Reports

Venus Clouds: Test for Hydrocarbons

Abstract. *Infrared reflection spectra of hydrocarbon clouds and frosts now give a critical test of Velikovsky's prediction that Venus is surrounded by a dense envelope of hydrocarbon clouds and dusts. Venus does not exhibit an absorption feature near 2.4 microns, although such a feature is prominent in every hydrocarbon spectrum observed.*

Some of the least expected discoveries made by planetary astronomers in recent years were correctly predicted by Velikovsky (*1*). He argued that Jupiter should be a strong source of radio waves, that the earth should have a magnetosphere, that the surface of Venus should be hot, that Venus might exhibit an anomalous rotation, and that Venus should be surrounded by a blanket of petroleum hydrocarbons (*2*). All except the last of these predictions have been verified, most of them by accident (*3*).

New data on hydrocarbon clouds and frosts, together with infrared observations of Venus, now permit a test of the remaining prediction. Each hydrocarbon (from methane through the hydrocarbon waxes and tars) absorbs infrared radiation in a band of wavelengths centered between 2.3 and 2.5 μ, the position varying somewhat with the molecular structure (*4*). This band is weaker than several other hydrocarbon absorption bands at longer wavelengths, but it lies conveniently in a spectral region for which the terrestrial atmosphere is rather transparent.

Reflection spectra of Venus in this wavelength region have been obtained by Kuiper (*5*), Sinton (*6*), Moroz (*7*), and Bottema *et al.* (*8*) (Fig. 1). Kuiper's spectrum is a ratio of the Venus reflectivity to that of a block of MgO in sunlight. The reflectivity of MgO falls off somewhat at longer wavelengths, at a rate which is dependent upon its moisture content; thus, if Kuiper's curve were corrected for this, it would be in better agreement with the other curves. The spectrum recorded by Bottema *et al.* was measured at a lower resolving power than that of the others (0.08 μ), and therefore the CO_2 absorption feature at 2.15 microns on Venus is smoothed out; a greater range of wavelengths was covered because the spectrum was recorded from a high-altitude balloon.

Reflection spectra of several representative hydrocarbons were recorded (*9*). Some hydrocarbons were formed into clouds by refrigeration in a copper box cooled with dry ice, following the procedure of Zander (*10*). Other hydrocarbons were formed into white frost on a blackened copper block partially immersed in liquid nitrogen. A few hydrocarbons of higher molecular weight, such as the waxes, were granulated and supported on black paper. Zander discovered that the spectral properties of clouds are quite similar to those of frosts; our results confirm his finding.

A 625-watt quartz-tungsten lamp illuminated the cloud, frost, or powder directly. Radiation scattered by each sample at an angle of 60° from the direction of incidence was reflected to a spectrophotometer (Perkin-Elmer model 12C) equipped with a LiF prism and an InAs detector. A layer of powdered sulfur was used as a reflectance standard (*11*), and all hydrocarbon spectra were compared with the sulfur reflection measurements in order to eliminate instrumental properties.

All hydrocarbons studied exhibited a substantial drop in reflectivity in a band near 2.4 μ. From the close similarity of the transmission spectra of all hydrocarbons in this region, it appears that a substantial loss in reflectivity near 2.4 μ should be a common property of clouds composed of hydrocarbon droplets or dust. Figure 1 shows the reflection characteristics of a cloud of liquid propane droplets in the refrigerated box and also of a frost of solid butane particles on a cold surface. For both, reflectivity between 2.3 and 2.5 μ is reduced below the continuum by a factor of about 2. This spectral feature, as well as a few others exhibited by hydrocarbon clouds at shorter wavelengths, is absent from the reflection spectrum of Venus.

The presence of condensed hydrocarbons in the clouds of Venus, a prediction regarded by Velikovsky as a crucial test of his concept of the development of the solar system, is not supported by the spectrophotometric

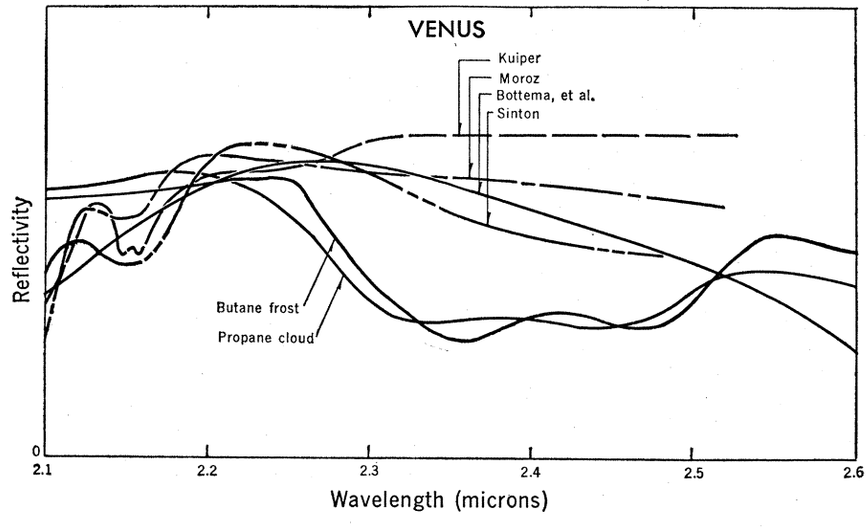

Fig. 1. Infrared reflectivities of propane cloud and butane frost contrasted with the reflection spectrum of Venus as measured by four observers.

evidence. On the other hand, Venus observations in this wavelength range and at other wavelengths are entirely compatible with the reflection spectrum of a noninfinite cloud layer composed of very small or slender ice particles (*12*).

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Triterpene Alcohol Isolation from Oil Shale

Abstract. *Isoarborinol, an intact pentacyclic unsaturated alcohol, was isolated from the Messel oil shale (about 50 × 10^6 years old). Complex organic substances, even those very sensitive to oxidation, reduction, or acidic conditions, can thus survive without alteration for long periods.*

From the Eocene oil shale of the Messel mine near Darmstadt, Germany, we have isolated an intact triterpene alcohol, isoarborinol (Fig. 1). This nonmarine oil shale has never been buried deeper than 200 to 300 meters and is thus a typical "unripe" sediment (*1*).

The samples of shale were finely layered and contained about 30 percent organic carbon. After being dried in a vacuum, shale (1000 g) was crushed to 2-cm pieces and cleaned with a mixture of benzene and methanol (3:1 by volume). It was then pulverized and extracted with a mixture of petroleum ether and ethyl acetate (4:1 by volume) by ultrasonic vibration (25 khz). The extraction was repeated twice, with 100 ml for 50 g of rock. Decantation, centrifugation, and evaporation of the solvents gave 9.9 g of residue, which was then chromatographed on Merck silica gel (0.05 to 0.2 mm). Three fractions were eluted—F_1 with petroleum ether, F_2 (4.7 g) with petroleum ether and ethyl acetate (4:1 by volume), and F_3 with benzene and methanol (3:1 by volume). Fraction F_2 was again chromatographed over silica gel and gave 300 mg of a crystalline mixture of secondary alcohols (infrared spectrum) of the same polarity as triterpene alcohols. They were acetylated (pyridine, acetic anhydride) and again chromatographed over silica gel impregnated with 10 percent silver nitrate (elution with cyclohexane and benzene, 3:1 by volume). One of the fractions (80 mg) proved homogeneous upon gas chromatography (*2*) and could be identified with isoarborinol acetate (Fig. 1) by the following criteria: melting point, R_F on thin-layer chromatography over silica gel and 10 percent silver nitrate, gas chromatography, and infrared and mass spectrometry.

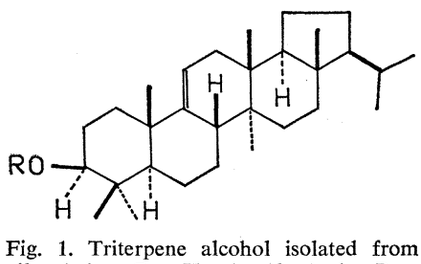

Fig. 1. Triterpene alcohol isolated from oil shale. R = H, isoarborinol. R = CH_3CO_2–, isoarborinol acetate.

Isoarborinol had never been isolated in our laboratory, and control experiments excluded the possibility of contamination.

The group of arborane triterpenoids is relatively new. Isoarborinol has been isolated from *Glycosmis arborea* (Rutaceae) (*3*), *Hedyotis acutangula* (Rubiaceae) (*4*), and *Imperata cylindrica* var. *koenigii* (Gramineae) (*5*). Its structure was defined by x-ray crystallography (*6*).

Triterpenoids have frequently been found in petroleum, in coal, or in sediments (*7*). It is, however, only from relatively young brown coal that intact triterpenes have been isolated (*8*). In the other cases, "aging" has been brought about by the acidic, oxidizing, reducing, or thermal conditions prevailing in the rock, and the substances isolated are modified derivatives of extant triterpenes (*9*).

The fact that isoarborinol is sensitive to oxidation, reduction, and acid treatment requires that mild conditions have prevailed during diagenesis in the Messel mine (*10*). In contrast to recent cases reported from our laboratory (*11*), we do not know from which of the fossil plants of the shale isoarborinol originates, and we must refrain from any comments on this point until several companions of this triterpene have been characterized. It is, however, remarkable that isoarborinol has so far been isolated only from tropical plants, and that the fossil flora and fauna found in the Messel oil shale are near relatives of the recent flora and fauna of South East Asia (*12*).

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