PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

An Atlas of the Infra-Red Solar Spectrum from 1 to 6$\cdot $5 $\mu $ Observed from a High-Altitude Aircraft

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AN ATLAS OF THE INFRA-RED SOLAR SPECTRUM FROM 1 TO 6·5 μ OBSERVED FROM A HIGH-ALTITUDE AIRCRAFT

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Records are presented of the infra-red solar spectrum from 1 to 6·5 μ, observed from altitudes up to 15 km. A resolution of about 1 cm^{-1} has been obtained over the whole region and 1200 absorption lines belonging to water vapour, CO_2, CO, N_2O and CH_4 have been identified.

1. Introduction

The infra-red solar spectrum has been the subject of intensive study from observatories on the earth's surface (see, for example, Migeotte, Neven & Swensson 1956). Large portions of the infra-red region, however, are completely obscured, even at high mountain observatories, by absorption bands of water vapour and carbon dioxide. At altitudes above 40000 ft., which are easily reached by modern jet aircraft, the water vapour absorption bands are largely transparent and the carbon dioxide absorption bands are much reduced, so that more of the solar spectrum is available for study. This project was initiated by Dr F. E. Jones in consultation with the Gassiot Committee of the Royal Society as a contribution to the programme of the International Geophysical Year.

This atlas of the infra-red solar spectrum from 1 to 6·5 μ is a record of observations made during ninety-eight flights with a high-resolution grating spectrometer installed in a Canberra aircraft of the Royal Aircraft Establishment, Farnborough, at altitudes of 20000 to 49000 ft. The instrumentation, which has been described in detail by Houghton, Moss & Chamberlain (1958), was, briefly, as follows. A gauze-covered hole in the unpressurized part of the aircraft fuselage allowed sunlight to fall on a plane mirror 6 in. square, which formed part of a sun-following system. The spectrometer, which had an $f/6$ optical system, used a prism pre-monochromator and a 7500 lines/in. diffraction grating, 4 in. $\times$ 3 in. in size. A resolution of about 1 cm^{-1} was obtained within the wavelength range 1 to 6·5 μ. Lead salt photoconductive detectors were used for the following spectral ranges: 1 to 3 μ, uncooled lead sulphide; 3 to 5 μ, cooled lead telluride, 5 to 6·5 μ, cooled lead selenide. A few results were also obtained with a gold-doped germanium detector. Great care was taken to ensure that the spectrometer was free of water vapour or other absorbing gases.

The spectrum was scanned by rotating the grating while the signal from the detector amplifier was recorded by a multi-channel film recording galvanometer. The galvanometer recorded on photographic paper, 60 mm wide, moving usually at $\frac{1}{4}$ in./s, but at $\frac{1}{16}$ in./s for the longest wavelengths. During preliminary work a potentiometer pen-recorder was used, but the spectra presented here were all made with the film recorder,

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which had the advantage of a much faster response. Additional channels indicated the output from a photocell monitoring the total sunlight entering the spectrometer and the angular position of the grating at intervals of 3 minutes of arc. The latter marks, which enabled a fairly accurate wavelength scale to be established, have been removed from the records which are reproduced in the atlas at approximately the original size.

Variations in the monitoring signal were due either to imperfect functioning of the sun-follower in compensating for aircraft movements or to variations in the degree of obscuration of the gauze 'window'. The variations in the monitor and detector signals are not necessarily in proportion and in general the monitor signal shows greater variation than the spectral record, probably because the former is determined mainly by the peak solar radiation which, for example, is much more susceptible to scattering by traces of high cloud than the infra-red radiation. Where the monitor shows little variation the spectra can be used directly to determine absolute absorption levels; where variations occur, careful comparison of the two traces will still enable a background energy curve to be drawn over small wavelength intervals in many cases.

2. The figures

The region from 1 to 6·5 μ has been divided into 35 sections, with a small overlap on each section. Wherever possible, an opening shows four observations of the same section, together with the appropriate portion of the table of line identification (table 2).

In general the three upper traces, on the left-hand page, show records obtained from the aircraft, divided into the altitude categories: (*a*) above 40000 ft., (*b*) 30000 to 40000 ft. and (*c*) 20000 to 30000 ft. On the right-hand page a ground level record (*d*), obtained near Farnborough (240 ft. above sea level) with the same instrument has been included for comparison. In the spectral regions where no solar radiation reaches the ground, suitable laboratory spectra are included in place of the solar spectrum (*d*). Table 1, pp. 51 and 52, identifies the conditions under which the spectra in each figure were observed.

Each section comprises about 8 in. of the original record, which for figures 1 to 33 would have taken 30 s to scan. For figures 34 and 35, which were recorded at the slower paper speed, the time would have been 120 s.

The monitor signal is usually the broader line on the trace. The zero level of the detector galvanometer is shown by the base line which has been drawn in, and a short example of the noise level encountered when the detector was not illuminated has been included at the end of the trace where appropriate. The spectral bandwith used in each observation is represented by the gap in the symbol ⊣ ⊢. A wave-number scale has been constructed for each page; small fluctuations in the recording speed often occurred and since these cannot be corrected the scale is to be used only as a guide.

3. The identifications

The most prominent features in each section have been marked with a vertical dash on one, or sometimes two, of the traces in each figure. Every tenth dash is numbered to correspond to table 2. In identifying these features the frequency was first established to within about 5 cm^{-1} by means of the grating rotation markers. Careful comparison of the records with data from other sources then enabled the identifications in table 2 to be listed. The wave numbers (corrected to vacuum) given in this table are quoted from the various sources noted by a number in the reference column. These numbered references have been listed on p. 53. Particular use has been made of the three photometric atlases covering the region studied in the present work: from 1 to 2·5 μ, Mohler, Pierce, McMath & Goldberg (1950), at the Mount Wilson Observatory; 2·8 to 5·3 μ, Migeotte *et al.* (1956) at the Jungfraujoch Observatory; and Shaw, Chapman, Howard & Oxholm (1951) at Columbus, Ohio.

Most of the spectra in this atlas are not so well resolved as those given in the sources quoted; many of the features, registered with a single mark, are blends of lines quite clearly resolved by other workers. In each of these cases the wave number assigned to the feature is that of the strongest component, which is listed first in the table. Where the intensities are approximately equal the identifications are given in the order of the wave numbers. The ν_2 band of water vapour near 6 μ, however, is revealed in greater detail in the high-altitude solar spectra than in published laboratory spectra. The additional features have been given an interpolated wave number from the known positions of nearby lines.

4. Discussion

The prominent features of the spectra are already well known (see, for example, Goldberg 1954), being bands due to the atmospheric constituents: water vapour, carbon dioxide, carbon monoxide, methane and nitrous oxide. Quantitative studies of some of the water-vapour lines have been made by Houghton & Seeley (1960), and of some of the lines of methane, nitrous oxide and carbon monoxide by Seeley & Houghton (1961).

Some lines due to absorption in the solar atmosphere are prominent in the high-altitude observations and are marked with the symbol ⊙ in table 2. Among these are three absorption lines of hydrogen which are obscured by water vapour in the ground-level spectrum and have not previously been observed. They are the second (4–6 transition) and fourth (4–8) members of the Brackett series and the first member (3–4 transition) of the Paschen–Ritz series. The line 4–6 occurs at 3808 cm^{-1} and overlaps the water-vapour line at 3806·7 cm^{-1} (figure 11, no. 24); it can be distinguished by comparing the solar spectra with figure 11 (*d*), which is a record of the residual water-vapour absorption in the spectrometer at 45000 ft. obtained by mounting a small tungsten filament lamp at the entrance slit. The other two new hydrogen lines appear on figure 6, lines no. 26 and no. 52.

The *R*-branch of the ν_3 band of methane, previously obscured by absorption due to the $2\nu_2$ water-vapour band, is revealed clearly in the high-altitude observations in figure 16. In figure 22 the ν_3 band of carbon dioxide is the only extended region of complete absorption which remained at the highest altitude (49000 ft.). The short-wavelength absorption edge is advanced by about 5 cm^{-1} towards the band centre at this altitude.

There are a number of spectral features listed in table 2 for figures 23 and 24 which have a separation *less* than the spectral bandwidth of the spectrometer. Calculations show that the bandwidth used is sufficient to give the partial resolution observed. The repetition of these features in the several observations confirms their reality.

Laboratory spectra, obtained with a short path (6 ft. of air at atmospheric pressure) are included in figures 31 to 35, since they have been helpful in identifying the new features observed at altitude in this region.

The data in the atlas are the culmination of a comprehensive flying programme, during which many members of the engineering services and aircrew associated with R.A.E. Radio Flight have given us their patient co-operation. We are grateful to our colleagues Mr I. D. Birch, who kept the equipment in working order and Mr T. D. F. Hawkins who acted as observer on many flights, and for assistance by our printing department in preparing the figures.

The lead selenide detector with a bloomed silicon window and the gold-doped germanium detector were generously provided by Dr B. Bode, Santa Barbara Research Centre, and Dr H. Levinstein, Syracuse University, respectively.

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TABLE 1

figure no.	year	month	day	time (G.M.T.)	altitude (ft.)	solar elevation (°)
1 (*b*)	1958	June	12	15.40	35000	41
(*d*)	1959	May	6	09.45	240	45
2 (*b*)	1958	June	12	15.40	35000	41
(*d*)	1959	May	6	09.45	240	45
3 (*a*)	1958	July	21	11.00	40000	57
(*b*)	1958	June	12	15.40	35000	41
(*c*)	1958	July	21	10.40	30000	55
(*d*) (i)	1959	May	6	09.45	240	45
(ii)	1960	September	21	11.05	240	40
4 (*a*)	1957	December	19	11.25	44000	18
(*b*)	1958	July	21	11.00	40000	57
(*c*)	1958	July	21	10.40	30000	55
(*d*)	1960	September	21	11.05	240	40
5 (*a*)	1958	July	21	11.00	40000	57
(*b*)	1958	July	21	10.40	30000	55
(*d*) (i)	1959	May	6	09.45	240	45
(ii)	1960	May	24	11.15	240	60
6 (*a*)	1958	July	21	11.00	40000	57
(*b*)	1957	December	19	11.05	32000	19
(*c*)	1958	July	21	10.40	30000	55
(*d*)	1960	May	24	11.15	240	60
7 (*a*)	1958	July	21	11.00	40000	51
(*b*)	1958	June	12	15.40	35000	41
(*c*)	1958	July	21	10.40	30000	55
(*d*)	1960	May	24	11.15	240	60
8 (*a*)	1958	July	21	11.00	40000	57
(*b*)	1958	June	12	15.40	35000	41
(*c*)	1958	July	21	10.40	30000	55
(*d*)	1960	May	24	11.15	240	60
9 (*a*)	1958	July	21	11.00	40000	57
(*b*) (i)	1958	June	12	15.40	35000	41
(ii)	1957	December	19	12.05	32000	19
(*c*)	1958	July	21	10.40	30000	55
(*d*) (i)	1960	May	24	11.15	240	60
(ii)	1959	May	6	09.45	240	45
10 (*a*)	1958	July	21	11.00	40000	57
(*b*)	1957	December	10	11.00	35000	15
(*c*)	1958	July	21	10.40	30000	55
(*d*)	1959	May	6	09.45	240	45
11 (*a*)	1958	January	20	12.45	48000	18
(*b*) (i)	1957	December	19	12.25	44000	17
(ii)	1958	June	12	16.10	45000	35
(iii)	1957	December	19	12.25	44000	17
(*c*) (i)	1957	December	17	11.40	40000	20
(ii)	1958	June	12	16.00	40000	38
(iii)	1958	July	25	15.30	40000	40
(*d*)	1958	June	12	—	—	—
12 (*a*)	1957	November	30	14.20	45000	11
(*b*)	1958	July	25	15.30	40000	40
(*d*)	1960	March	24	—	—	—
13 (*a*)	1958	July	25	15.30	40000	40
(*d*)	1960	May	24	13.15	240	58
14 (*a*)	1958	July	29	14.30	40000	47
(*b*)	1958	August	15	14.00	25000	51
(*c*)	1958	July	29	10.50	20000	54
(*d*)	1960	May	24	13.25	240	57
15 (*a*)	1958	July	29	14.30	40000	47
(*b*)	1958	July	29	14.00	25000	51
(*c*)	1958	July	29	10.50	20000	54
(*d*)	1960	May	24	13.25	240	57
16 (*a*)	1958	July	29	14.30	40000	47
(*b*)	1958	July	29	14.00	25000	51
(*c*)	1958	July	29	10.50	20000	54
(*d*)	1960	May	24	13.30	240	56
17 (*a*)	1958	July	29	14.20	35000	48
(*b*)	1958	July	29	14.00	25000	51
(*c*)	1958	July	29	10.50	20000	54
(*d*)	1960	May	24	13.30	240	56
18 (*a*)	1958	July	29	14.20	35000	48
(*b*)	1958	July	29	14.00	25000	51
(*c*)	1958	July	29	10.50	20000	54
(*d*)	1960	May	24	13.30	240	56
19 (*a*)	1958	July	29	14.20	35000	48
(*b*)	1958	July	29	14.00	25000	51
(*c*)	1958	July	29	10.50	20000	54
(*d*)	1960	May	24	13.30	240	56

TABLE 1 (*continued*)

figure no.	year	month	day	time (G.M.T.)	altitude (ft.)	solar elevation (°)
20 (*b*)	1958	July	29	14.20	35000	48
(*c*)	1958	July	29	14.00	25000	51
(*d*)	1959	October	22	15.00	240	18
21 (*b*)	1958	July	29	14.20	35000	48
(*c*)	1958	July	29	14.00	25000	51
(*d*)	1960	May	24	13.30	240	56
22 (*b*)	1958	July	29	14.20	35000	48
(*c*)	1958	July	29	14.00	25000	51
(*d*)	1960	May	24	13.30	240	56
23 (*a*)	1958	August	15	15.10	45000	38
(*b*)	1958	August	15	14.50	40000	40
(*c*)	1958	August	15	11.10	25000	51
(*d*)	1960	March	9	—	—	—
24 (*a*)	1958	August	15	15.10	45000	38
(*b*)	1958	August	15	14.50	40000	40
(*c*)	1958	August	15	11.10	25000	51
(*d*)	1960	May	24	13.35	240	55
25 (*a*)	1958	August	15	15.10	45000	38
(*b*)	1958	August	15	14.50	40000	40
(*c*)	1958	August	15	11.10	25000	51
(*d*)	1960	May	24	13.35	240	55
26 (*a*)	1958	August	15	15.10	45000	38
(*b*)	1958	August	15	14.50	40000	40
(*c*)	1959	July	21	14.00	30000	53
(*d*)	1960	May	24	13.35	240	55
27 (*a*)	1958	August	15	15.10	45000	38
(*b*)	1958	August	15	14.50	40000	40
(*c*)	1959	July	29	10.20	20000	53
(*d*)	1960	May	24	13.35	240	55

figure no.	year	month	day	time (G.M.T.)	altitude (ft.)	solar elevation (°)
28 (*b*)	1958	August	15	11.10	25000	51
(*c*)	1959	July	29	10.20	20000	53
(*d*)	1960	May	24	13.35	240	55
29 (*a*)	1959	July	29	10.30	30000	54
(*b*)	1958	August	15	11.10	25000	51
(*c*)	1959	July	29	10.20	20000	53
(*d*)	1960	May	24	13.40	240	55
30 (*b*)	1959	July	29	10.30	30000	54
(*c*)	1959	September	4	14.30	30000	38
(*d*)	1960	May	24	13.50	240	54
31 (*a*)	1959	September	15	15.10	45000	26
(*b*)	1959	September	15	15.00	40000	28
(*c*)	1959	September	15	14.50	30000	30
(*d*)	1960	March	9	—	—	—
32 (*a*)	1959	September	15	15.10	45000	26
(*b*)	1959	September	15	15.00	40000	28
(*c*)	1959	September	15	14.50	30000	30
(*d*)	1960	March	9	—	—	—
33 (*a*)	1959	September	15	15.10	45000	26
(*b*)	1959	September	15	15.00	40000	28
(*c*)	1959	September	15	14.50	30000	30
(*d*)	1960	March	9	—	—	—
34 (*a*)	1959	September	16	11.00	45000	41
(*b*)	1959	September	16	10.50	40000	40
(*c*)	1959	September	16	10.30	30000	39
(*d*)	1959	December	16	—	—	—
35 (*a*)	1959	September	16	14.45	45000	30
(*b*)	1959	September	16	14.35	40000	32
(*c*)	1959	September	16	14.20	30000	35
(*d*) (i)	1959	December	16	—	—	—
(ii)	1960	March	9	—	—	—

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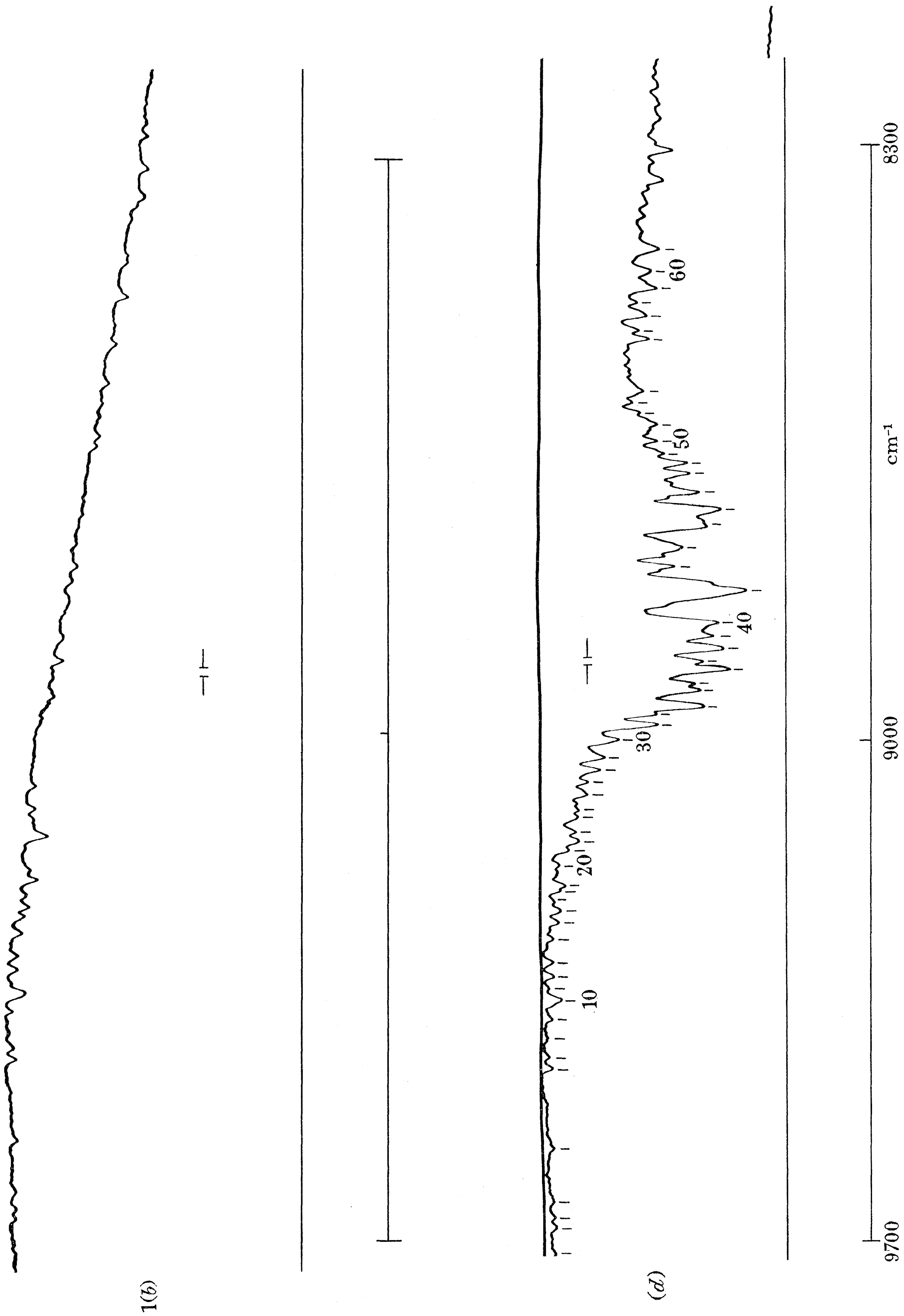


Figure 1

TABLE 2 (figure 1)

line no.	ν (cm⁻¹) (vac.)	ident.	band	ref.
1	9716·5	⊙ Si	—	3b
2	9680·7	⊙ Sr	—	3b
		⊙ Ni	—	3b
3	9664·8	⊙ Ca	—	3b
4	9639·6	⊙ Si	—	3b
		⊙ Ni	—	3b
5	9560·4	⊙ S	—	3b
6	9444·7	⊙ Si	—	3b
7	9428·7	⊙ Si	—	3b
8	9406·5	⊙ Si	—	3b
9	9377·4	⊙ Si	—	3b
10	9351·1	⊙ C	—	3b
		⊙ Si	—	3b
11	9337·1	⊙ C	—	3b
12	9319·7	⊙ Si	—	3b
13	9300·6	⊙ Si	—	3b
14	9267·9	⊙ Si	—	3b
15	9247·3	?	—	3b
		⊙ Mg	—	3b
16	9233·6	⊙ Si	—	3b
		⊙ He	—	3b
17	9219·2	⊙ Si	—	3b
		?	—	3b
18	9205·6	—	—	3b
19	9197·1	⊙ Si	—	3b
20	9171·0	—	—	3b
21	9152·5	—	—	3b
22	9139·1	⊙ H	3–6	3b
23	9124·1	H_2O	$\nu_1+\nu_2+\nu_3$	3b
24	9107·5	H_2O	$\nu_1+\nu_2+\nu_3$	3b
25	9093·4	—	—	3b
26	9073·6	—	—	3b
27	9055·5	—	—	3b
28	9039·1	—	—	3b

line no.	ν (cm⁻¹) (vac.)	ident.	band	ref.
29	9018·7	—	—	3b
30	8998·4	H_2O	$\nu_1+\nu_2+\nu_3$	3b
31	8982·3	H_2O	$\nu_1+\nu_2+\nu_3$	3b
32	8967·8	H_2O	$\nu_1+\nu_2+\nu_3$	3b
33	8955·7	H_2O	$\nu_1+\nu_2+\nu_3$	3b
34	8941·3	H_2O	$\nu_1+\nu_2+\nu_3$	3b
35	8934·9	H_2O	$\nu_1+\nu_2+\nu_3$	3b
36	8907·8	H_2O	$\nu_1+\nu_2+\nu_3$	3b
37	8899·1	H_2O	$\nu_1+\nu_2+\nu_3$	3b
38	8884·1	H_2O	$\nu_1+\nu_2+\nu_3$	3b
39	8866·0	H_2O	$\nu_1+\nu_2+\nu_3$	3b
40	8851·0	H_2O	$\nu_1+\nu_2+\nu_3$	3b
41	8811·3	H_2O	$\nu_1+\nu_2+\nu_3$	3b
42	8783·4	H_2O	$\nu_1+\nu_2+\nu_3$	3b
43	8764·9	H_2O	$\nu_1+\nu_2+\nu_3$	3b
44	8738·1	H_2O	$\nu_1+\nu_2+\nu_3$	3b
45	8717·5	H_2O	$\nu_1+\nu_2+\nu_3$	3b
46	8697·1	H_2O	$\nu_1+\nu_2+\nu_3$	3b
47	8675·2	H_2O	$\nu_1+\nu_2+\nu_3$	3b
48	8665·4	H_2O	$\nu_1+\nu_2+\nu_3$	3b
49	8651·9	H_2O	$\nu_1+\nu_2+\nu_3$	3b
50	8637·0	H_2O	$\nu_1+\nu_2+\nu_3$	3b
51	8617·6	H_2O	$\nu_1+\nu_2+\nu_3$	3b
52	8603·5	H_2O	$\nu_1+\nu_2+\nu_3$	3b
53	8593·9	—	—	3b
54	8577·7	—	—	3b
55	8517·7	—	—	3b
56	8507·6	—	—	3b
57	8491·0	—	—	3b
58	8477·3	—	—	3b
59	8460·8	—	—	3b
60	8443·6	—	—	3b
61	8419·5	—	—	3b

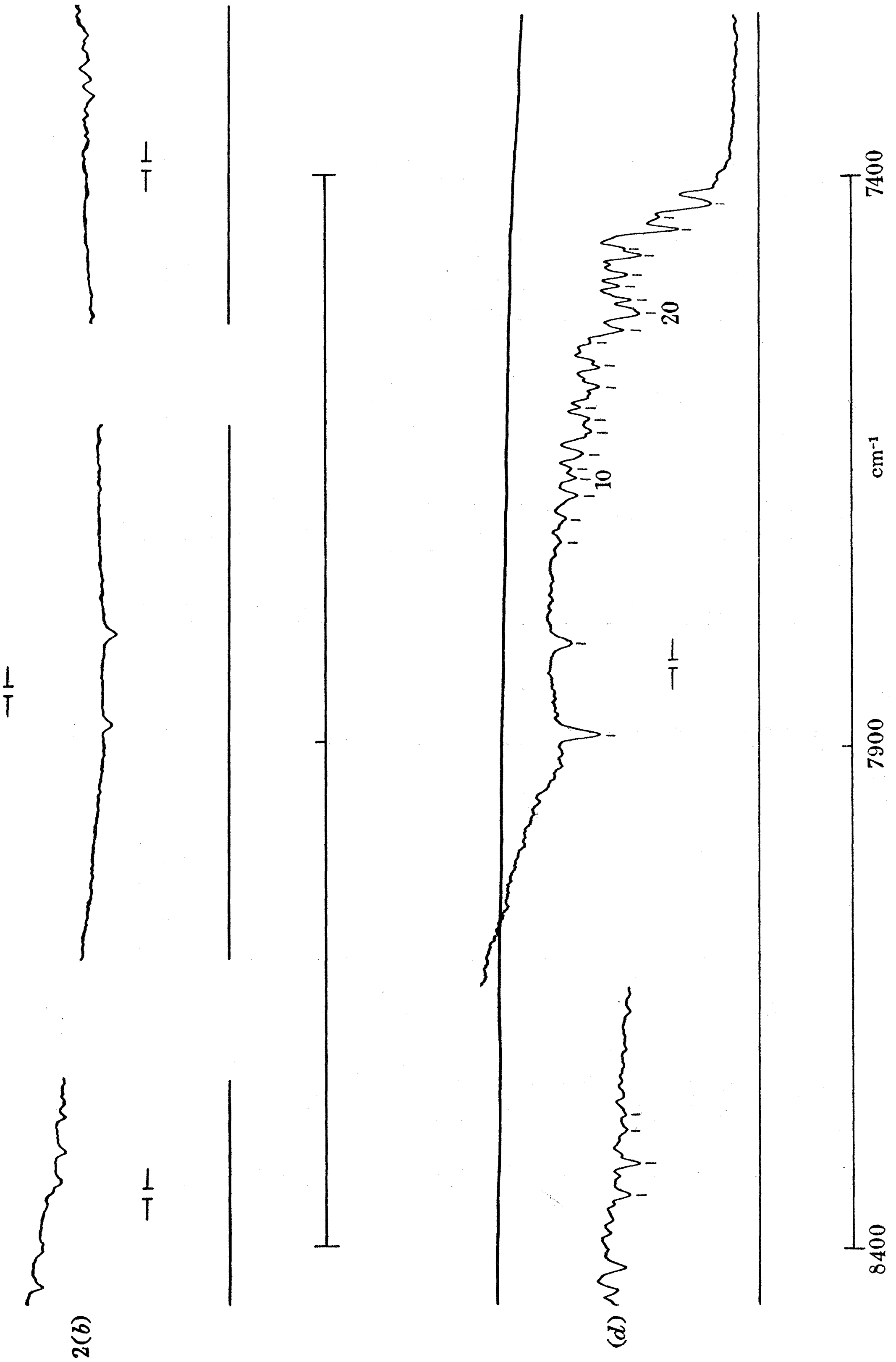
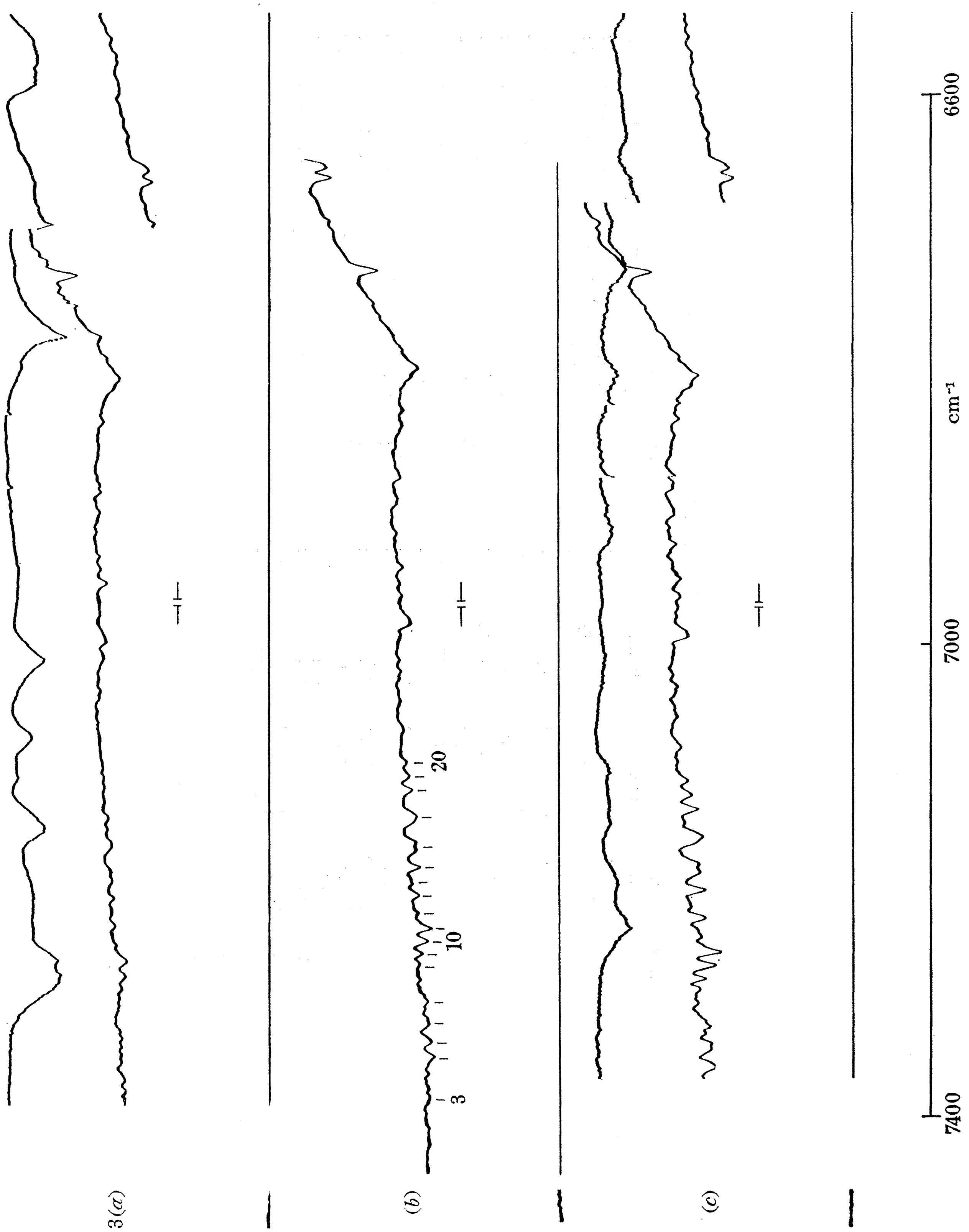


FIGURE 2

TABLE 2 (figure 2)

line no.	ν (cm^{-1}) (vac.)	ident.		band	ref.
1	8341·7	⊙	Si	—	3*a*
			H_2O	$3\nu_2+\nu_3$	3*a*
2	8307·4	⊙	Si	—	3*a*
			H_2O	$3\nu_2+\nu_3$	3*a*
			CO_2	—	3*a*
3	8273·4	⊙	Mg	—	3*a*
			H_2O	$3\nu_2+\nu_3$	3*a*
4	8255·2		H_2O	$3\nu_2+\nu_3$	3*a*
5	7881·3		O_2	—	3*a*
6	7799·3	⊙	H	3–5	3*a*
7	7704·2		H_2O	$2\nu_3$	3*a*
8	7685·9		H_2O	$2\nu_3$	3*a*
9	7667·0		H_2O	$2\nu_3$	3*a*
10	7653·1		H_2O	$2\nu_3$	3*a*
11	7644·6		H_2O	$2\nu_3$	3*a*
12	7633·8		H_2O	$2\nu_3$	3*a*
13	7612·0		H_2O	$2\nu_3$	3*a*
		⊙	Ca	—	3*a*
14	7601·9		H_2O	$\nu_1+\nu_3, 2\nu_3$	3*a*
		⊙	Al	—	3*a*
15	7593·0		H_2O	$2\nu_3$	3*a*
16	7575·1		H_2O	$2\nu_3$	3*a*
17	7557·2		H_2O	$\nu_1+\nu_3, 2\nu_3$	3*a*
18	7536·0		H_2O	$\nu_1+\nu_3, 2\nu_3$	3*a*
19	7524·0		H_2O	$\nu_1+\nu_3, 2\nu_3$	3*a*
20	7511·0		H_2O	$\nu_1+\nu_3$	3*a*
21	7495·4		H_2O	$\nu_1+\nu_3, 2\nu_3$	3*a*
22	7484·9		H_2O	$\nu_1+\nu_3, 2\nu_3$	3*a*
23	7476·7		H_2O	$2\nu_3$	3*a*
24	7466·4		H_2O	$2\nu_3$	3*a*
25	7461·2		H_2O	$2\nu_1, 2\nu_3$	3*a*
26	7437·2		H_2O	$2\nu_1, \nu_1+\nu_3$	3*a*
27	7431·7		H_2O	$2\nu_1, \nu_1+\nu_3$	3*a*
28	7419·6		H_2O	$2\nu_1, \nu_1+\nu_3$	3*a*



3(a)
(b)
(c)
3
10
20
7400
7000
6600
cm-1

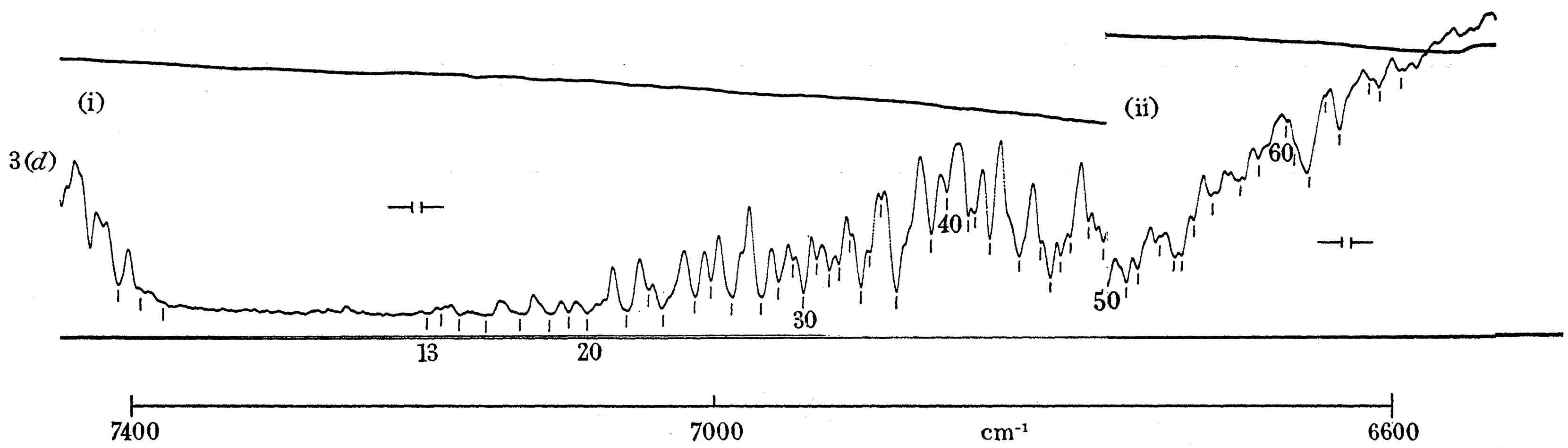
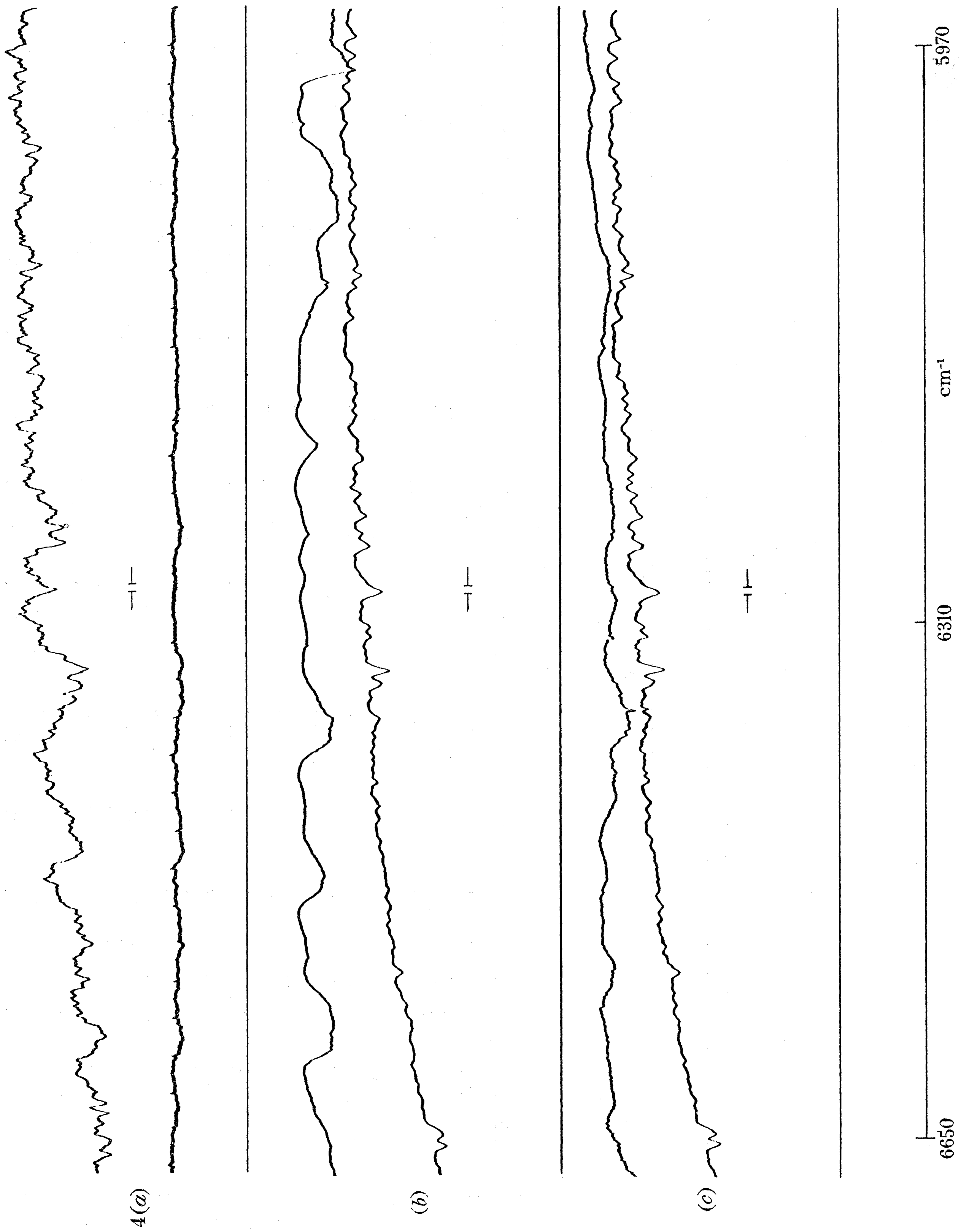


FIGURE 3

TABLE 2 (figure 3)

line no.	ν (cm⁻¹) (vac.)	ident.	band	ref.	line no.	ν (cm⁻¹) (vac.)	ident.	band	ref.	line no.	ν (cm⁻¹) (vac.)	ident.	band	ref.
1	7419·6	H_2O	$2\nu_1, \nu_1+\nu_3$	3a	26	7001·9	H_2O	$2\nu_2+\nu_3$	3a	48	6775·9	H_2O	$2\nu_2+\nu_3$	3a
2	7405·3	H_2O	$\nu_1+\nu_3$	3a	27	6980·9	{ H_2O { CO_2	$2\nu_1$ $3\nu_3$	3a 3a	49	6766·5	H_2O	$2\nu_2+\nu_3$	3a
3	7390·4	H_2O	$\nu_1+\nu_3$	3a	28	6971·3	H_2O	$2\nu_2+\nu_3$	3a	50	6755·0	H_2O	$2\nu_2+\nu_3$	3a
4	7342·1	H_2O	$\nu_1+\nu_3$	3a	29	6963·0	H_2O	$2\nu_2+\nu_3$	3a	51	6748·8	H_2O	$2\nu_2+\nu_3$	3a
5	7327·3	H_2O	$\nu_1+\nu_3$	3a	30	6954·8	H_2O	$\nu_1+\nu_3$	3a	52	6736·8	H_2O	$2\nu_2+\nu_3$	3a
6	7311·3	H_2O	$\nu_1+\nu_3$	3a	31	6946·9	H_2O	$2\nu_2+\nu_3$	3a	53	6726·1	H_2O	$2\nu_2+\nu_3$	3a
7	7293·9	H_2O	$\nu_1+\nu_3$	3a	32	6937·2	H_2O	$2\nu_2+\nu_3$	3a	54	6720·4	{ H_2O { ⊙ Mg	$2\nu_2+\nu_3$ —	3a 3a
8	7272·9	H_2O	$\nu_1+\nu_3$	3a	33	6930·2	H_2O	$2\nu_2+\nu_3$	3a	55	6712·7	H_2O	$2\nu_2+\nu_3$	3a
9	7252·9	H_2O	$\nu_1+\nu_3$	3a	34	6923·4	H_2O	$2\nu_1$	3a	56	6704·9	H_2O	$2\nu_2+\nu_3$	3a
10	7242·9	H_2O	$\nu_1+\nu_3$	3a	35	6917·0	H_2O	$2\nu_2+\nu_3$	3a	57	6685·3	{ H_2O { ⊙ Fe	$\nu_1+2\nu_2$ —	3a 3a
11	7232·1	H_2O	$\nu_1+\nu_3$	3a	36	6910·1	H_2O	$2\nu_2+\nu_3$	3a	58	6675·0	H_2O	$\nu_1+2\nu_2$	3a
12	7219·7	H_2O	$\nu_1+\nu_3$	3a	37	6905·0	H_2O	$2\nu_2+\nu_3$	3a	59	6658·3	{ H_2O { ⊙ Fe	$2\nu_2+\nu_3$ —	3a 3a
13	7204·1	H_2O	$\nu_1+\nu_3$	3a	38	6893·4	H_2O	$2\nu_2+\nu_3$	3a	60	6653·7	{ H_2O { ⊙ Mg	$\nu_1+2\nu_2$ —	3a 3a
14	7194·6	H_2O	$\nu_1+\nu_3$	3a	39	6871·2	H_2O	$2\nu_2+\nu_3$	3a	61	6647·0	{ H_2O { ⊙ Mg	$\nu_1+2\nu_2$ —	3a 3a
15	7181·6	H_2O	$\nu_1+\nu_3$	3a	40	6859·8	H_2O	$2\nu_2+\nu_3$	3a	62	6634·5	H_2O	$2\nu_2+\nu_3$	3a
16	7167·3	H_2O	$\nu_1+\nu_3$	3a	41	6847·7	H_2O	$2\nu_2+\nu_3$	3a	63	6627·6	H_2O	$\nu_1+2\nu_2$	3a
17	7138·4	H_2O	$\nu_1+\nu_3$	3a	42	6843·3	H_2O	$2\nu_2+\nu_3$	3a	64	6611·9	H_2O	$\nu_1+2\nu_2$	3a
18	7120·0	H_2O	$2\nu_1, \nu_1+\nu_3$	3a	43	6834·1	H_2O	$2\nu_2+\nu_3$	3a	65	6605·9	H_2O	$\nu_1+2\nu_2$	3a
19	7105·7	H_2O	$2\nu_1, \nu_1+\nu_3$	3a	44	6816·3	H_2O	$2\nu_2+\nu_3$	3a	66	6589·2	H_2O	$\nu_1+2\nu_2$	3a
20	7094·4	H_2O	$\nu_1+\nu_3$	3a	45	6804·3	H_2O	$2\nu_2+\nu_3$	3a					
21	7068·4	H_2O	$\nu_1+\nu_3$	3a	46	6799·3	{ H_2O { ⊙ Fe	$2\nu_2+\nu_3$ —	3a 3a					
22	7054·1	H_2O	$\nu_1+\nu_3$	3a	47	6791·7	H_2O	$2\nu_2+\nu_3$	3a					
23	7045·5	H_2O	$2\nu_2+\nu_3$	3a										
24	7022·5	H_2O	$2\nu_1$	3a										
25	7015·8	H_2O	$2\nu_2+\nu_3$	3a										



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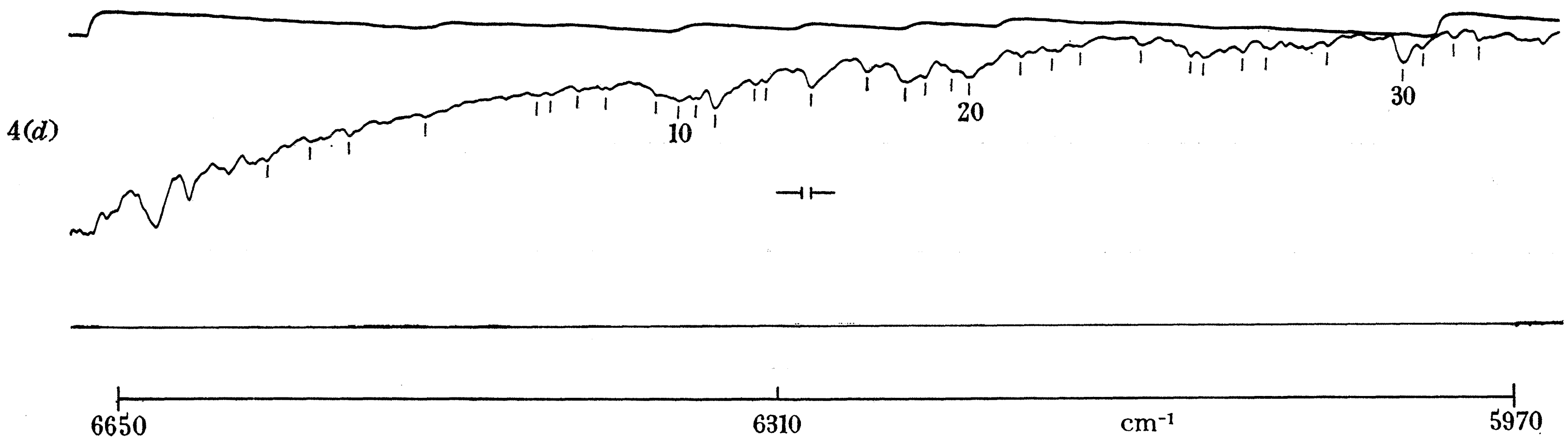
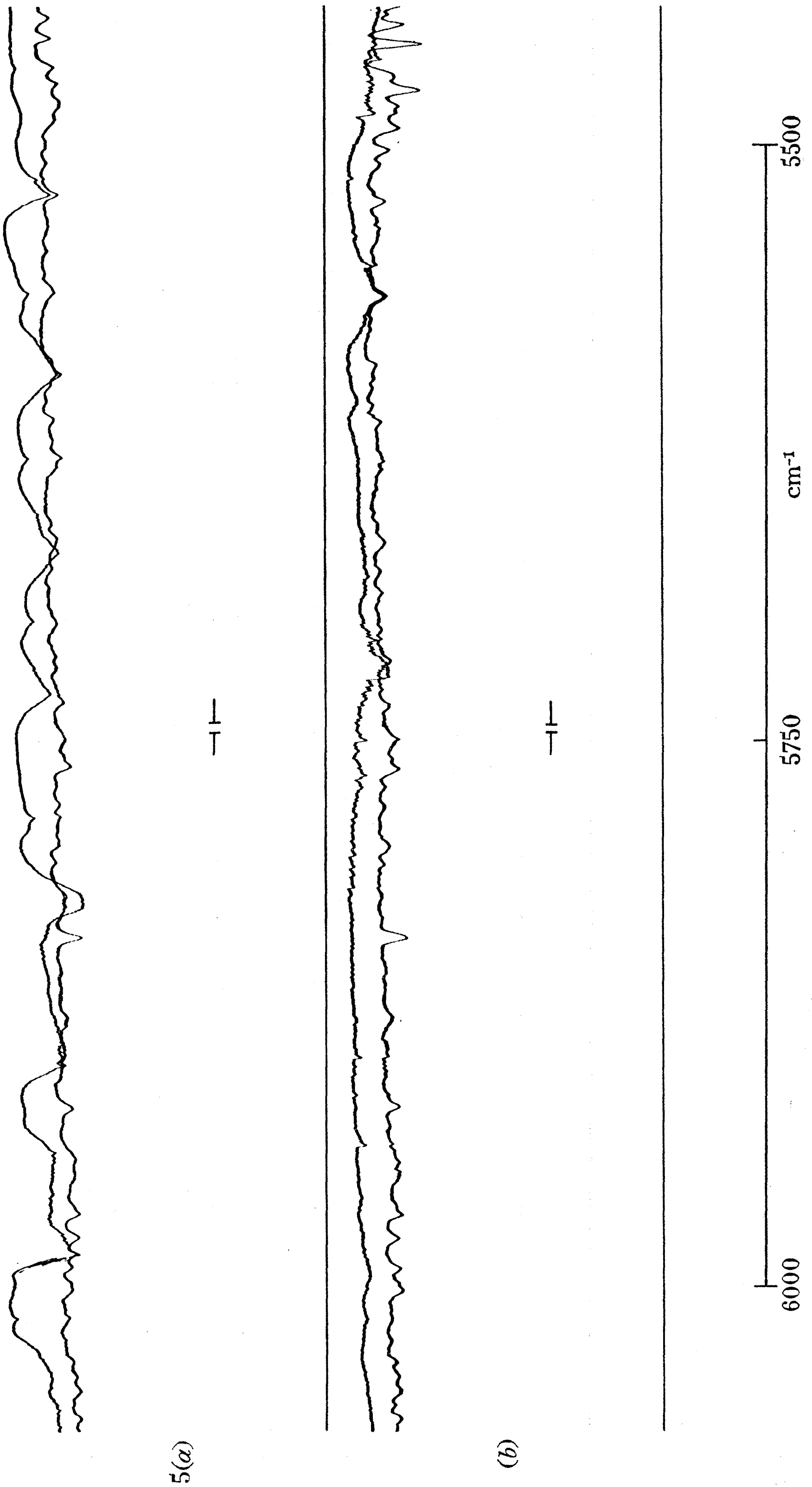


FIGURE 4

TABLE 2 (figure 4)

line no.	ν (cm^{-1}) (vac.)	ident.	band	ref.
1	6605·9	H_2O	$\nu_1+2\nu_2$	3 *a*
2	6589·2	H_2O	$\nu_1+2\nu_2$	3 *a*
3	6536·4	$\odot$ Fe	—	3 *a*
4	6493·9	$\odot$ Fe	—	3 *a*
5	6435·6	$\odot$ Fe	—	3 *a*
6	6425·8	$\odot$ Si	—	3 *a*
		$\odot$ Ni	—	3 *a*
7	6412·0	$\odot$ Si	—	3 *a*
8	6399·6	$\odot$ Fe	—	3 *a*
9	6370·9	CO_2	$2\nu_1+2\nu_2+\nu_3$	3 *a*
		$\odot$	—	3 *a*
10	6358·2	CO_2	$2\nu_1+2\nu_2+\nu_3$	3 *a*
		$\odot$ Fe	—	3 *a*
11	6347·8	$\odot$ Mg	—	3 *a*
12	6341·0	$\odot$ Mg	—	3 *a*
		$\odot$ Fe	—	3 *a*
		CO_2	$2\nu_1+2\nu_2+\nu_3$	3 *a*
13	6320·0	$\odot$ Fe	—	3 *a*
14	6313·3	$\odot$ Fe	—	3 *a*
15	6292·1	$\odot$ Si	—	3 *a*
		$\odot$ Mg	—	3 *a*
		$\odot$ Fe	—	3 *a*
16	6263·9	$\odot$ Si	—	3 *a*
		$\odot$ Fe	—	3 *a*
		$\odot$ Al	—	3 *a*
17	6246·2	CO_2	$\nu_1+4\nu_2+\nu_3$	3 *a*
		$\odot$ Fe	—	3 *a*
18	6232·4	CO_2	$\nu_1+4\nu_2+\nu_3$	3 *a*
		$\odot$ Fe	—	3 *a*
19	6218·7	CO_2	$\nu_1+4\nu_2+\nu_3$	3 *a*
		$\odot$	—	3 *a*
20	6211·4	$\odot$ Si	—	3 *a*
		CO_2	$\nu_1+4\nu_2+\nu_3$	3 *a*
21	6184·4	$\odot$ Fe	—	3 *a*
		$\odot$ Si	—	3 *a*
22	6172·2	$\odot$ Ca	—	3 *a*
23	6155·2	$\odot$ Si	—	3 *a*
24	6127·1	$\odot$ Fe	—	3 *a*
25	6102·7	$\odot$ Si	—	3 *a*
26	6096·4	CH_4	—	3 *a*
27	6079·2	$\odot$ Fe	—	3 *a*
28	6063·8	$\odot$ Fe	—	3 *a*
29	6036·3	$\odot$	—	3 *a*
		CH_4	—	3 *a*
30	6002·5	CH_4	—	3 *a*
31	5993·2	$\odot$ Si	—	3 *a*
		$\odot$ Fe	—	3 *a*
32	5979·5	$\odot$ Al	—	3 *a*
33	5968·3	$\odot$ Al	—	3 *a*



5(a)

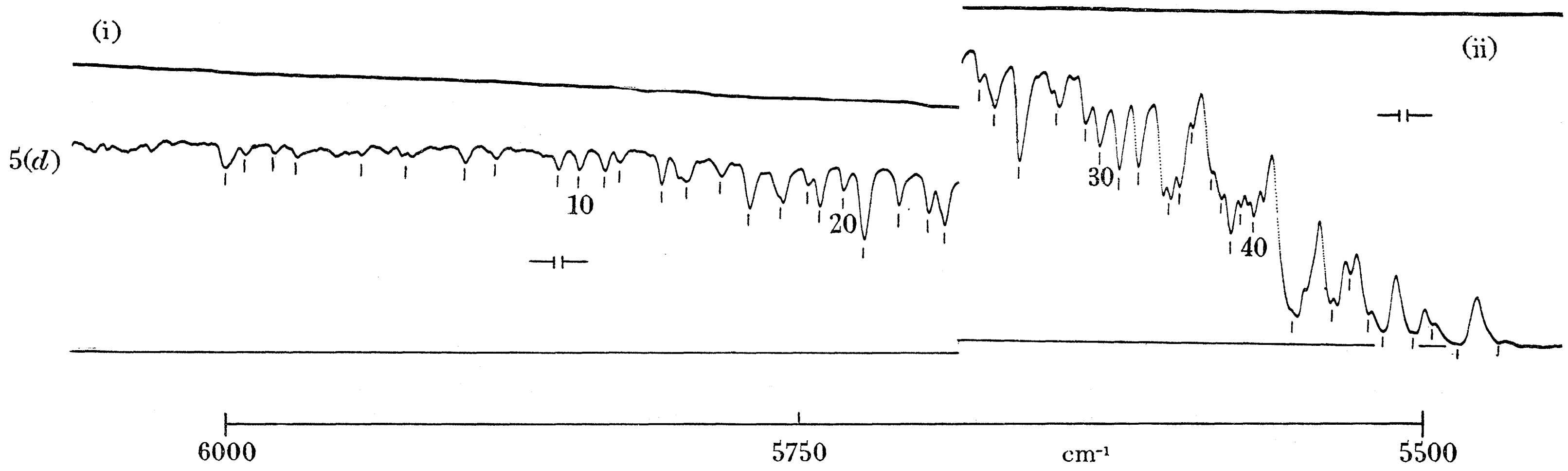


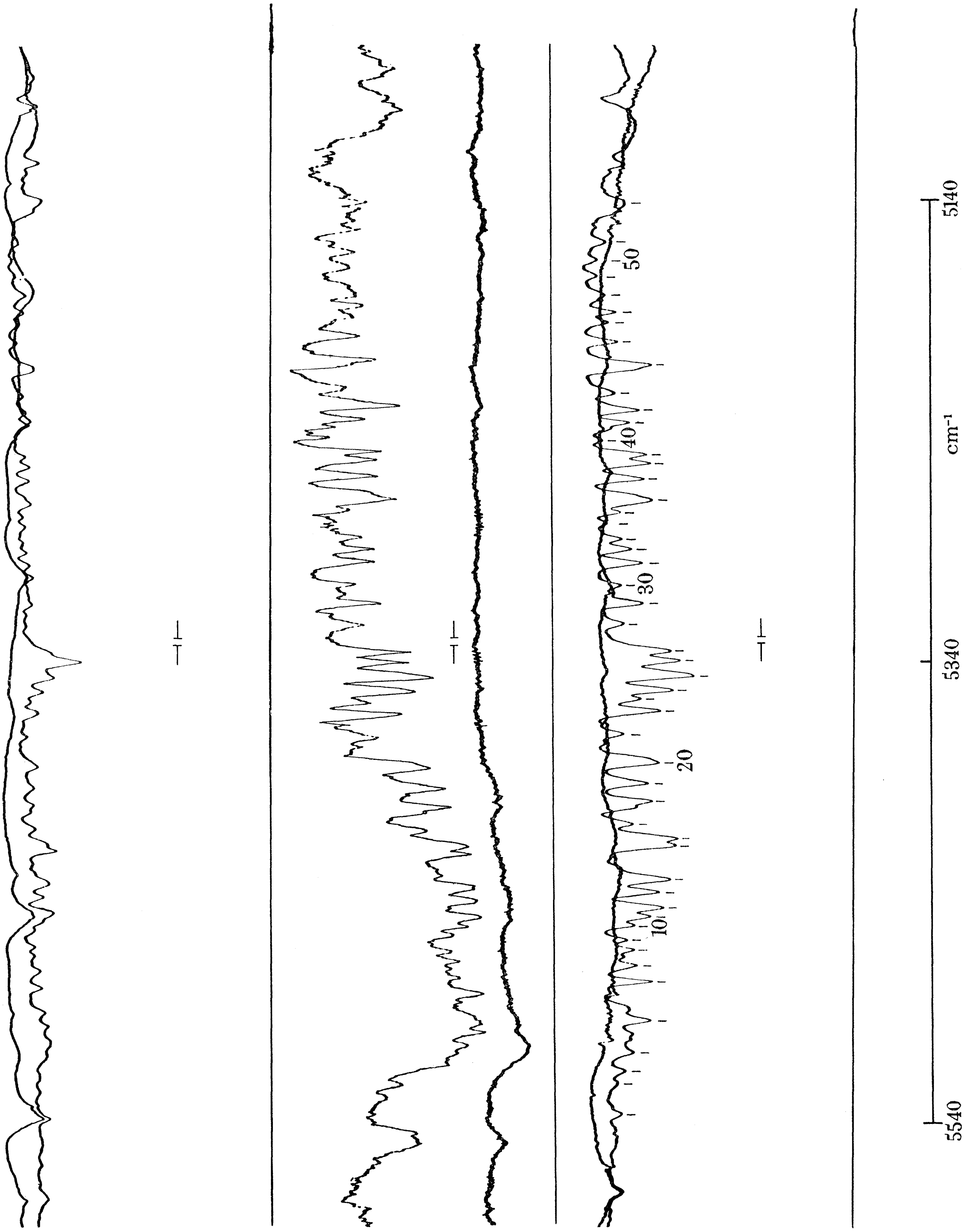
FIGURE 5

TABLE 2 (figure 5)

line no.	ν (cm^{-1}) (vac.)	ident.	band	ref.
1	6002·5	CH_4	—	3a
2	5993·2	⊙ Si	—	3a
		⊙ Fe	—	3a
3	5979·5	⊙ Al	—	3a
4	5968·3	⊙ Al	—	3a
5	5938·1	CH_4	—	3a
		⊙ Ni	—	3a
6	5915·1	CH_4	—	3a
7	5891·7	H_2O	$\nu_2+\nu_3$	3a
		⊙ Fe	—	3a
8	5880·4	⊙ Ni	—	3a
		⊙ Fe	—	3a
		H_2O	$\nu_2+\nu_3$	3a
9	5852·7	H_2O	$\nu_2+\nu_3$	3a
10	5843·4	⊙ Mg	—	3a
11	5833·2	H_2O	$\nu_2+\nu_3$	3a
12	5827·1	H_2O	$\nu_2+\nu_3$	3a
		⊙ Fe	—	3a
13	5809·0	H_2O	$\nu_2+\nu_3$	3a

line no.	ν (cm^{-1}) (vac.)	ident.	band	ref.
14	5801·9	H_2O	$\nu_2+\nu_3$	3a
		⊙ Si	—	3a
15	5784·0	H_2O	$\nu_2+\nu_3$	3a
16	5772·4	H_2O	$\nu_2+\nu_3$	3a
		⊙ Fe	—	3a
17	5759·9	H_2O	$\nu_2+\nu_3$	3a
18	5747·6	H_2O	$\nu_2+\nu_3$	3a
		⊙	—	3a
19	5742·8	H_2O	$\nu_2+\nu_3$	3a
20	5732·4	H_2O	$\nu_2+\nu_3$	3a
21	5724·9	H_2O	$\nu_2+\nu_3$	3a
22	5709·2	H_2O	$\nu_2+\nu_3$	3a
23	5697·4	H_2O	$\nu_2+\nu_3$	3a
24	5690·0	H_2O	$\nu_2+\nu_3$	3a
25	5678·4	H_2O	$\nu_2+\nu_3$	3a
26	5671·9	H_2O	$\nu_2+\nu_3$	3a
27	5662·7	H_2O	$\nu_2+\nu_3$	3a
28	5647·3	H_2O	$\nu_2+\nu_3$	3a
29	5636·9	H_2O	$\nu_2+\nu_3$	3a
30	5629·8	H_2O	$\nu_2+\nu_3$	3a

line no.	ν (cm^{-1}) (vac.)	ident.	band	ref.
31	5621·6	H_2O	$\nu_2+\nu_3$	3a
32	5614·0	H_2O	$\nu_2+\nu_3$	3a
33	5602·8	H_2O	$\nu_2+\nu_3$	3a
34	5595·5	H_2O	$\nu_2+\nu_3$	3a
35	5590·2	H_2O	$\nu_2+\nu_3$	3a
36	5585·1	H_2O	$\nu_2+\nu_3$	3a
37	5582·1	H_2O	$\nu_2+\nu_3$	3a
38	5579·4	H_2O	$\nu_2+\nu_3$	3a
39	5574·3	H_2O	$\nu_2+\nu_3$	3a
40	5570·1	H_2O	$\nu_2+\nu_3$	3a
41	5551·8	H_2O	$\nu_2+\nu_3$	3a
42	5536·1	H_2O	$\nu_2+\nu_3$	3a
43	5527·8	H_2O	$\nu_2+\nu_3$	3a
44	5521·1	H_2O	$\nu_2+\nu_3$	3a
45	5516·0	H_2O	$\nu_2+\nu_3$	3a
46	5507·6	H_2O	$\nu_2+\nu_3$	3a
47	5498·9	H_2O	$\nu_2+\nu_3$	3a
48	5492·8	H_2O	$\nu_2+\nu_3$	3a
49	5475·2	H_2O	$\nu_2+\nu_3$	3a



6(*a*) (*b*) (*c*)

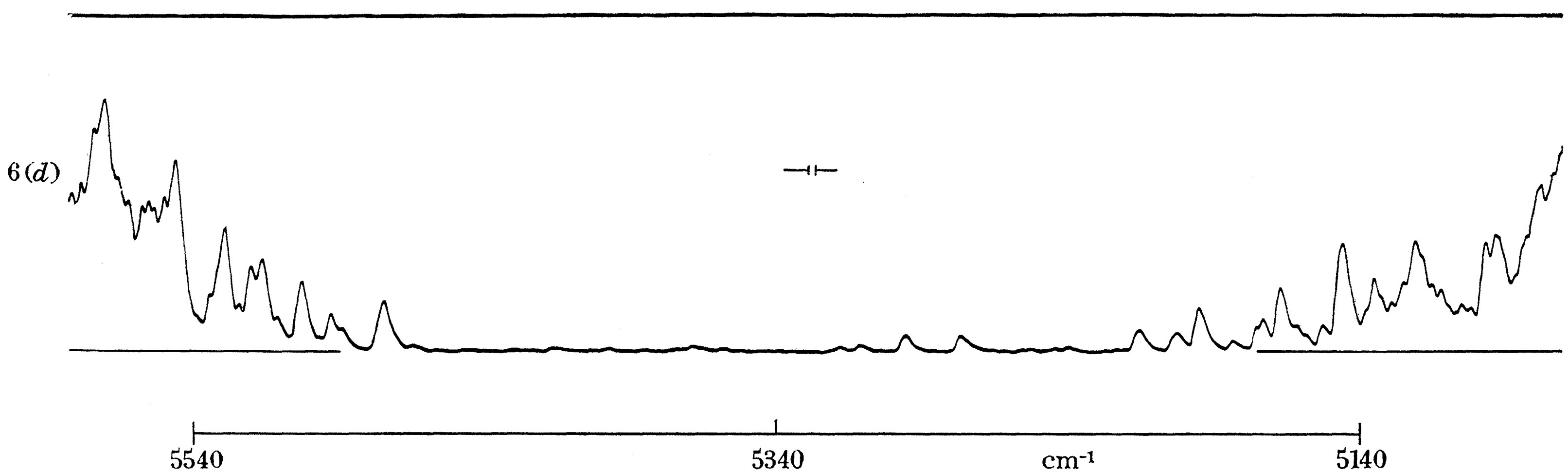
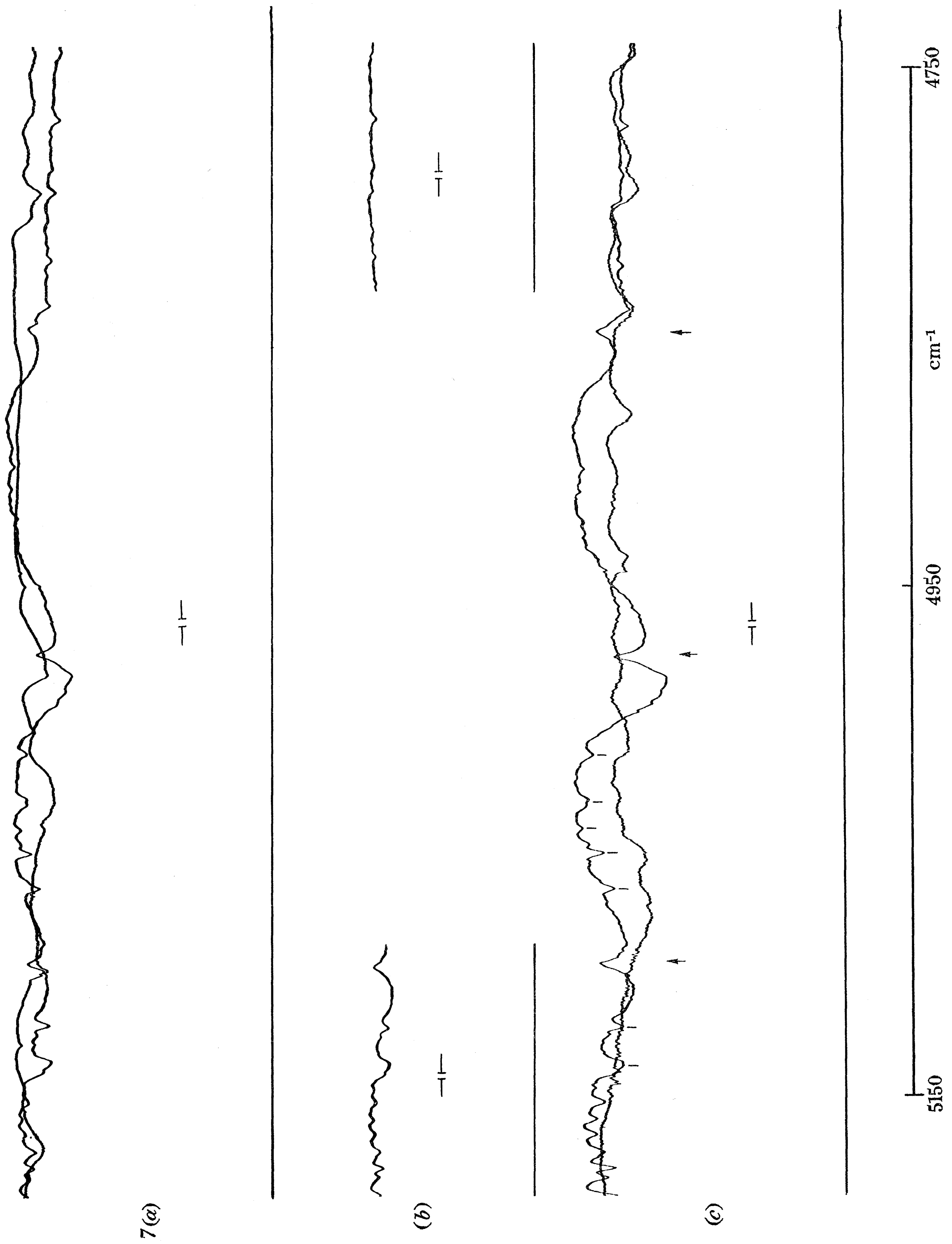


FIGURE 6

TABLE 2 (figure 6)

line no.	ν (cm⁻¹) (vac.)	ident.	band	ref.
1	5536·1	H_2O	$\nu_2+\nu_3$	3*a*
2	5521·1	H_2O	$\nu_2+\nu_3$	3*a*
3	5516·0	H_2O	$\nu_2+\nu_3$	3*a*
4	5507·6	H_2O	$\nu_2+\nu_3$	3*a*
5	5495·8	H_2O	$\nu_2+\nu_3$	6
6	5475·2	H_2O	$\nu_2+\nu_3$	3*a*
7	5470·0	H_2O	$\nu_2+\nu_3$	6
8	5464·3	H_2O	$\nu_2+\nu_3$	6
9	5459·5	H_2O	$\nu_2+\nu_3$	6
10	5452·6	H_2O	$\nu_2+\nu_3$	6
11	5448·0	H_2O	$\nu_2+\nu_3$	6
12	5443·2	H_2O	$\nu_2+\nu_3$	6
13	5437·3	H_2O	$\nu_2+\nu_3$	6
14	5431·0	H_2O	$\nu_2+\nu_3$	6
15	5416·7	H_2O	$\nu_2+\nu_3$	6
16	5413·7	H_2O	$\nu_2+\nu_3$	6
17	5406·0	H_2O	$\nu_2+\nu_3$	6
18	5395·8	H_2O	$\nu_2+\nu_3$	6
19	5388·0	H_2O	$\nu_2+\nu_3$	6
20	5378·7	H_2O	$\nu_2+\nu_3$	6
21	5366·1	H_2O	$\nu_2+\nu_3$	6
22	5354·9	H_2O	$\nu_2+\nu_3$	6
23	5350·8	H_2O	$\nu_2+\nu_3$	6
24	5346·4	H_2O	$\nu_2+\nu_3$	6
25	5339·9	H_2O	$\nu_2+\nu_3$	6
26	5333·4	{ H_2O	$\nu_2+\nu_3$	6
		{ ⊙ H	3–4	3*b*
27	5329·5	H_2O	$\nu_2+\nu_3$	6
28	5318·0	H_2O	$\nu_2+\nu_3$	6
29	5309·7	H_2O	$\nu_2+\nu_3$	6
30	5302·0	H_2O	$\nu_2+\nu_3$	6
31	5292·0	H_2O	$\nu_2+\nu_3$	6
32	5286·8	H_2O	$\nu_2+\nu_3$	6
33	5282·1	H_2O	$\nu_2+\nu_3$	6
34	5274·6	H_2O	$\nu_2+\nu_3$	3*a*
35	5272·8	H_2O	$\nu_2+\nu_3$	3*a*
36	5265·9	H_2O	$\nu_2+\nu_3$	6
37	5256·6	H_2O	$\nu_2+\nu_3$	6
38	5250·1	H_2O	$\nu_2+\nu_3$	6
39	5246·6	H_2O	$\nu_2+\nu_3$	6
40	5239·9	H_2O	$\nu_2+\nu_3$	6
41	5232·2	H_2O	$\nu_2+\nu_3$	6
42	5227·5	H_2O	$\nu_2+\nu_3$	6
43	5220·3	H_2O	$\nu_2+\nu_3$	6
44	5210·6	H_2O	$\nu_2+\nu_3$	6
45	5199·0	H_2O	$\nu_2+\nu_3$	6
46	5189·0	H_2O	$\nu_2+\nu_3$	6
47	5181·9	H_2O	$\nu_2+\nu_3$	6
48	5172·0	H_2O	$\nu_2+\nu_3$	6
49	5165·5	H_2O	$\nu_2+\nu_3$	6
50	5157·1	H_2O	$\nu_2+\nu_3$	6
51	5152·2	H_2O	$\nu_2+\nu_3$	6
52	5141·7	{ H_2O	$\nu_2+\nu_3$	3*a*
		{ ⊙ H	4–8, etc.	


7(a)
(b)
(c)
4750
cm-1
4950
5150

7(*d*)

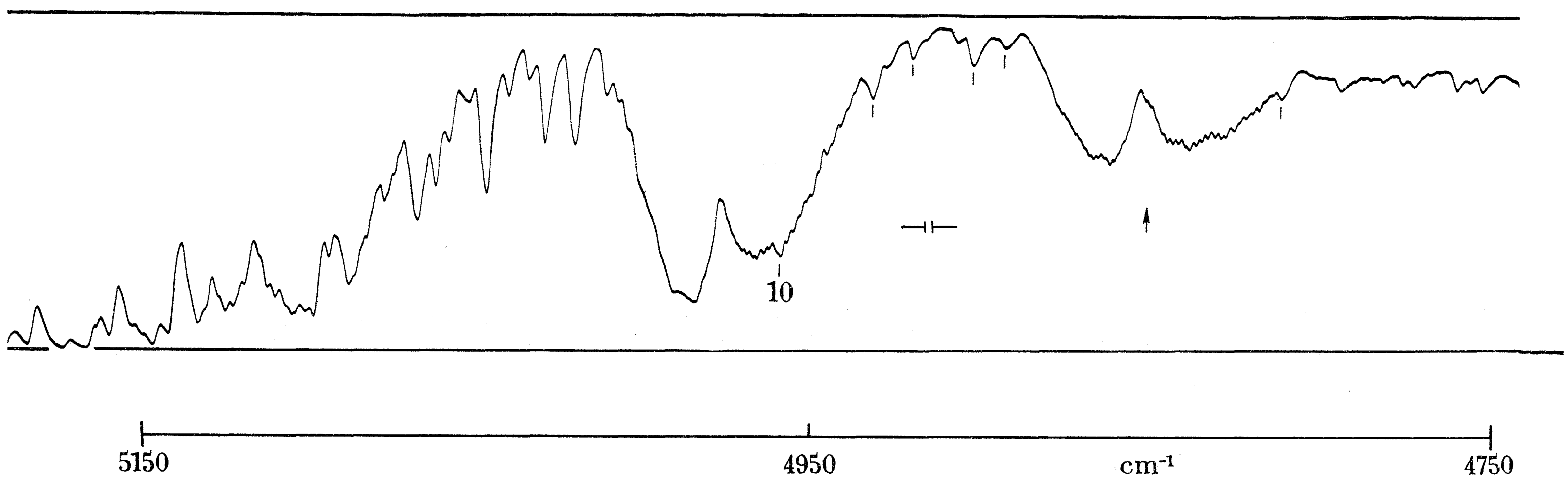
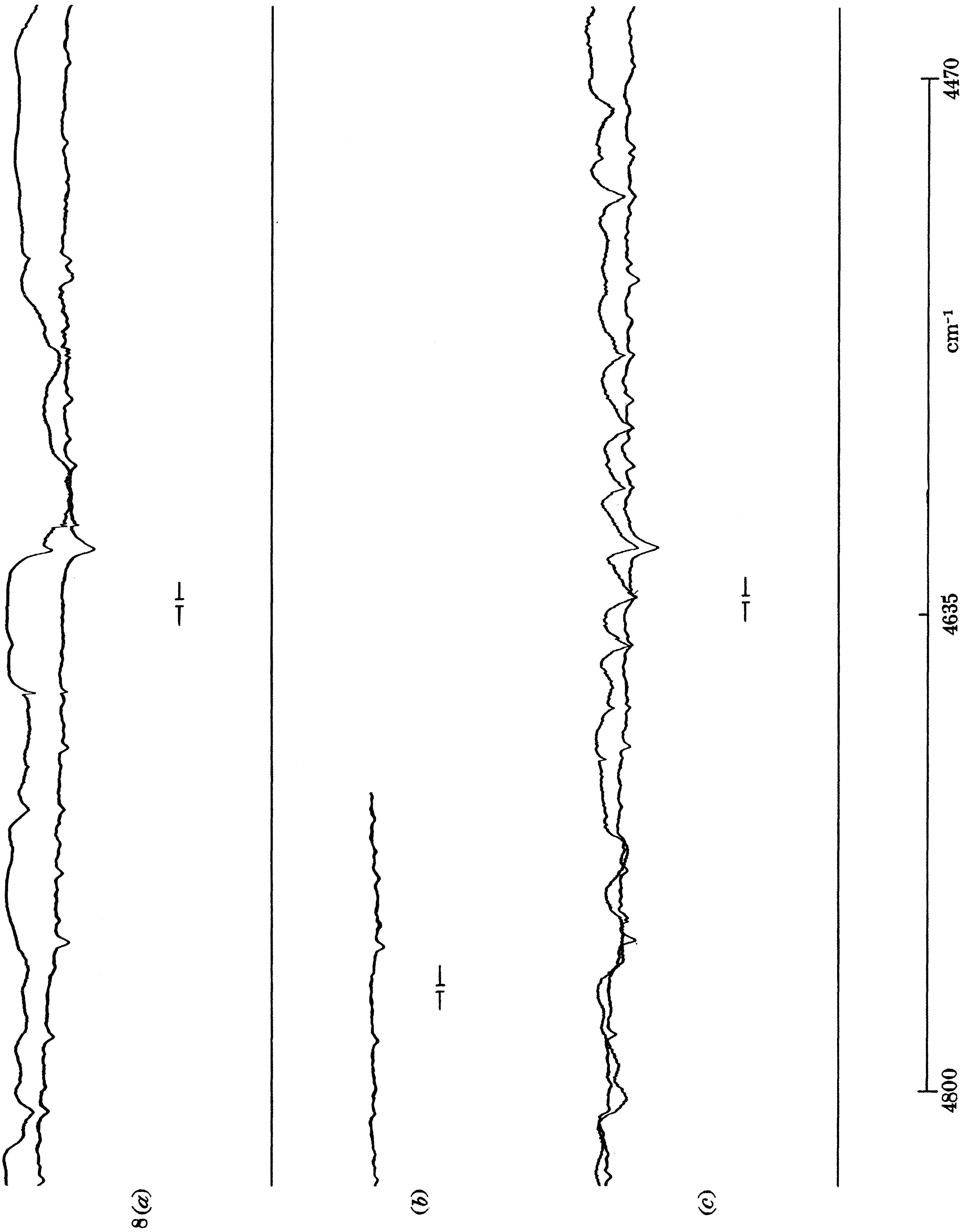


FIGURE 7

TABLE 2 (figure 7)

line no.	ν (cm^{-1}) (vac.)	ident.	band	ref.	line no.	ν (cm^{-1}) (vac.)	ident.	band	ref.
1	5141·7	H_2O	$\nu_2+\nu_3$	3*a*	10	4957·9	CO_2	$\nu_1+2\nu_2+\nu_3$	3*a*
		⊙ H	4–8, etc.				H_2O	$\nu_2+\nu_3$	3*a*
2	5119·5	H_2O	$\nu_2+\nu_3$	3*a*	11	4929·8	CO_2	$\nu_1+2\nu_2+\nu_3$	3*a*
		CO_2	$2\nu_1+\nu_3$	3*a*			H_2O	$\nu_2+\nu_3$	3*a*
3	5100*	CO_2	$2\nu_1+\nu_3$	3*a*	12	4918·3	H_2O	$\nu_2+\nu_3$	3*a*
4	5081·3	CO_2	$2\nu_1+\nu_3$	3*a*	13	4901·7	H_2O	$\nu_2+\nu_3$	3*a*
5	5072·0	H_2O	$\nu_1+\nu_2$	3*a*	14	4892	H_2O	$\nu_2+\nu_3$	3*a*
		CO_2	$2\nu_1+\nu_3$	3*a*			$^{13}CO_2$	$\nu_1+2\nu_2+\nu_3$	3*a*
6	5065·2	H_2O	$\nu_2+\nu_3$	3*a*	15	4853*	CO_2	$4\nu_2+\nu_3$	3*a*
7	5050·7	H_2O	$\nu_1+\nu_2$	3*a*	16	4812·9	CO_2	$4\nu_2+\nu_3$	3*a*
8	5032·5	H_2O	$\nu_2+\nu_3$	3*a*			H_2O	$3\nu_2$	3*a*
9	4977*	CO_2	$\nu_1+2\nu_2+\nu_3$	3*a*					

* Approximate centre of unresolved bands.


8(a)
(b)
(c)
4800
4635
4470
cm⁻¹

8(*d*)

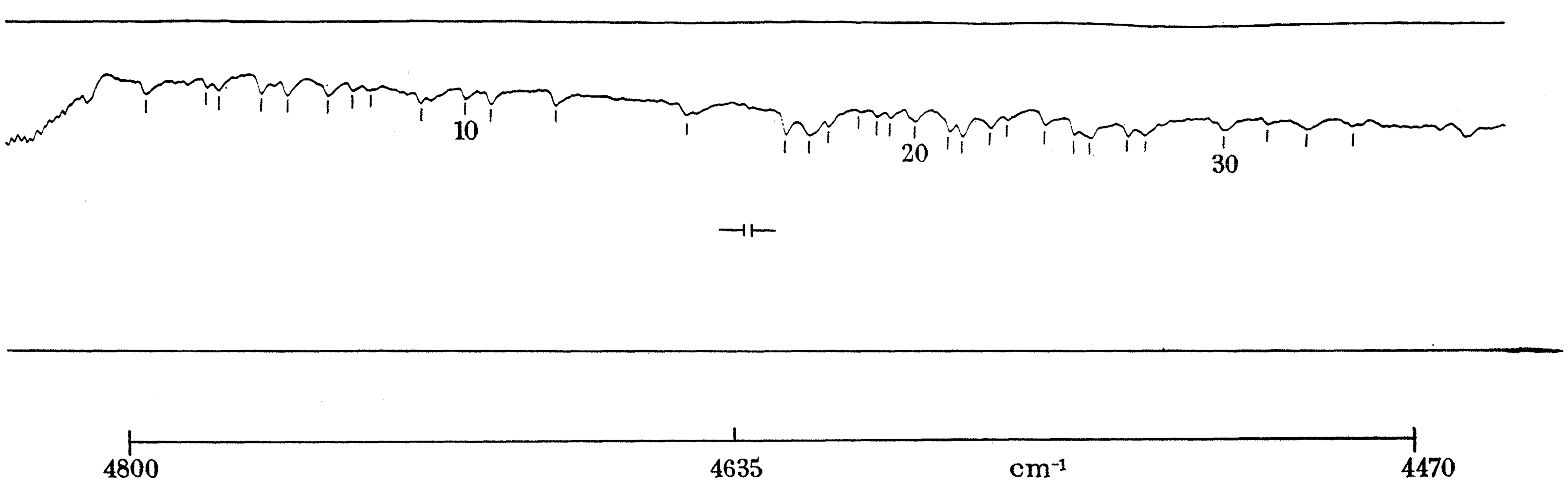
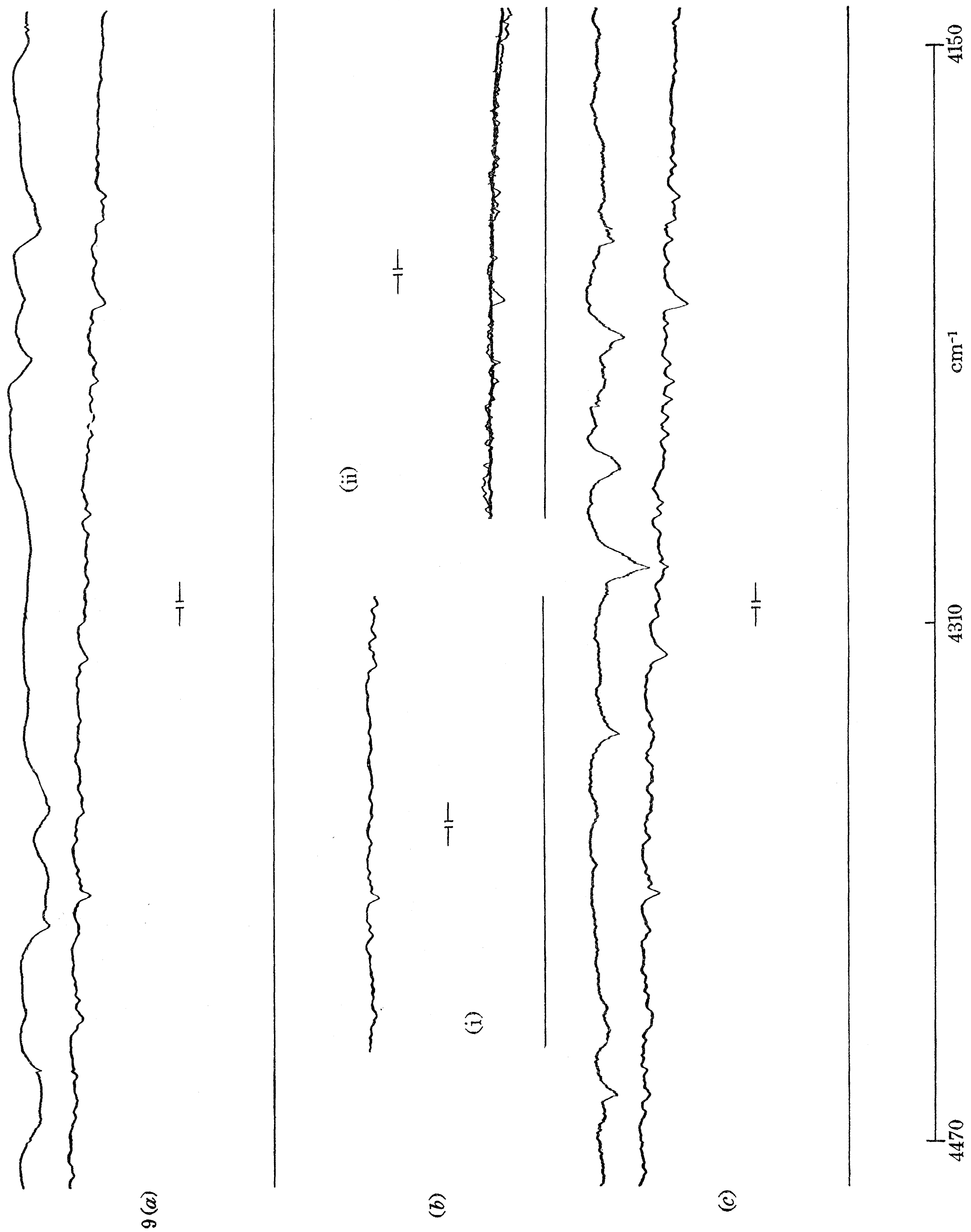


FIGURE 8

TABLE 2 (figure 8)

line no.	ν (cm⁻¹) (vac.)	ident.	band	ref.	line no.	ν (cm⁻¹) (vac.)	ident.	band	ref.
1	4796·4	H_2O	$3\nu_2$	3*a*	18	4598·7	H_2O	$3\nu_2$	3*a*
2	4779·4	⊙	—	3*a*	19	4594·9	H_2O	$3\nu_2$	3*a*
3	4775·8	H_2O	$3\nu_2$	3*a*	20	4590·1	CH_4	—	3*a*
4	4764·6	H_2O	$3\nu_2$	3*a*	21	4580·0	H_2O	$3\nu_2$	3*a*
5	4757·9	H_2O	$3\nu_2$	3*a*	22	4576·8	H_2O	$3\nu_2$	3*a*
6	4747·0	H_2O	$3\nu_2$	3*a*	23	4569·8	{ H_2O ⊙	$3\nu_2$ —	3*a* 3*a*
7	4739·6	⊙ Al	—	3*a*					
8	4735·2	H_2O	$3\nu_2$	3*a*	24	4565·1	H_2O	$3\nu_2$	3*a*
9	4720·1	H_2O	$3\nu_2$	3*a*	25	4556·5	H_2O	$3\nu_2$	3*a*
10	4707·2	H_2O	$3\nu_2$	3*a*	26	4549·0	H_2O	$3\nu_2$	3*a*
11	4699·7	H_2O	$3\nu_2$	3*a*	27	4543·5	CH_4	—	3*a*
12	4681·6	⊙ Si	—	3*a*	28	4535·3	H_2O	$3\nu_2$	3*a*
13	4648·2	H_2O	$3\nu_2$	3*a*	29	4532·6	⊙ Na	—	3*a*
14	4622·2	H_2O	$3\nu_2$	3*a*	30	4512·6	H_2O	$3\nu_2$	3*a*
15	4616·5	⊙ H	4–7, etc.	3*a*	31	4501·6	CH_4	—	3*a*
16	4611·1	H_2O	$3\nu_2$	3*a*	32	4493·9	H_2O	$3\nu_2$	3*a*
17	4602·7	CH_4	—	3*a*	33	4481·0	CH_4	—	3*a*


9 (a)
(b)
(c)
(i)
(ii)
4150
4310
4470
cm⁻¹

9(d)

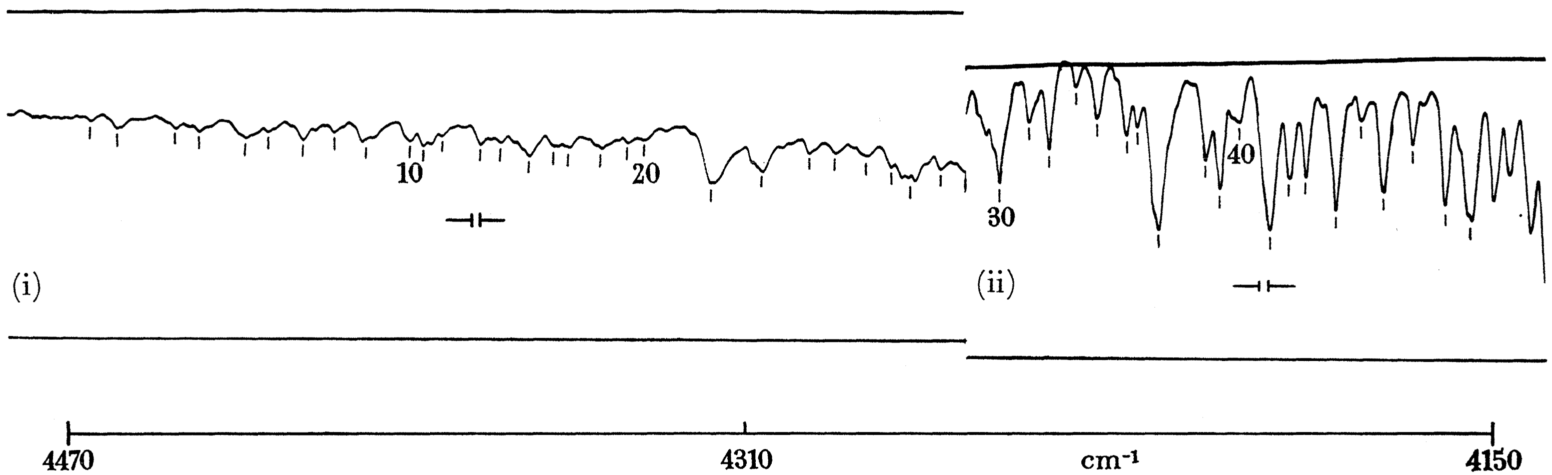
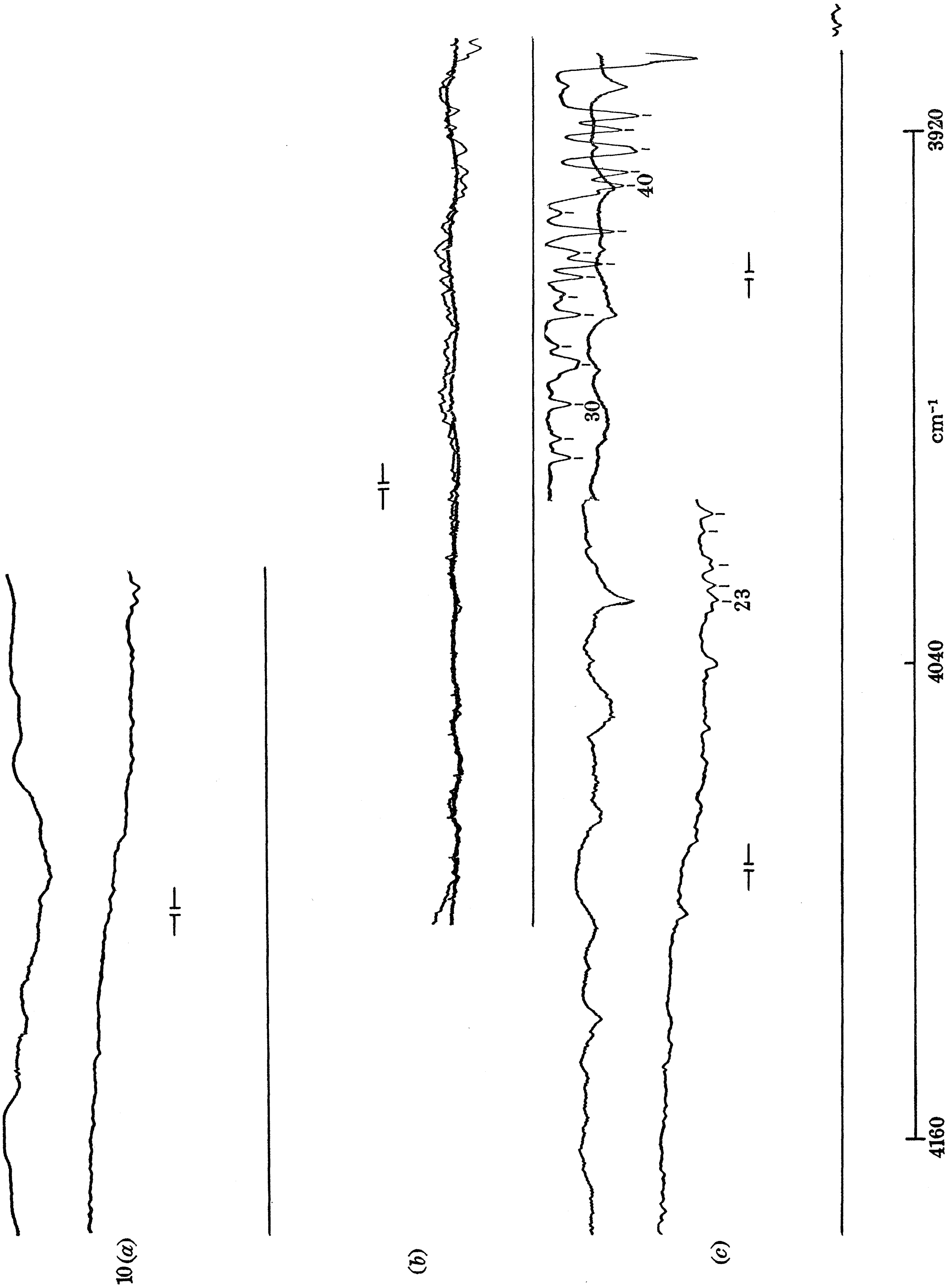


FIGURE 9

TABLE 2 (figure 9)

line no.	ν (cm⁻¹) (vac.)	ident.	band	ref.
1	4466·9	CH_4	—	3a
2	4463·7	CH_4	—	3a
3	4456·3	CH_4	—	3a
4	4449·9	CH_4	—	3a
5	4435·8	CH_4	—	3a
6	4430·8	CH_4	—	3a
7	4421·4	CH_4	—	3a
8	4415·5	CH_4	—	3a
9	4407·8	H_2O	ν_3	3a
10	4400·5	CH_4	—	3a
11	4394·3	CH_4	—	3a
12	4391·3	CH_4	—	3a
13	4384·3	CH_4	—	3a
14	4380·6	CH_4	—	3a
15	4375·6	CH_4	—	3a
16	4367·0	CH_4	—	3a
17	4362·0	CH_4	—	3a
18	4356·1	H_2O	ν_3	3a
19	4348·9	{ H_2O { CH_4	— —	3a 3a
20	4333·7	CH_4	—	3a
21	4315·6	CH_4	—	3a
22	4306·7	H_2O	ν_3	3a
23	4294·5	H_2O	ν_3	3a
24	4288·8	H_2O	ν_3	3a
25	4281·7	{ ⊙ Na { CH_4	— —	3a 3a
26	4276·1	{ ⊙ Na { H_2O	— ν_3	3a 3a
27	4269·8	H_2O	ν_3	3a
28	4264·3	H_2O	ν_3	3a
29	4261·1	CH_4	—	3a
30	4250·8	H_2O	ν_3	3a
31	4244·8	CH_4	—	3a
32	4239·9	H_2O	ν_3	3a
33	4234·4	CH_4	—	3a
34	4230·1	H_2O	ν_3	3a
35	4224·3	H_2O	ν_3	3a
36	4221·2	H_2O	ν_3	3a
37	4218·3	{ CH_4 { H_2O	— ν_3	3a 3a
38	4208·0	H_2O	ν_3	3a
39	4204·8	H_2O	ν_3	3a
40	4200·2	H_2O	ν_3	3a
41	4194·5	H_2O	ν_3	3a
42	4191·1	H_2O	ν_3	3a
43	4187·3	H_2O	ν_3	3a
44	4181·5	H_2O	ν_3	3a
45	4176·4	H_2O	ν_3	3a
46	4171·3	H_2O	ν_3	3a
47	4165·9	H_2O	ν_3	3a
48	4159·2	H_2O	ν_3	3a
49	4154·6	H_2O	ν_3	3a



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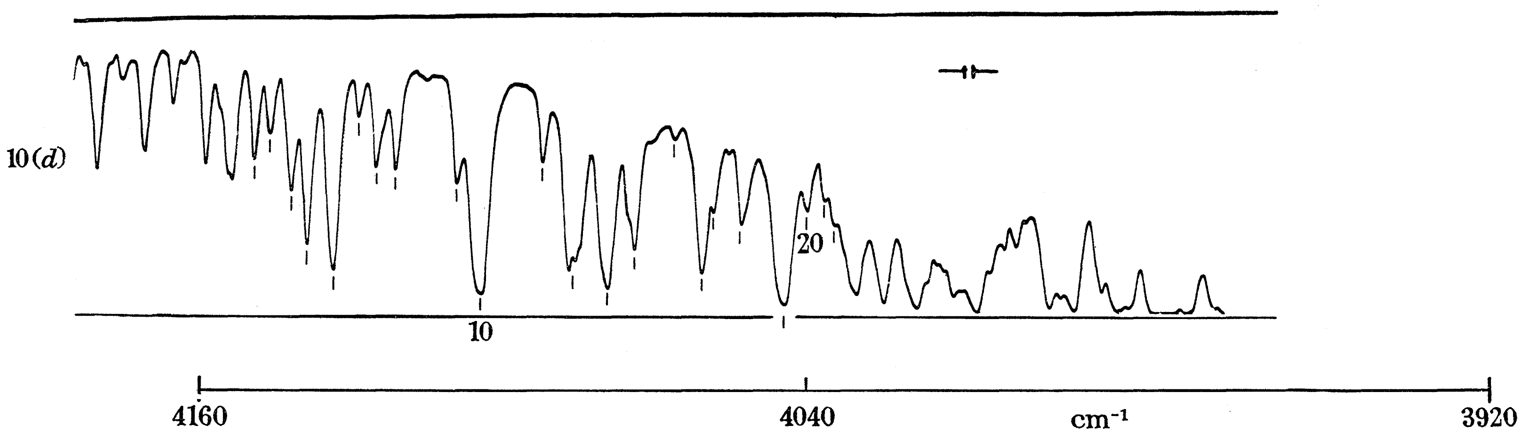
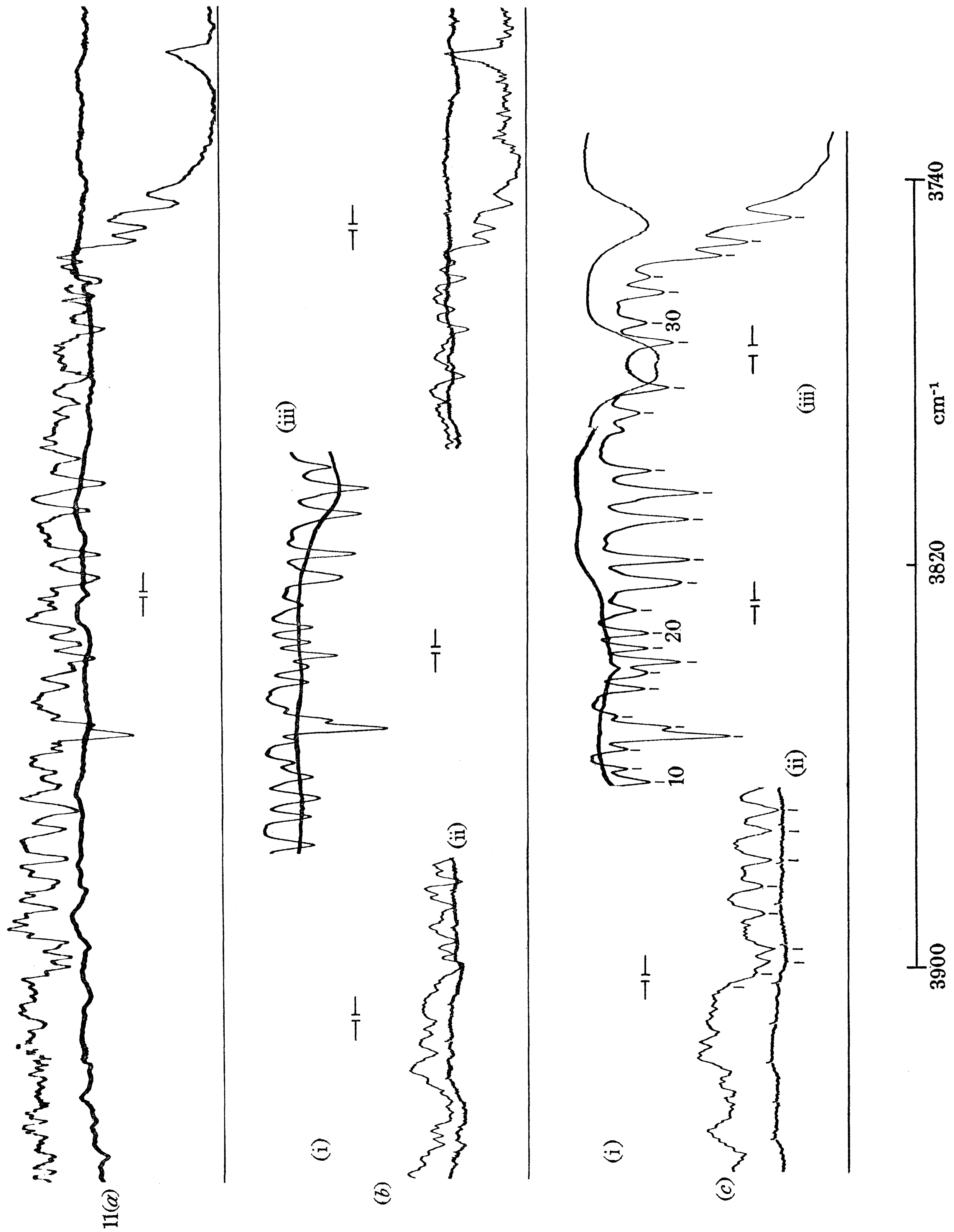


FIGURE 10

TABLE 2 (figure 10)

line no.	ν (cm^{-1}) (vac.)	ident.	band	ref.	line no.	ν (cm^{-1}) (vac.)	ident.	band	ref.
1	4149·5	H_2O	all ν_1, ν_3	3*a*	23	4031·4	H_2O	all ν_1, ν_3	3*a*
2	4146·3	H_2O		3*a*	24	4025·4	H_2O		3*a*
3	4141·9	H_2O		3*a*	25	4019·5	H_2O		3*a*
4	4138·8	H_2O		3*a*	26	4012·7	H_2O		3*a*
5	4133·6	H_2O		3*a*	27	4008·6	H_2O		3*a*
6	4128·7	H_2O		3*a*	28	3995·0	H_2O		3*a*
7	4125·2	H_2O		3*a*	29	3990·7	H_2O		3*a*
8	4121·4	H_2O		3*a*	30	3982·2	H_2O		3*a*
9	4109·5	H_2O		3*a*	31	3974·0	H_2O		2
10	4106·0	H_2O		3*a*	32	3969·4	H_2O		2
11	4093·5	H_2O		3*a*	33	3961·9	H_2O		2
12	4088·1	H_2O		3*a*	34	3957·1	H_2O		2
13	4079·3	H_2O		3*a*	35	3953·3	H_2O		2
14	4073·9	H_2O		3*a*	36	3950·1	H_2O		2
15	4066·1	H_2O		3*a*	37	3948·4	H_2O		2
16	4060·5	H_2O		3*a*	38	3942·9	H_2O		2
17	4057·8	H_2O		3*a*	39	3938·4	H_2O		2
18	4052·2	H_2O		3*a*	40	3932·4	H_2O		2
19	4044·5	H_2O		3*a*	41	3929·5	H_2O		2
20	4040·1	H_2O		3*a*	42	3925·2	H_2O		2
21	4036·4	H_2O		3*a*	43	3920·1	H_2O		2
22	4034·5	H_2O		3*a*	44	3917·3	H_2O		2



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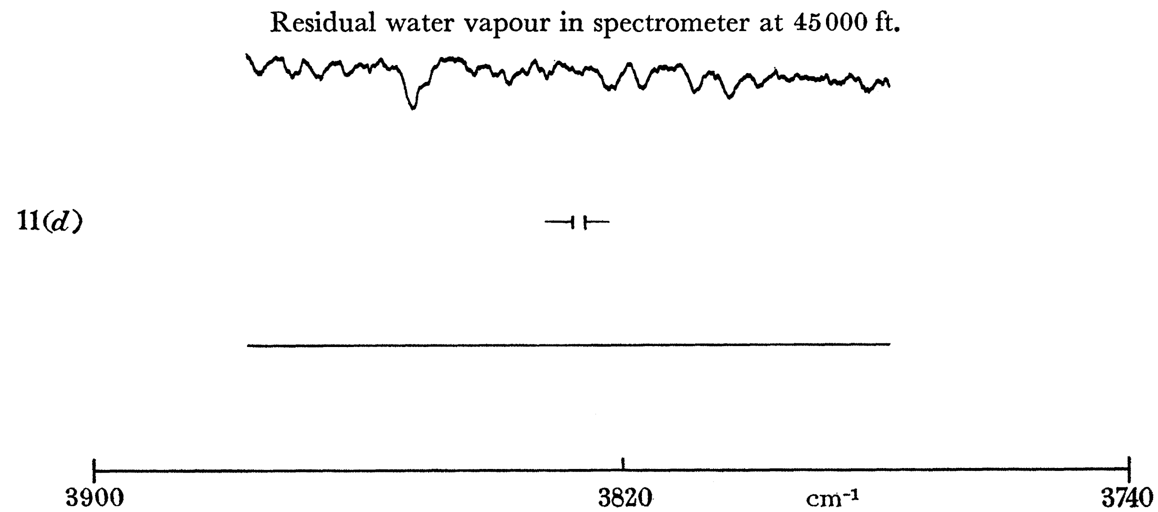
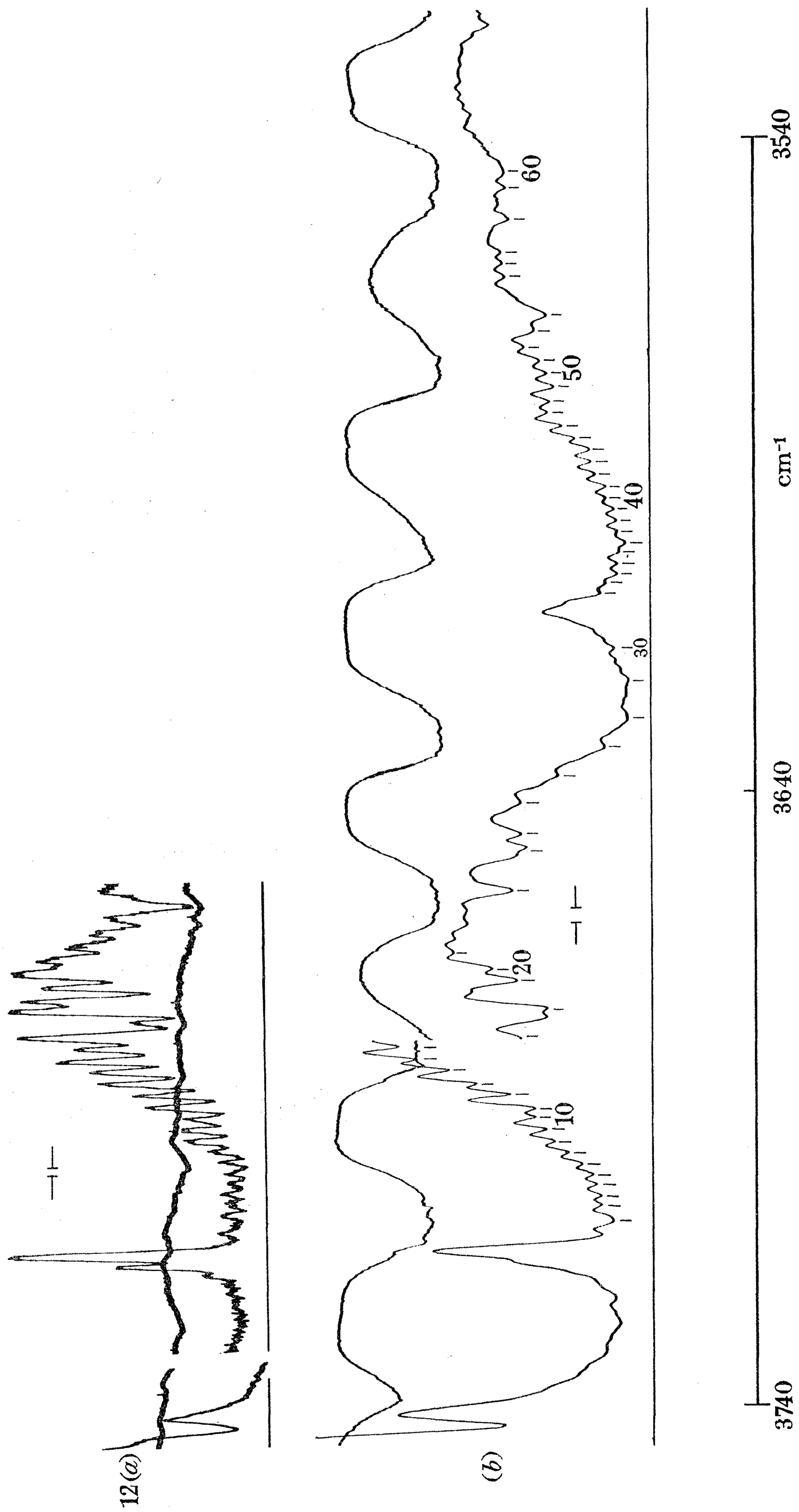


FIGURE 11

TABLE 2 (figure 11)

line no.	ν (cm⁻¹) (vac.)	ident.	band	ref.	line no.	ν (cm⁻¹) (vac.)	ident.	band	ref.
1	3906·2	H_2O	ν_3	2	19	3835·0	H_2O	ν_3	2
2	3904·2	H_2O	ν_3	2	20	3831·7	H_2O	ν_3	2
3	3901·9	H_2O	ν_1, ν_3	2	21	3826·7	H_2O	ν_3	2
4	3899·4	H_2O	ν_3	2	22	3821·7	H_2O	ν_3	2
5	3891·3	H_2O	ν_1, ν_3	2	23	3816·0	H_2O	ν_3	2
6	3886·0	H_2O	ν_3	2	24	3806·7	{ H_2O	ν_3	2
7	3880·3	H_2O	ν_3	2			{ ⊙ H	4–6, etc.	
8	3874·5	H_2O	ν_1, ν_3	2	25	3801·2	H_2O	ν_3	2
9	3870·0	H_2O	ν_3	2	26	3796·1	H_2O	ν_3	2
10	3865·2	H_2O	ν_3	2	27	3784·4	H_2O	ν_1, ν_3	2
11	3861·9	H_2O	ν_3	2	28	3779·4	H_2O	ν_3	2
12	3857·4	H_2O	ν_3	2	29	3769·7	H_2O	ν_1, ν_3	2
13	3854·3	H_2O	ν_3	2	30	3765·6	H_2O	ν_3	2
14	3852·3	H_2O	ν_3	2	31	3759·8	H_2O	ν_1, ν_3	2
15	3849·9	H_2O	ν_1, ν_3	2	32	3756·6	H_2O	ν_3	2
16	3843·9	H_2O	ν_3	2	33	3752·1	H_2O	ν_1, ν_3	2
17	3841·2	H_2O	ν_3	2	34	3749·3	H_2O	ν_1, ν_3	2
18	3838·0	H_2O	ν_3	2	35	3744·0	H_2O	ν_3	2



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Laboratory spectrum (14 atm. cm of CO_2 at 500 mb)

12(*d*)

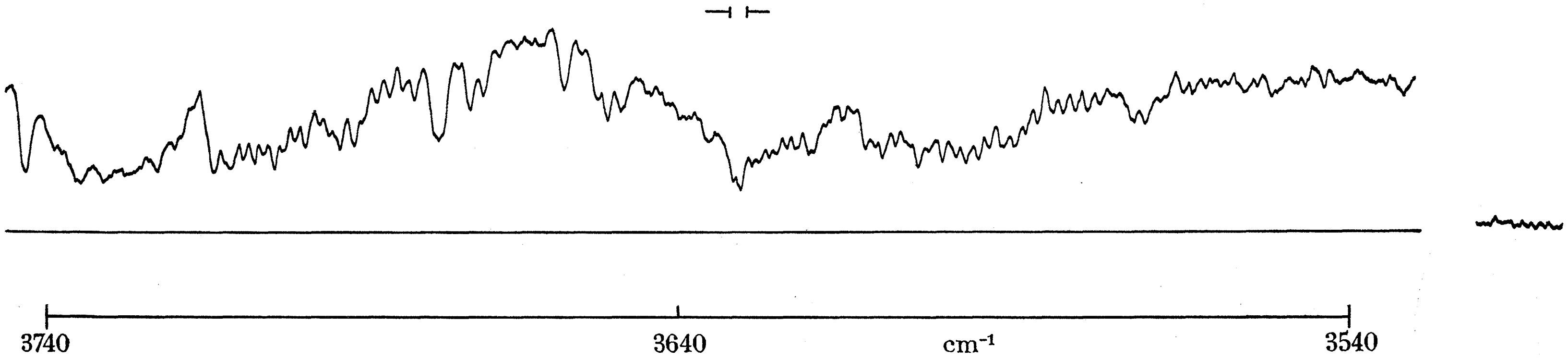


FIGURE 12

TABLE 2 (figure 12)

line no.	ν (cm⁻¹) (vac.)	ident.	band		ref.
1	3711·4	CO_2	$\nu_1+\nu_3$	*P*4	2
		H_2O	ν_1		2
		CO_2	$\nu_1+\nu_3$	*P*6	2
2	3708·1	CO_2	$\nu_1+\nu_3$	*P*8	2
		H_2O	ν_1		2
3	3706·4	CO_2	$\nu_1+\nu_3$	*P*10	2
4	3704·7	CO_2	$\nu_1+\nu_3$	*P*12	2
5	3703·0	CO_2	$\nu_1+\nu_3$	*P*14	2
6	3701·5	CO_2	$\nu_1+\nu_3$	*P*16	2
		H_2O	ν_3		2
7	3699·5	CO_2	$\nu_1+\nu_3$	*P*18	2
8	3697·7	CO_2	$\nu_1+\nu_3$	*P*20	2
9	3696·0	CO_2	$\nu_1+\nu_3$	*P*22	2
10	3694·1	CO_2	$\nu_1+\nu_3$	*P*24	2
11	3692·3	CO_2	$\nu_1+\nu_3$	*P*26	2
12	3690·7	CO_2	$\nu_1+\nu_3$	*P*28	2
13	3688·3	CO_2	$\nu_1+\nu_3$	*P*30	2
		H_2O	ν_3		2
14	3686·5	CO_2	$\nu_1+\nu_3$	*P*32	2
15	3684·5	CO_2	$\nu_1+\nu_3$	*P*34	2
16	3682·6	CO_2	$\nu_1+\nu_3$	*P*36	2
17	3680·5	CO_2	$\nu_1+\nu_3$	*P*38	2
18	3675·0	H_2O	ν_1, ν_3		2
		CO_2	$\nu_1+\nu_3$		2
19	3670·9	H_2O	ν_3		2
20	3668·8	H_2O	ν_3		2
21	3661·2	—	—		2
22	3656·5	H_2O	ν_3		2
23	3649·2	H_2O	ν_3		2
24	3647·0	H_2O	ν_1, ν_3		2
25	3642·0	H_2O	ν_3		2
26	3638·0	H_2O	ν_1		2
		CO_2	$2\nu_2+\nu_3$	*R*36	2
27	3634·0	CO_2	$2\nu_2+\nu_3$	*R*30	2
		H_2O	ν_3		2
28	3628·3	CO_2	$2\nu_2+\nu_3$	*R*20	2
		H_2O	ν_3		2
29	3621·2	CO_2	$2\nu_2+\nu_3$	*R*10	2
		H_2O	ν_3		2
30	3618·0	CO_2	$2\nu_2+\nu_3$	*R*6	2
		H_2O	ν_1, ν_3		2
31	3609·6	CO_2	$2\nu_2+\nu_3$	*P*4	2
32	3608·1	CO_2	$2\nu_2+\nu_3$	*P*6	2
33	3606·5	CO_2	$2\nu_2+\nu_3$	*P*8	2
34	3604·9	CO_2	$2\nu_2+\nu_3$	*P*10	2
35	3603·1	CO_2	$2\nu_2+\nu_3$	*P*12	2
36	3601·4	CO_2	$2\nu_2+\nu_3$	*P*14	2
		H_2O	ν_1		2
37	3599·7	CO_2	$2\nu_2+\nu_3$	*P*16	2
38	3598·2	CO_2	$2\nu_2+\nu_3$	*P*18	2
39	3596·2	CO_2	$2\nu_2+\nu_3$	*P*20	2
40	3594·5	CO_2	$2\nu_2+\nu_3$	*P*22	2
41	3592·7	CO_2	$2\nu_2+\nu_3$	*P*24	2
42	3590·6	CO_2	$2\nu_2+\nu_3$	*P*26	2
43	3588·7	CO_2	$2\nu_2+\nu_3$	*P*28	2
44	3586·9	CO_2	$2\nu_2+\nu_3$	*P*30	2
		H_2O	ν_1, ν_3		2
45	3585·2	CO_2	$2\nu_2+\nu_3$	*P*32	2
46	3583·3	CO_2	$2\nu_2+\nu_3$	*P*34	2
47	3581·3	CO_2	$2\nu_2+\nu_3$	*P*36	2
48	3579·4	CO_2	$2\nu_2+\nu_3$	*P*38	2
49	3577·4	CO_2	$2\nu_2+\nu_3$	*P*40	2
		H_2O	ν_1		2
50	3575·1	CO_2	$2\nu_2+\nu_3$	*P*42	2
51	3572·8	CO_2	$2\nu_2+\nu_3$	*P*44	2
52	3570·5	CO_2	$2\nu_2+\nu_3$	*P*46	2
53	3568·0	H_2O	ν_3		2
		CO_2	$2\nu_2+\nu_3$	*P*48	2
54	3566·0	H_2O	ν_1, ν_3		2
		CO_2	$2\nu_2+\nu_3$	*P*50	2
55	3562·3	H_2O	ν_1, ν_3		2
		CO_2	$2\nu_2+\nu_3$		2
56	3560·1	H_2O	ν_1, ν_3		2
		CO_2	$2\nu_2+\nu_3$		2
57	3557·1	H_2O	ν_1		2
		CO_2	$2\nu_2+\nu_3$		2
58	3552·3	H_2O	ν_1		2
59	3547·2	H_2O	ν_3		2
60	3545·2	H_2O	ν_1, ν_3		2

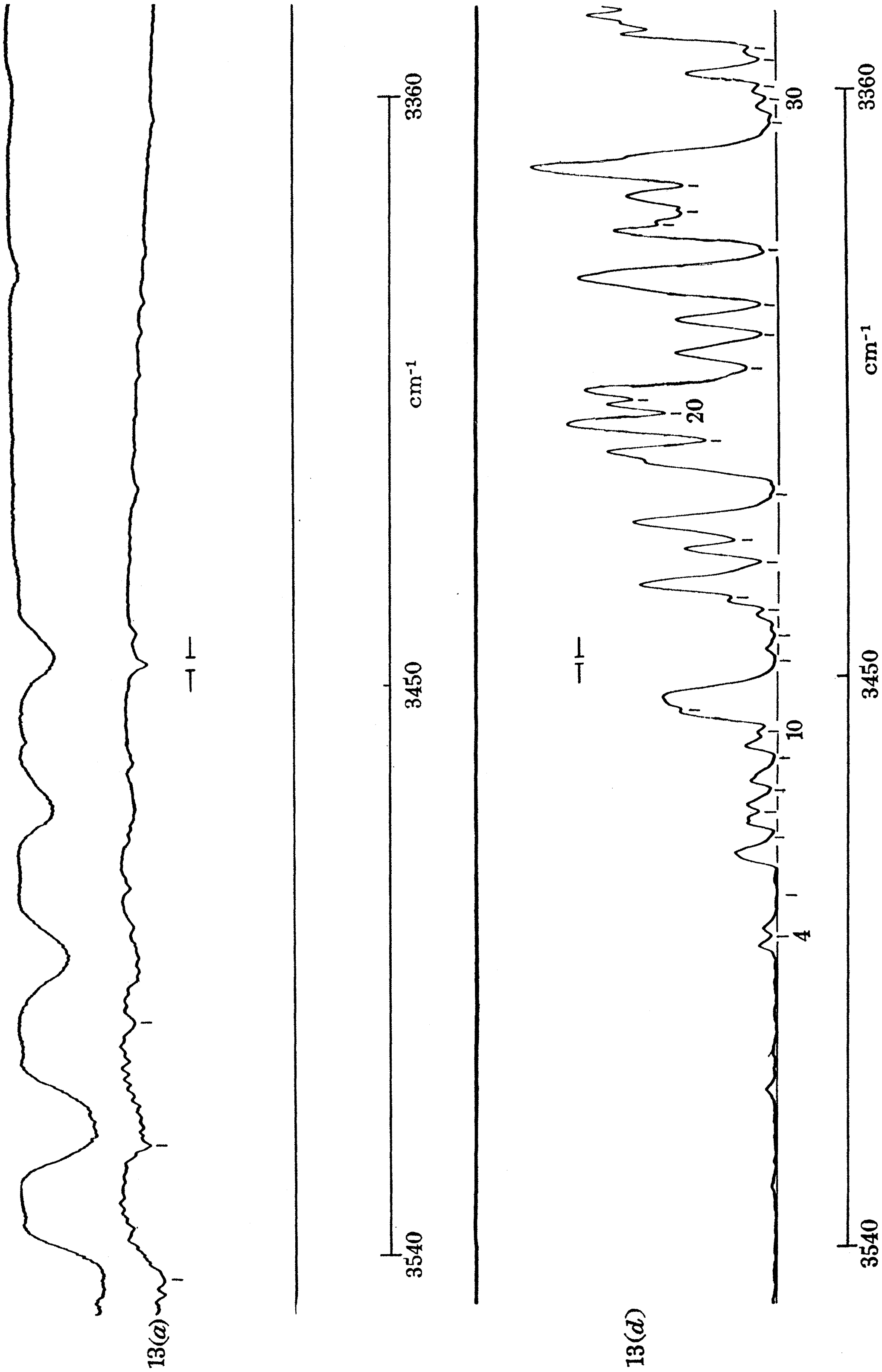
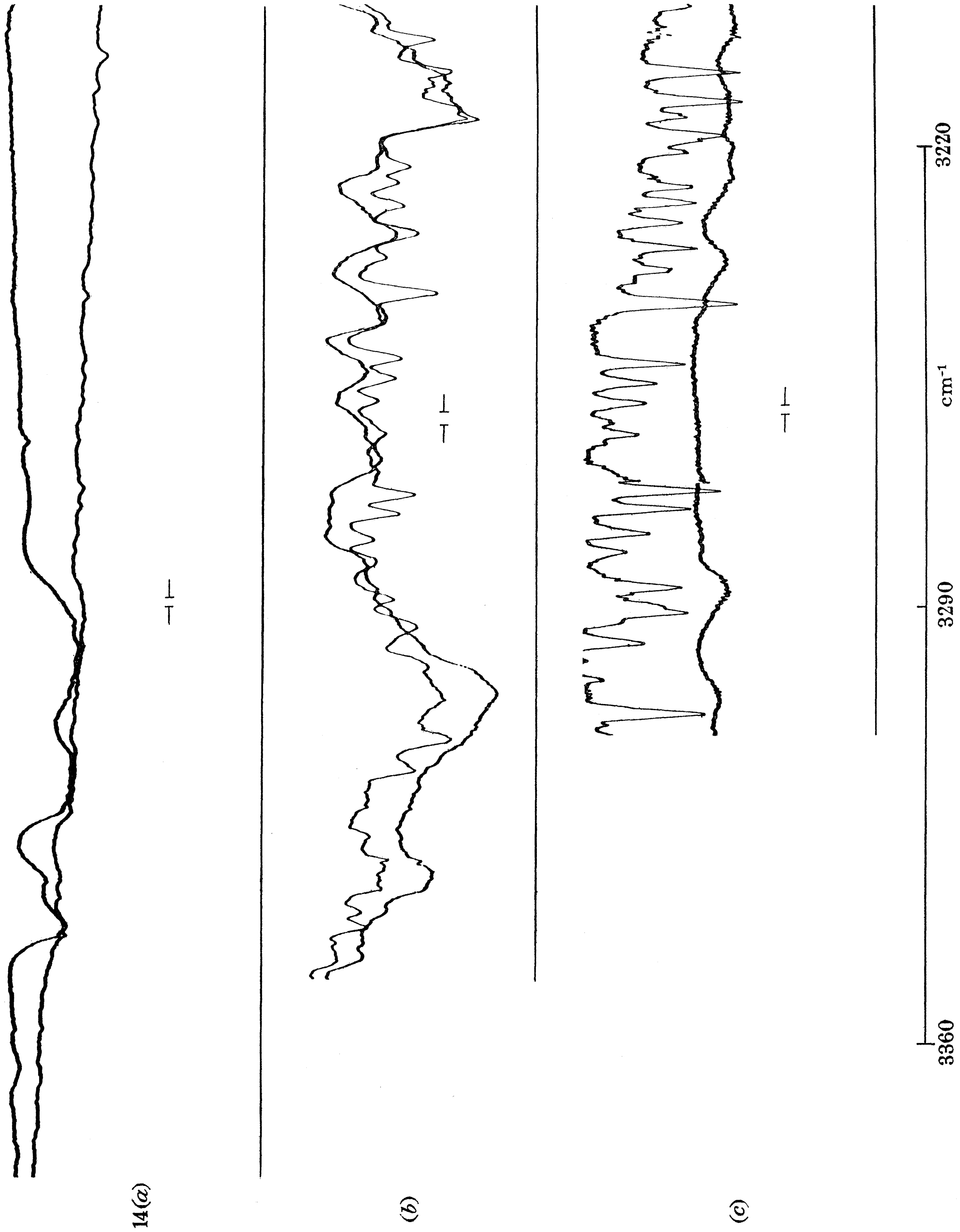


FIGURE 13

TABLE 2 (figure 13)

line no.	ν (cm^{-1}) (vac.)	ident.	band	ref.	line no.	ν (cm^{-1}) (vac.)	ident.	band	ref.
1	3545·2	H_2O	ν_1, ν_3	2	17	3427·9	H_2O	ν_3	4
		$^{13}CO_2$	$2\nu_2+\nu_3$	4	18	3420·4	H_2O	ν_1	4
2	3528·0	H_2O	ν_3	4	19	3413·0	H_2O	ν_3	4
		$^{13}CO_2$	$2\nu_2+\nu_3$	4	20	3408·8	H_2O	ν_3	4
3	3503·0	H_2O	ν_1	4	21	3406·7	H_2O	ν_1	4
4	3496·7	H_2O	ν_1	4	22	3403·6	H_2O	$2\nu_2$, ν_1	4
5	3488·2	H_2O	ν_3, ν_1	4	23	3397·2	H_2O	ν_1	4
6	3474·8	H_2O	ν_1, ν_3	4	24	3392·7	H_2O	ν_1, $2\nu_2$	4
7	3470·5	H_2O	ν_3, ν_1	4	25	3385·6	H_2O	$2\nu_2$	4
8	3467·2	H_2O	ν_1	4	26	3380·4	H_2O	ν_1	4
9	3461·4	H_2O	$2\nu_2$, ν_3	4	27	3377·5	H_2O	$2\nu_2$	4
10	3455·7	H_2O	ν_3	4	28	3374·7	H_2O	ν_1	4
11	3453·2	H_2O	ν_3	4	29	3365·7	H_2O	$2\nu_2$	4
12	3446·6	H_2O	ν_1	4	30	3361·6	H_2O	ν_1	4
13	3442·3	H_2O	ν_1	4	31	3359·5	H_2O	ν_3	4
14	3440·1	H_2O	$2\nu_2$, ν_3	4	32	3355·6	H_2O	ν_3	4
15	3438·1	H_2O	ν_3	4	33	3353·7	H_2O	$2\nu_2$	4
16	3430·9	H_2O	ν_1	4					


14(a)
(b)
(c)
3360
3290
3220
cm^{-1}

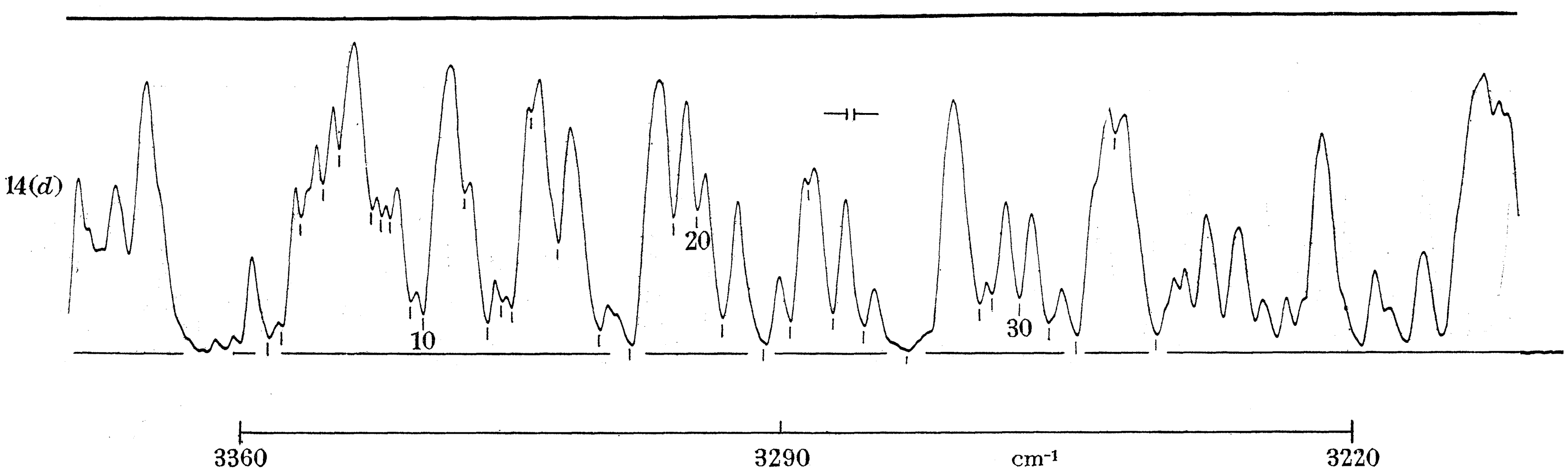
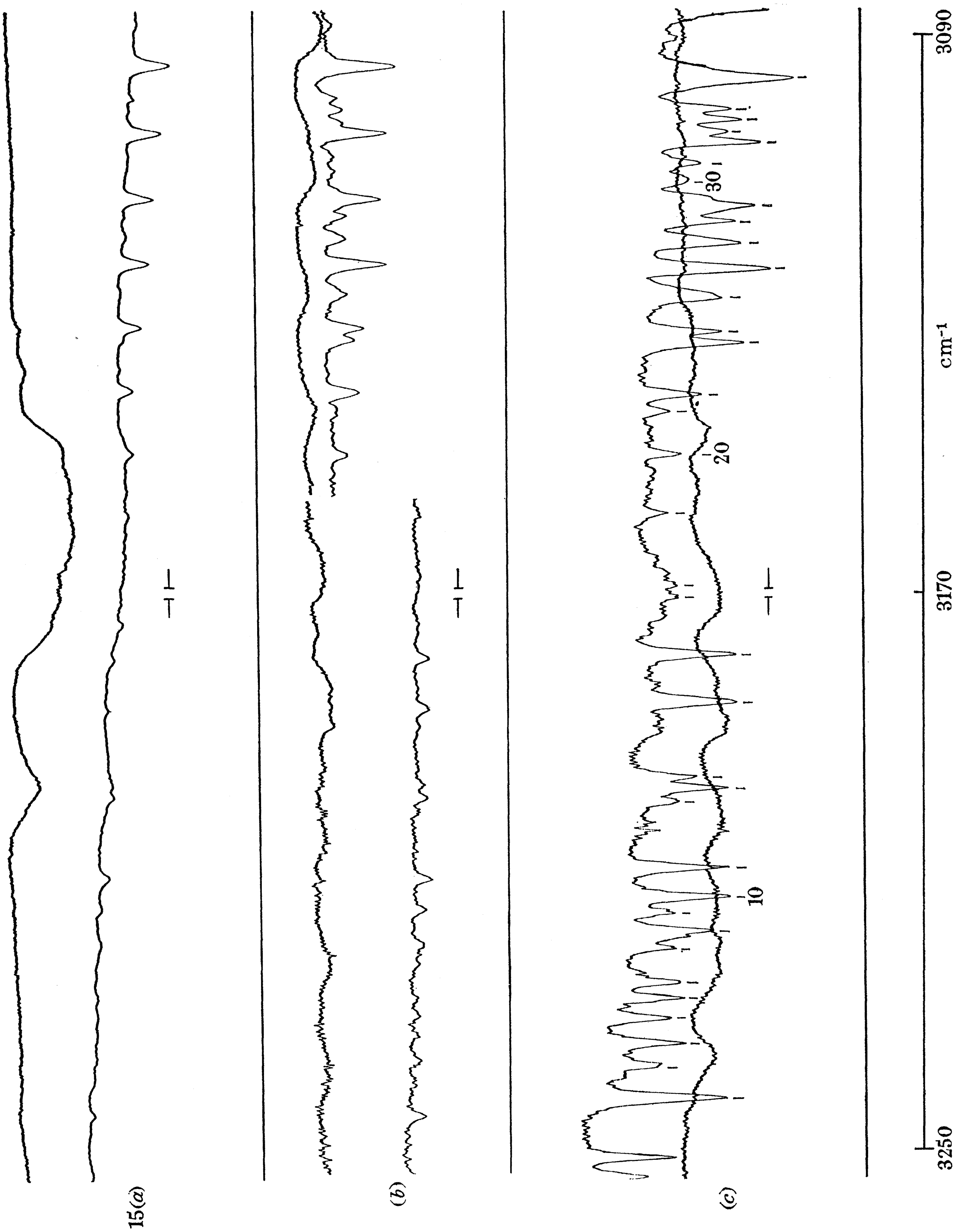


FIGURE 14

TABLE 2 (figure 14)

line no.	ν (cm^{-1}) (vac.)	ident.	band	ref.
1	3355·6	H_2O	ν_3	4
2	3353·7	H_2O	$2\nu_2$	4
3	3351·2	H_2O	$2\nu_2$	4
4	3348·4	H_2O	ν_3	4
5	3346·0	H_2O	$2\nu_2$	4
6	3342·3	H_2O	ν_1	4
7	3340·1	H_2O	$2\nu_2$	4
8	3339·0	H_2O	$2\nu_2$	4
9	3336·7	H_2O	$2\nu_2$	4
10	3334·5	H_2O	ν_1	4
11	3329·5	H_2O	ν_3	4
12	3327·4	{H_2O	$2\nu_2$	4
		{H_2O	ν_3	4
13	3324·6	H_2O	$2\nu_2$	4
14	3323·0	{H_2O	ν_3	4
		{H_2O	$2\nu_2$	4
15	3320·5	H_2O	$2\nu_2$	4
16	3317·3	H_2O	ν_1	4
17	3313·0	H_2O	$2\nu_2$	4

line no.	ν (cm^{-1}) (vac.)	ident.	band	ref.
18	3308·5	H_2O	$2\nu_2$	4
19	3303·2	H_2O	$2\nu_2$	4
20	3300·0	H_2O	ν_3	4
21	3297·4	H_2O	$2\nu_2$	4
22	3292·6	H_2O	$2\nu_2$	4
23	3288·5	H_2O	$2\nu_2$	4
24	3286·1	H_2O	ν_3	4
25	3282·9	{H_2O	$2\nu_2$	4
		{H_2O	ν_1	4
26	3280·0	H_2O	$2\nu_2$	4
27	3275	H_2O	$2\nu_2$	4
28	3265·0	H_2O	$2\nu_2$	4
29	3263·8	H_2O	$2\nu_2$	4
30	3260·4	H_2O	$2\nu_2$	4
31	3257·1	H_2O	$2\nu_2$	4
32	3254·0	H_2O	$2\nu_2$	4
33	3249·4	H_2O	ν_1	4
34	3245·1	H_2O	$2\nu_2$	4


15(a)
(b)
(c)
10
20
30
3250
3170
3090
cm⁻¹

15(*d*)

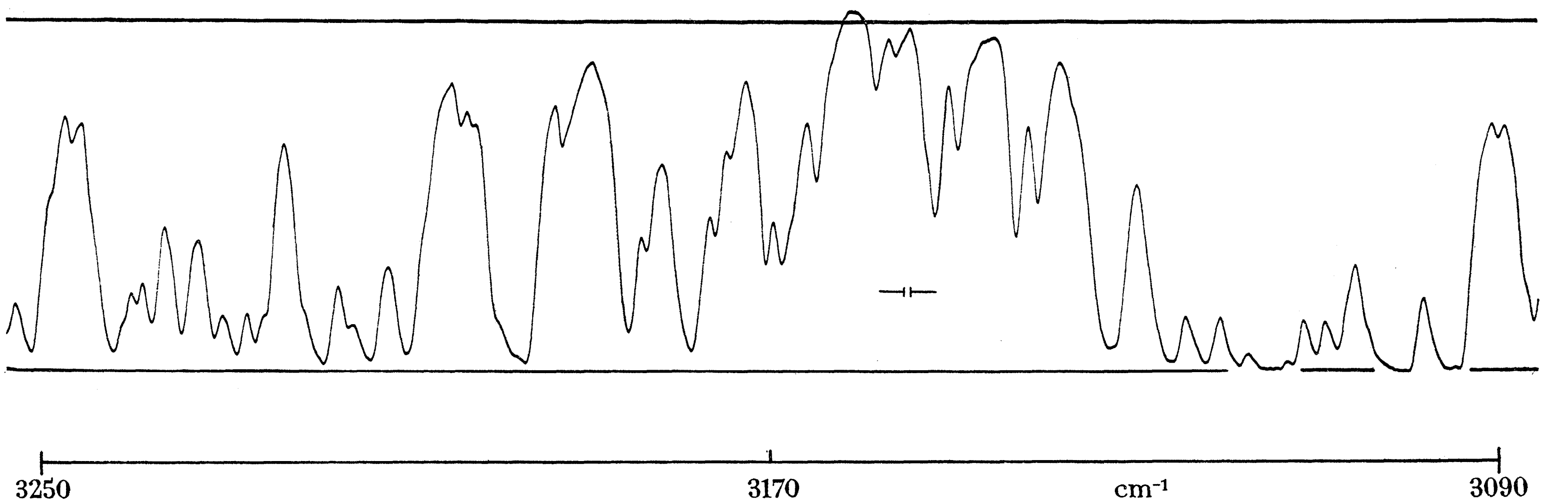
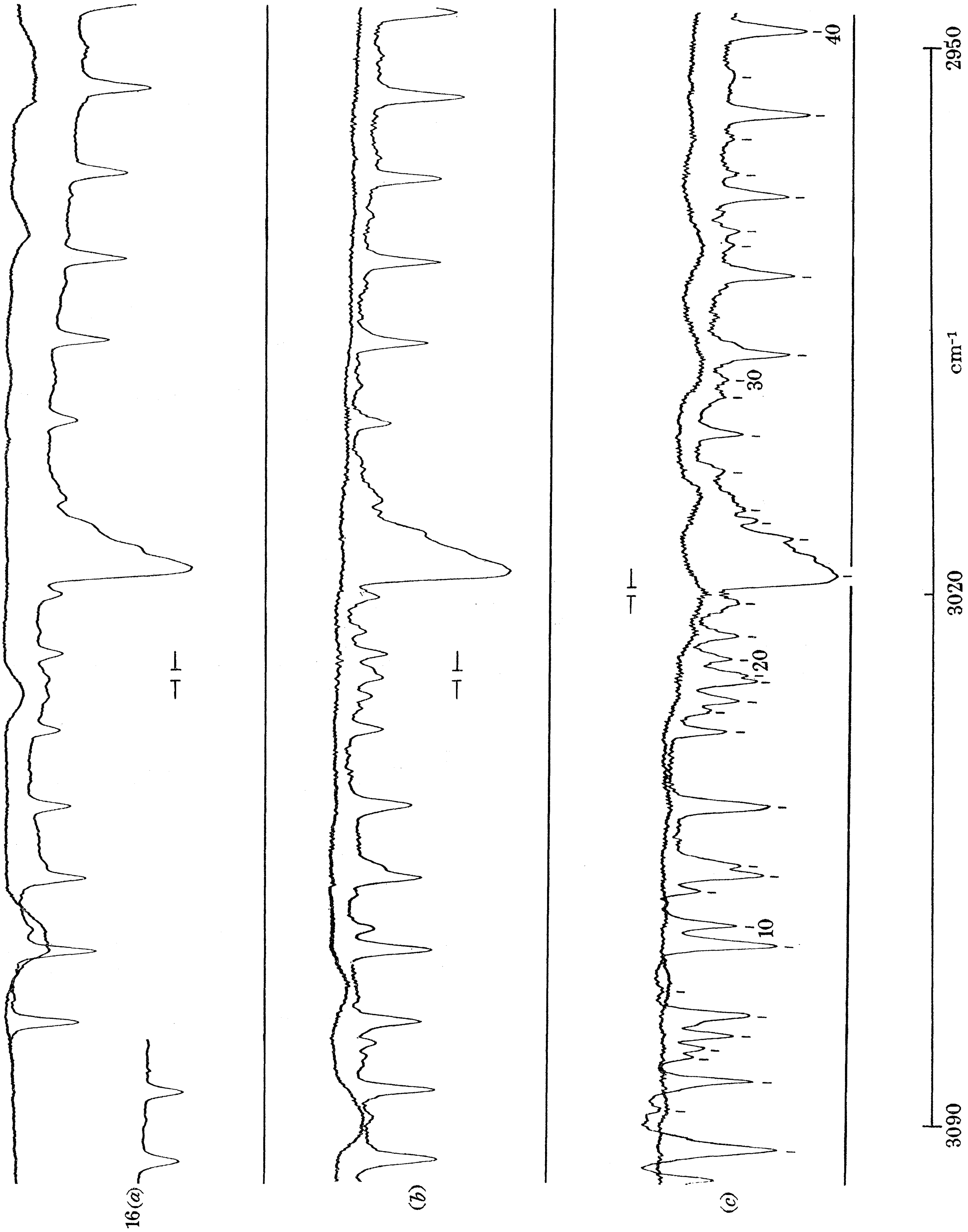


FIGURE 15

TABLE 2 (figure 15)

line no.	ν (cm^{-1}) (vac.)	ident.	band	ref.	line no.	ν (cm^{-1}) (vac.)	ident.	band	ref.
1	3245·1	H_2O	$2\nu_2$	4	22	3140·1	CH_4	ν_3 *R*12	4
2	3240·0	H_2O	$2\nu_2$	4	23	3133·1	H_2O	$2\nu_2$	4
3	3236·6	H_2O	$2\nu_2$	4	24	3131·4	CH_4	ν_3 *R*11	4
4	3232·9	H_2O	$2\nu_2$	4	25	3126·0	H_2O	$2\nu_2$	4
5	3230·0	H_2O	$2\nu_2$	4			CH_4	—	4
6	3227·5	H_2O	$2\nu_2$	4	26	3122·9	CH_4	ν_3 *R*10	4
7	3222·0	H_2O	$2\nu_2$	4			H_2O	$2\nu_2$	4
8	3219·3	H_2O	$2\nu_2$	4	27	3119·1	H_2O	$2\nu_2$	4
9	3216·5	H_2O	$2\nu_2$	4			CH_4	—	4
10	3214·1	H_2O	$2\nu_2$	4	28	3115·9	H_2O	$2\nu_2$	4
11	3209·8	H_2O	$2\nu_2$	4	29	3113·3	CH_4	ν_3 *R*9	4
12	3199·8	H_2O	$2\nu_2$	4			H_2O	$2\nu_2$	4
13	3197·9	H_2O	$2\nu_2$	4	30	3109·6	H_2O	$2\nu_2$	4
14	3196·2	H_2O	$2\nu_2$	4	31	3107·3	H_2O	$2\nu_2$	4
15	3185·2	H_2O	$2\nu_2$	4	32	3104·4	CH_4	ν_3 *R*8	4
16	3178·2	H_2O	$2\nu_2$	4	33	3103·1	H_2O	$2\nu_2$	4
17	3169·7	H_2O	$2\nu_2$	4	34	3101·2	H_2O	$2\nu_2$	4
18	3167·9	H_2O	$2\nu_2$	4	35	3099·6	H_2O	$2\nu_2$	4
19	3157·5	CH_4	ν_3 *R*14	4			CH_4	—	4
20	3148·9	CH_4	ν_3 *R*13	4	36	3095·2	CH_4	ν_3 *R*7	4
21	3142·8	H_2O	$2\nu_2$	4			H_2O	$2\nu_2$	4


16(a)
(b)
(c)
10
20
30
40
3090
3020
2950
cm-1

16(d)

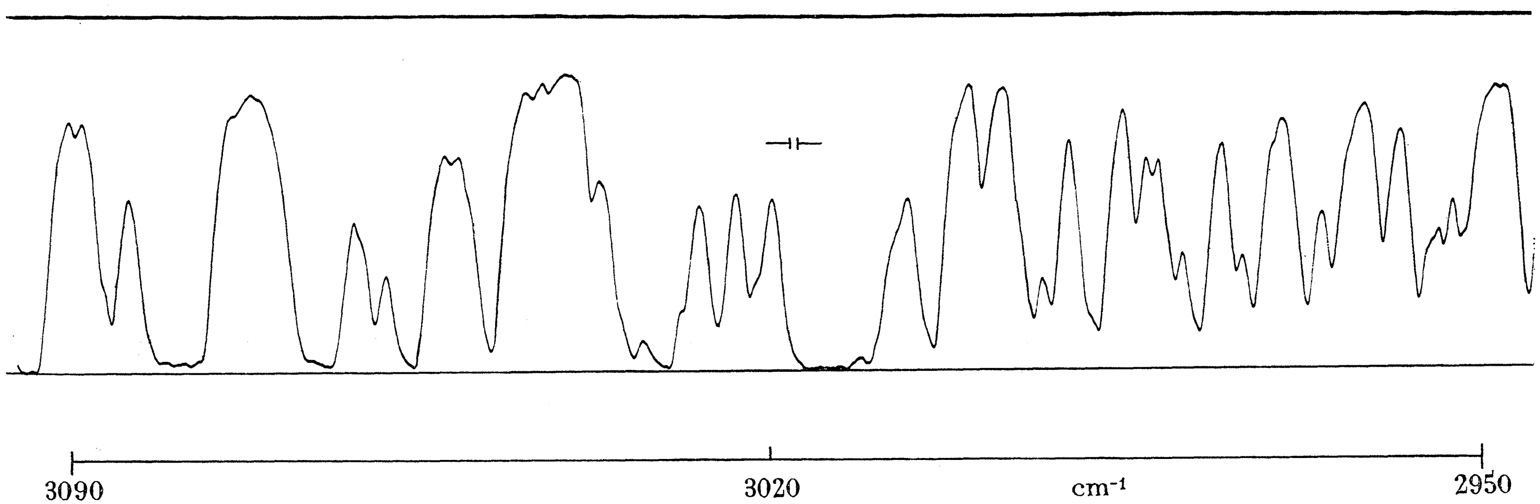
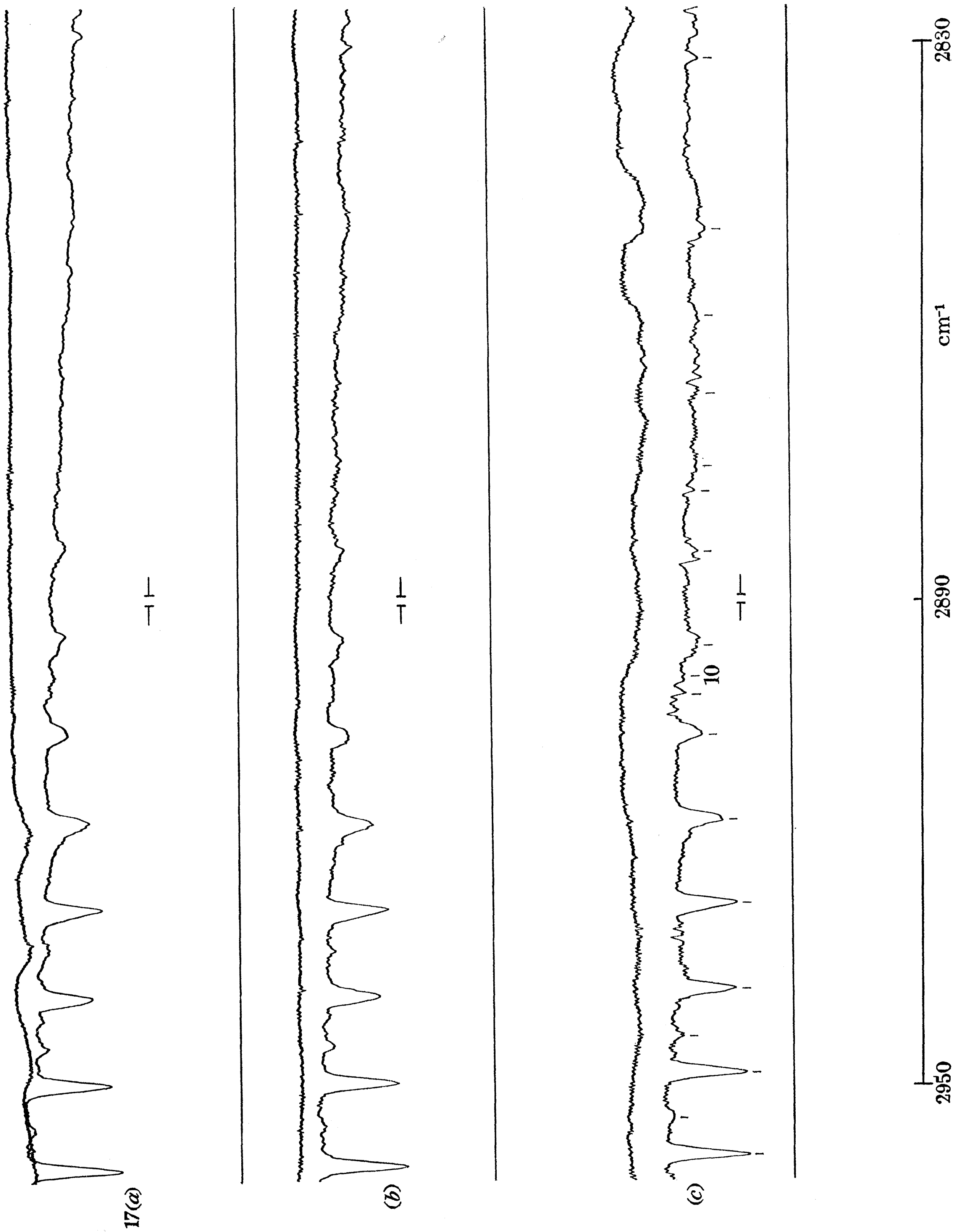


FIGURE 16

TABLE 2 (figure 16)

line no.	ν (cm^{-1}) (vac.)	ident.	band	ref.
1	3095·2	CH_4	ν_3 *R*7	4
		H_2O	$2\nu_2$	4
2	3089·7	CH_4	—	4
3	3086·0	CH_4	ν_3 *R*6	4
		H_2O	$2\nu_2$	4
4	3082·6	H_2O	$2\nu_2$	4
5	3081·3	H_2O	$2\nu_2$	4
6	3079·6	CH_4	—	4
		H_2O	$2\nu_2$	4
7	3076·7	CH_4	ν_3 *R*5	4
		H_2O	$2\nu_2$	4
8	3073·3	CH_4	—	4
9	3067·2	CH_4	ν_3 *R*4	4
10	3064·3	H_2O	$2\nu_2$	4
11	3059·9	H_2O	$2\nu_2$	4
		CH_4	—	4
12	3057·7	CH_4	ν_3 *R*3	4
13	3056·4	H_2O, O_3	$2\nu_2$, $3\nu_3$	4
14	3048·4	CH_4	ν_3 *R*2	4
		H_2O	—	4
15	3038·5	CH_4	ν_3 *R*1	4
16	3035·8	H_2O	$2\nu_2$	4
17	3034·4	CH_4	—	4
		H_2O	$2\nu_2$	4
18	3031·9	H_2O	$2\nu_2$	4
19	3030·8	H_2O	$2\nu_2$	4
20	3028·8	CH_4	ν_3 *R*0	4
21	3025·8	H_2O	$2\nu_2$	4
		CH_4	—	4
22	3021·1	H_2O	$2\nu_2$	4
		CH_4	—	4
23	3017·3	CH_4	ν_3 *Q*0	4
24	3012·4	CH_4	ν_3 *Q*	4
		H_2O	$2\nu_2$	4
25	3010·3	H_2O	$2\nu_2$	4
		CH_4	ν_3 *Q*	4
26	3008·9	CH_4	ν_3 *P*1	4
27	3003·7	H_2O	$2\nu_2$	4
28	2998·9	CH_4	ν_3 *P*2	4
29	2994·4	H_2O	$2\nu_2$	4
		CH_4	—	4
30	2991·9	H_2O	$2\nu_2$	4
31	2988·8	CH_4	ν_3 *P*3	4
		H_2O	—	4
32	2978·9	CH_4	ν_3 *P*4	4
		H_2O	$2\nu_2$	4
33	2975·2	H_2O	$2\nu_2$	4
		CH_4	—	4
34	2973·3	H_2O	$2\nu_2$	4
		CH_4	—	4
35	2968·6	CH_4	ν_3 *P*5	4
36	2966·0	H_2O	$2\nu_2$	4
		CH_4	—	4
37	2961·5	H_2O	$2\nu_2$	4
38	2958·3	CH_4	ν_3 *P*6	4
39	2953·6	CH_4	—	4
40	2947·9	CH_4	ν_3 *P*7	4


17(a)
(b)
(c)
10
2830
2890
2950
cm⁻¹

17 (*d*)

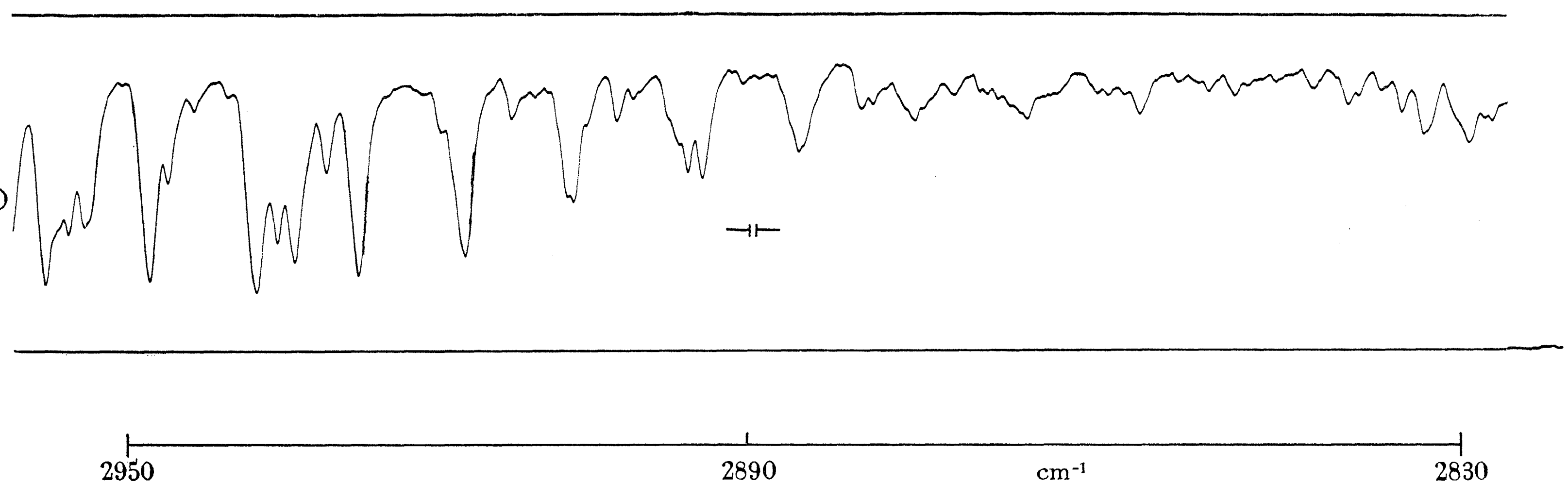
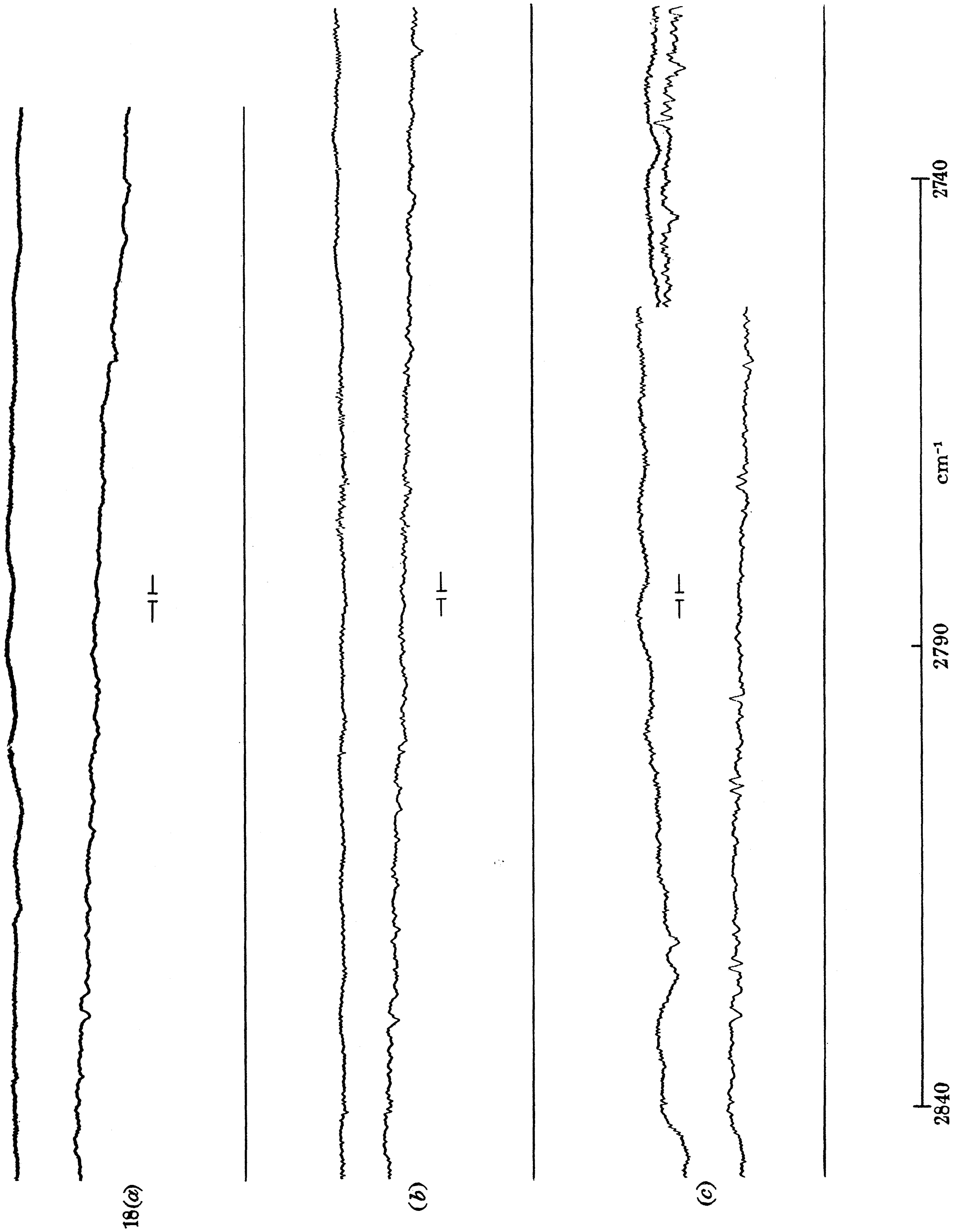


FIGURE 17

TABLE 2 (figure 17)

line no.	ν (cm⁻¹) (vac.)	ident.	band	ref.	line no.	ν (cm⁻¹) (vac.)	ident.	band	ref.
1	2958·3	CH_4	ν_3 *P*6	4	10	2900·0	CH_4	—	4
2	2953·6	CH_4	—	4	11	2896·0	CH_4	ν_3 *P*12	4
3	2947·9	CH_4	ν_3 *P*7	4	12	2885·1	CH_4	ν_3 *P*13	4
4	2943·3	CH_4	—	4	13	2878·4	CH_4	—	4
5	2937·8	CH_4	ν_3 *P*8	4	14	2874·8	CH_4	ν_3 *P*14	4
6	2927·3	CH_4	ν_3 *P*9	4	15	2864·8	CH_4	ν_3 *P*15	4
7	2916·8	CH_4	ν_3 *P*10	4	16	2853·9	CH_4	ν_3 *P*16	4
8	2906·7	CH_4	ν_3 *P*11	4	17	2841·7	CH_4	ν_3 *P*17	4
9	2901·8	CH_4	—	4			H_2O	$2\nu_2$	4
		H_2O	$2\nu_2$	4	18	2830·8	CH_4	—	4


18(a)
(b)
(c)
2840
2790
2740
cm⁻¹

18(*d*)

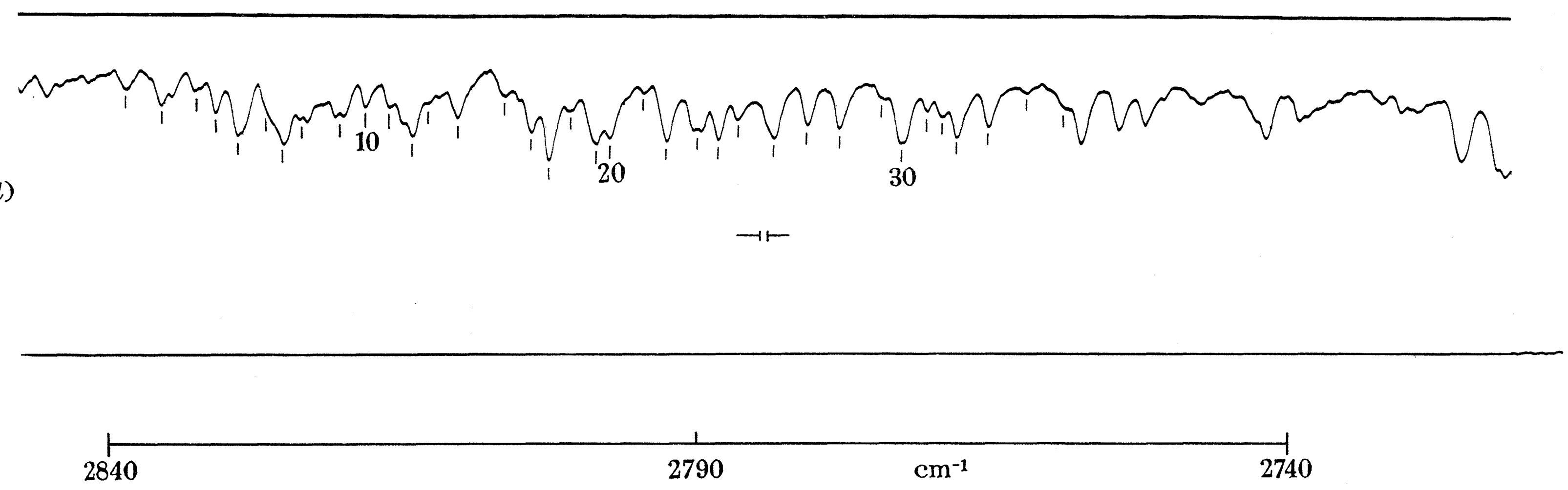
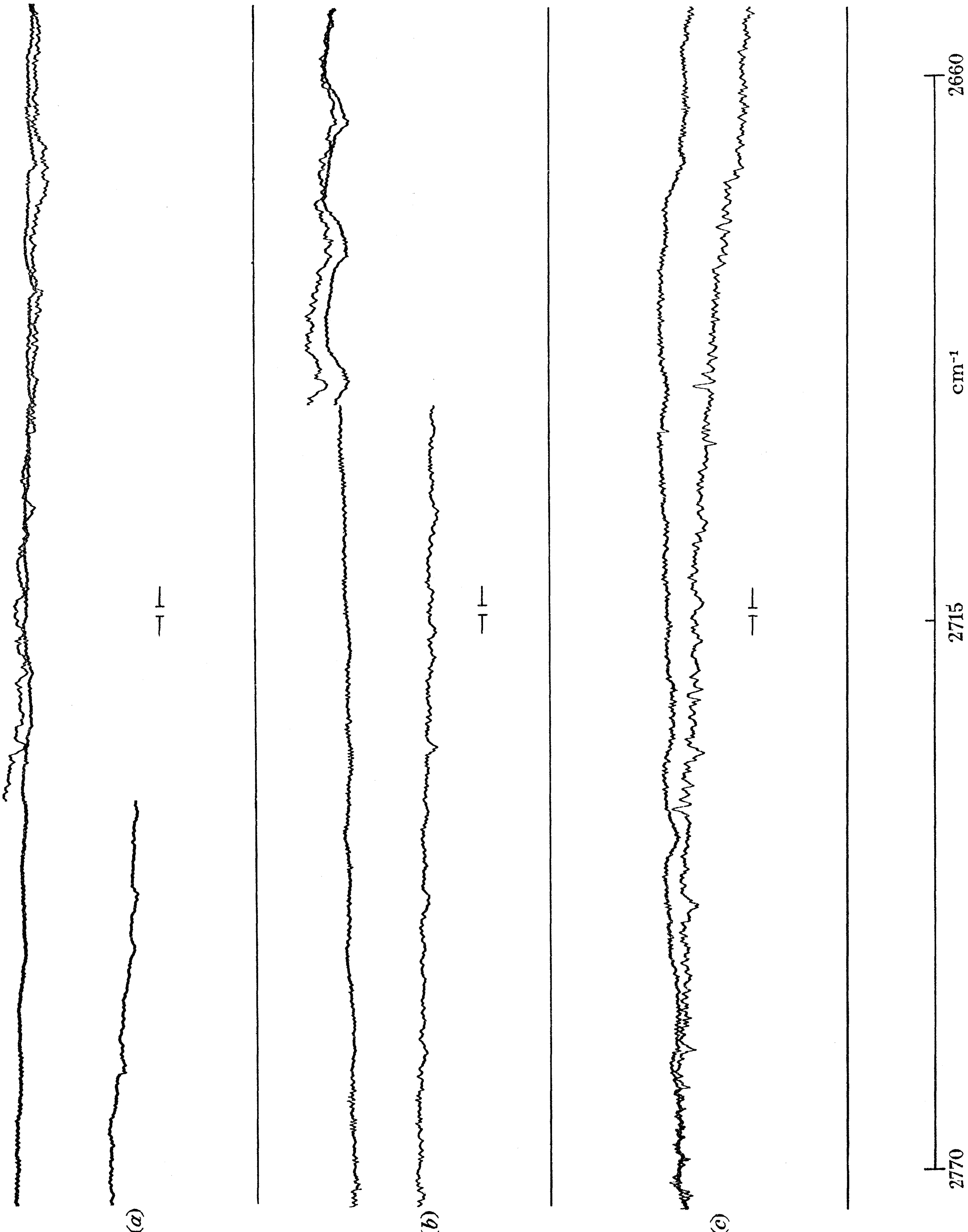


FIGURE 18

TABLE 2 (figure 18)

line no.	ν (cm^{-1}) (vac.)	ident.	band	ref.
1	2838·3	HDO	ν_1	8
		CH_4	—	8
2	2835·0	HDO	ν_1	8
		CH_4	—	8
3	2831·9	CH_4	—	8
4	2830·2	CH_4	—	8
5	2828·2	HDO	ν_1	8
		CH_4	—	8
6	2825·5	CH_4	—	8
7	2824·3	HDO	ν_1	8
8	2822·5	CH_4	—	8
		HDO	ν_1	4
9	2819·8	H_2O	$2\nu_2$	4
10	2817·0	HDO	ν_1	8
11	2815·0	HDO	ν_1	8
		CH_4	—	8
12	2813·0	HDO	ν_1	8
		CH_4	—	8
13	2811·0	HDO	ν_1	8
14	2809·2	HDO	ν_1	4
15	2805·4	HDO	ν_1	8
16	2803·2	HDO	ν_1	8
		CH_4	—	8
17	2801·6	HDO	ν_1	8
18	2799·8	CH_4	—	8
19	2797·9	HDO	ν_1	8
20	2794·8	CH_4	—	8
21	2793·7	CH_4	—	8
22	2792·0	HDO	ν_1	8
		CH_4	—	8
23	2789·0	HDO	ν_1	8
		CH_4	—	8
24	2787·5	HDO	ν_1	4
25	2785·9	HDO	ν_1	8
		CH_4	—	8
26	2783·3	HDO	ν_1	8
		CH_4	—	8
27	2780·2	HDO	ν_1	8
		CH_4	—	8
28	2777·5	HDO	ν_1	8
29	2774·0	HDO	ν_1	8
		CH_4	—	8
30	2772·4	HDO	ν_1	4
31	2770·1	HDO	ν_1	8
		CH_4	—	8
32	2768·8	HDO	ν_1	4
33	2767·5	HDO	ν_1	8
34	2764·8	HDO	ν_1	8
35	2762·0	CH_4	—	8
36	2758·2	CH_4	$2\nu_4$	4



19(*a*) (*b*) (*c*)

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19(*d*)

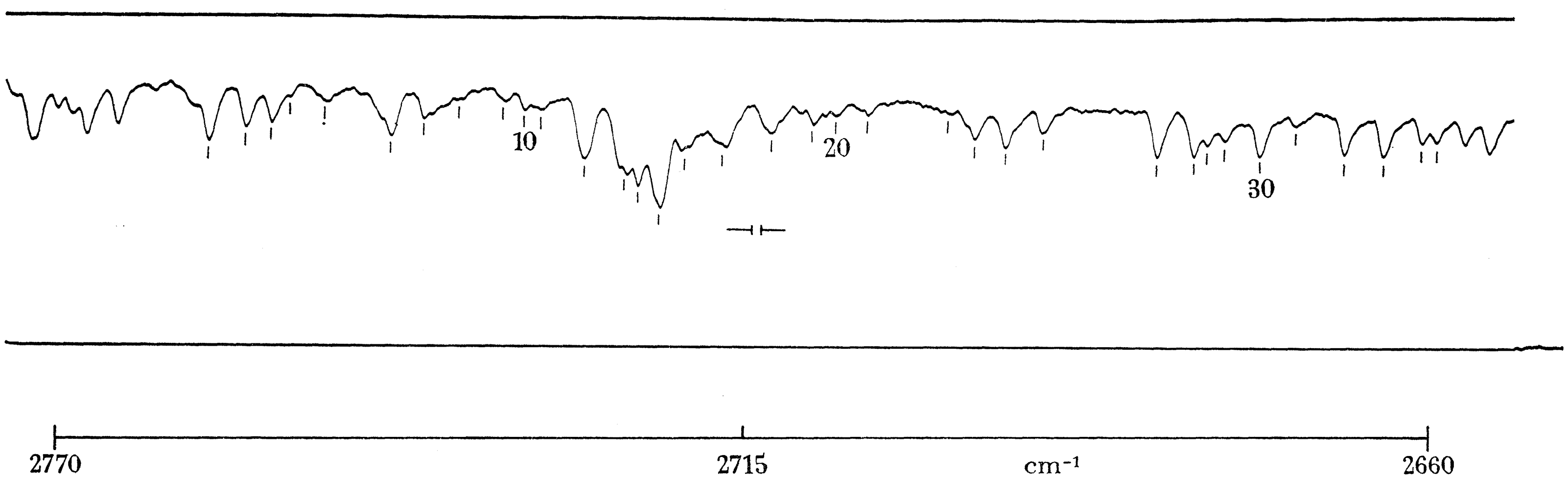
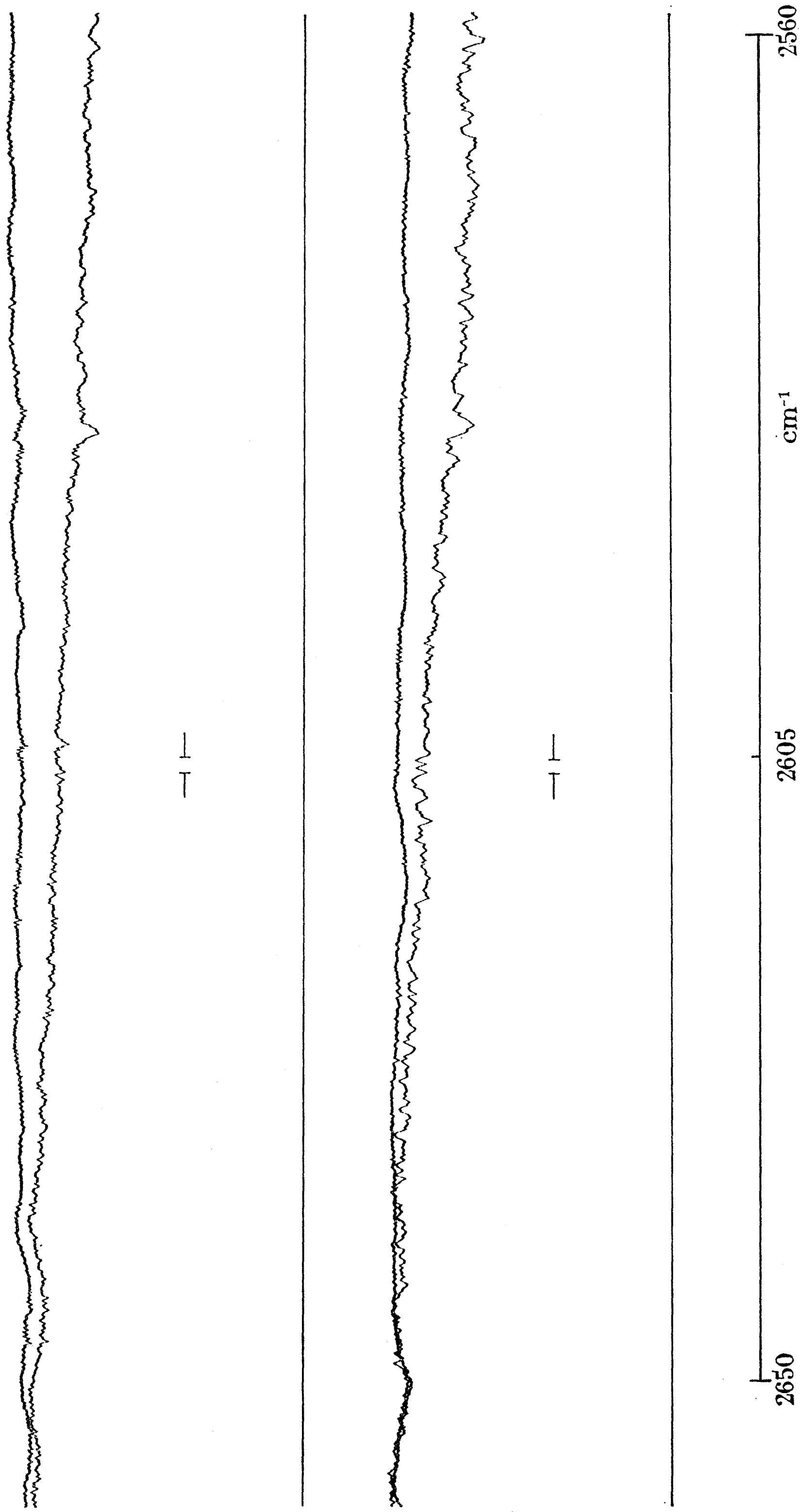


FIGURE 19

TABLE 2 (figure 19)

line no.	ν (cm^{-1}) (vac.)	ident.	band	ref.
1	2756·9	CH_4	$2\nu_4$	4
2	2753·8	HDO	ν_1	8
3	2751·6	HDO	ν_1	8
4	2750·0	CH_4	—	4
5	2746·2	CH_4	—	4
6	2741·8	CH_4	$2\nu_4$	4
7	2738·9	HDO	ν_1	8
8	2737·4	CH_4	—	8
9	2732·8	—	—	4
10	2731·1	HDO	ν_1	8
11	2729·9	HDO	ν_1	8
12	2726·6	{ CH_4 HDO	$2\nu_4$ ν_1	4 8
13	2723·6	HDO	ν_1	8
14	2722·2	HDO	ν_1	8
15	2720·7	HDO	ν_1 Q	4
16	2718·9	HDO	ν_1	8
17	2716·4	HDO	ν_1	8
18	2712·0	CH_4	$2\nu_4$	4
19	2708·3	HDO	ν_1	8

line no.	ν (cm^{-1}) (vac.)	ident.	band	ref.
20	2706·6	CH_4	—	8
21	2704·8	CH_4	—	8
22	2697·6	{ CH_4 HDO	$2\nu_4$ ν_1	4 8
23	2695·5	HDO	ν_1	8
24	2693·1	HDO	ν_1	8
25	2690·1	HDO	ν_1	8
26	2680·9	HDO	ν_1	8
27	2678·0	{ HDO CH_4	ν_1 —	8 8
28	2676·7	HDO	ν_1	8
29	2675·4	HDO	ν_1	8
30	2672·8	{ HDO CH_4	ν_1 —	8 8
31	2669·9	{ HDO CH_4	ν_1 —	8 8
32	2666·4	HDO	ν_1	8
33	2663·3	HDO	ν_1	8
34	2660·6	HDO	ν_1	8
35	2659·6	HDO	ν_1	8



20(*b*)

(*c*)

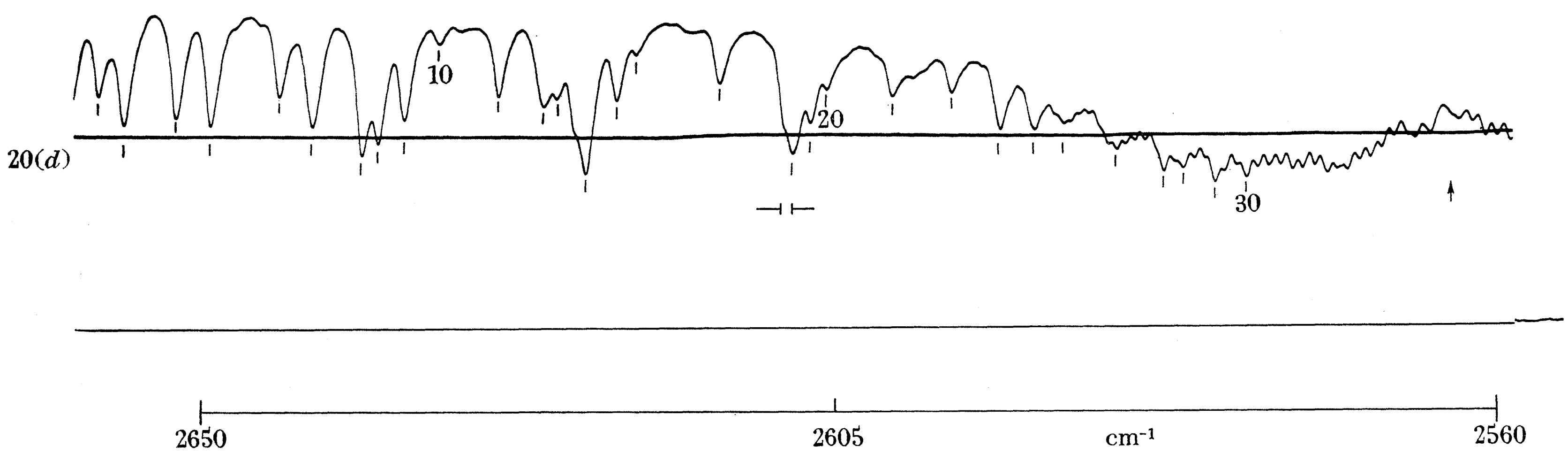
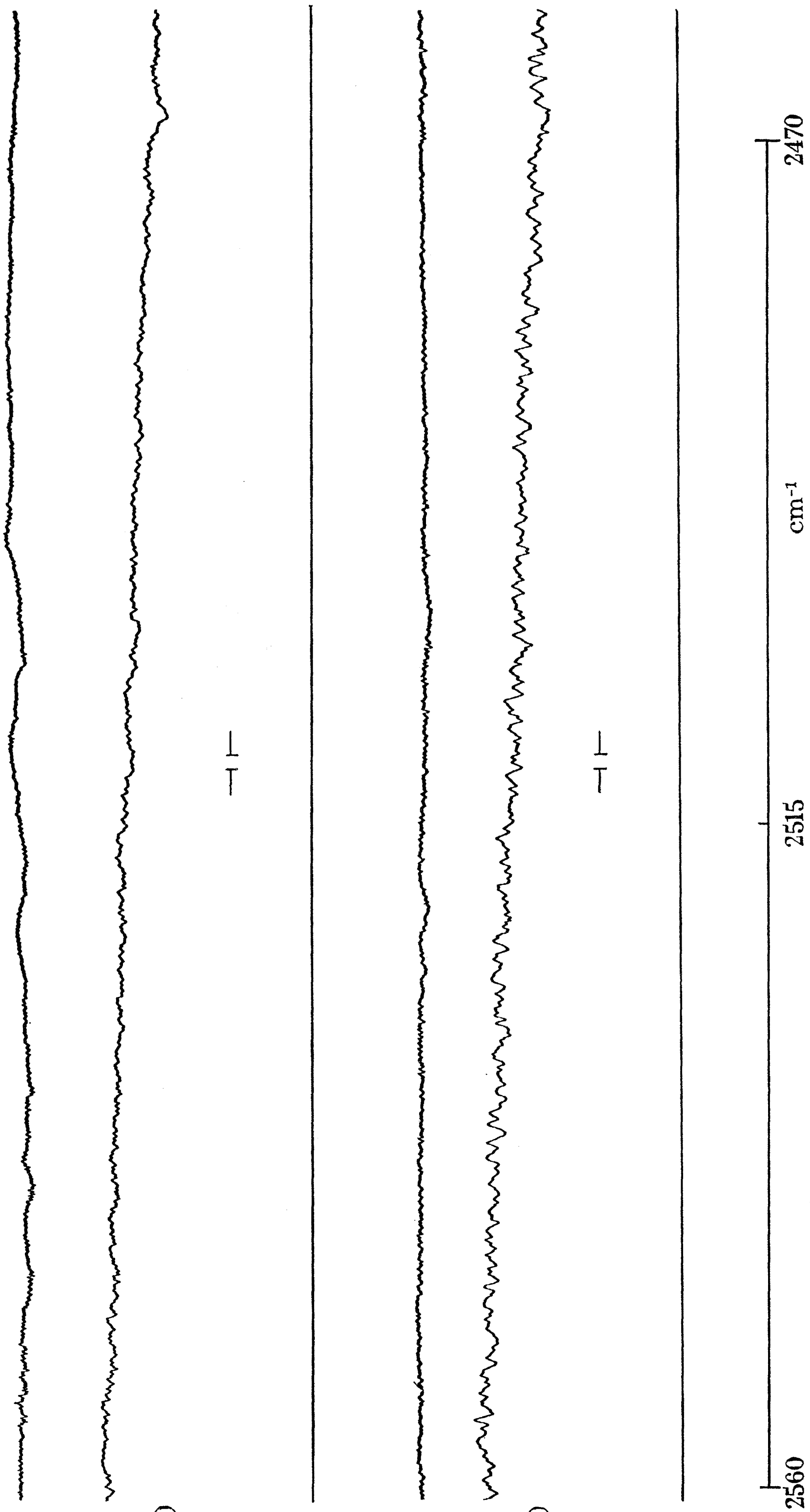


FIGURE 20

TABLE 2 (figure 20)

line no.	ν (cm^{-1}) (vac.)	ident.	band	ref.	line no.	ν (cm^{-1}) (vac.)	ident.	band	ref.
1	2657·5	HDO	ν_1	8	15	2619·9	HDO	ν_1	4
2	2655·6	HDO	ν_1	8			CH_4	—	4
		CH_4	—	8	16	2618·5	CH_4	$2\nu_4$	4
3	2651·9	HDO	ν_1	8	17	2612·7	HDO	ν_1	4
		CH_4	—	8	18	2608·4	HDO	ν_1	4
4	2649·5	HDO	ν_1	8	19	2607·7	HDO	ν_1	4
		CH_4	$2\nu_4$	8	20	2605·3	HDO	ν_1	4
5	2644·6	HDO	ν_1	8	21	2601·0	HDO	ν_1	4
6	2642·3	HDO	ν_1	8	22	2596·9	HDO	ν_1	4
		CH_4	—	4	23	2593·6	HDO	ν_1	4
7	2638·8	HDO	ν_1	8			N_2O	$2\nu_1$	4
		CH_4	—	8	24	2591·2	HDO	ν_1	4
8	2637·5	HDO	ν_1	8			N_2O	$2\nu_1$	4
		CH_4	—	4	25	2588·5	N_2O	$2\nu_1$	4
9	2635·7	HDO	ν_1	8	26	2586·1	N_2O	$2\nu_1$	4
		CH_4	—	4	27	2582·2	N_2O	$2\nu_1$	4
10	2633·1	CH_4	$2\nu_4$	4			CH_4	—	4
11	2628·8	HDO	ν_1	8			HDO	ν_1	4
12	2625·5	HDO	ν_1	8	28	2580·8	N_2O	$2\nu_1$	4
		CH_4	—	4	29	2578·7	HDO	ν_1	4
13	2624·3	HDO	ν_1	8			N_2O	$2\nu_1$	4
14	2622·3	HDO	ν_1	4	30	2576·7	N_2O	ν_1	4
					31	2563*	N_2O	ν_1	4

* N_2O band centre 3·9 μ.



21(b)

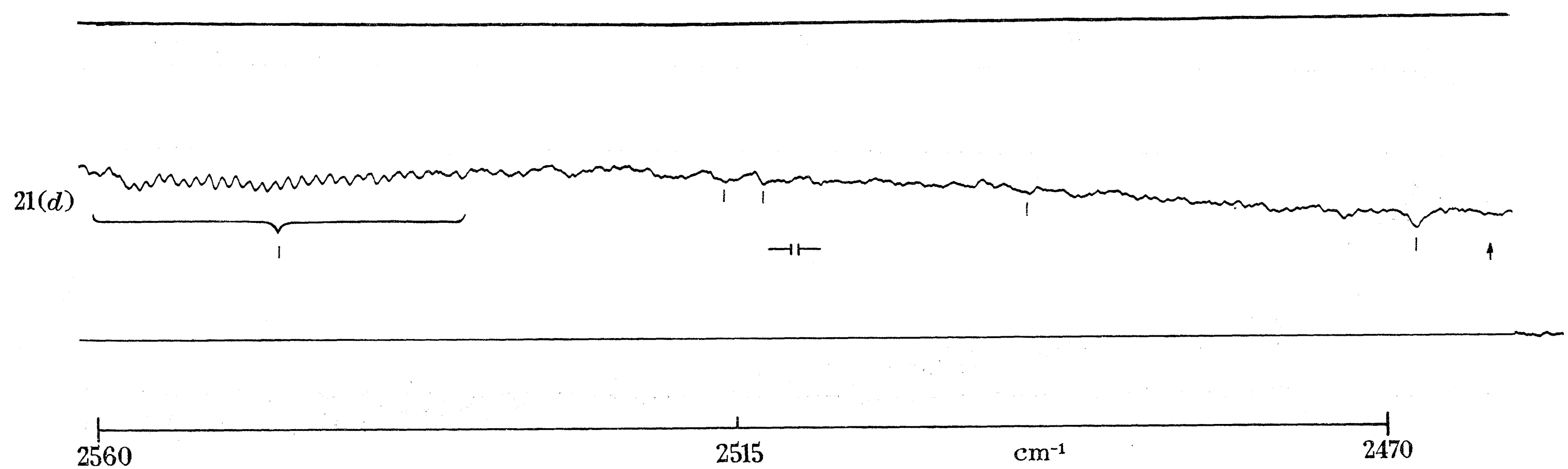
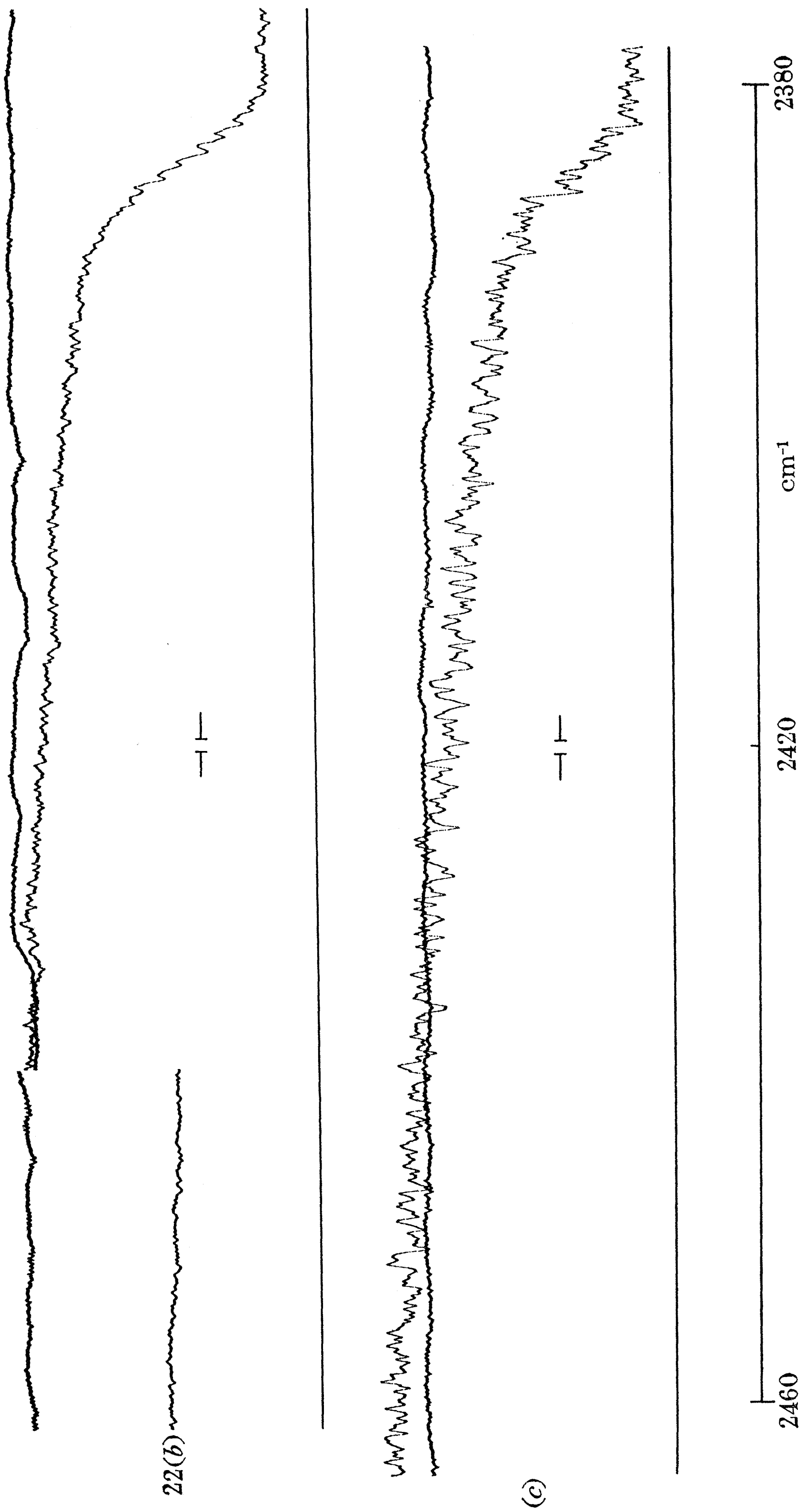


FIGURE 21

TABLE 2 (figure 21)

line no.	ν (cm⁻¹) (vac.)	ident.	band	ref.
1	2560 to 2525	N_2O	$2\nu_1$ *P* branch	4, 8
2	2515·6	CH_4	—	4, 8
3	2512·0	CH_4	—	4, 8
		N_2O	—	4, 8
4	2494·8	CH_4	—	4, 8
		N_2O	—	4, 8
5	2467·8	⊙ H	4–5	4, 8
		N_2O	$\nu_1+2\nu_2$	4, 8
6	2462*	N_2O	$\nu_1+2\nu_2$	4, 8

* N_2O band centre 4·06 μ.


22(b)
(c)
2380
2420
2460
cm⁻¹

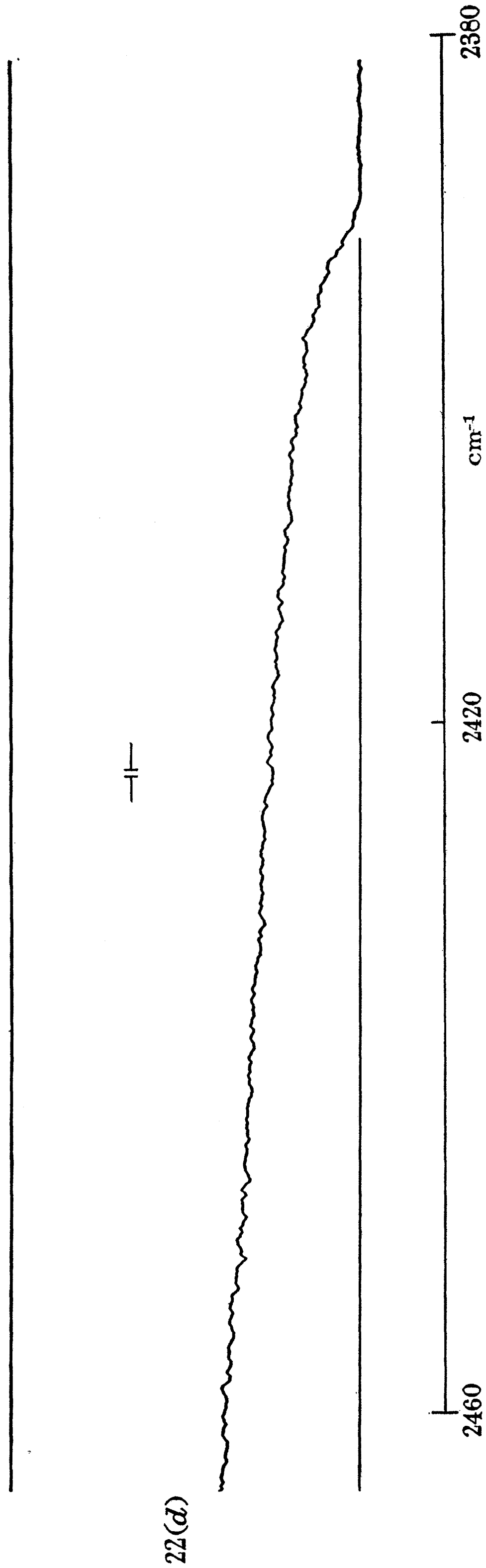
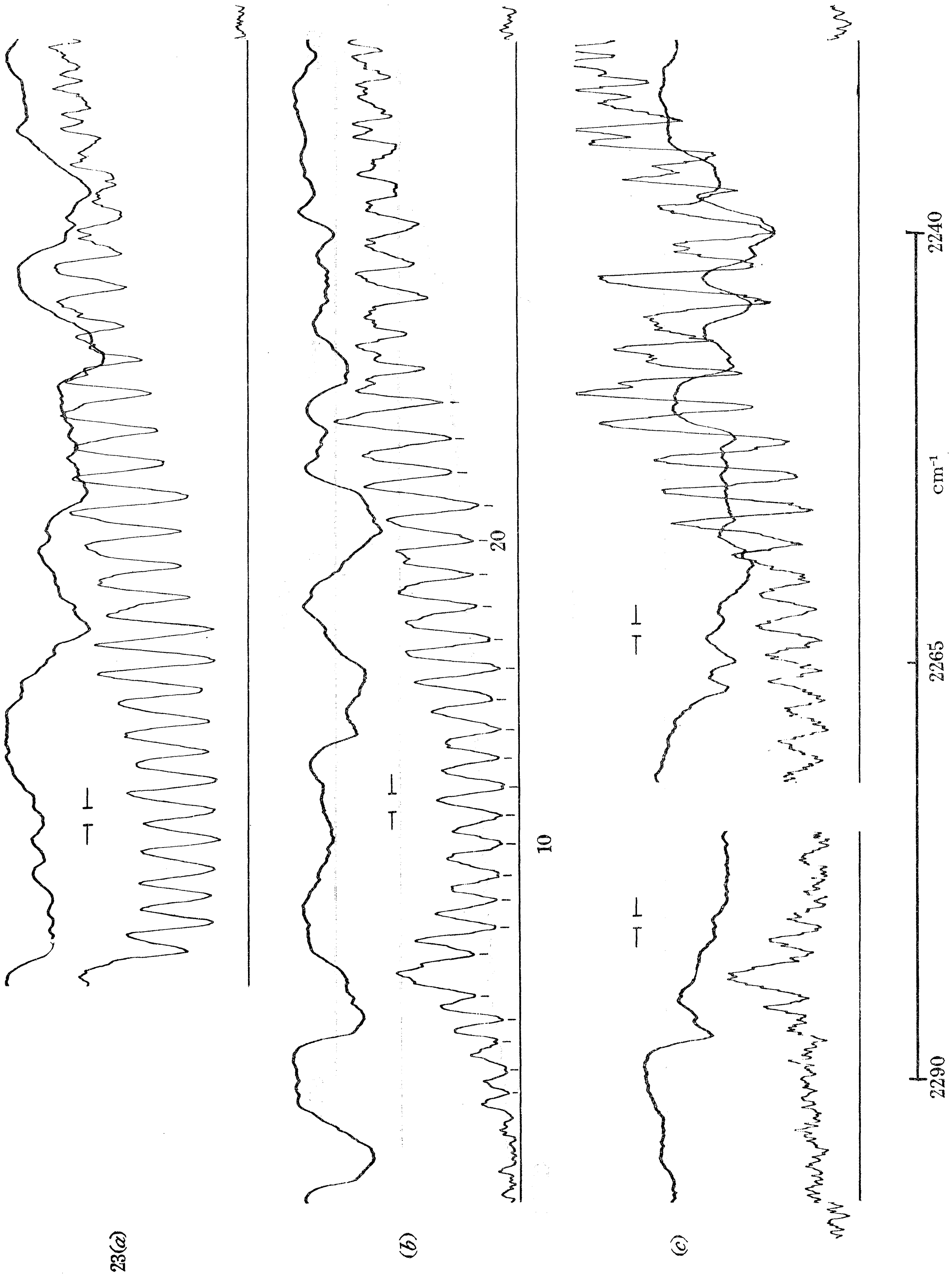


FIGURE 22


23(a)
(b)
(c)
20
10
2240
2265
2290
cm⁻¹

23(d)

Laboratory spectrum (6 ft. air)

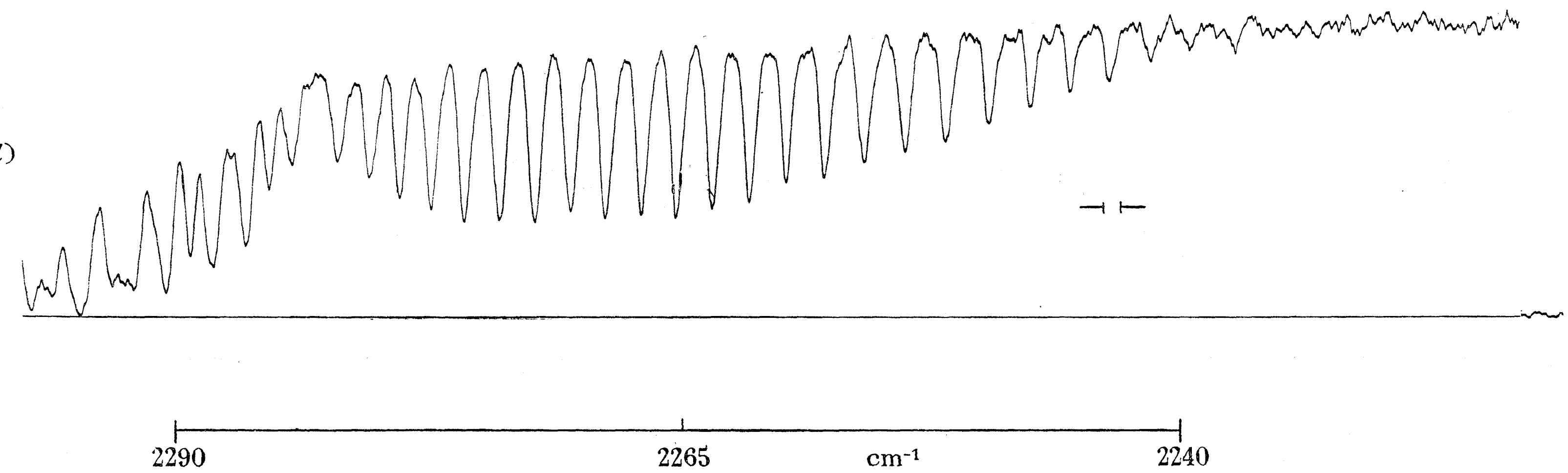
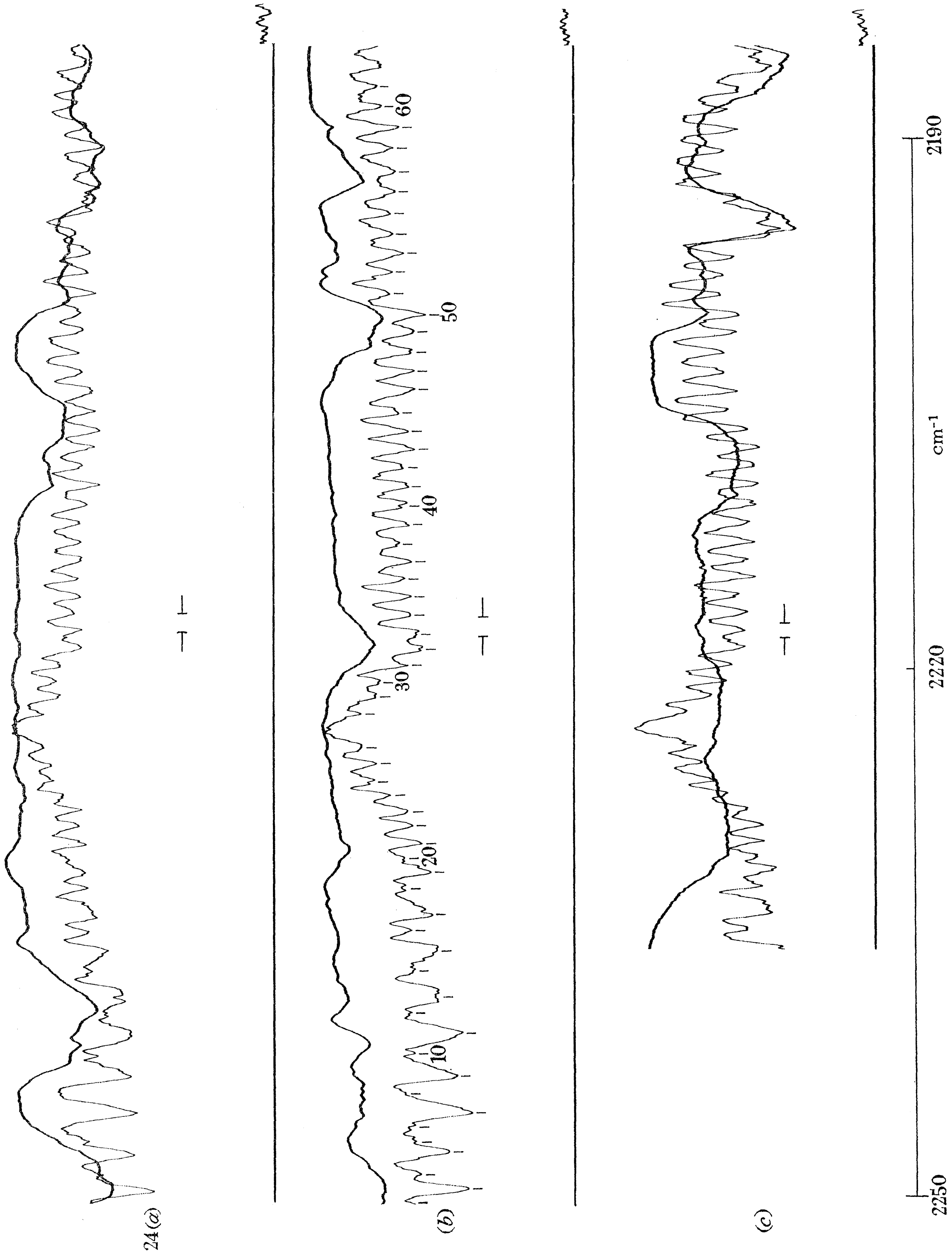


FIGURE 23

TABLE 2 (figure 23)

line no.	ν (cm^{-1}) (vac.)	ident.	band	ref.	line no.	ν (cm^{-1}) (vac.)	ident.	band	ref.
1	2290·8	$^{13}C^{16}O_2$	ν_3 $R8$	7	12	2272·5	$^{13}C^{16}O_2$	ν_3 $P14$	7
2	2289·5	{ $^{14}C^{16}O_2$	ν_3 $P62$	7	13	2270·7	$^{13}C^{16}O_2$	ν_3 $P16$	7
		{ $^{13}C^{16}O_2$	ν_3 $R6$	7	14	2269·2	$^{13}C^{16}O_2$	ν_3 $P18$	7
3	2287·8	{ $^{14}C^{16}O_2$	ν_3 $P64$	7	15	2267·3	$^{13}C^{16}O_2$	ν_3 $P20$	7
		{ $^{13}C^{16}O_2$	ν_3 $R4$	7	16	2265·5	$^{13}C^{16}O_2$	ν_3 $P22$	7
4	2286·4	$^{13}C^{16}O_2$	ν_3 $R2$	7	17	2263·7	$^{13}C^{16}O_2$	ν_3 $P24$	7
5	2284·9	$^{13}C^{16}O_2$	ν_3 $R0$	7	18	2261·8	$^{13}C^{16}O_2$	ν_3 $P26$	7
6	2282·7	$^{13}C^{16}O_2$	ν_3 $P2$	7	19	2259·7	$^{13}C^{16}O_2$	ν_3 $P28$	7
7	2281·0	$^{13}C^{16}O_2$	ν_3 $P4$	7	20	2258·0	$^{13}C^{16}O_2$	ν_3 $P30$	7
8	2279·4	$^{13}C^{16}O_2$	ν_3 $P6$	7	21	2256·0	$^{13}C^{16}O_2$	ν_3 $P32$	7
9	2277·7	$^{13}C^{16}O_2$	ν_3 $P8$	7	22	2253·9	$^{13}C^{16}O_2$	ν_3 $P34$	7
10	2276·0	$^{13}C^{16}O_2$	ν_3 $P10$	7	23	2252·1	$^{13}C^{16}O_2$	ν_3 $P36$	7
11	2274·2	$^{13}C^{16}O_2$	ν_3 $P12$	7	24	2250·0	$^{13}C^{16}O_2$	ν_3 $P38$	7


24 (a)
(b)
(c)
10
20
30
40
50
60
2250
2220
2190
cm^{-1}

24(*d*)

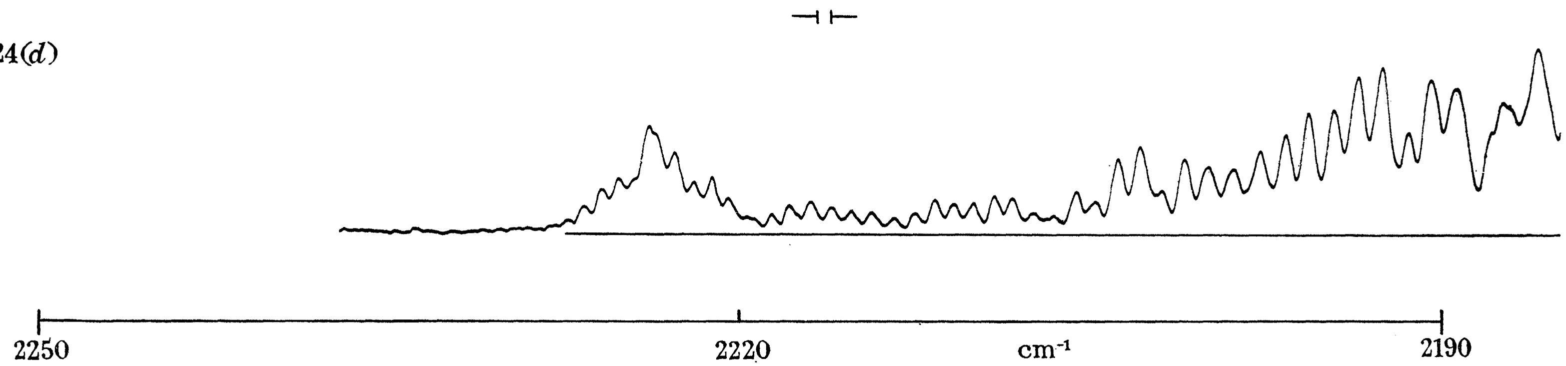


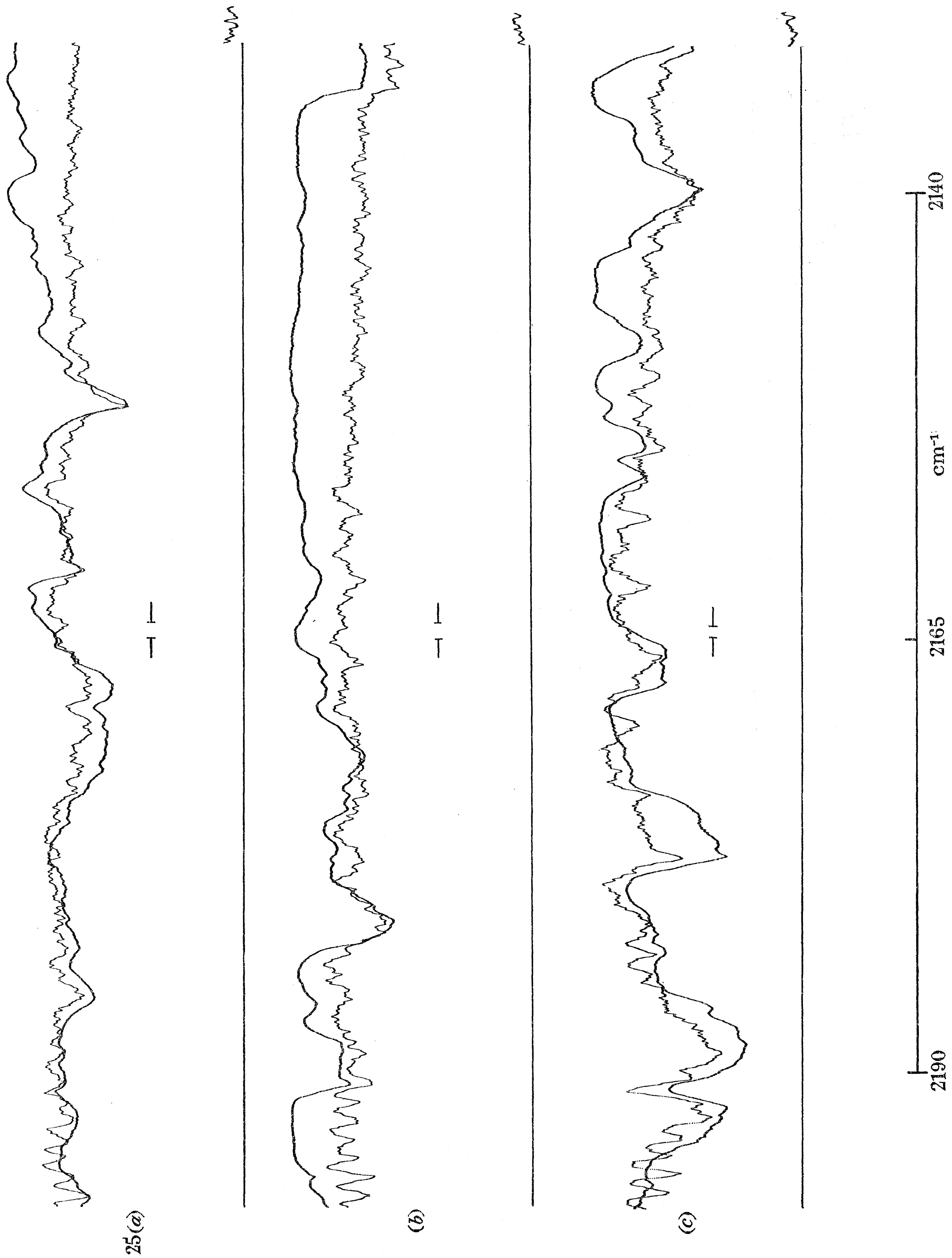
FIGURE 24

TABLE 2 (figure 24)

line no.	ν (cm⁻¹) (vac.)	ident.	band	ref.
1	2248·7	N_2O	ν_3 *R*34	4
		$^{13}C^{16}O_2$	ν_3 *P*40	4
2	2247·7	N_2O	ν_3 *R*33	4
		N_2O	ν_3 *R*32	4
3	2246·9	N_2O	ν_3 *R*31	4
		$^{13}C^{16}O_2$	ν_3 *P*42	4
4	2245·7	N_2O	ν_3 *R*30	4
		N_2O	ν_3 *R*29	4
5	2245·0	N_2O	ν_3 *R*28	4
6	2244·4	N_2O	ν_3 *R*27	4
		$^{13}C^{16}O_2$	ν_3 *P*44	4
7	2243·7	N_2O	ν_3 *R*26	4
		N_2O	ν_3 *R*25	4
8	2242·4	N_2O	ν_3 *R*24	4
		$^{13}C^{16}O_2$	ν_3 *P*46	4
9	2241·6	N_2O	ν_3 *R*23	4
		N_2O	ν_3 *R*22	4
10	2240·5	N_2O	ν_3 *R*21	4
		$^{13}C^{16}O_2$	ν_3 *P*48	4
11	2239·5	N_2O	ν_3 *R*20	4
		N_2O	ν_3 *R*19	4
12	2238·4	N_2O	ν_3 *R*18	4
		$^{13}C^{16}O_2$	ν_3 *P*50	4
13	2237·0	N_2O	ν_3 *R*17	4
		N_2O	ν_3 *R*16	4
14	2236·3	N_2O	ν_3 *R*15	4
		$^{13}C^{16}O_2$	ν_3 *P*52	4
15	2234·9	N_2O	ν_3 *R*14	4
		N_2O	ν_3 *R*13	4

line no.	ν (cm⁻¹) (vac.)	ident.	band	ref.
16	2234·0	N_2O	ν_3 *R*12	4
		$^{13}C^{16}O_2$	ν_3 *P*54	4
17	2233·3	N_2O	ν_3 *R*11	4
		N_2O	ν_3 *R*10	4
18	2231·8	N_2O	ν_3 *R*9	4
19	2230·9	N_2O	ν_3 *R*8	4
		$^{13}C^{16}O_2$	ν_3 *P*56	4
20	2230·2	N_2O	ν_3 *R*7	4
21	2229·5	N_2O	ν_3 *R*6	4
22	2228·6	N_2O	ν_3 *R*5	4
23	2227·8	N_2O	ν_3 *R*4	4
24	2227·1	N_2O	ν_3 *R*3	4
25	2226·2	N_2O	ν_3 *R*2	4
26	2225·5	N_2O	ν_3 *R*1	4
27	2224·6	N_2O	ν_3 *R*0	4
28	2222·9	N_2O	ν_3 *P*1	4
29	2222·0	N_2O	ν_3 *P*2	4
30	2221·2	N_2O	ν_3 *P*3	4
31	2220·4	N_2O	ν_3 *P*4	4
32	2219·5	N_2O	ν_3 *P*5	4
33	2218·6	N_2O	ν_3 *P*6	4
34	2217·7	N_2O	ν_3 *P*7	4
35	2216·8	N_2O	ν_3 *P*8	4
36	2215·9	N_2O	ν_3 *P*9	4
		CO	1–0 *R*20	4
37	2215·1	N_2O	ν_3 *P*10	4
38	2214·1	N_2O	ν_3 *P*11	4
39	2213·2	N_2O	ν_3 *P*12	4

line no.	ν (cm⁻¹) (vac.)	ident.	band	ref.
40	2212·3	N_2O	ν_3 *P*13	4
		CO	1–0 *R*19	4
41	2211·3	N_2O	ν_3 *P*14	4
42	2210·4	N_2O	ν_3 *P*15	4
43	2209·5	N_2O	ν_3 *P*16	4
		CO	1–0 *R*18	4
44	2208·6	N_2O	ν_3 *P*17	4
45	2207·6	N_2O	ν_3 *P*18	4
46	2206·7	N_2O	ν_3 *P*19	4
		CO	1–0 *R*17	4
47	2205·7	N_2O	ν_3 *P*20	4
48	2204·7	N_2O	ν_3 *P*21	4
49	2203·7	N_2O	ν_3 *P*22	4
50	2202·7	N_2O	ν_3 *P*23	4
		CO	1–0 *R*16	4
51	2201·8	N_2O	ν_3 *P*24	4
52	2200·8	N_2O	ν_3 *P*25	4
53	2199·8	N_2O	ν_3 *P*26	4
		CO	1–0 *R*15	4
54	2198·7	N_2O	ν_3 *P*27	4
55	2197·7	N_2O	ν_3 *P*28	4
56	2196·7	N_2O	ν_3 *P*29	4
		CO	1–0 *R*14	4
57	2195·7	N_2O	ν_3 *P*30	4
58	2194·6	N_2O	ν_3 *P*31	4
59	2193·5	CO	1–0 *R*13	4
		N_2O	ν_3 *P*32	4
60	2192·4	N_2O	ν_3 *P*33	4
61	2191·4	N_2O	ν_3 *P*34	4


25(a)
(b)
(c)
2140
2165
2190
cm-1

25(*d*)

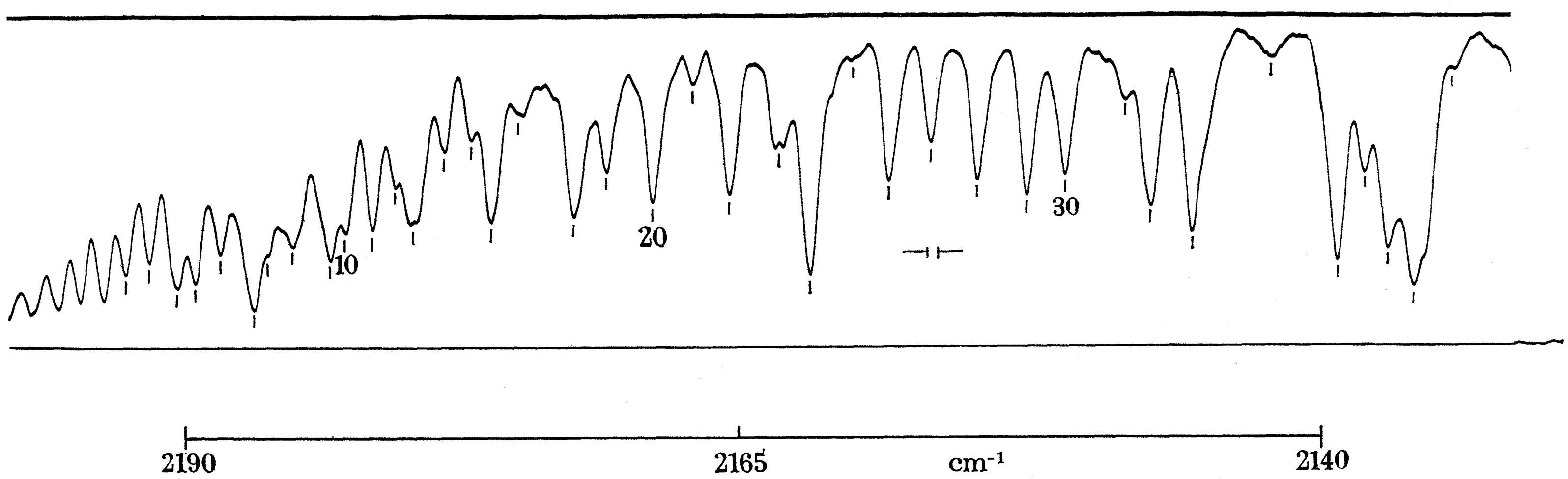
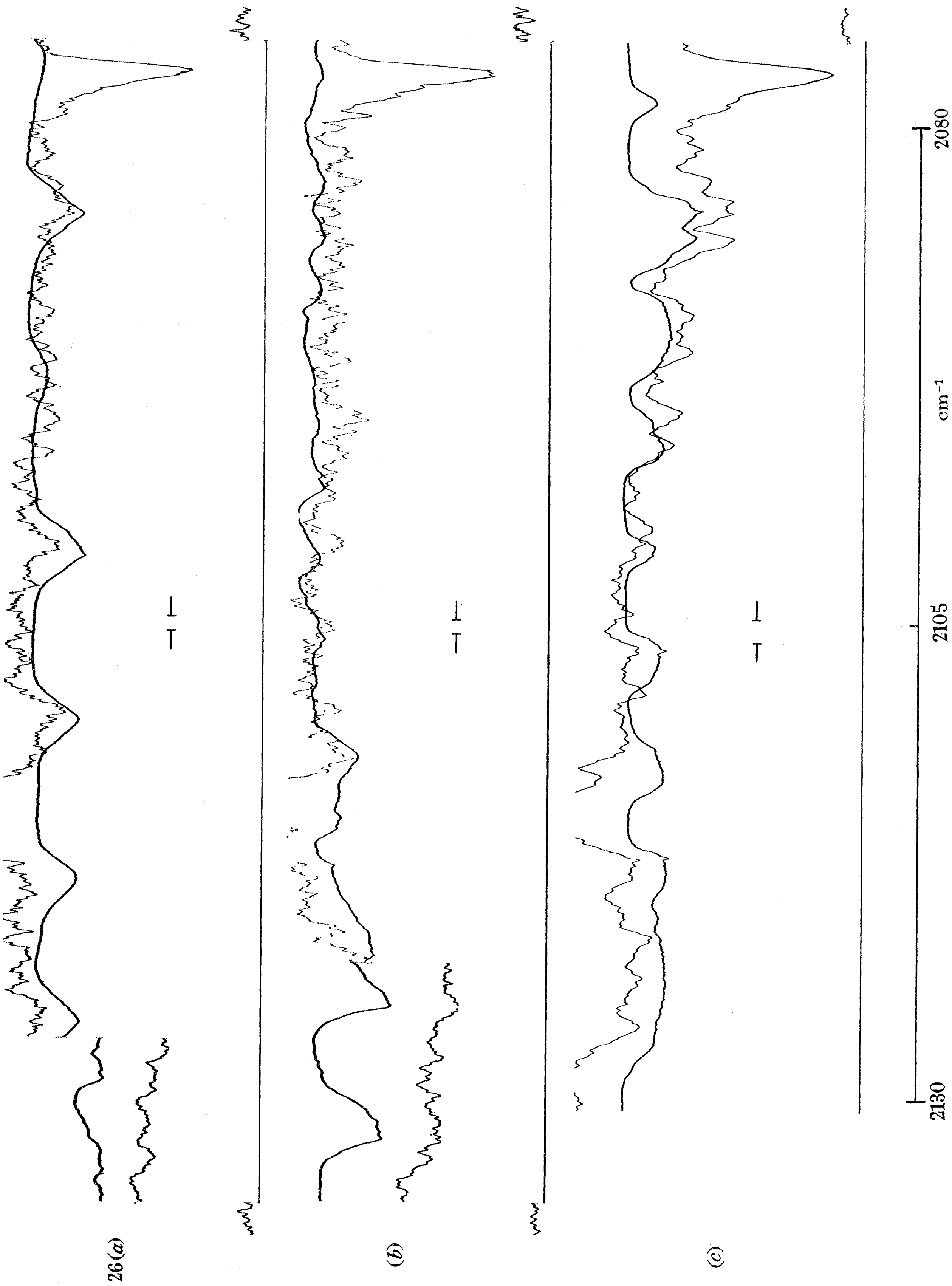


FIGURE 25

TABLE 2 (figure 25)

line no.	ν (cm^{-1}) (vac.)	ident.	band	ref.
1	2192·6	N_2O	ν_3 *P*33	4
2	2191·6	N_2O	ν_3 *P*34	4
3	2190·4	CO	1–0 *R*12	4
		N_2O	ν_3 *P*35	4
4	2189·6	N_2O	ν_3 *P*36	4
5	2188·4	N_2O	ν_3 *P*37	4
6	2187·0	CO	1–0 *R*11	4
		N_2O	ν_3 *P*38	4
7	2186·1	N_2O	ν_3 *P*39	4
8	2185·1	N_2O	ν_3 *P*40	4
9	2183·5	CO	1–0 *R*10	4
		N_2O	ν_3 *P*41	4
10	2182·8	N_2O	ν_3 *P*42	4
11	2181·6	N_2O	ν_3 *P*43	4
12	2180·4	N_2O	ν_3 *P*44	4
13	2179·8	CO	1–0 *R*9	4
		N_2O	ν_3 *P*45	4
14	2178·3	N_2O	ν_3 *P*46	4
15	2177·1	N_2O	ν_3 *P*47	4
16	2176·3	CO	1–0 *R*8	4
		N_2O	ν_3 *P*48	4
17	2174·7	N_2O	ν_3 *P*49	4
18	2172·9	CO	1–0 *R*7	4
		N_2O	ν_3 *P*50	4
		N_2O	ν_3 *P*51	4
19	2171·4	H_2O	ν_2	4
		N_2O	ν_3 *P*52	4
20	2169·3	CO	1–0 *R*6	4
21	2167·5	H_2O	ν_2	4
22	2165·7	CO	1–0 *R*5	4
23	2163·5	H_2O	ν_2	4
24	2161·9	CO	1–0 *R*4	4
25	2159·6	N_2O	ν_3	4
26	2158·4	CO	1–0 *R*3	4
27	2156·7	H_2O	ν_2	4
28	2154·7	CO	1–0 *R*2	4
29	2152·6	H_2O	ν_2	4
30	2151·0	CO	1–0 *R*1	4
31	2148·5	—	—	4
32	2147·4	CO	1–0 *R*0	4
33	2145·6	H_2O	ν_2	4
34	2141·3	$^{13}C^{16}O$	1–0 *R*	4
35	2139·5	CO	1–0 *P*1	4
36	2138·3	H_2O	ν_2	4
37	2137·3	H_2O	ν_2	4
38	2135·8	CO	1–0 *P*2	4
39	2134·4	$^{13}C^{16}O$	1–0 *R*	4


26(a)
(b)
(c)
2080
2105
2130
cm-1

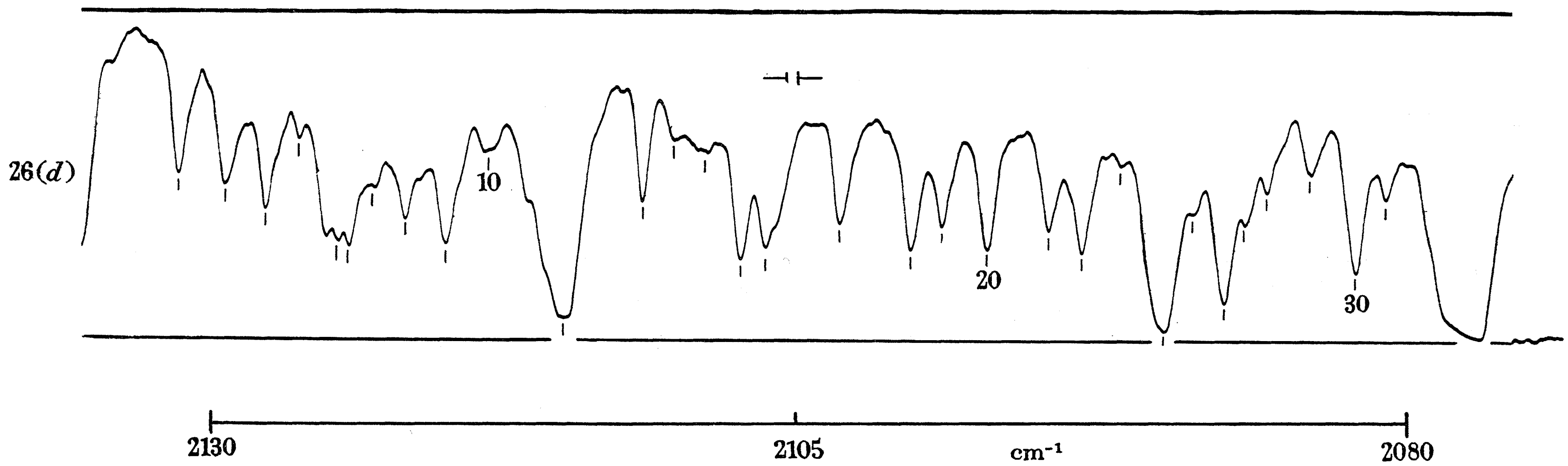
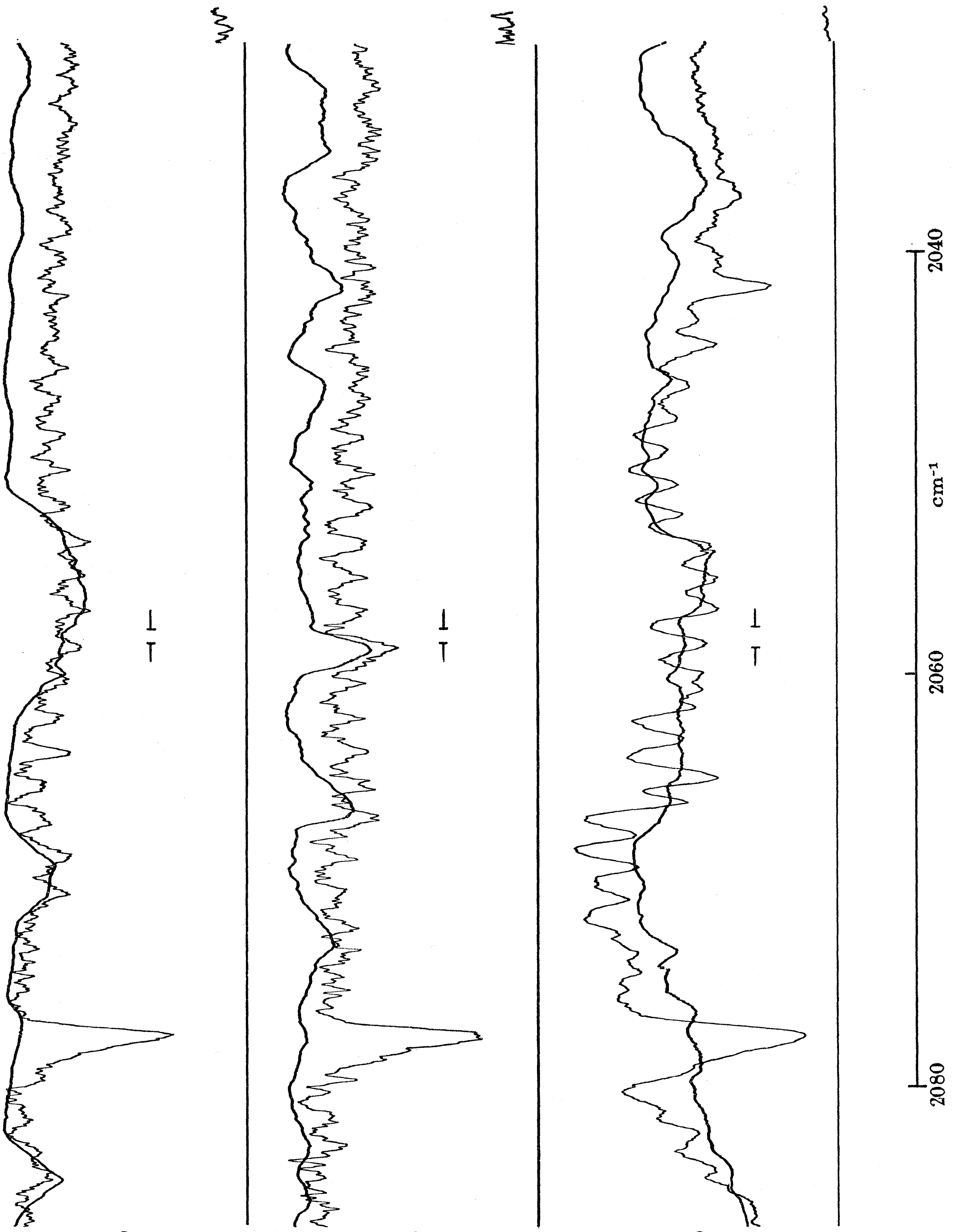


FIGURE 26

TABLE 2 (figure 26)

line no.	ν (cm⁻¹) (vac.)	ident.	band	ref.	line no.	ν (cm⁻¹) (vac.)	ident.	band	ref.
1	2131·6	CO	1–0 $P3$	4	17	2103·2	CO	1–0 $P10$	4
2	2129·6	CO_2	$2\nu_1-\nu_2$ Q	4	18	2100·5	H_2O	ν_2	4
3	2127·7	CO	1–0 $P4$	4	19	2099·1	CO	1–0 $P11$	4
4	2126·1	CO_2	$2\nu_1-\nu_2$ $P5$	4	20	2097·3	H_2O	ν_2	4
		$^{13}C^{16}O$	1–0	4	21	2094·9	CO	1–0 $P12$	4
5	2124·2	CO_2	$2\nu_1-\nu_2$	4	22	2093·5	CO_2	$\nu_1+2\nu_2^2-\nu_2$	4
		H_2O	ν_2	4	23	2091·7	CO_2	$\nu_1+\nu_2$ $R18$	4
6	2123·6	CO	1–0 $P5$	4			H_2O	ν_2	4
7	2122·7	H_2O	$\nu_3-\nu_2$	4	24	2090·6	CO_2	$\nu_1+\nu_2$ $R16$	4
		CO_2	$2\nu_1-\nu_2$	4			CO	1–0 $P13$	4
8	2121·3	H_2O	ν_2	4	25	2088·5	CO_2	$\nu_1+\nu_2$ $R14$	4
		CO_2	$2\nu_1-\nu_2$	4	26	2087·1	CO_2	$\nu_1+\nu_2$ $R12$	4
9	2119·7	CO	1–0 $P6$	4			H_2O	ν_2	4
10	2118·0	O_3	—	4	27	2086·3	CO	1–0 $P14$	4
11	2115·6	CO	1–0 $P7$	4	28	2085·4	CO_2	$\nu_1+\nu_2$ $R10$	4
12	2111·6	CO	1–0 $P8$	4	29	2083·8	CO_2	$\nu_1+\nu_2$ $R8$	4
13	2110·2	CO_2	$2\nu_1-\nu_2$	4			CO	1–0 $P15$	4
14	2108·7	CO_2	$2\nu_1-\nu_2$	4	30	2081·9	CO_2	$\nu_1+\nu_2$ $R6$	4
15	2107·4	CO	1–0 $P9$	4			H_2O	ν_2	4
16	2106·4	H_2O	ν_2	4	31	2080·8	CO_2	$\nu_1+\nu_2$ $R4$	4



27(a) (b) (c)

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27(*d*)

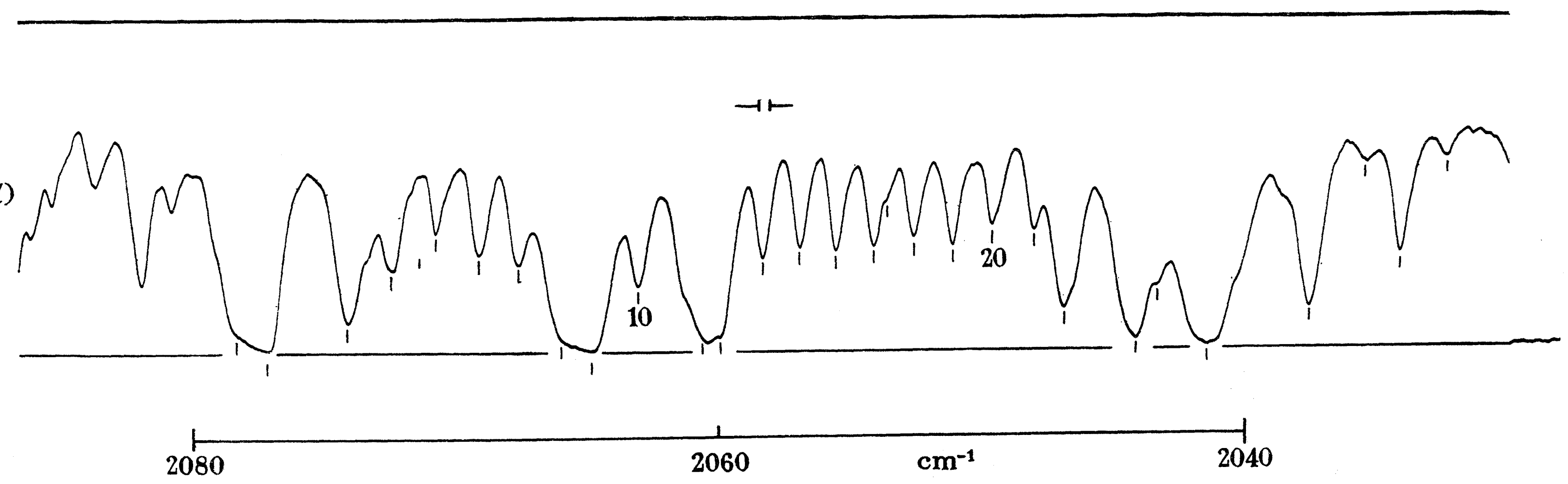
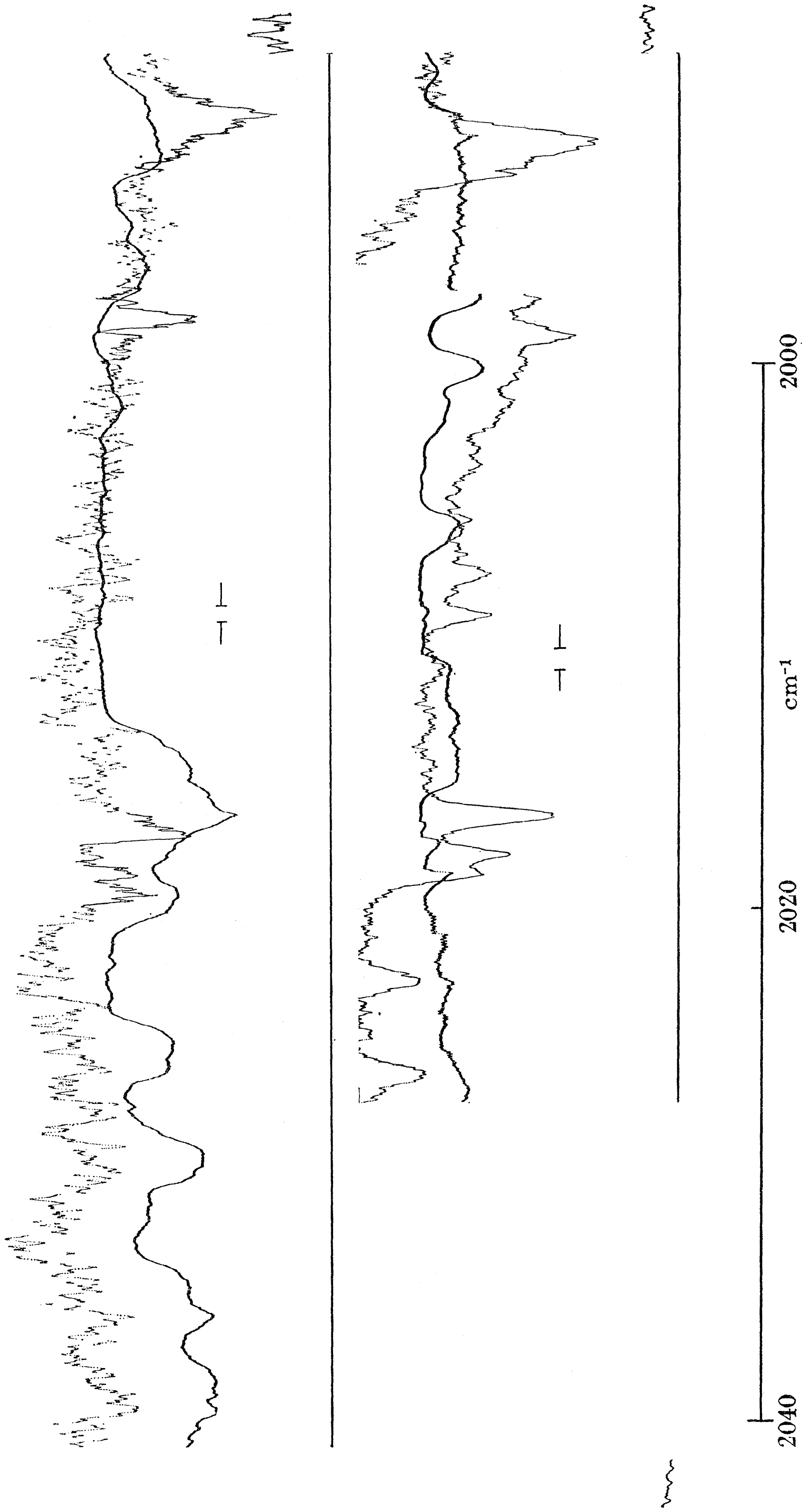


FIGURE 27

TABLE 2 (figure 27)

line no.	ν (cm^{-1}) (vac.)	ident.	band	ref.
1	2077·3	CO	1–0 *P*16	4
		CO_2	$\nu_1+\nu_2$ *R*0	4
2	2076·9	CO_2	$\nu_1+\nu_2$ *Q*	4
		H_2O	$\nu_3-\nu_2$	4
3	2073·2	CO	1–0 *P*17	4
		H_2O	ν_2	4
		CO_2	$\nu_1+\nu_2$ *P*4	4
		CO_2	$\nu_1+2\nu_2^2-\nu_2$	4
4	2072·2	CO_2	$\nu_1+\nu_2$ *P*6	4
5	2070·6	CO_2	$\nu_1+\nu_2$ *P*8	4
6	2068·9	CO	1–0 *P*18	4
		CO_2	$\nu_1+\nu_2$ *P*10	4
7	2067·5	CO_2	$\nu_1+\nu_2$ *P*12	4
8	2065·9	CO_2	$\nu_1+\nu_2$ *P*14	4
		H_2O	ν_2	4
9	2064·5	H_2O	ν_2	4
		CO_2	$\nu_1+\nu_2$ *P*16	4
		CO	1–0 *P*19	4
10	2062·7	CO_2	$\nu_1+\nu_2$ *P*18	4
11	2061·3	CO_2	$\nu_1+\nu_2$ *P*20	4
12	2059·8	CO_2	$\nu_1+\nu_2$ *P*22	4
		H_2O	ν_2	4
		CO	1–0 *P*20	4
13	2058·2	CO_2	$\nu_1+\nu_2$ *P*24	4
14	2056·6	CO_2	$\nu_1+\nu_2$ *P*26	4
15	2055·2	CO_2	$\nu_1+\nu_2$ *P*28	4
16	2053·6	CO_2	$\nu_1+\nu_2$ *P*30	4
17	2052·9	$H_2{}^{18}O$	ν_2	4
18	2052·1	CO_2	$\nu_1+\nu_2$ *P*32	4
19	2050·5	CO_2	$\nu_1+\nu_2$ *P*34	4
20	2049·0	CO_2	$\nu_1+\nu_2$ *P*36	4
21	2047·5	CO_2	$\nu_1+\nu_2$ *P*38	4
22	2046·0	CO_2	$\nu_1+\nu_2$ *P*40	4
23	2044·4	H_2O	ν_2	4
		CO_2	$\nu_1+\nu_2$ *P*42	4
24	2042·9	CO_2	$\nu_1+\nu_2$ *P*44	4
25	2041·3	CO_2	$\nu_1+\nu_2$ *P*46	4
		H_2O	ν_2	4
26	2037·4	H_2O	ν_2	4
27	2035·4	CO_2	$\nu_1+\nu_2$ *P*54	4
28	2034·0	H_2O	ν_2	4
		CO_2	$\nu_1+\nu_2$ *P*56	4
29	2032·3	CO_2	$\nu_1+\nu_2$ *P*58	4



28(b)

(c)

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28(*d*)

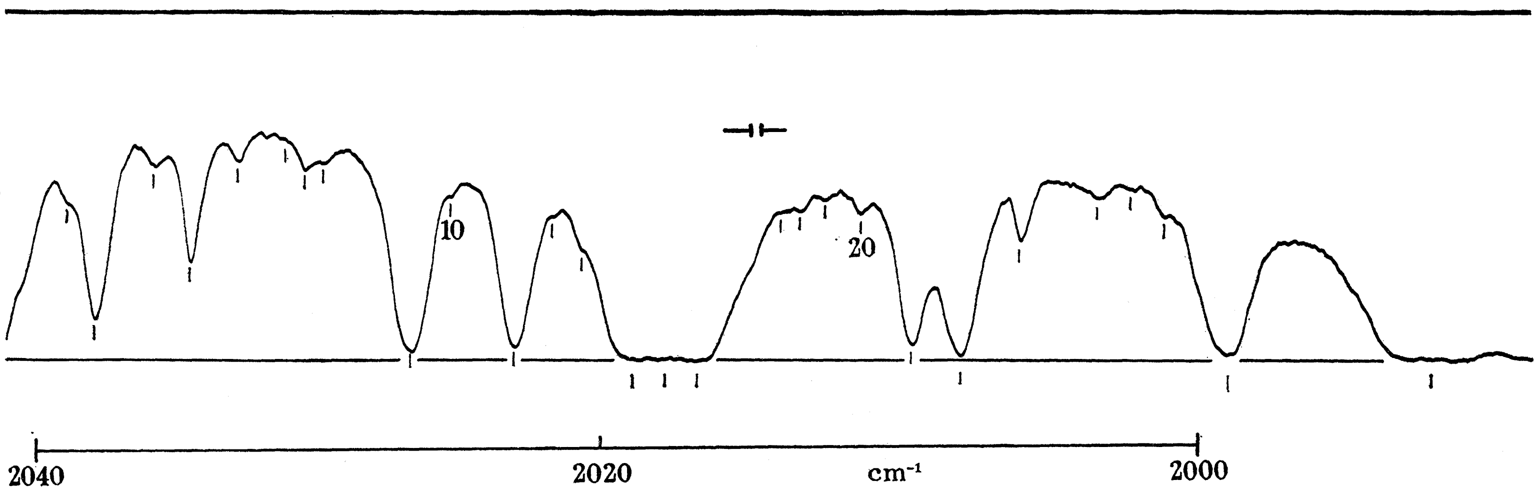
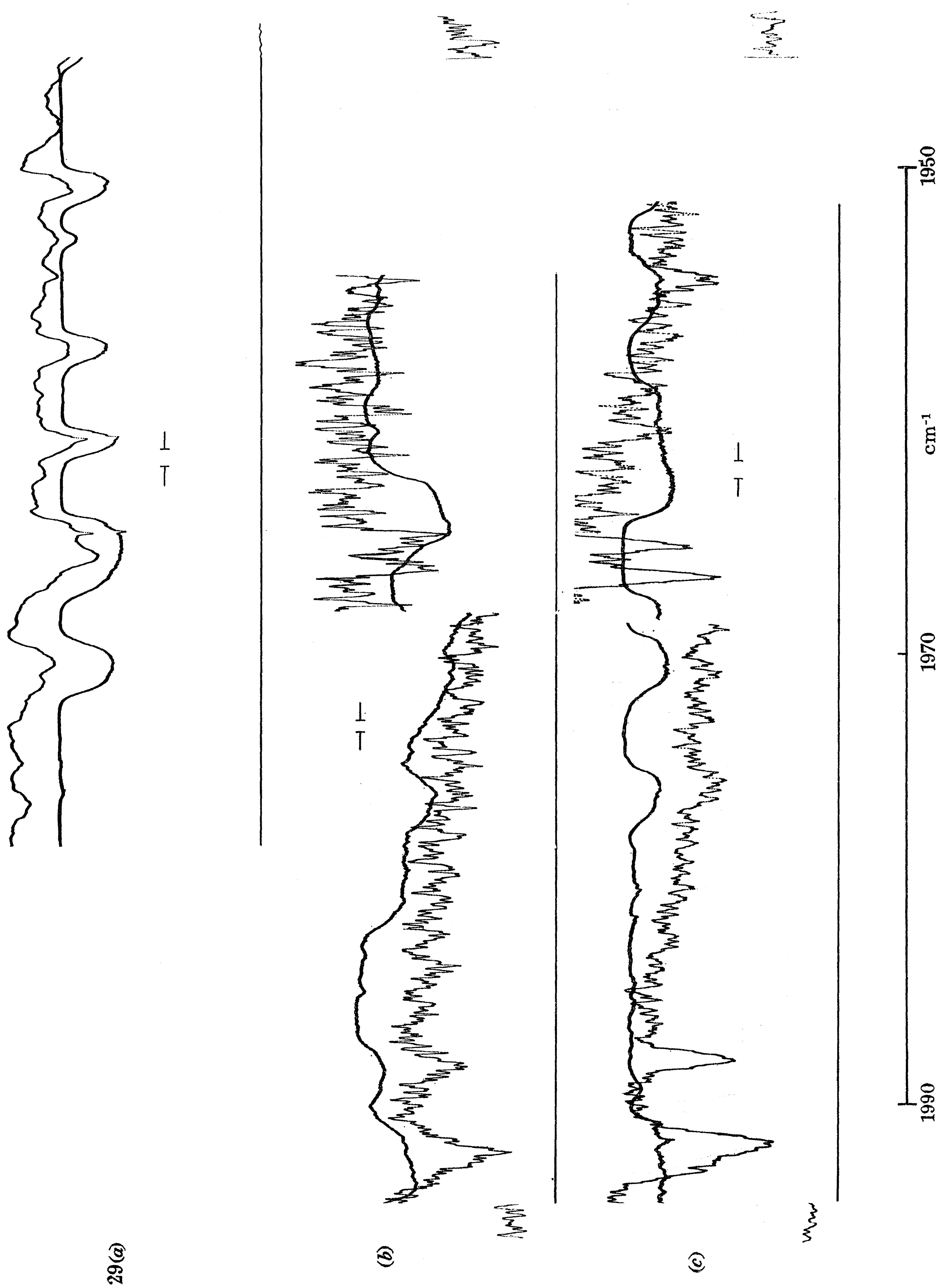


FIGURE 28

TABLE 2 (figure 28)

line no.	ν (cm^{-1}) (vac.)	ident.	band	ref.	line no.	ν (cm^{-1}) (vac.)	ident.	band	ref.
1	2038·5	CO_2	$\nu_1+\nu_2$ *P* 50	4	15	2018·3	H_2O	ν_2	4
2	2037·4	H_2O	ν_2	4	16	2016·8	H_2O	ν_2	4
		CO_2	$\nu_1+\nu_2$ *P* 52	4	17	2015·1	$^{13}C^{16}O_2$	$\nu_1+\nu_2$	4
3	2035·4	CO_2	$\nu_1+\nu_2$ *P* 54	4			⊙ CO	—	4
4	2034·0	H_2O	ν_2	4	18	2013·5	$^{13}C^{16}O_2$	$\nu_1+\nu_2$	4
		CO_2	$\nu_1+\nu_2$ *P* 56	4	19	2012·4	$^{13}C^{16}O_2$	$\nu_1+\nu_2$	4
5	2032·3	CO_2	$\nu_1+\nu_2$ *P* 58	4			H_2O	$\nu_3-\nu_2$	4
6	2030·9	CO_2	$\nu_1+\nu_2$ *P* 60	4	20	2011·4	⊙ CO	—	4
7	2030·2	$H_2{}^{18}O$	ν_2	4	21	2009·3	H_2O	ν_2	4
8	2029·3	CO_2	$\nu_1+\nu_2$ *P* 62	4	22	2007·6	H_2O	ν_2	4
		$^{13}C^{16}O_2$	$\nu_1+\nu_2$	4	23	2005·6	$H_2{}^{18}O$?	ν_2	4
9	2026·6	H_2O	ν_2	4	24	2003·2	H_2O	$\nu_1-\nu_2$	4
10	2025·0	$^{13}C^{16}O$	1–0	4			⊙ CO	1–0	4
11	2023·0	H_2O	ν_2	4	25	2002·1	⊙ CO	—	4
12	2021·5	$^{13}C^{16}O_2$	$\nu_1+\nu_2$	4	26	2000·9	H_2O	—	4
13	2019·7	$^{13}C^{16}O_2$	$\nu_1+\nu_2$	4	27	1998·9	H_2O	ν_2	4
14	2019·0	H_2O	ν_2	4	28	1992·2	H_2O	ν_2	4



PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

29(*d*)

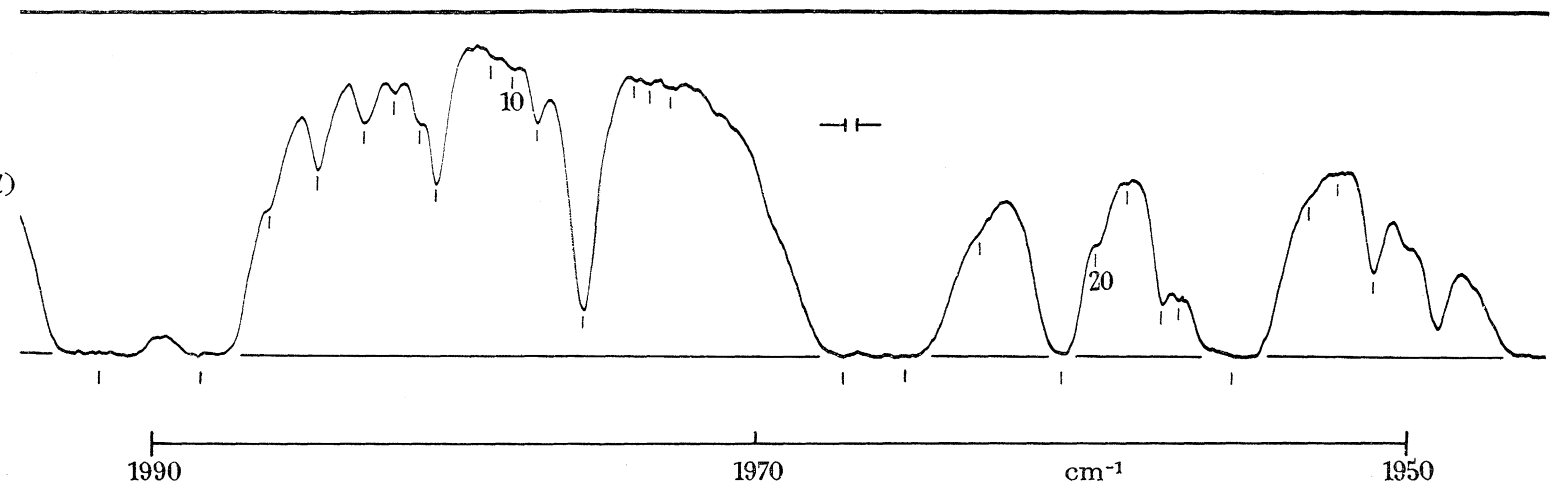
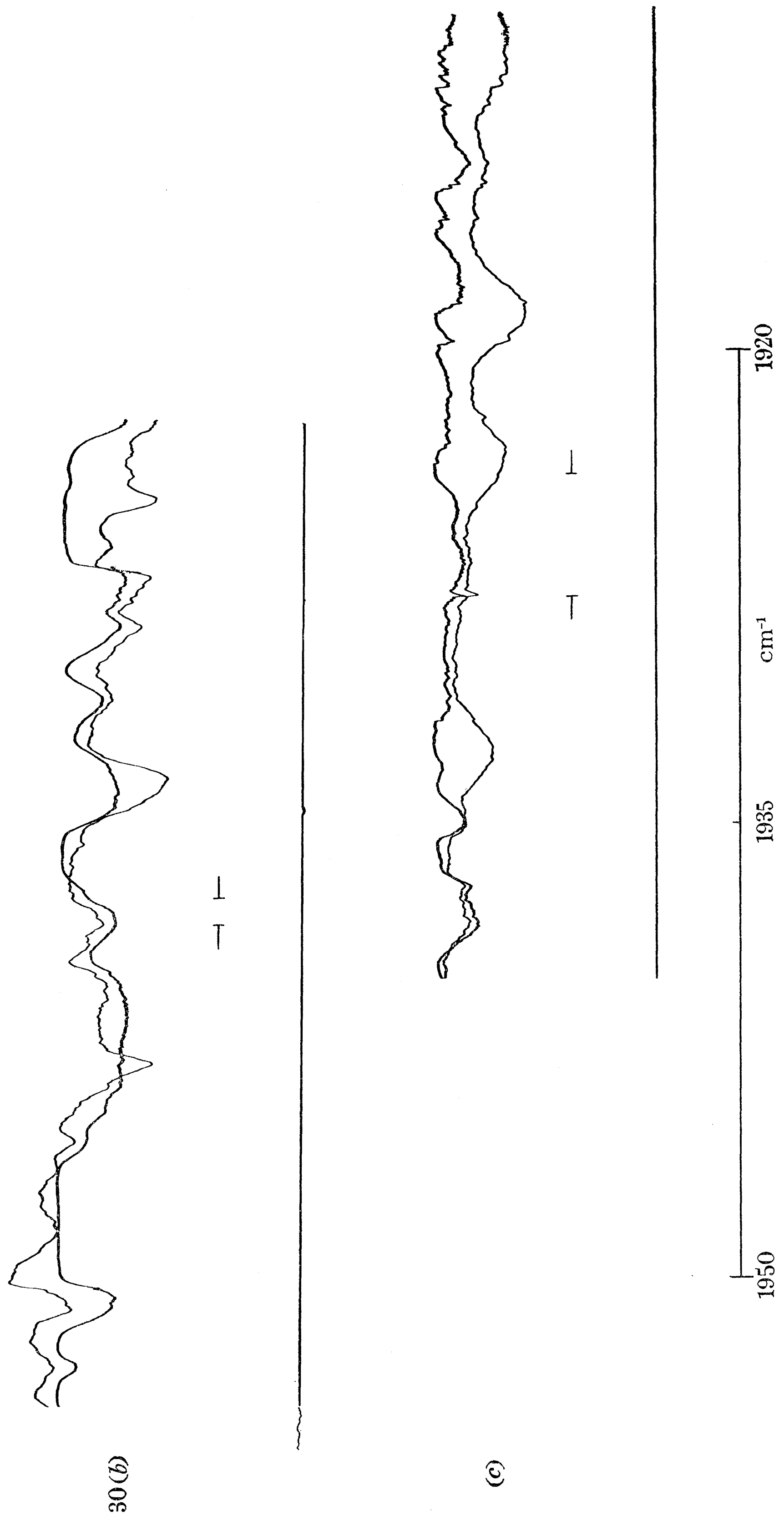


FIGURE 29

TABLE 2 (figure 29)

line no.	ν (cm^{-1}) (vac.)		ident.	band		ref.
1	1992·2		H_2O	ν_2		4
2	1988·4		H_2O	ν_2		4
3	1986·2		$H_2{}^{17}O$	ν_2		4
4	1984·5		H_2O	ν_2		4
5	1983·0		H_2O	ν_2		4
		⊙	CO	—		4
6	1982·2		H_2O	—		4
7	1981·3	⊙	CO	—		4
8	1980·8		H_2O	$\nu_3-\nu_2$		4
			$H_2{}^{18}O$	ν_2		4
9	1978·9	⊙	CO	1–0		4
10	1978·3	⊙	CO	—		4
11	1977·6		$H_2{}^{18}O$	ν_2		4
12	1976·2		H_2O	ν_2		4
13	1974·4	⊙	CO	—		4
14	1973·9	⊙	CO	1–0		4
15	1973·4	⊙	CO	—		4
16	1967·4		H_2O	ν_2		4
17	1966·2		H_2O	ν_2		4
18	1963·7	⊙	CO	1–0		4
			CO_2	$3\nu_2^1$	$R38$	4
19	1961·2		H_2O	ν_2		4
			CO_2	$3\nu_2^1$	$R36$	4
					$R34$	4
20	1959·6		H_2O	ν_2		4
21	1958·7	⊙	CO	1–0		4
			CO_2	$3\nu_2^1$	$R32$	4
22	1957·6		H_2O	ν_2		4
23	1957·0		$H_2{}^{18}O$	ν_2		4
			CO_2	$3\nu_2^1$	$R30$	4
24	1955·0		H_2O	ν_2		4
			CO_2	$3\nu_2^1$	$R28$	4
					$R26$	4
25	1952·9	⊙	CO	—		4
26	1952·2		CO_2	$3\nu_2^1$	$R24$	4
27	1951·1		H_2O	ν_2		4
			CO_2	$3\nu_2^1$	$R22$	4



30(b)
(c)
1920
1935
1950
cm⁻¹

30(*d*)

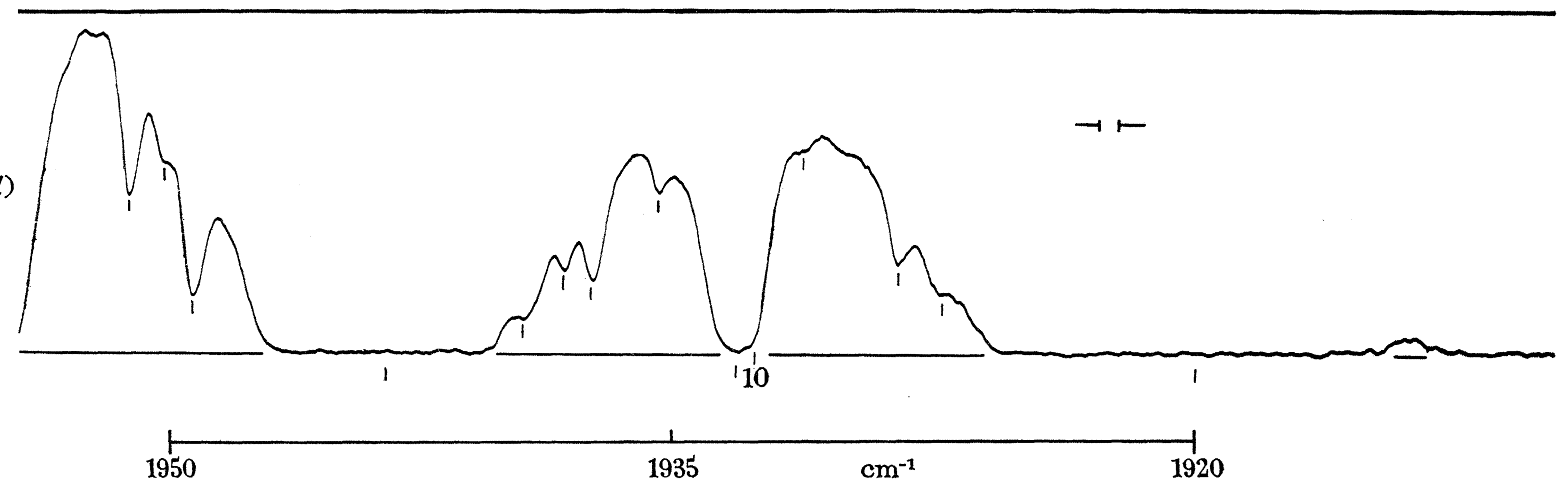
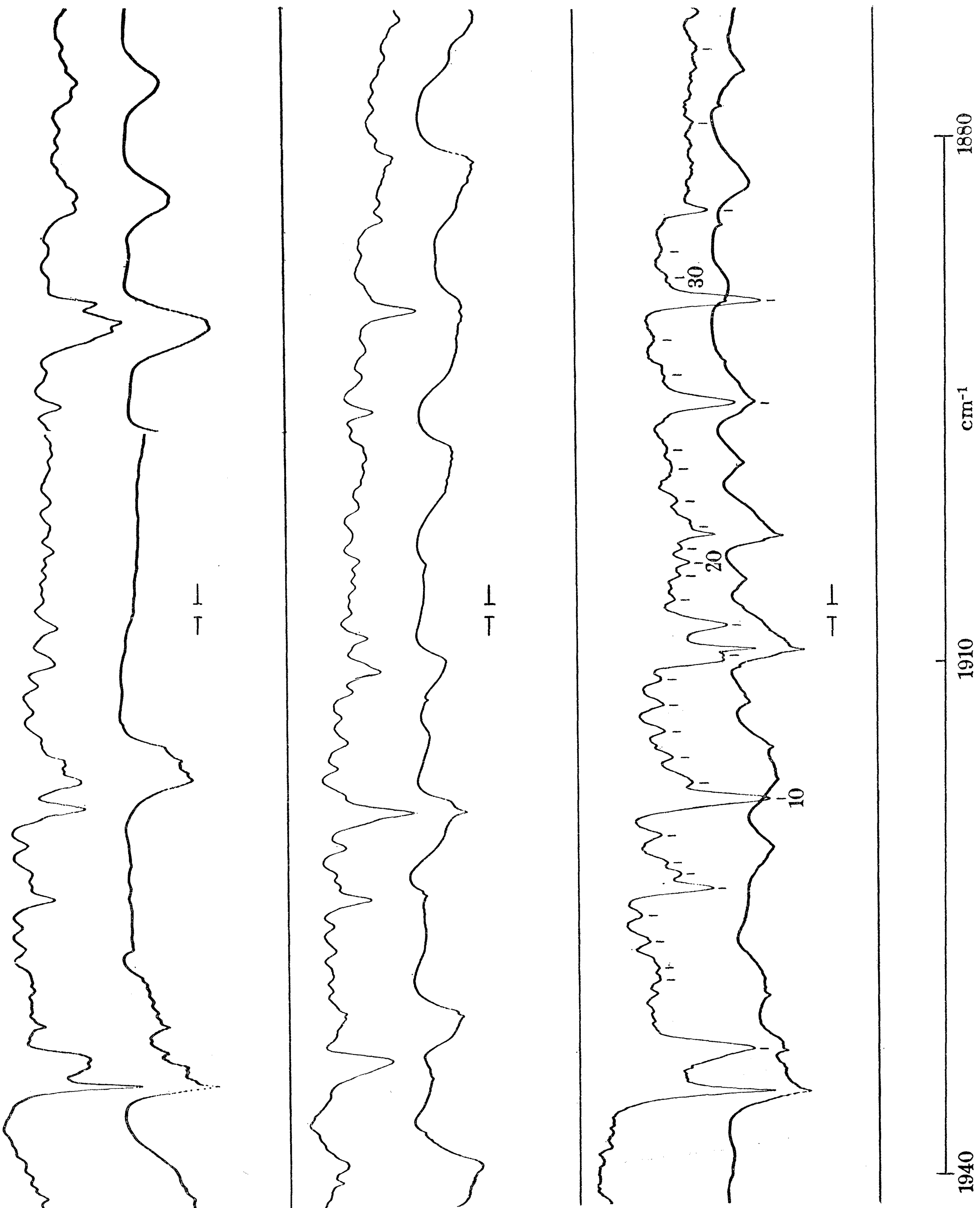


FIGURE 30

TABLE 2 (figure 30)

line no.	ν (cm^{-1}) (vac.)	ident.	band	ref.
1	1951·1	{H_2O	ν_2	4
		{CO_2	$3\nu_2^1$ *R*22	4
2	1950·1	H_2O	ν_2	4
3	1949·3	{H_2O	ν_2	4
		{CO_2	$3\nu_2^1$ *R*20	4
4	1943	H_2O	ν_2	4
5	1939·2	H_2O	ν_2	4
6	1938·0	CO_2	$3\nu_2^1$ *R*6	4
7	1937·2	H_2O	ν_2	4
8	1935·4	H_2O	—	4
9	1933·2	{H_2O	ν_2	4
		{CO_2	$3\nu_2^1$ *Q*	4
10	1932·1	$H_2{}^{18}O$	ν_2	4
11	1930·6	⊙ CO	—	4
12	1927·8	{H_2O	ν_2	4
		{CO_2	$3\nu_2^1$ *P*6	4
13	1926·7	{H_2O	ν_2	4
		{CO_2	$3\nu_2^1$ *P*8	4
14	1920	H_2O	ν_2	4



31(a) (b) (c)

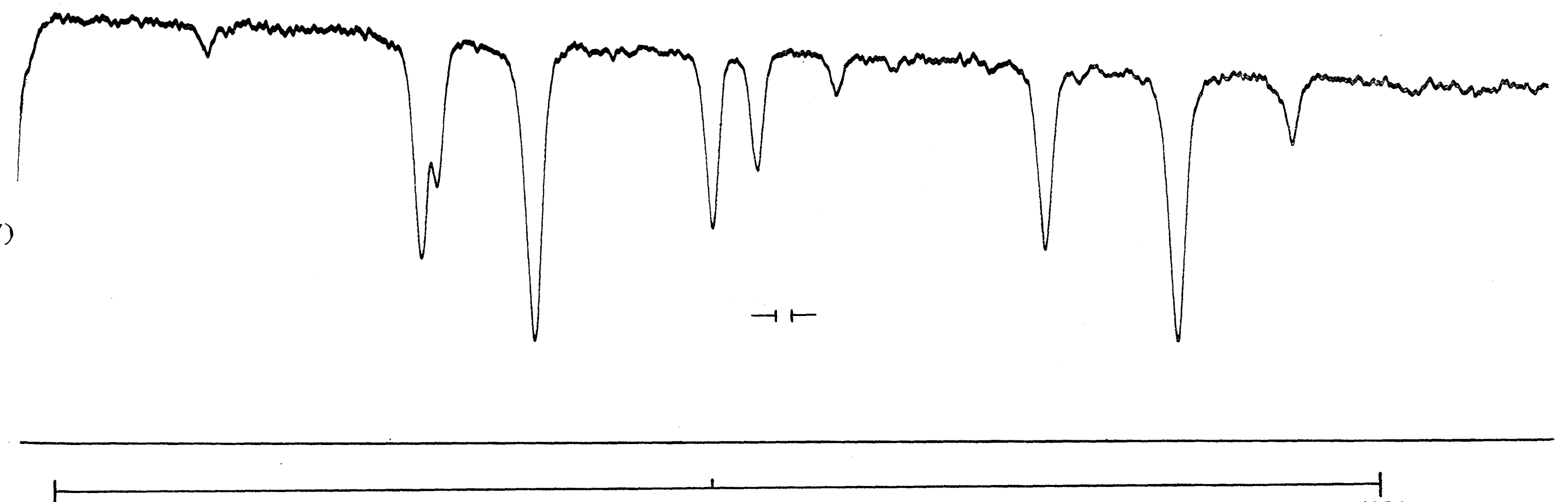
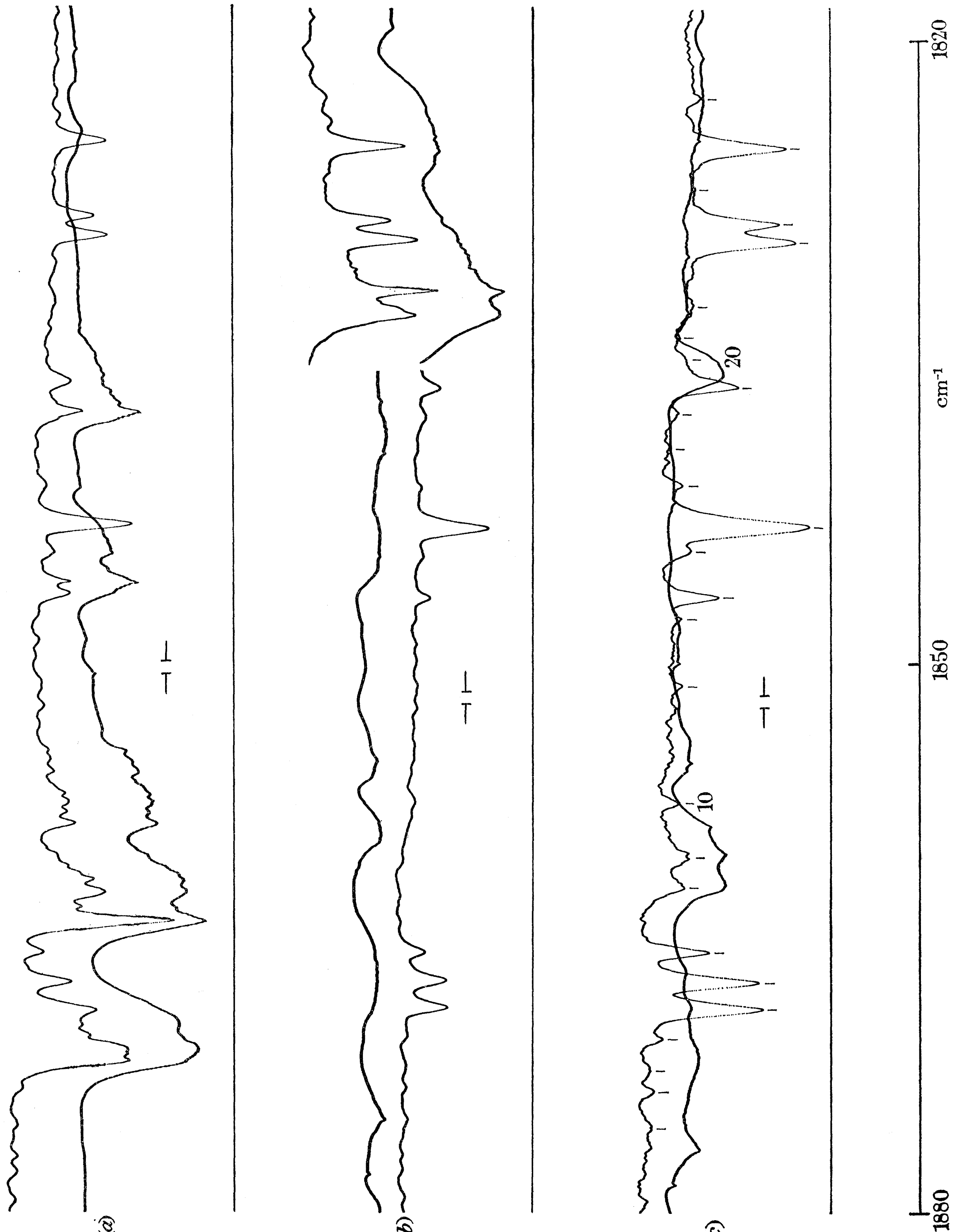


FIGURE 31

TABLE 2 (figure 31)

line no.	ν (cm⁻¹) (vac.)	ident.	band		ref.
1	1933·1	H_2O	ν_2		1
		CO_2	$3\nu_2^1$	Q	4
2	1928·6	⊙ CO		—	4
3	1927·8	CO_2	$3\nu_2^1$	$P6$	4
4	1926·2	CO_2	$3\nu_2^1$	$P8$	4
5	1924·7	CO_2	$3\nu_2^1$	$P10$	4
6	1923·1	H_2O	ν_2		1
		CO_2	$3\nu_2^1$	$P12$	1
7	1922·4	H_2O	ν_2		1
8	1921·7	CO_2	$3\nu_2^1$	$P14$	4
9	1920·0	CO_2	$3\nu_2^1$	$P16$	4
10	1918·1	H_2O	ν_2		1
		CO_2	$3\nu_2^1$	$P18$	1
11	1917·2*	CO_2	$3\nu_2^1$	$P20$	1
12	1915·5	CO_2	$3\nu_2^1$	$P22$	4
13	1914·1	CO_2	$3\nu_2^1$	$P24$	4
14	1912·6	CO_2	$3\nu_2^1$	$P26$	4
15	1911·0	CO_2	$3\nu_2^1$	$P28$	4
16	1910·1	H_2O	ν_2		1
		CO_2	$3\nu_2^1$	$P30$	1
17	1908·1	H_2O	ν_2		1
		CO_2	$3\nu_2^1$	$P32$	1
18	1906·5	CO_2	$3\nu_2^1$	$P34$	4
19	1905·0	CO_2	$3\nu_2^1$	$P36$	4
20	1904·5	H_2O	ν_2		1
21	1903·6	CO_2	$3\nu_2^1$	$P38$	4
22	1902·1	CO_2	$3\nu_2^1$	$P40$	4
		H_2O	ν_2		1
23	1900·6	CO_2	$3\nu_2^1$	$P42$	4
24	1899·2	CO_2	$3\nu_2^1$	$P44$	4
25	1897·9	CO_2	$3\nu_2^1$	$P46$	4
26	1895·3	H_2O	ν_2		1
		CO_2	$3\nu_2^1$	$P48$	1
		CO_2	$3\nu_2^1$	$P50$	1
27	1893·2	CO_2	$3\nu_2^1$	$P52$	4
28	1891·7	CO_2	$3\nu_2^1$	$P54$	4
29	1889·6	H_2O	ν_2		1
		CO_2	$3\nu_2^1$	$P56$	1
		CO_2	$3\nu_2^1$	$P58$	1
30	1887·4	CO_2	$3\nu_2^1$	$P60$	4
31	1886·0	CO_2	$3\nu_2^1$	$P62$	4
32	1884·6	H_2O	ν_2		1
33	1879·4	H_2O	ν_2		1
34	1876·7	H_2O	ν_2		1

* Interpolated value.



32(a)

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

Laboratory spectrum

32(*d*)

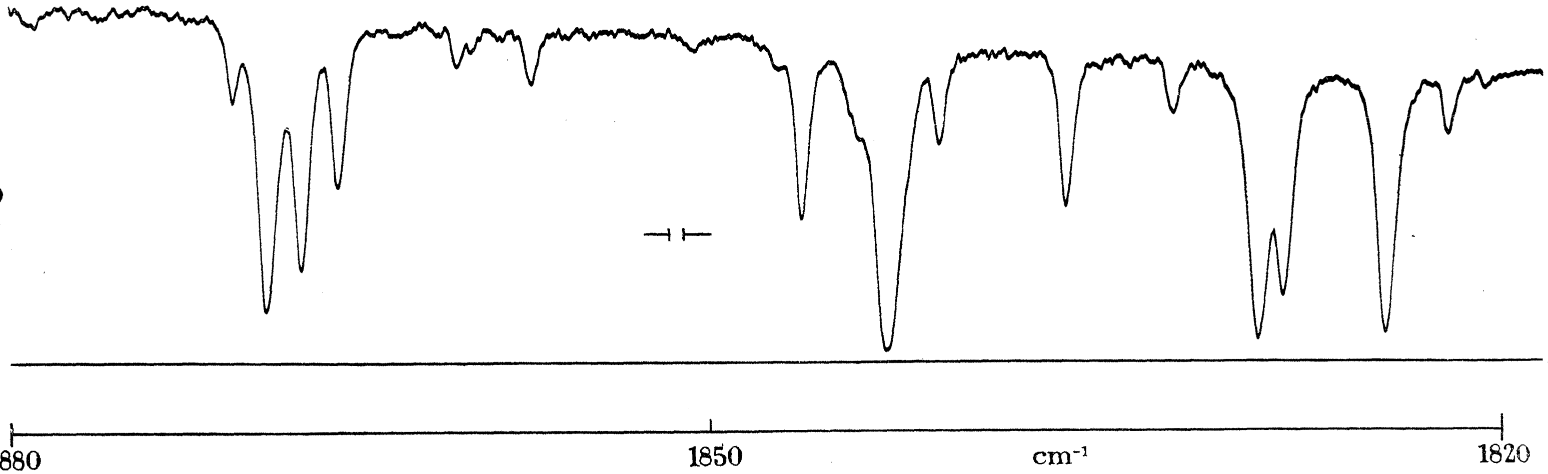
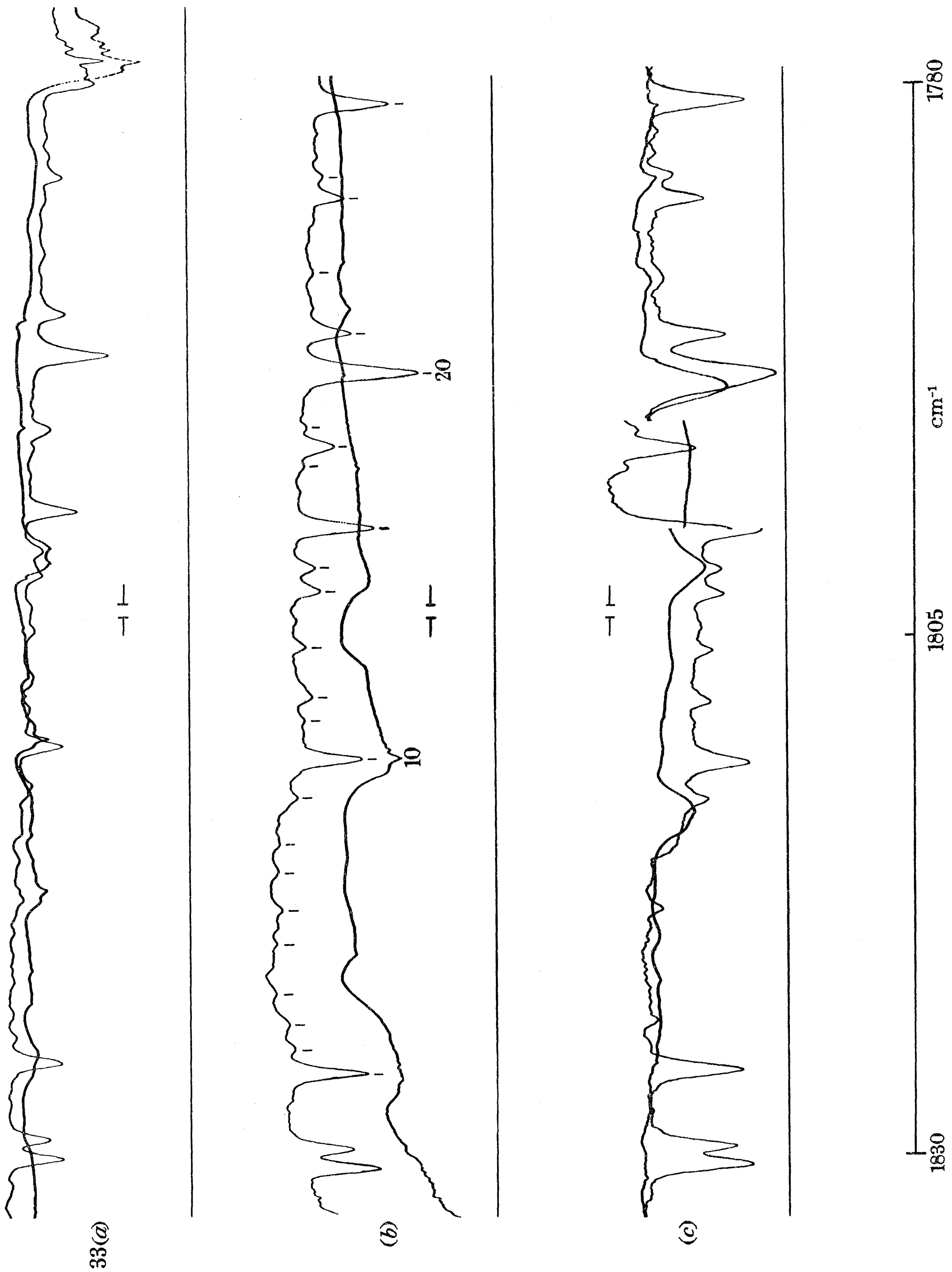


FIGURE 32

TABLE 2 (figure 32)

line no.	ν (cm^{-1}) (vac.)	ident.	band	ref.	line no.	ν (cm^{-1}) (vac.)	ident.	band	ref.
1	1876·7	H_2O	ν_2	1	15	1844·2	H_2O	ν_2	1
2	1873·5	⊙ CO	—	4	16	1842·3	H_2O	ν_2	1
3	1872·5	⊙ CO	—	4	17	1840·5	H_2O	ν_2	1
4	1870·8	H_2O	ν_2	1	18	1839·3	H_2O	$2\nu_2-\nu_2$	1
5	1869·3	H_2O	ν_2	1	19	1837·3	H_2O	ν_2	1
6	1867·9	H_2O	ν_2	1	20	1836·1	{ H_2O	ν_2	1
7	1866·4	H_2O	ν_2	1			$H_2{}^{18}O$	ν_2	1
8	1864·1	H_2O	ν_2	1	21	1834·8	$H_2{}^{18}O$	ν_2	4
9	1861·5	H_2O	ν_2	1	22	1833·4	H_2O	ν_2	1
10	1858·5	H_2O	ν_2	1	23	1830·3	H_2O	ν_2	1
11	1852·4	H_2O	ν_2	1	24	1829·4	H_2O	ν_2	1
12	1848·8	H_2O	ν_2	1	25	1827·1	⊙ CO	—	4
13	1847·8	{ H_2O	ν_2	1	26	1825·3	H_2O	ν_2	1
		⊙ CO	—	4	27	1822·8	H_2O	ν_2	1
14	1845·4	H_2O	ν_2	1					



PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

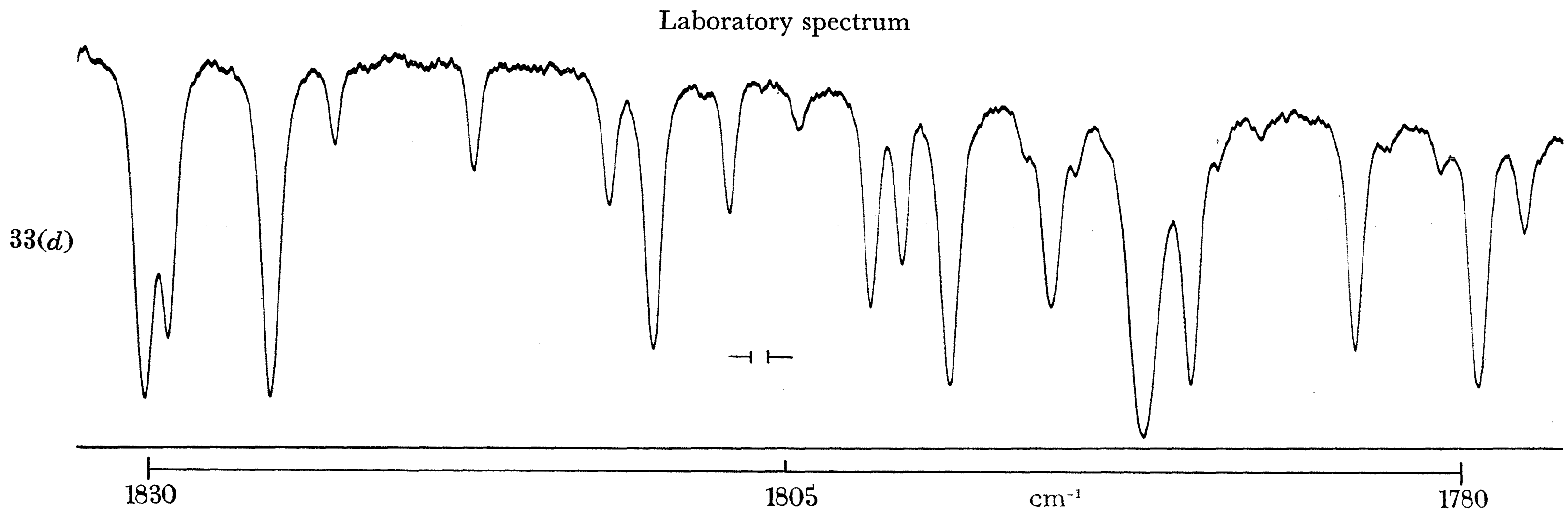
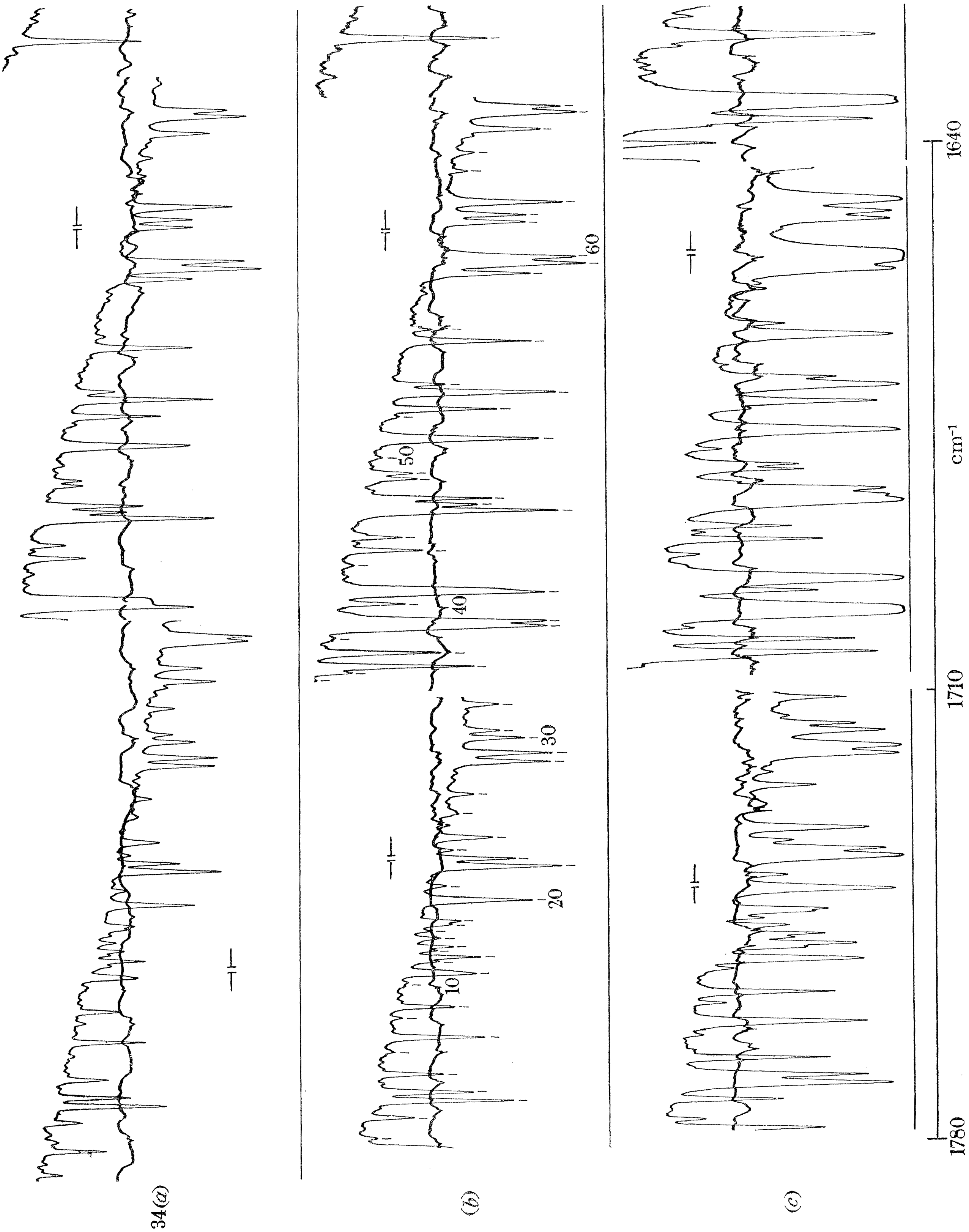


FIGURE 33

TABLE 2 (figure 33)

line no.	ν (cm^{-1}) (vac.)		ident.	band	ref.	line no.	ν (cm^{-1}) (vac.)	ident.	band	ref.
1	1825·3		H_2O	ν_2	1	13	1805·2	H_2O	ν_2	1
2	1824·1*	⊙	?	—	1	14	1802·4	H_2O	ν_2	1
3	1822·8		H_2O	ν_2	1	15	1801·4	H_2O	ν_2	1
4	1821·4		H_2O	ν_2	1	16	1799·6	H_2O	ν_2	1
5	1819·0	⊙	CO	—	4	17	1796·9	H_2O	ν_2	1
6	1817·5		H_2O	ν_2	1	18	1796·0	H_2O	ν_2	1
7	1816·1	{ ⊙	CO	—	4	19	1795·2	H_2O	ν_2	1
			$H_2{}^{18}O$	ν_2	4	20	1792·6	H_2O	ν_2	1
8	1814·5*	⊙	?	—	4	21	1791·0	H_2O	ν_2	1
9	1812·2		H_2O	ν_2	1	22	1788·5	H_2O	ν_2	1
10	1810·6		H_2O	ν_2	1	23	1784·9	H_2O	ν_2	1
11	1808·6		H_2O	ν_2	1	24	1784·0	H_2O	ν_2	1
12	1807·8		H_2O	ν_2	1	25	1780·7	H_2O	ν_2	1

* Interpolated value.



PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

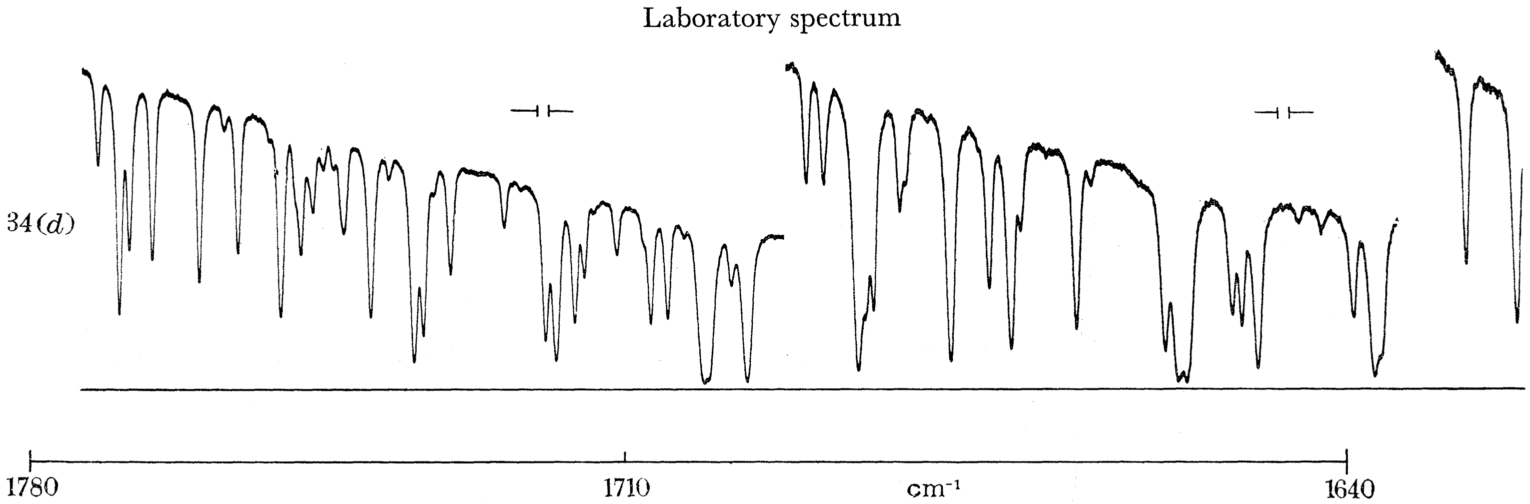
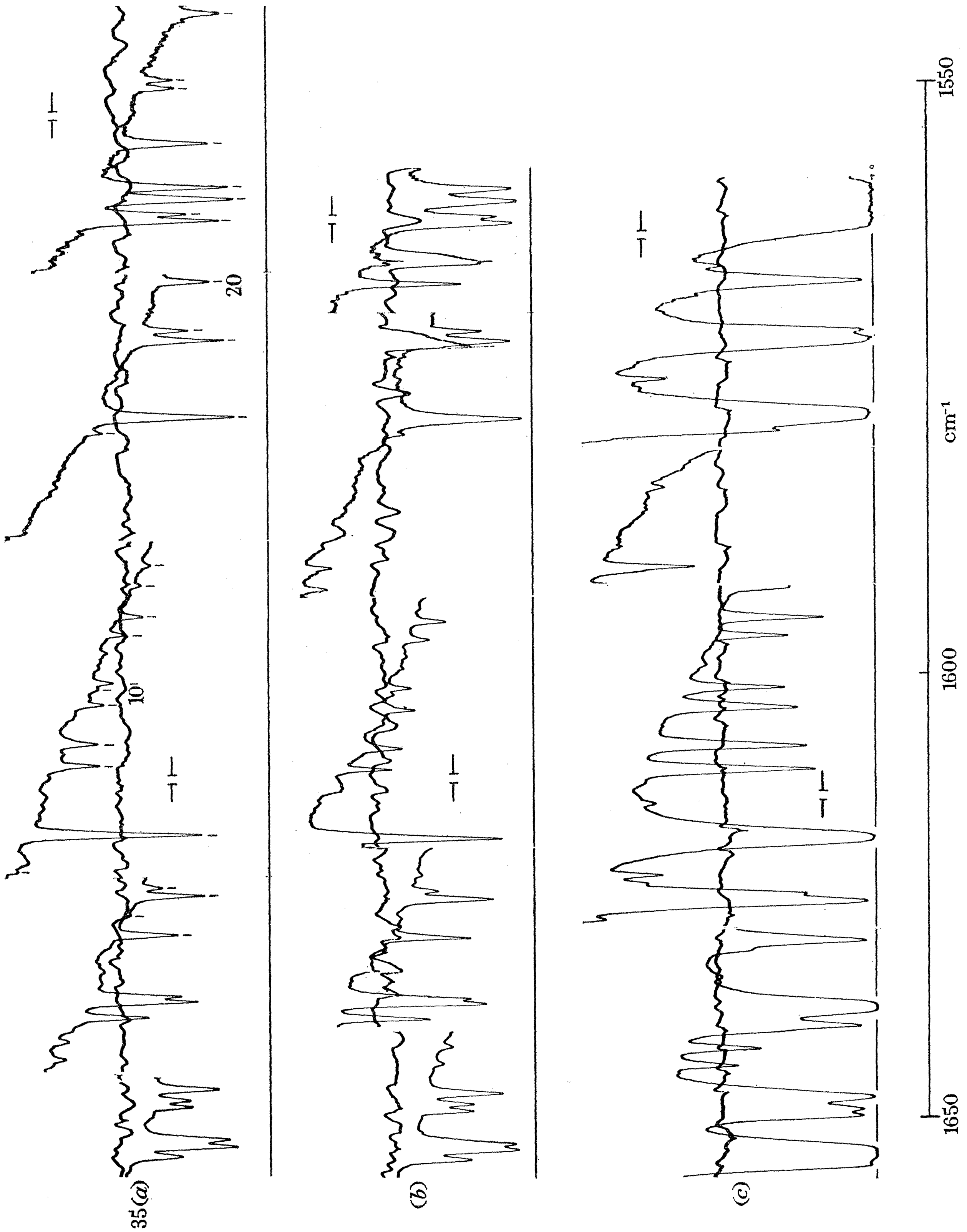


FIGURE 34

TABLE 2 (figure 34)

line no.	ν (cm⁻¹) (vac.)	ident.	band	ref.	line no.	ν (cm⁻¹) (vac.)	ident.	band	ref.	line no.	ν (cm⁻¹) (vac.)	ident.	band	ref.
1	1779·1	H_2O	ν_2	1	24	1732·3*	H_2O	—	5	47	1683·5	H_2O	ν_2	5
2	1775·6	H_2O	ν_2	1	25	1730·4	H_2O	—	5	48	1680·8	H_2O	ν_2	5
3	1772·6	H_2O	ν_2	1	26	1727·0*	H_2O	—	5	49	1680·1	H_2O	ν_2	5
4	1771·4	H_2O	ν_2	1	27	1724·2	H_2O	—	5	50	1678·1*	H_2O	—	5
5	1768·2	H_2O	ν_2	1	28	1718·9	H_2O	ν_2	5	51	1675·6	H_2O	ν_2	5
6	1764·2	$H_2{}^{18}O$	ν_2	1	29	1717·8	H_2O	ν_2	5	52	1672·6*	H_2O	—	5
7	1761·9	H_2O	ν_2	1	30	1715·8	H_2O	—	5	53	1671·5	H_2O	ν_2	5
8	1760·4*	H_2O	—	1	31	1714·6	H_2O	ν_2	5	54	1669·6	H_2O	ν_2	5
9	1757·1	H_2O	—	5	32	1710·8	H_2O	ν_2	5	55	1669·0	H_2O	ν_2	5
10	1752·3*	H_2O	—	5	33	1708·8*	⊙ ?	—	5	56	1663·2	H_2O	ν_2	5
11	1751·6	H_2O	ν_2	5	34	1707·6	H_2O	ν_2	5	57	1661·7	H_2O	ν_2	5
12	1750·2*	H_2O	—	5	35	1706·7	H_2O	ν_2	5	58	1655·4	H_2O	ν_2	5
13	1749·6	H_2O	ν_2	5	36	1704·9	H_2O	ν_2	5	59	1654·0	H_2O	ν_2	5
14	1748·5*	H_2O	—	5	37	1703·2*	H_2O	—	5	60	1653·0	H_2O	ν_2	5
15	1747·5	H_2O	ν_2	5	38	1701·8	H_2O	ν_2	5	61	1648·6	H_2O	ν_2	5
16	1746·0	H_2O	ν_2	5	39	1700·5	H_2O	ν_2	5	62	1648·1	H_2O	ν_2	5
17	1744·4	H_2O	—	5	40	1697·8	H_2O	ν_2	5	63	1646·3	H_2O	ν_2	5
18	1743·8*	H_2O	—	5	41	1696·4	H_2O	ν_2	5	64	1643·7	H_2O	—	5
19	1743·2	H_2O	ν_2	5	42	1692·9*	H_2O	—	5	65	1641·2	H_2O	ν_2	5
20	1740·2	H_2O	ν_2	5	43	1690·9	H_2O	ν_2	5	66	1638·3	H_2O	ν_2	5
21	1737·8	H_2O	—	5	44	1689·9	H_2O	ν_2	5	67	1635·9	H_2O	ν_2	5
22	1734·6	H_2O	ν_2	5	45	1686·1	H_2O	ν_2	5	68	1635·3	H_2O	ν_2	5
23	1733·6	H_2O	ν_2	5	46	1684·6	H_2O	ν_2	5	69	1628·3	H_2O	ν_2	5

* Interpolated value.


35(a)
(b)
(c)
10
20
1550
1600
1650
cm⁻¹

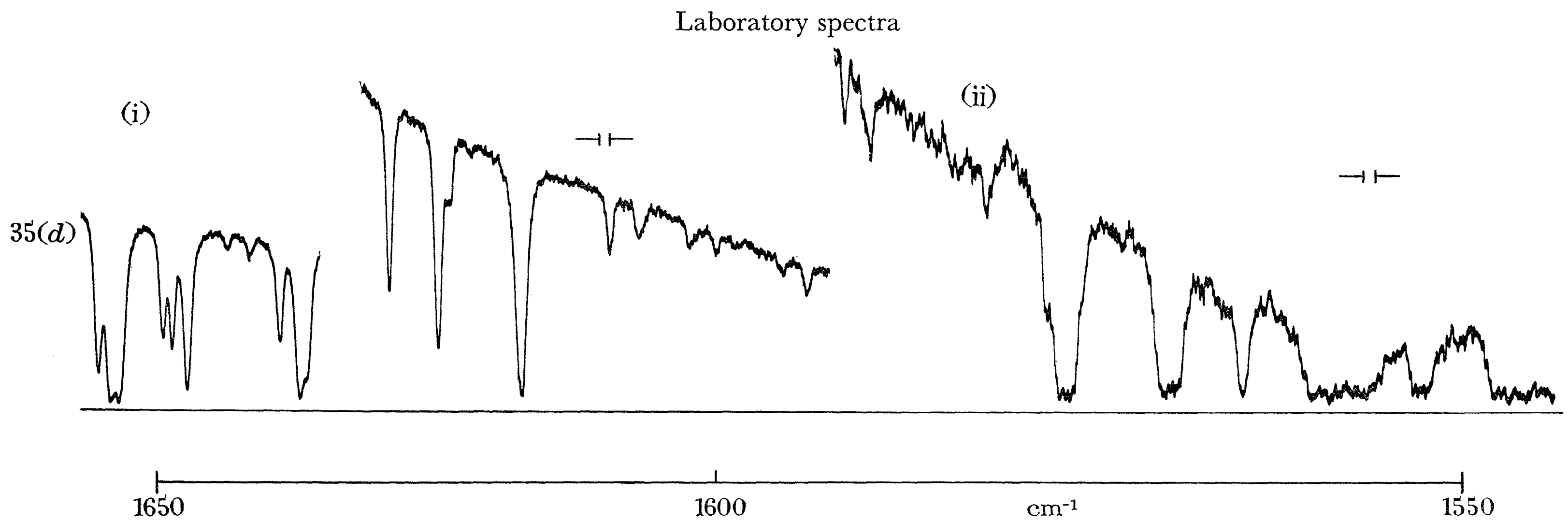


FIGURE 35

TABLE 2 (figure 35)

line no.	ν (cm⁻¹) (vac.)	ident.	band	ref.	line no.	ν (cm⁻¹) (vac.)	ident.	band	ref.
1	1628·3	H_2O	ν_2	5	15	1589·0	H_2O	ν_2	5
2	1626·2*	☉	—	5	16	1577·6*	H_2O	ν_2	5
3	1624·2	H_2O	ν_2	5	17	1576·2	H_2O	ν_2	5
4	1623·3	H_2O	ν_2	5	18	1569·8	H_2O	ν_2	5
5	1621·5*	H_2O	—	5	19	1569·0	H_2O	ν_2	5
6	1617·4	H_2O	ν_2	5	20	1565·1	H_2O	ν_2	5
7	1610·2	H_2O	ν_2	5	21	1560·3	H_2O	ν_2	5
8	1607·8	H_2O	ν_2	5	22	1559·6	H_2O	ν_2	5
9	1603·7	H_2O	ν_2	5	23	1558·9	H_2O	ν_2	5
10	1602·3*	☉	—	5	24	1557·9	H_2O	ν_2	5
11	1601·6	H_2O	ν_2	5	25	1554·4	H_2O	ν_2	5
12	1596·7	H_2O	ν_2	5	26	1550·3	H_2O	ν_2	5
13	1594·7	H_2O	ν_2	5	27	1549·8	H_2O	ν_2	5
14	1592·3	H_2O	ν_2	5	28	1545·3	—	—	5

* Interpolated value.