6}$, and $H_2S < 2 \times 10^{-4}$.

1. *Introduction*

This paper presents results of attempts to estimate the upper limits of the abundances of carbonyl sulfide (COS) and hydrogen sulfide (H_2S) in the Venus atmosphere using new spectroscopic data. Such limits are especially relevant to the Venus problem because of the computer models of chemical and thermodynamic equilibria in planetary atmospheres (Lewis 1968, and Lippincott *et al.* 1967) that are now available. The sulfur gases also relate directly to the current level of volcanic activity on Venus.

2. *Carbonyl Sulfide*

Tracings of the near-infrared spectrum of COS were published by Kuiper and Cruikshank (1964). The strongest band in the region 0.9–2.6 μ is centered at 2.44 μ. New tracings of this and adjacent bands with resolution ($\lambda/\Delta\lambda$) 7000 are shown in Figure 1 for different amounts of the gas from 4.7 mm-atm to 50 mm-atm, all at 705 mm Hg pressure and room temperature. No COS is detected in the Venus atmosphere where the laboratory spectra are compared with the Venus tracings of Kuiper (1962), Moroz (1964), and Kuiper and Forbes (1967). The latter are much more suitable because the heavy telluric water-vapor absorptions are greatly reduced. An upper limit of 5 mm-atm in the two-way transmission in the Venus atmosphere may be established on the basis of this comparison. For 4 km-atm CO_2 in the Venus atmosphere two-way transmission, this corresponds to an upper limit to the mixing ratio of 10^{-6}.

3. *Hydrogen Sulfide*

The test for H_2S is less sensitive than for COS because of contamination of the Venus spectrum by many bands of CO_2. The ultraviolet electronic bands occur as a broad continuum from 1900–2700 Å (Herzberg 1966, p. 489) and are therefore unsuitable for our purpose. A strong vibrational band at 1.58 μ lies on a branch of the 301 band of $C^{13}O_2$ (1.5714 μ) which is very strong in the Venus spectrum. The 101 band of H_2S at 1.94 μ is similarly blended with CO_2 in the atmospheres of the earth and Venus, and with telluric H_2O. A rough upper limit of 1 m-atm for H_2S can be established, however, using Kuiper's spectra and those of Moroz (1964) with the H_2S spectra of Cruikshank (1967). Relative to 4 km-atm CO_2 in the Venus atmosphere, this corresponds to an upper limit in the mixing ratio of 2×10^{-4}.

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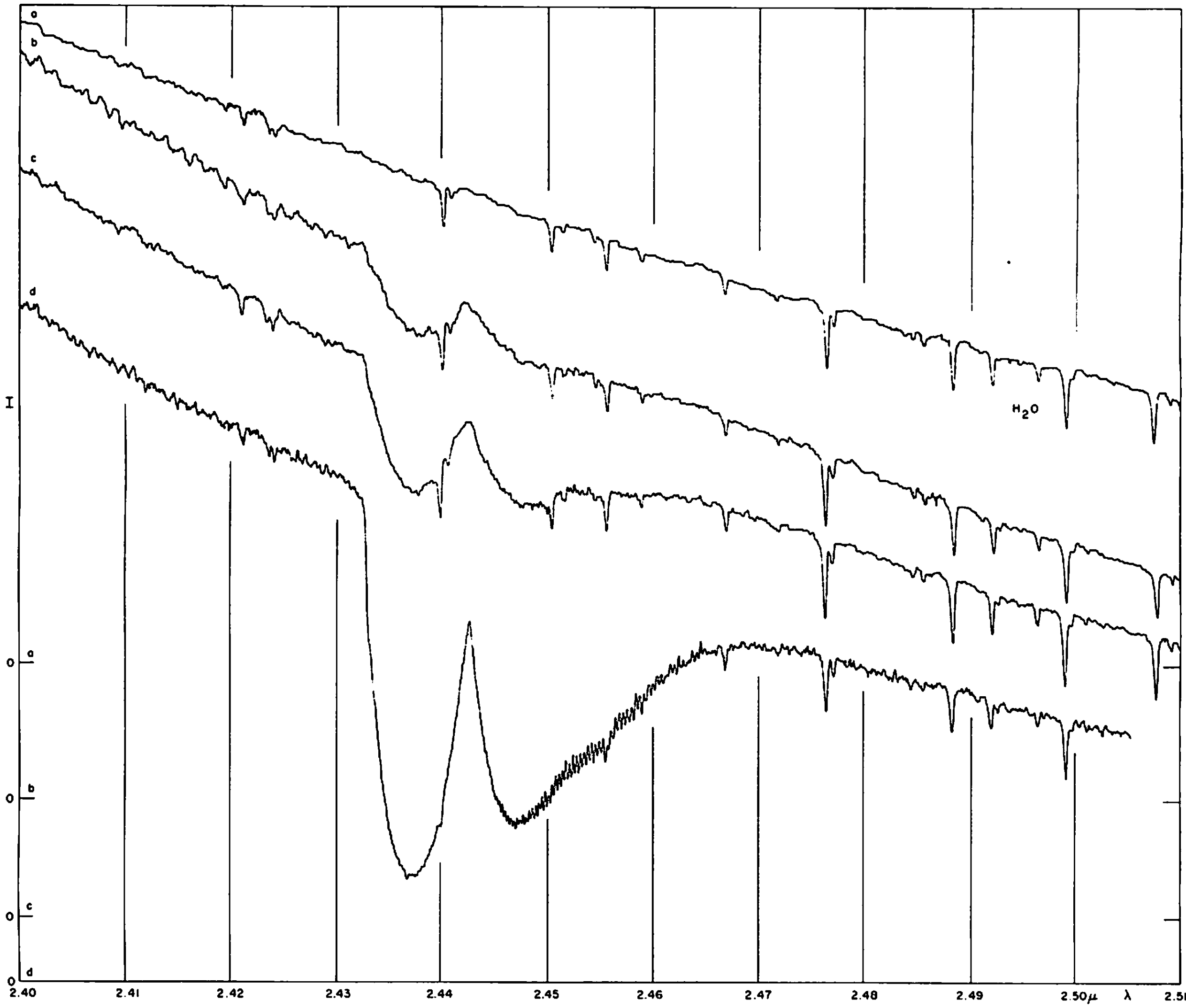

Fig. 1 A portion of the infrared spectrum of COS showing the development of the band with various amounts of gas. (a) Blank run with no COS but 4.36 m laboratory air in optical path, including spectrometer, (b) same air path with 4.7 mm COS at p = 1 atm, (c) air path with 7.1 mm COS at p = 1 atm, (d) air path with 50 mm COS at p = 1 atm. B-spectrometer slit 0.05 mm, detector width 0.05 mm.

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