No. 163 ARIZONA-NASA ATLAS OF THE INFRARED SOLAR SPECTRUM, REPORT VII

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ABSTRACT

This paper is a continuation of *Comm. LPL* 161, covering the interval λλ 17731–21492 Å. For purposes of identification a laboratory spectrum of the 1.8 μ water-vapor band is given and Courtoy's CO_2 spectrum is reproduced for the interval λλ 19374–20930 Å.

The present Report continues the record of the solar spectrum beyond λ 17731 Å, the wavelength limit of *Comm. LPL* No. 161. Nearly half of the spectral interval here covered is reproduced in duplicate runs, as may be seen from Table 1 which records the observing data in the form used before. The tracings were obtained on 4 days, July 17-19 and August 1, 1968. The last part of the July 17 flight was disturbed by unusually strong aircraft vibrations due to severe air turbulence. As a result, the record obtained, given in Figs. 1a, c (parts of Chart 33) is of low quality. Fig. 10, a duplicate run of Fig. 2 (Chart 34), is similarly disturbed and will not be included in the final Atlas (no Chart No. assigned here). As before we have added the matching parts of the Michigan *Photometric Atlas of the Near-Infrared Solar Spectrum* λ *8465–* λ *25242*, Figs. 1M-9M.

Two laboratory spectra of the 1.8 μ water-vapor band, taken in the Lunar and Planetary Laboratory, were used in distinguishing water-vapor absorptions from solar absorptions. One of the spectra was taken by using the absorptions at ambient air inside and outside the 4-m spectrometer; the other one was taken with the 4-m spectrometer being flushed with dry nitrogen. The latter matches the amount of water-vapor absorptions in the solar spectrum more closely, so that we reproduced this record (Figs. 11c, d, 12, 13a, b, c) for the central part of the band. In the wings of the band, the absorptions in this spectrum become less clear, due to pressure broadening. Therefore, we reproduced the stronger of the two laboratory spectra for this region (Figs. 11a, b, and 13d).

The identification of the numerous CO_2 bands in this part of the spectrum is almost entirely based

on Courtoy's *Spectre Infrarouge à Grande Dispersion et Constantes Moleculaires du CO_2*. With the kind permission of Dr. Courtoy we reproduce his absorption spectra for ready reference in Figs. 14–16.

In Figs. 1, 2, 3a, c (Charts 33, 34, 35a, c) the Corning 2540 filter was used beyond 1.8 μ, with a second-order leak resulting. The calculated zero intensity line for the first-order spectrum is shown by dashed lines. The second-order absorption lines shown are indicated with a double dot above the spectral trace. As before, a single dot above the trace indicates a water-vapor absorption; a triangle, a methane absorption; and a short vertical line, a CO_2 absorption. Where several CO_2 bands occur in the same region, we have tried to separate them by using vertical lines at different levels.

The wavelength scale was again based on Mohler's *Table of Solar Spectrum Wavelengths 11984 A to 25578 A*. The wavelength scale of the laboratory water-vapor spectrum was adapted from that of the solar records through the assistance of Mr. D. C. Benner.

The water-vapor absorptions in the spectrometer during the flights are not negligible. For an evaluation of the contribution of the spectrometer absorption, see *Comm. LPL* 160.

The solar spectra were obtained in the NASA CV-990 by Messrs. Kuiper and Cruikshank. The derivation of the wavelength scale and the identifications were all performed by Mr. Bijl, who also obtained the laboratory spectra of the 1.8 μ H_2O band; and prepared the charts for publication.

Acknowledgments. We wish to thank Messrs. J. Percy, B. McClendon, A. Thomson, and Rev. G. Sill of LPL and Mr. D. Olsen of NASA-Ames for their assistance during the flights. Mrs. A. P. Agnieray and Mr. S. M. Larson assisted in the preparation of the figures. This research was supported by NASA through Grant NsG 161-61 and the University of Arizona Institutional Grant NGR-03-002-091.

REFERENCES

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Mohler, O. C., Pierce, A. K., McMath, R. R., and Goldberg, L. 1950, *Photometric Atlas of the Near Infrared Solar Spectrum λ 8465 to λ 25242,* Ann Arbor.

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SOLAR SPECTRUM RECORDS, 4-M SPECTROMETER, NASA CV-990 JET
600 l/mm GRATING, DETECTOR 0.1 mm, $\tau = 0.12$ SEC., FILTER 1 μ, JUL. 17, 19; 1.8 μ, JUL. 18, AUG. 1

FIG.	CHART	λ (Å)	1968 DATE	UT	ALT. (FT.)	OUTSIDE TEMP. (°C)	CABIN ALT. (FT.)	GAIN	SLIT (MM)	GRATING BLAZE (μ)
1	33 a	17731–17886	July 17	20:18	39,000	–52	8500	5–2	0.10	1.6
	b	17731–17886	July 19	20:31	39,000	–53	8500	5–3	0.08	1.6
	c	17886–18044	July 17	20:21	39,000	–52	8500	5–2	0.10	1.6
	d	17886–18044	July 19	20:33/19:59	39,000	–53	8500	5–3	0.08	1.6
2	34 a	18044–18195	July 19	20:02	39,000	–53	8500	5–3	0.08	1.6
	b	18195–18340	July 19	20:05	39,000	–53	8500	5–3	0.08	1.6
	c	18340–18492	July 19	20:08	39,000	–53	8500	5–3	0.08	1.6
	d	18492–18644	July 19	20:11	39,000	–53	8500	5–3	0.08	1.6
3	35 a	18644–18800	July 19	20:14	39,000	–53	8500	5–3	0.08	1.6
	b	18644–18800	July 18	19:00	39,000	–56	8500	5–5	0.09	1.6
	c	18800–18961	July 19	20:18	39,000	–53	8500	5–3	0.08	1.6
	d	18800–18962	July 18	19:03	39,000	–56	8500	5–5/5–4	0.09	1.6
4	36 a	18962–19115	July 18	19:06	39,000	–56	8500	5–4	0.09	1.6
	b	19115–19262	July 18	19:09	39,000	–56	8500	5–4/5–3	0.09	1.6
	c	19262–19413	July 18	19:12	39,000	–56	8500	5–3	0.09	1.6
	d	19413–19565	July 18	19:15	39,000	–56	8500	5–3	0.09	1.6
5	37 a	19565–19710	July 18	19:19	39,000	–56	8500	5–3	0.09	1.6
	b	19710–19859	July 18	19:22	39,000	–56	8500	5–3	0.09	1.6
	c	19859–20009	July 18	19:25	39,000	–56	8500	5–3	0.09	1.6
	d	20009–20156	July 18	19:28	39,000	–56	8500	5–3/5–4	0.09	1.6
6	38 a	20156–20300	July 18	19:31	39,000	–56	8500	5–4	0.09	1.6
	b	20300–20448	July 18	19:34	39,000	–56	8500	5–4	0.09	1.6
	c	20448–20600	July 18	19:37	39,000	–56	8500	5–4	0.09	1.6
	d	20448–20600	Aug. 1	19:51	41,500	–59	9300	5–2	0.12	2.5
7	39 a	20600–20749	July 18	19:40	39,000	–56	8500	5–4	0.09	1.6
	b	20600–20749	Aug. 1	19:55	41,500	–59	9300	5–2	0.12	2.5
	c	20749–20901	July 18	19:44	39,000	–56	8500	5–4	0.09	1.6
	d	20749–20901	Aug. 1	19:58	41,500	–59	9300	5–2	0.12	2.5
8	40 a	20901–21050	July 18	19:48	39,000	–56	8500	5–4	0.09	1.6
	b	20901–21050	Aug. 1	20:01	41,500	–59	9300	5–2/5–3	0.12	2.5
	c	21050–21194	July 18	19:51	39,000	–56	8500	5–4	0.09	1.6
	d	21050–21194	Aug. 1	20:04	41,500	–59	9300	5–3	0.12	2.5
9	41 a	21194–21345	July 18	19:55	39,000	–56	8500	5–4	0.09	1.6
	b	21194–21345	Aug. 1	20:08	41,500	–59	9300	5–3	0.12	2.5
	c	21345–21492	July 18	19:58	39,000	–56	8500	5–4	0.09	1.6
	d	21345–21492	Aug. 1	20:11	41,500	–59	9300	5–3	0.12	2.5

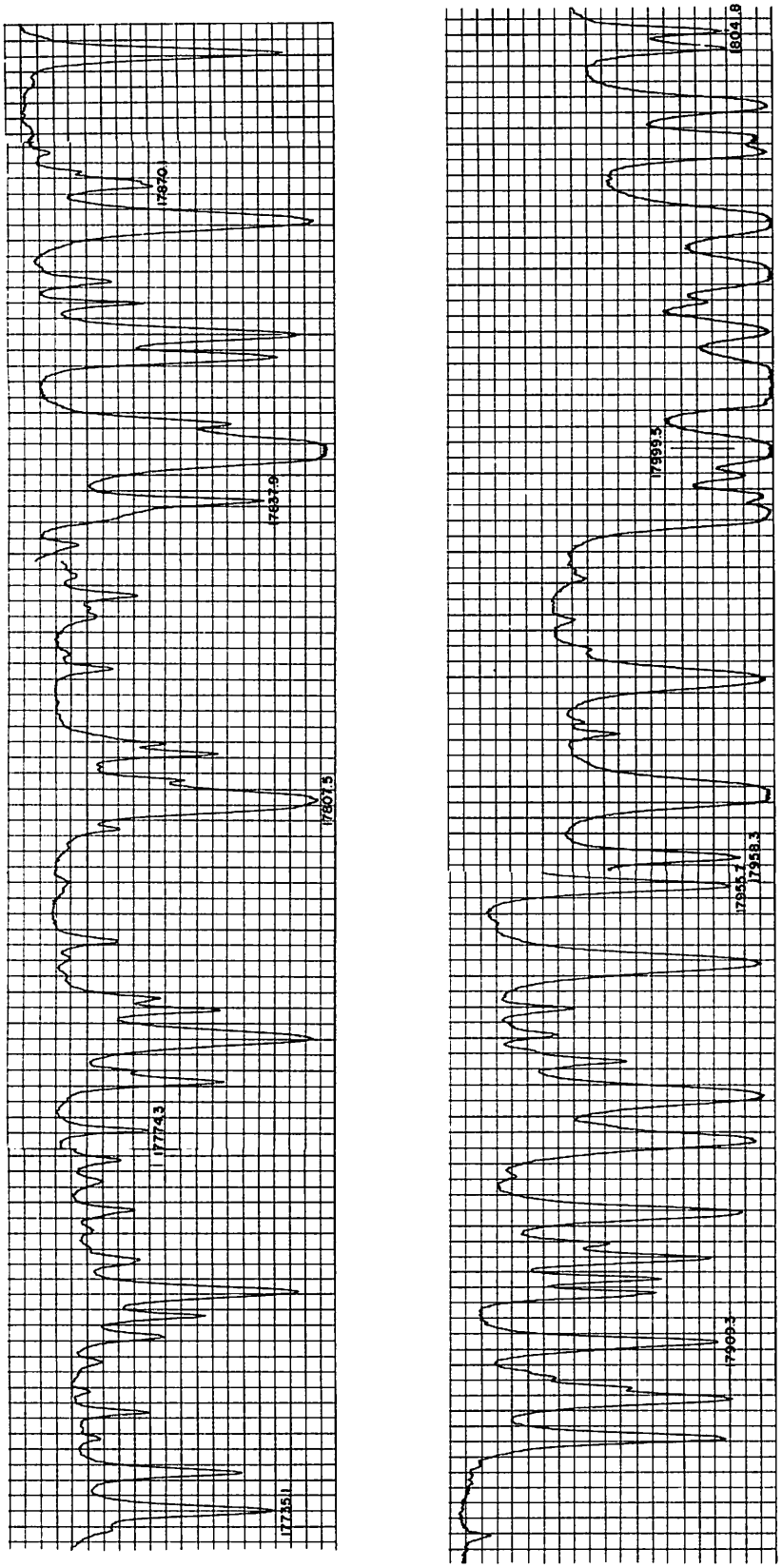

Fig. 1M Part of the Michigan Atlas, that matches *Fig. 1*. (*Figs. 1M–9M* reproduced with permission).

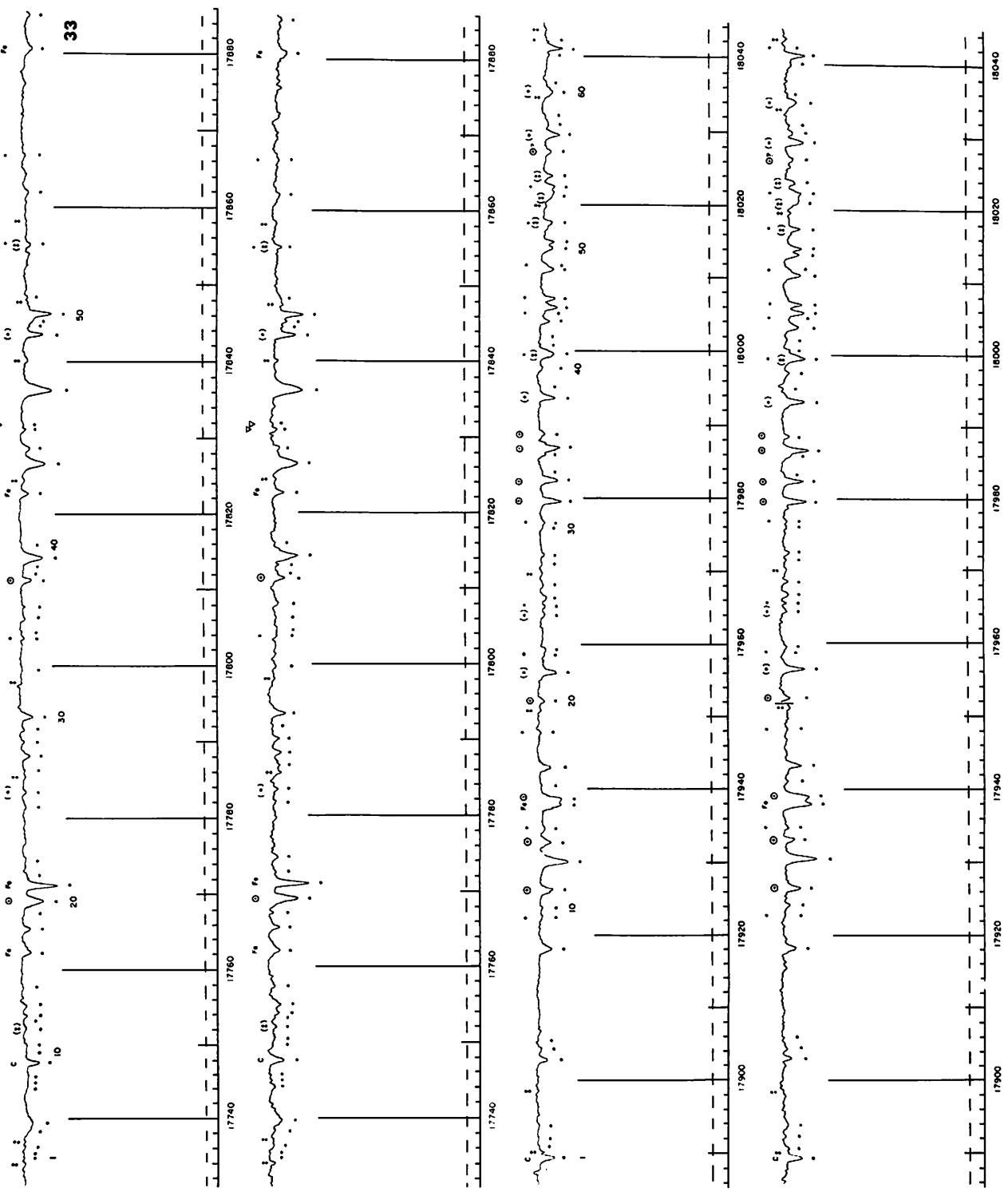

Fig. 1 Solar Spectrum λλ 17731–18044, in four strips (cf. Table 1).

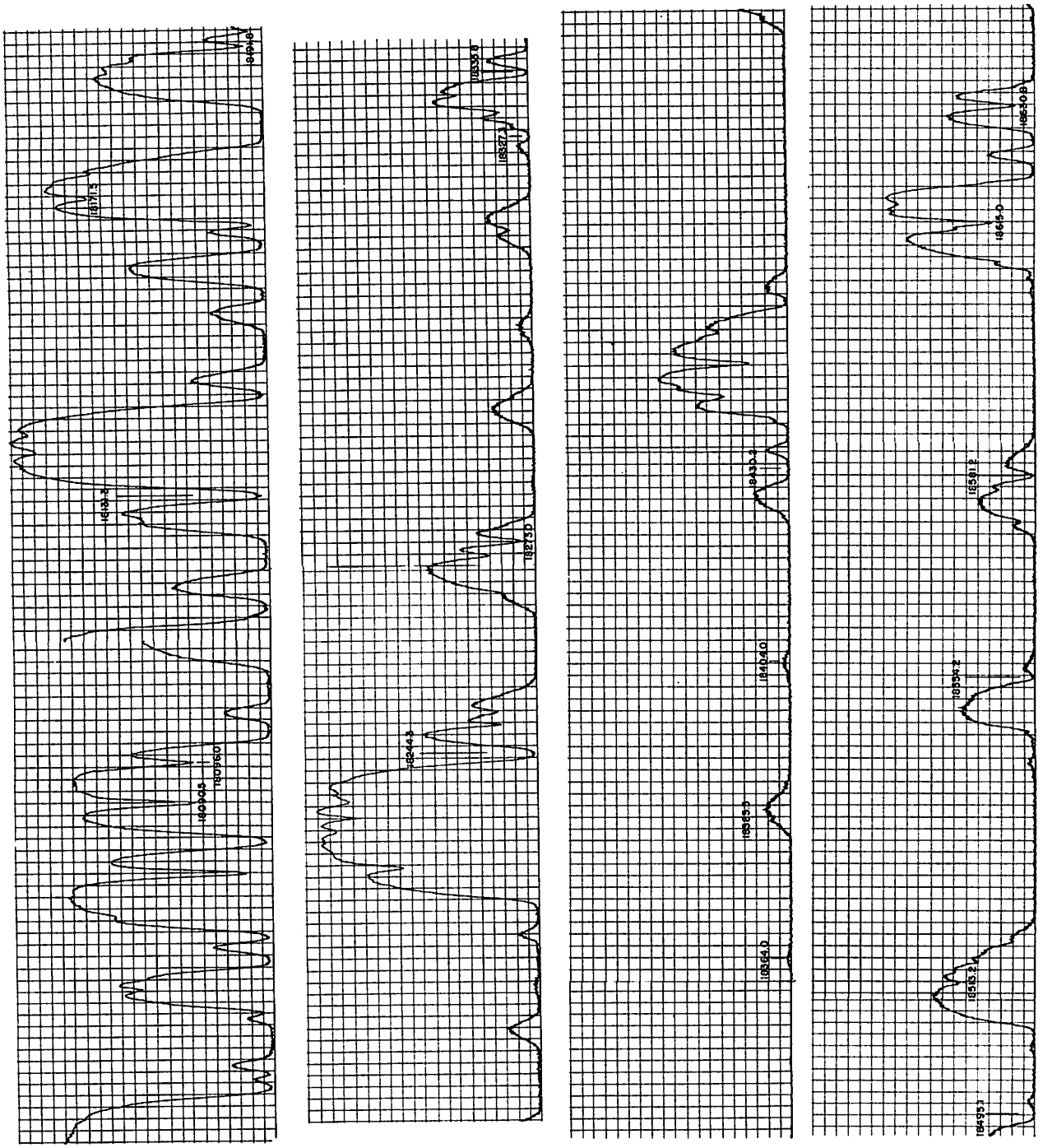

Fig. 2M Part of the Michigan Atlas, that matches *Fig. 2*.

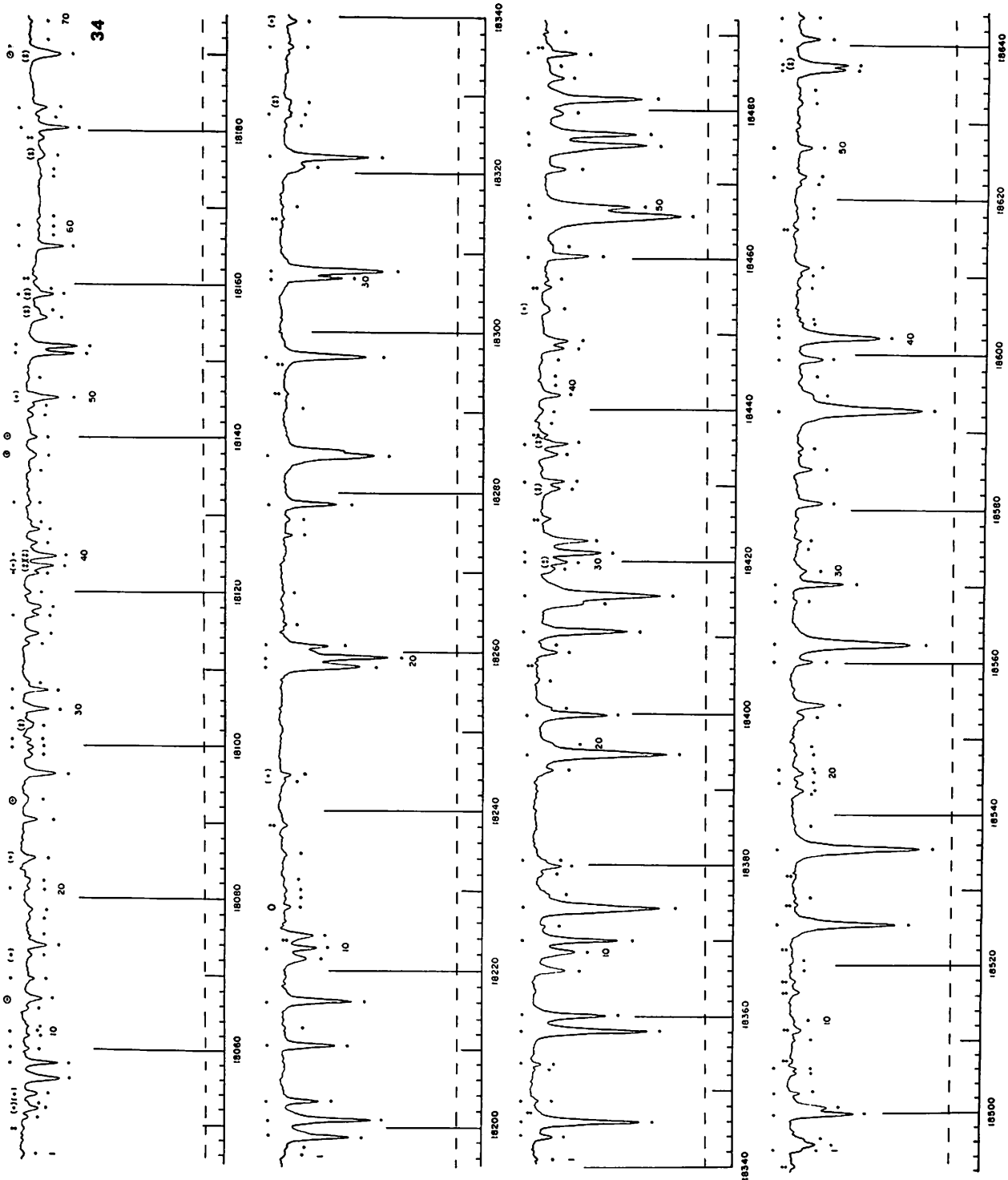

Fig. 2 Solar Spectrum λλ 18044–18644, in four strips (cf. Table 1). See also Fig. 10.

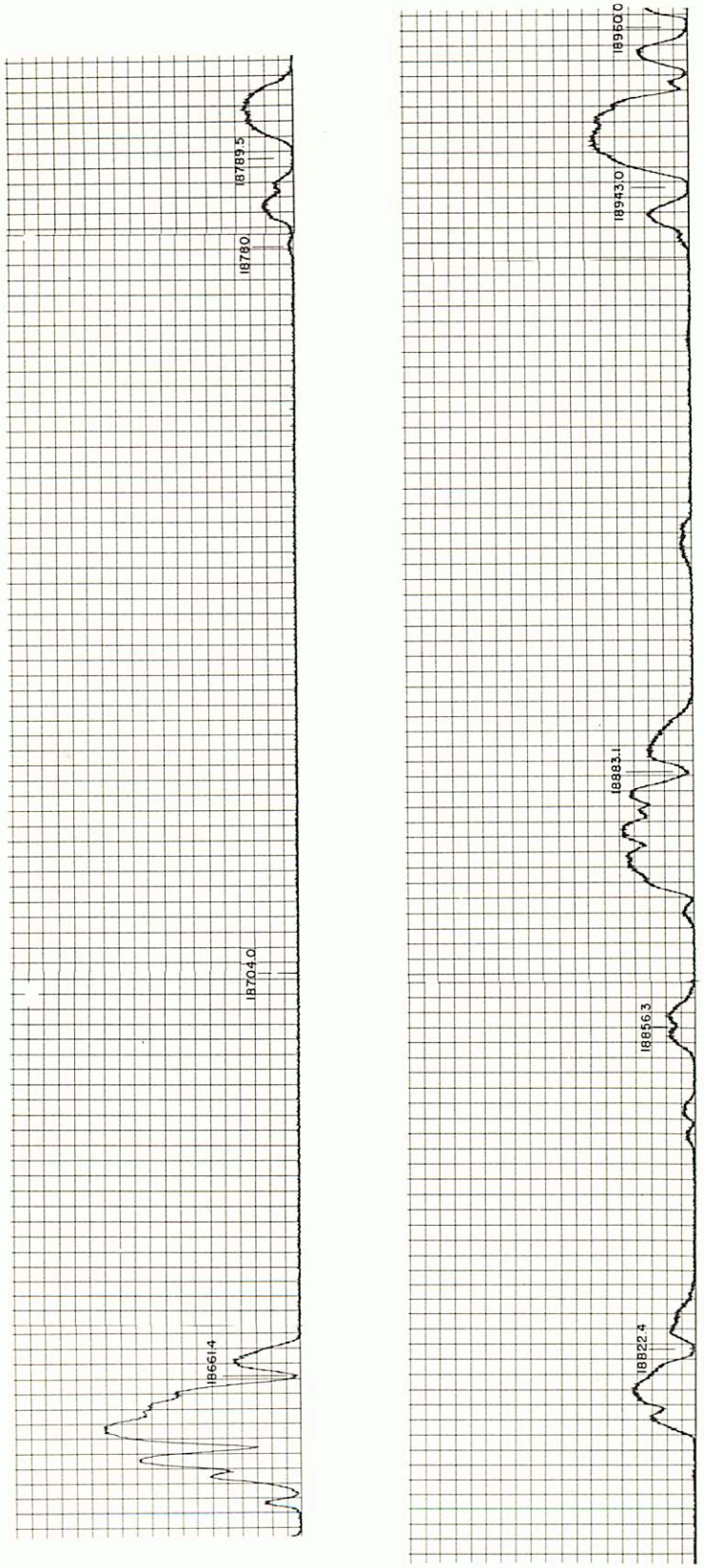

Fig. 3M Part of the Michigan Atlas, that matches *Fig. 3*.

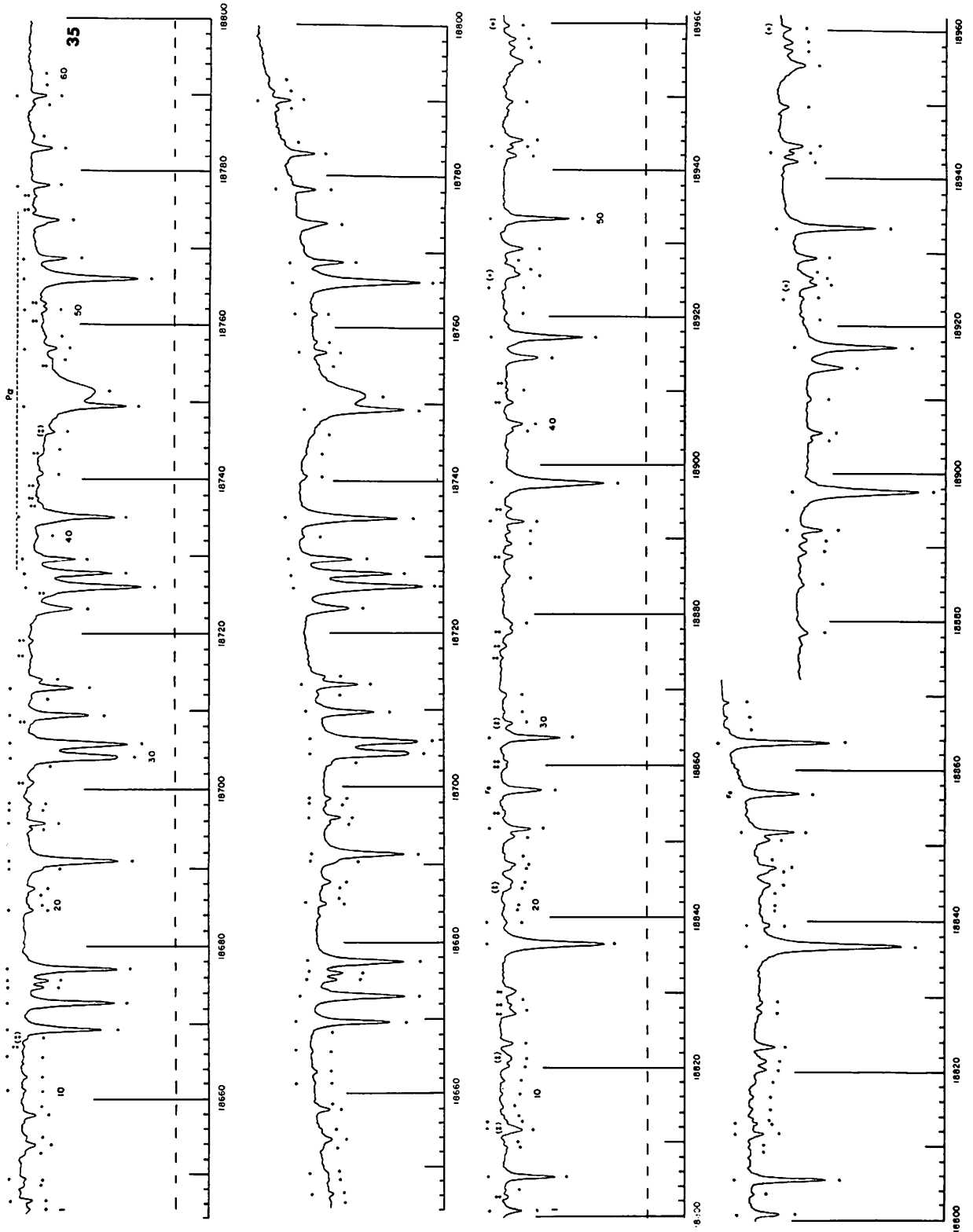

Fig. 3 Solar Spectrum λλ 18644–18962, in four strips (cf. Table 1).

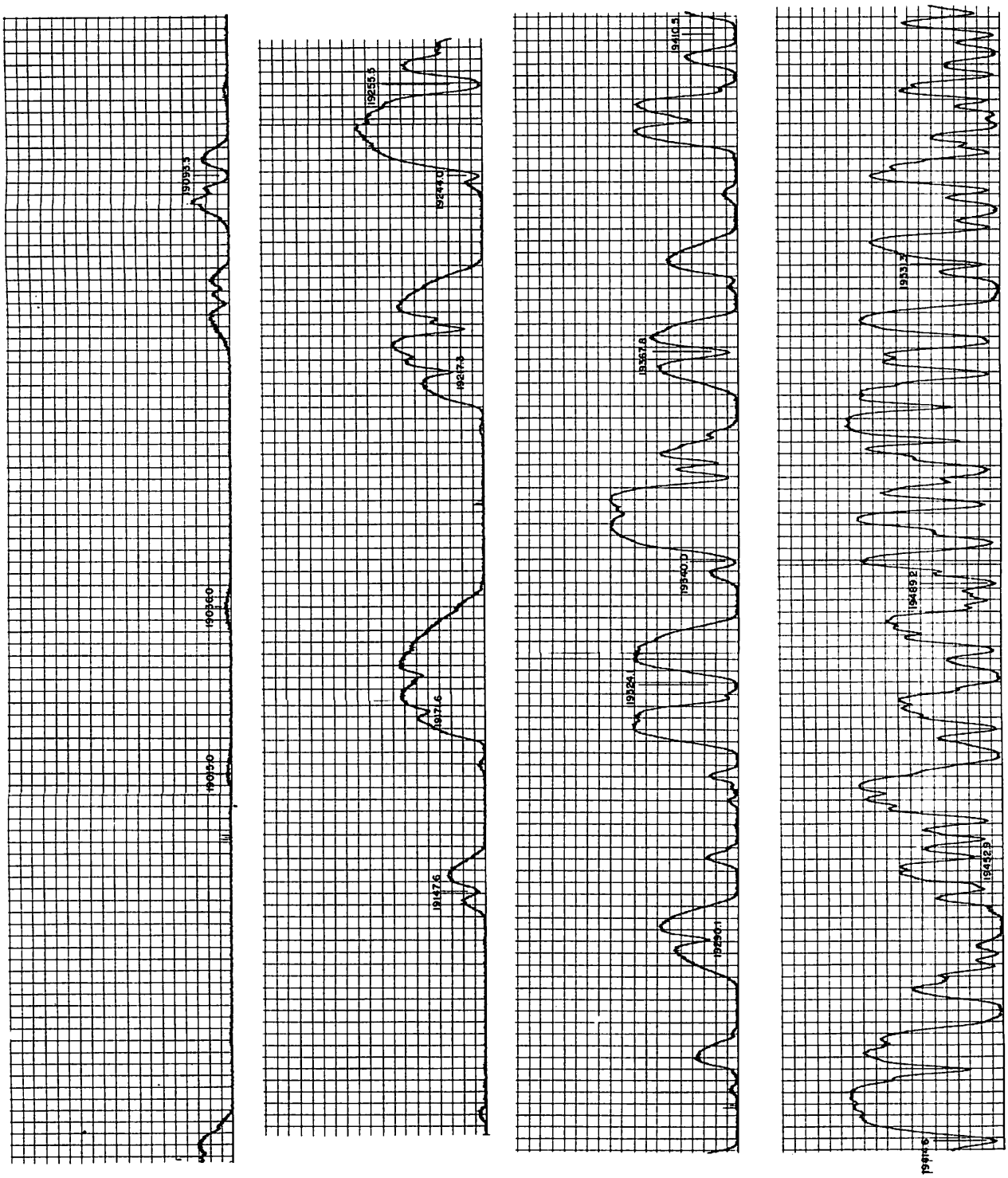

Fig. 4M Part of the Michigan Atlas, that matches *Fig. 4*.

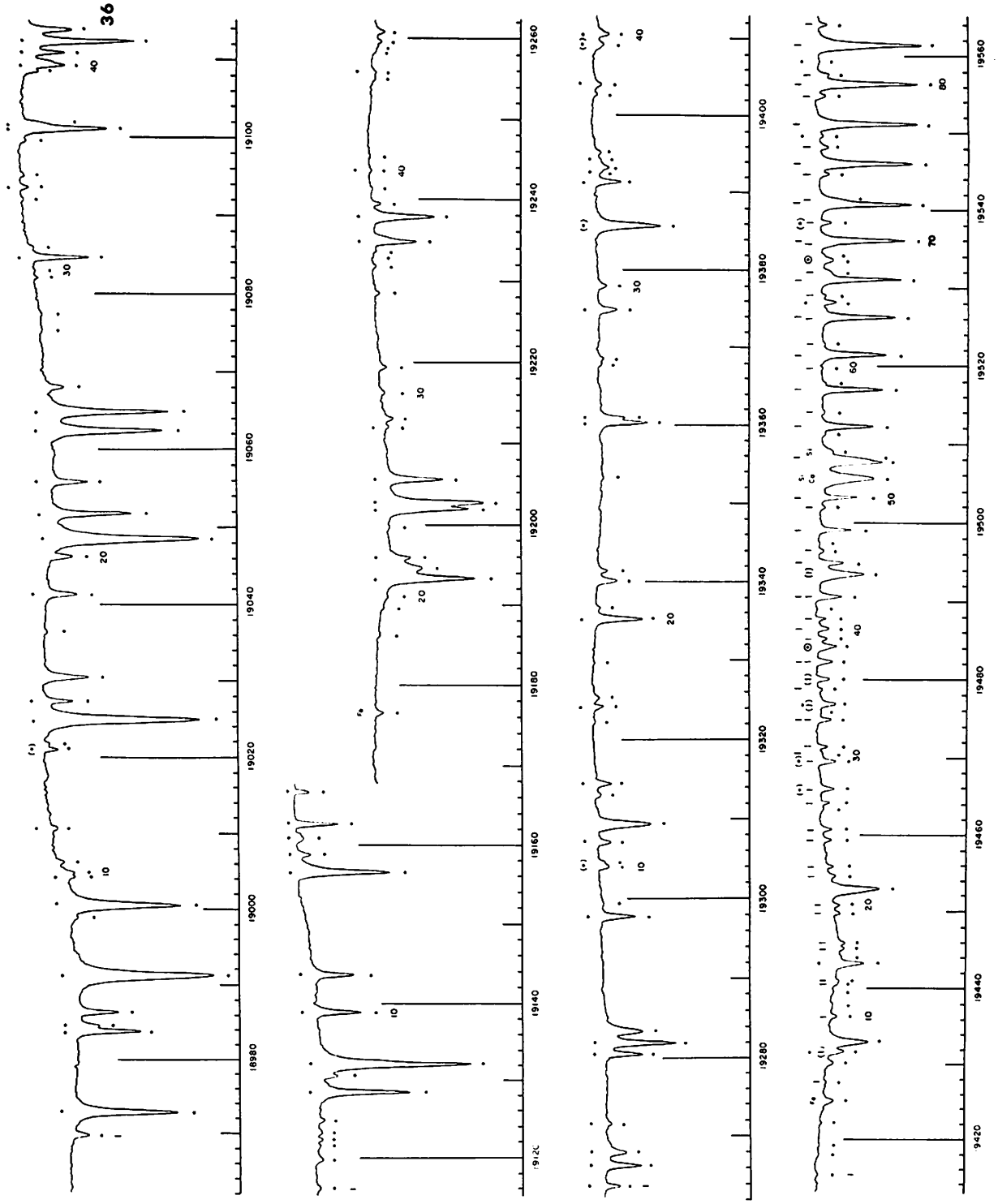

Fig. 4 Solar Spectrum λλ 18962–19565, in four strips (cf. Table 1).

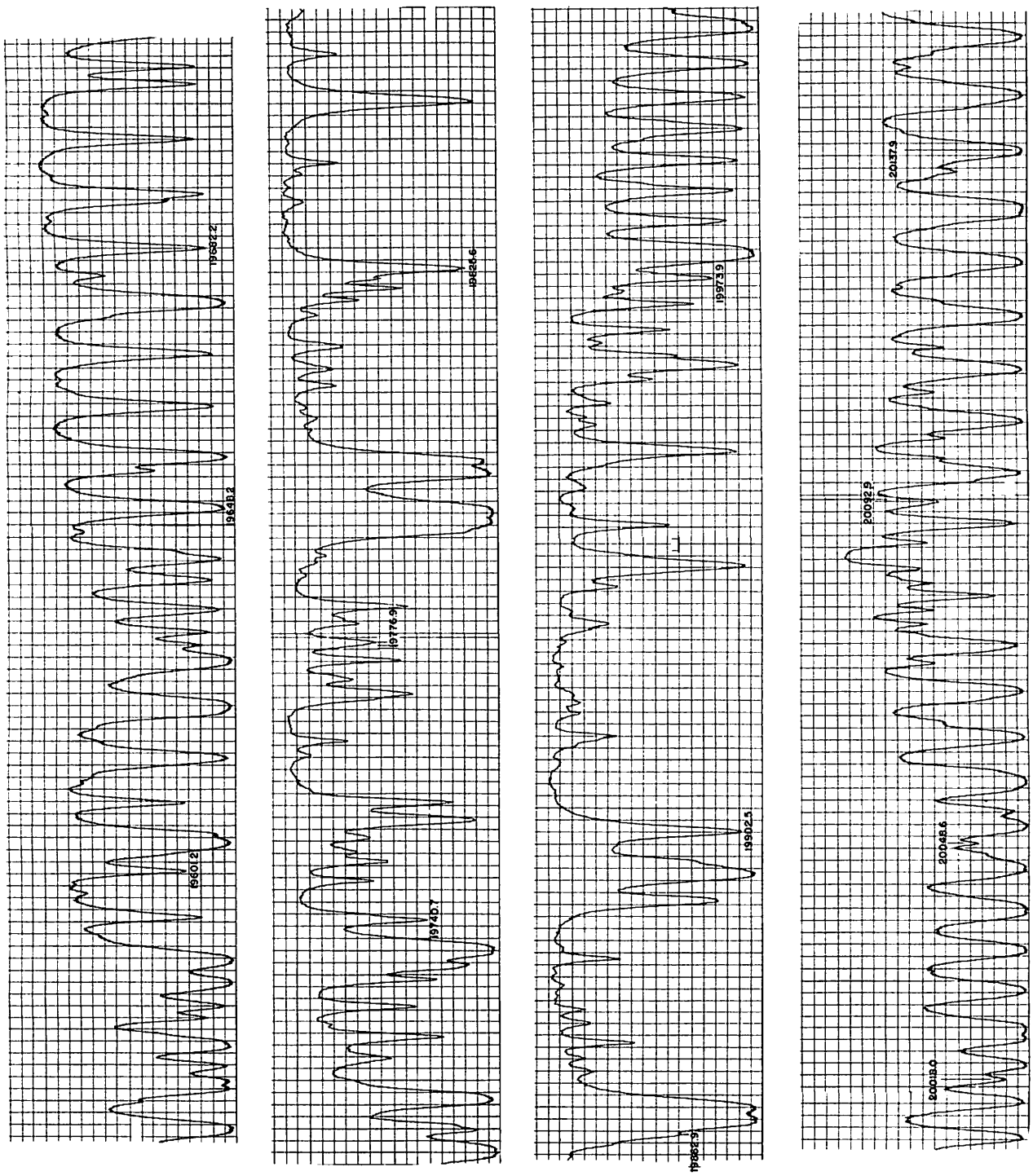

Fig. 5M Part of the Michigan Atlas, that matches *Fig. 5*.

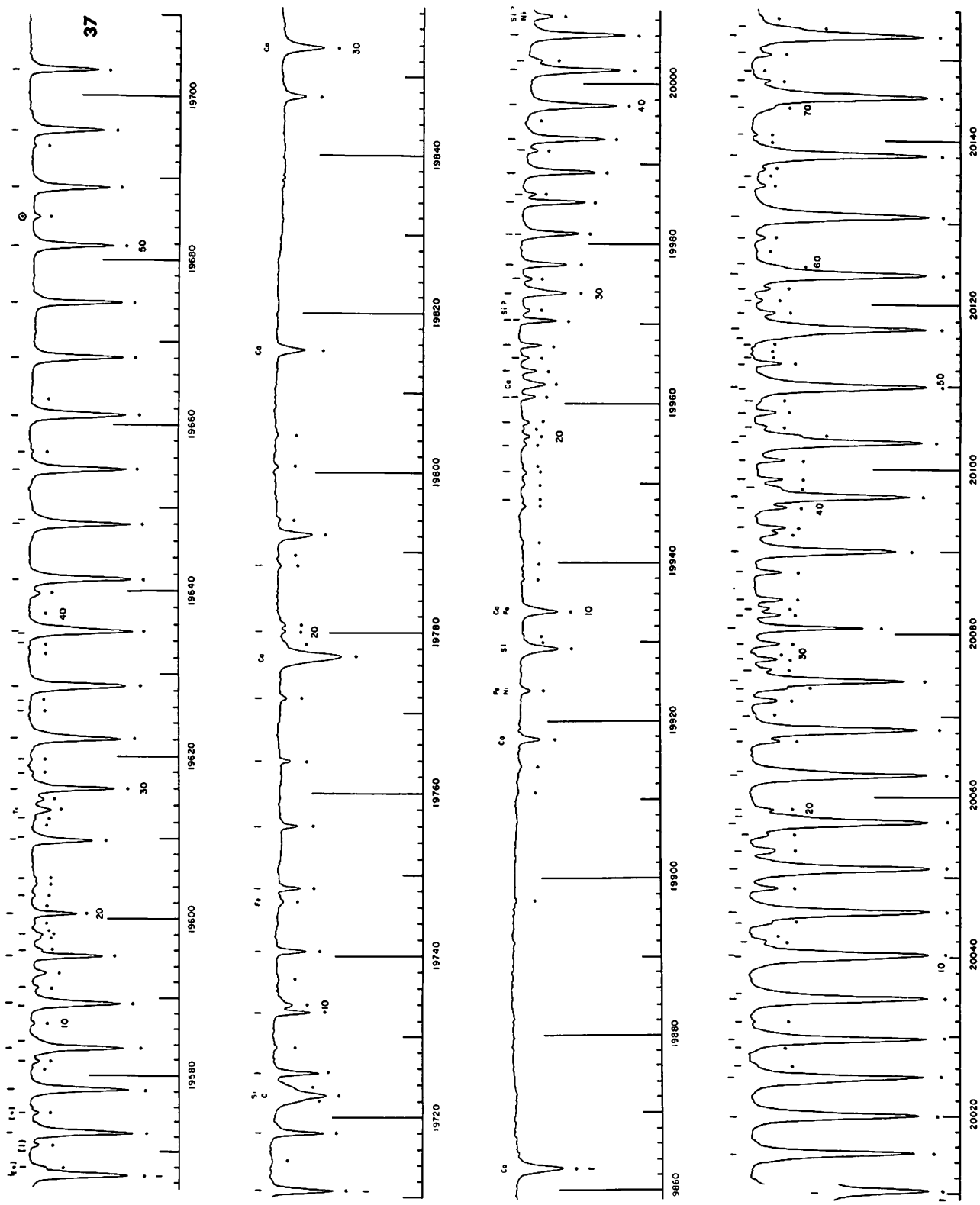

Fig. 5 Solar Spectrum λλ 19565–20156, in four strips (cf. Table 1).

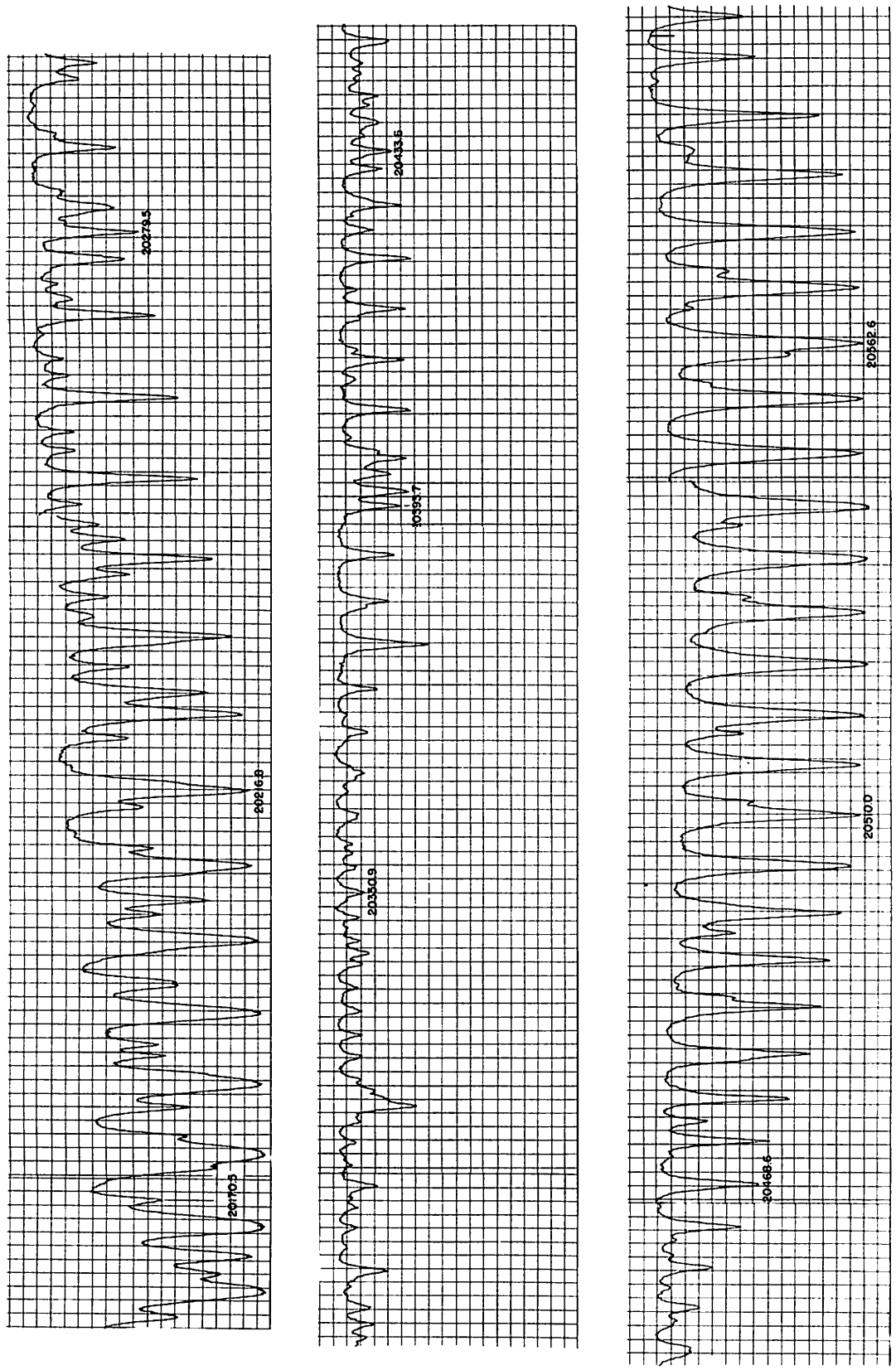

Fig. 6M Part of the Michigan Atlas, that matches *Fig. 6*.

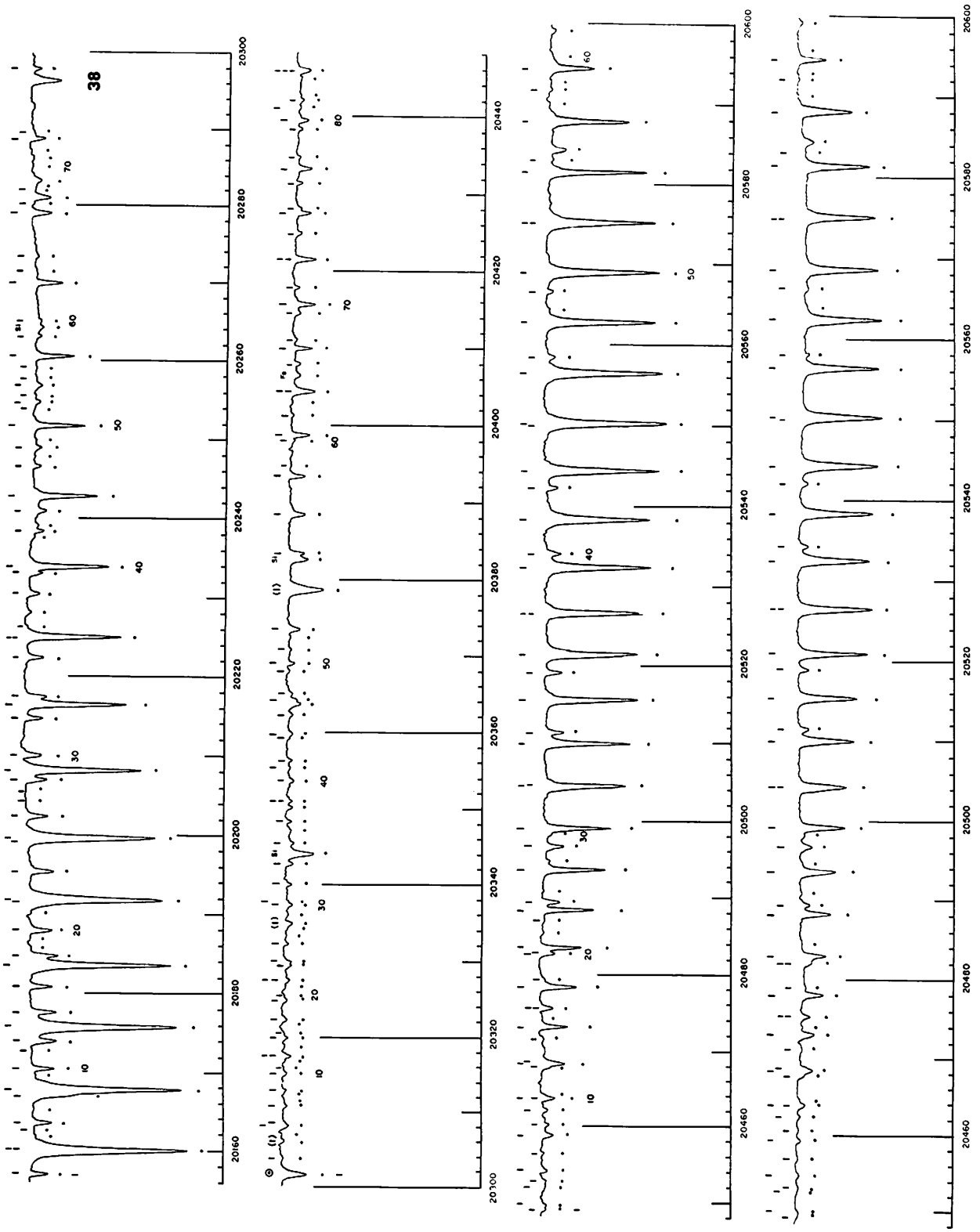

Fig. 6 Solar Spectrum λλ 20156–20600, in four strips (cf. Table 1).

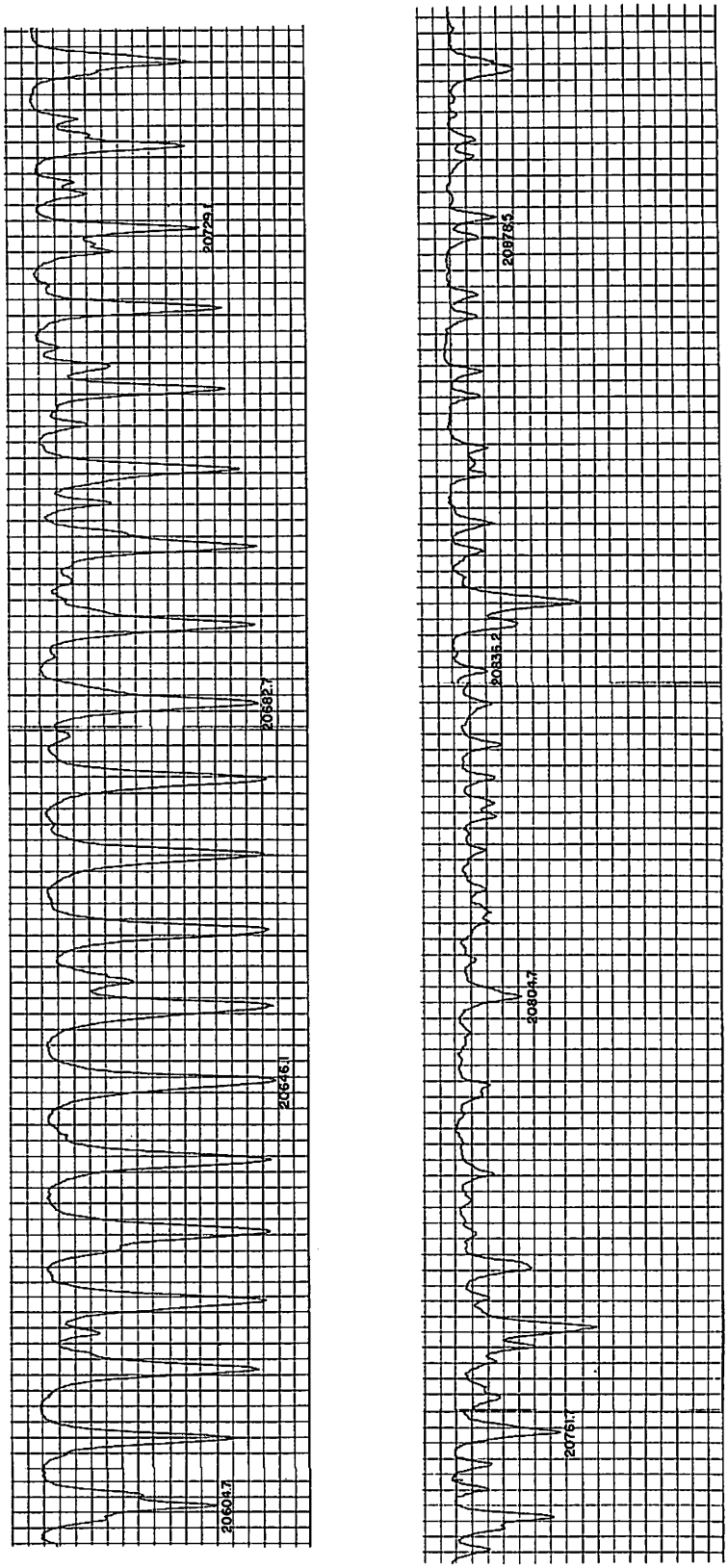

Fig. 7M Part of the Michigan Atlas, that matches *Fig. 7.*

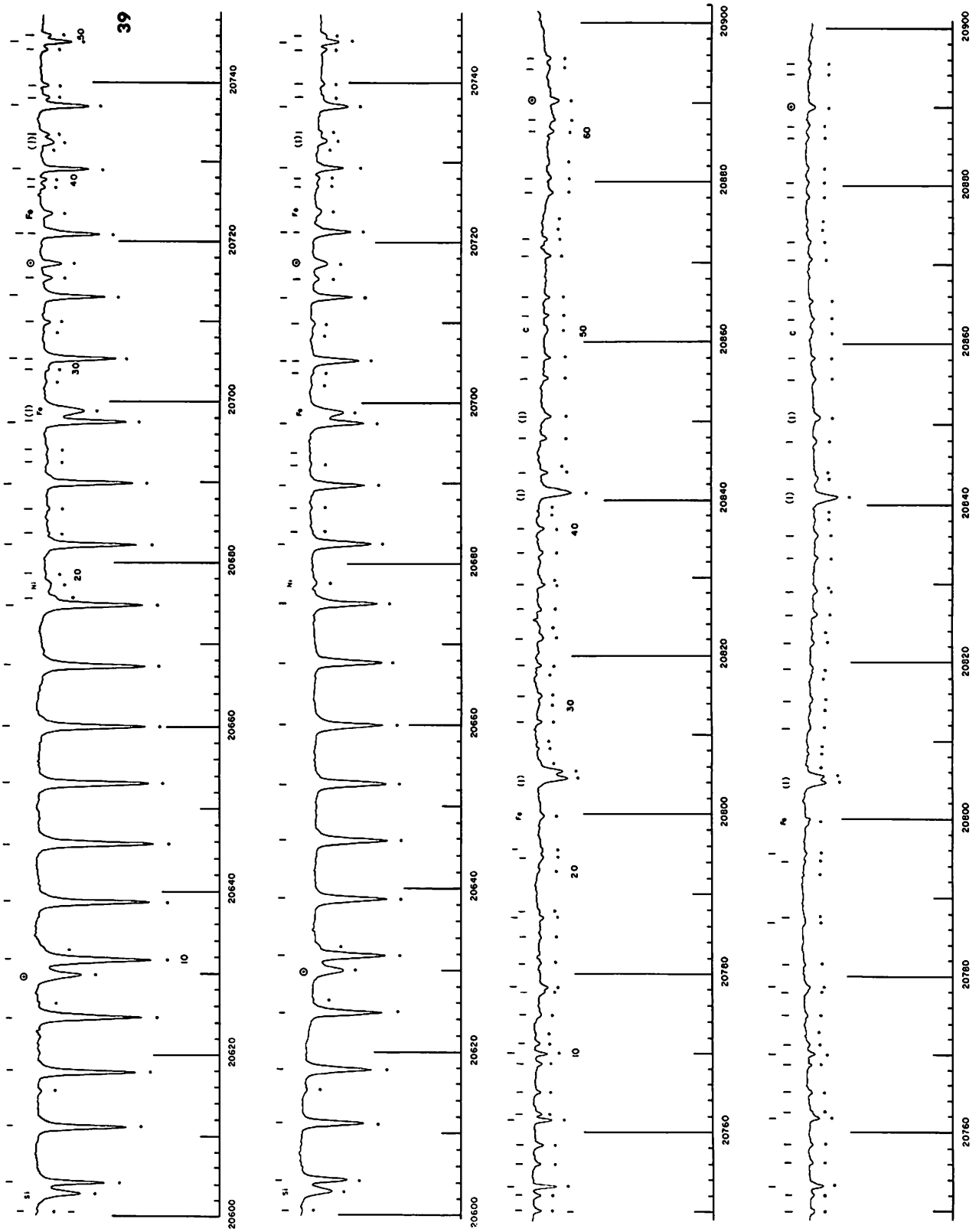

Fig. 7 Solar Spectrum λλ 20600–20901, in four strips (cf. Table 1).

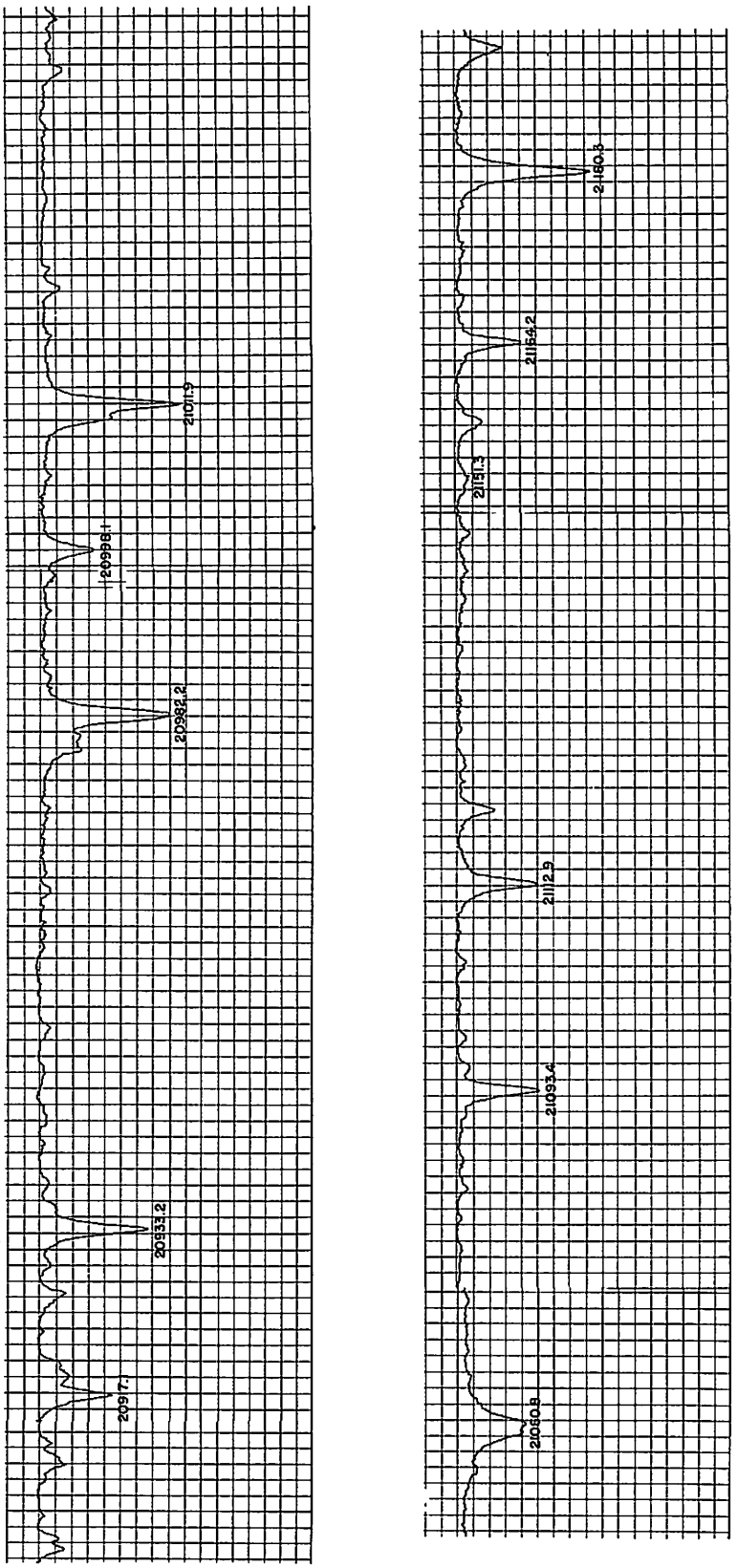

Fig. 8M Part of the Michigan Atlas, that matches *Fig. 8*.

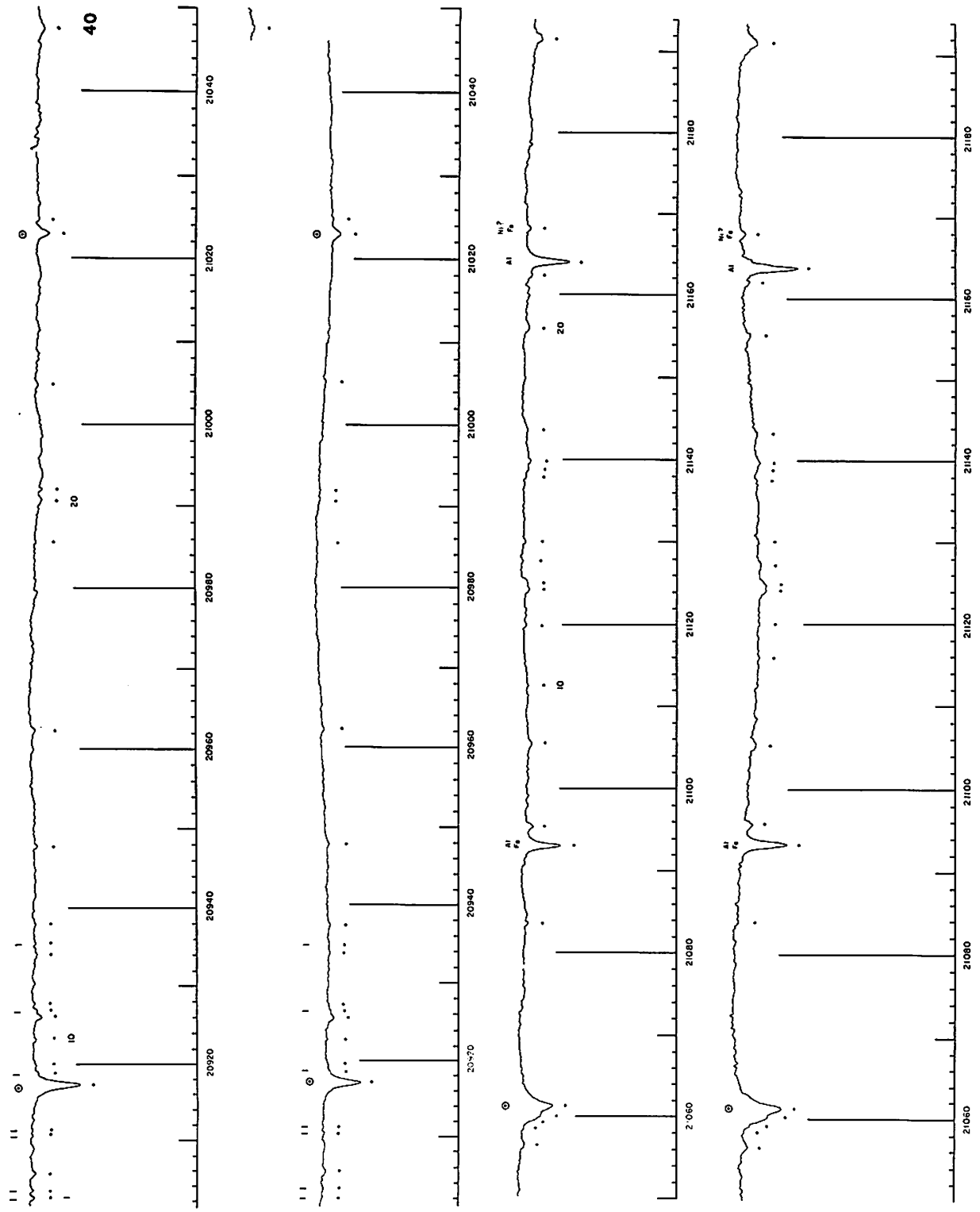

Fig. 8 Solar Spectrum λλ 20901–21194, in four strips (cf. Table 1).

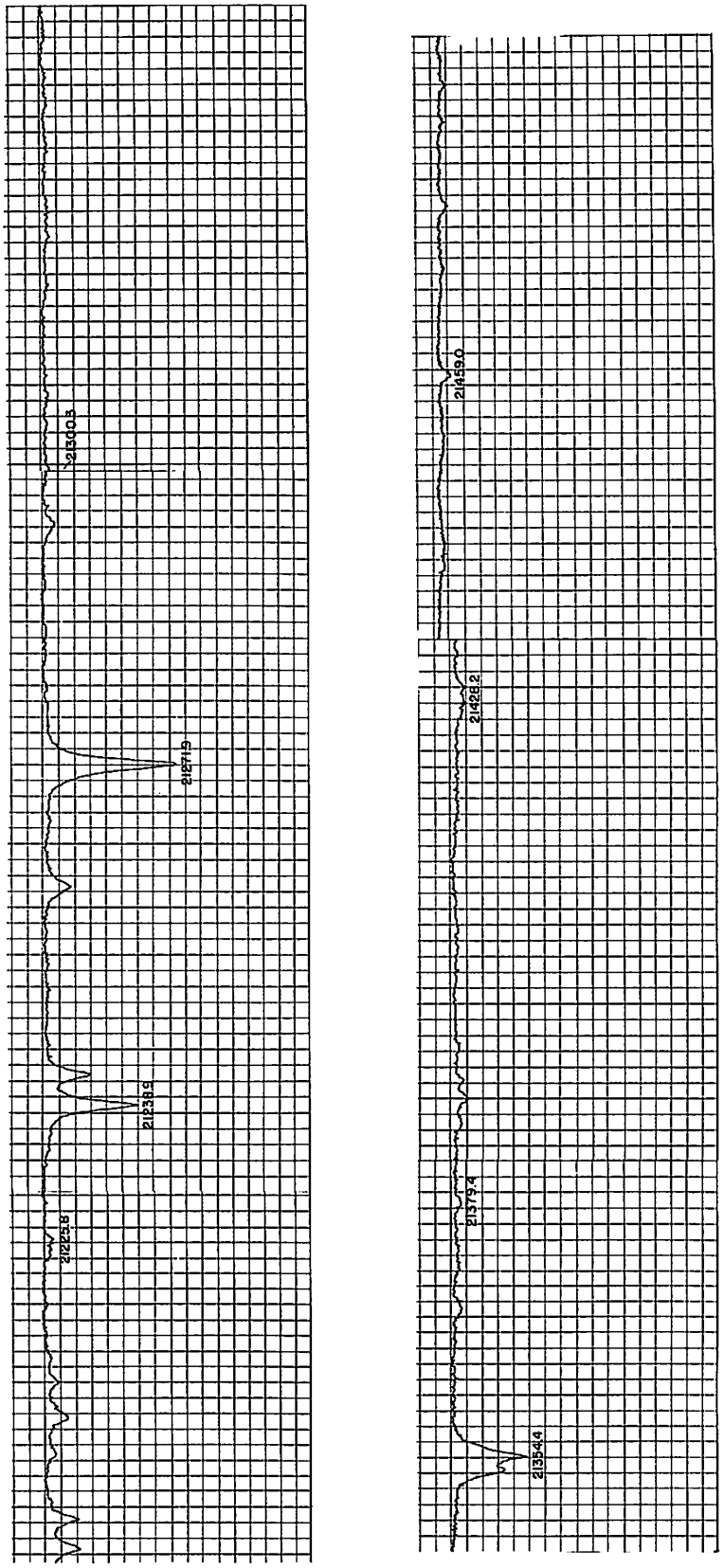

Fig. 9M Part of the Michigan Atlas, that matches *Fig. 9.*

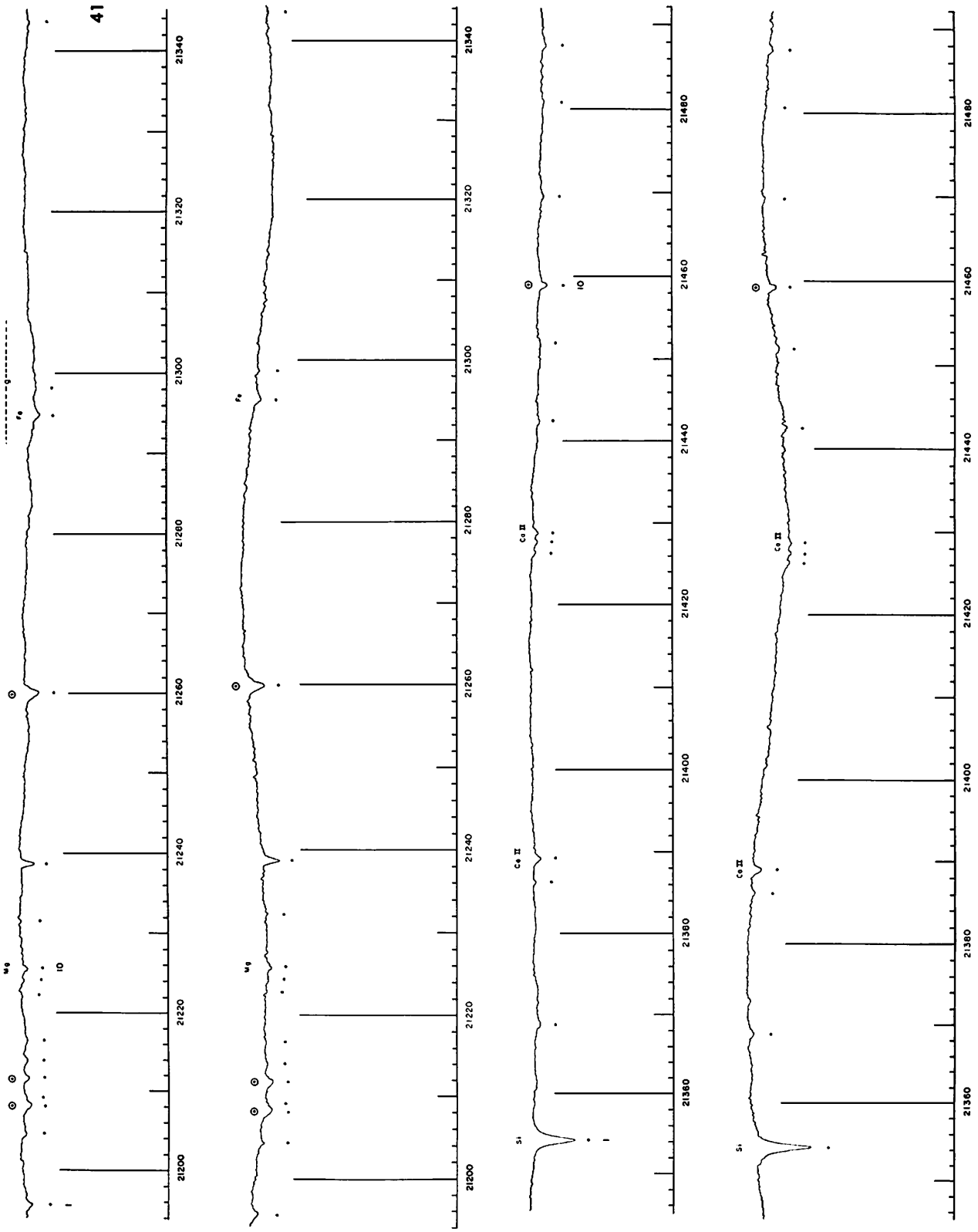

Fig 9 Solar Spectrum λλ 21194–21492, in four strips (cf. Table 1).

Fig. 10 Solar Spectrum λλ 18044–18644, the spectral interval also covered by *Fig. 2*. Explanation in text.

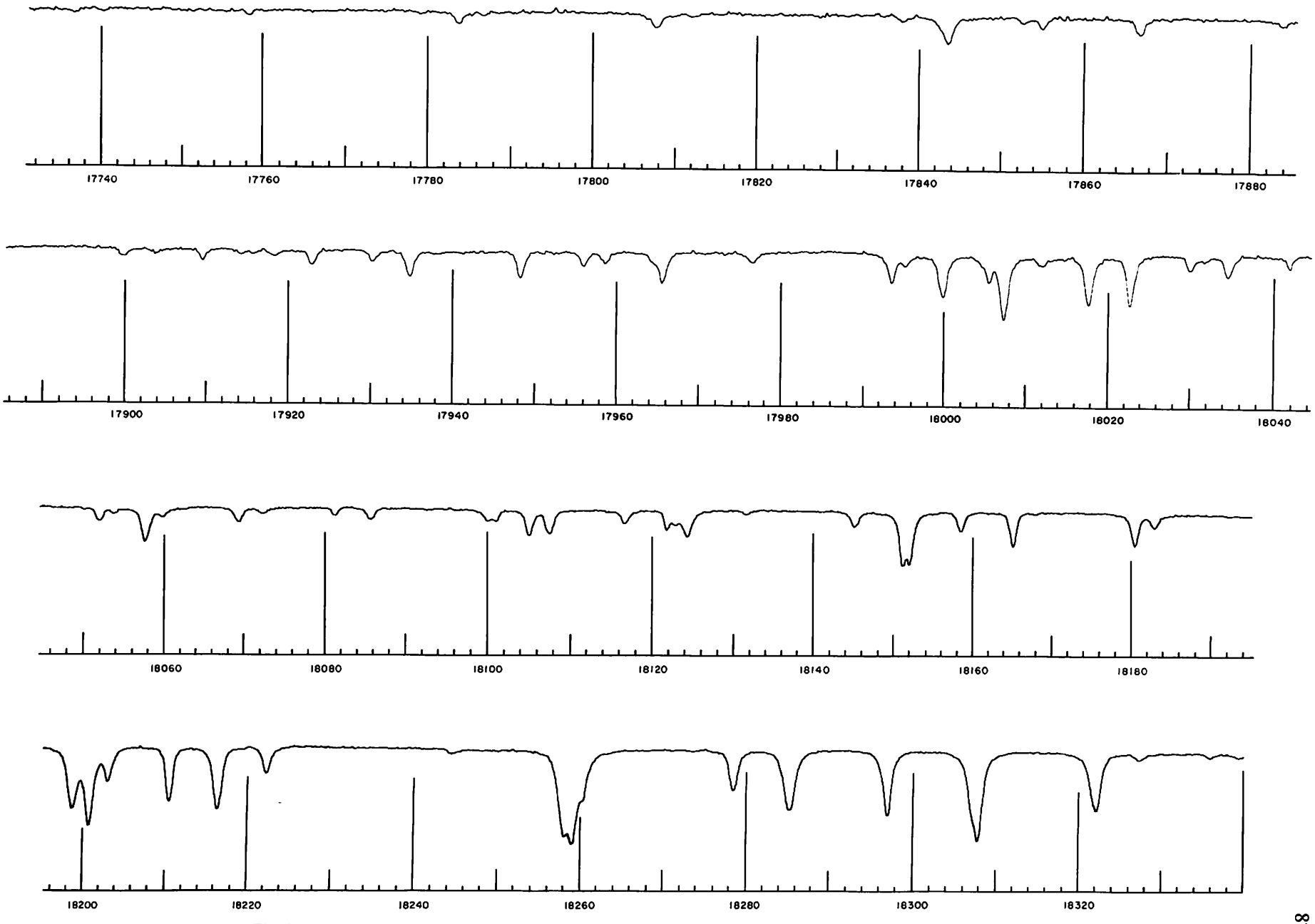

Fig. 11 Laboratory Spectrum of water vapor λλ 17731–18340 Å, that matches the solar spectrum *Figs. 1, 2a, b.*
Strips *a* and *b*: Spectrometer not flushed.
Strips *c* and *d*: Spectrometer flushed with dry nitrogen.

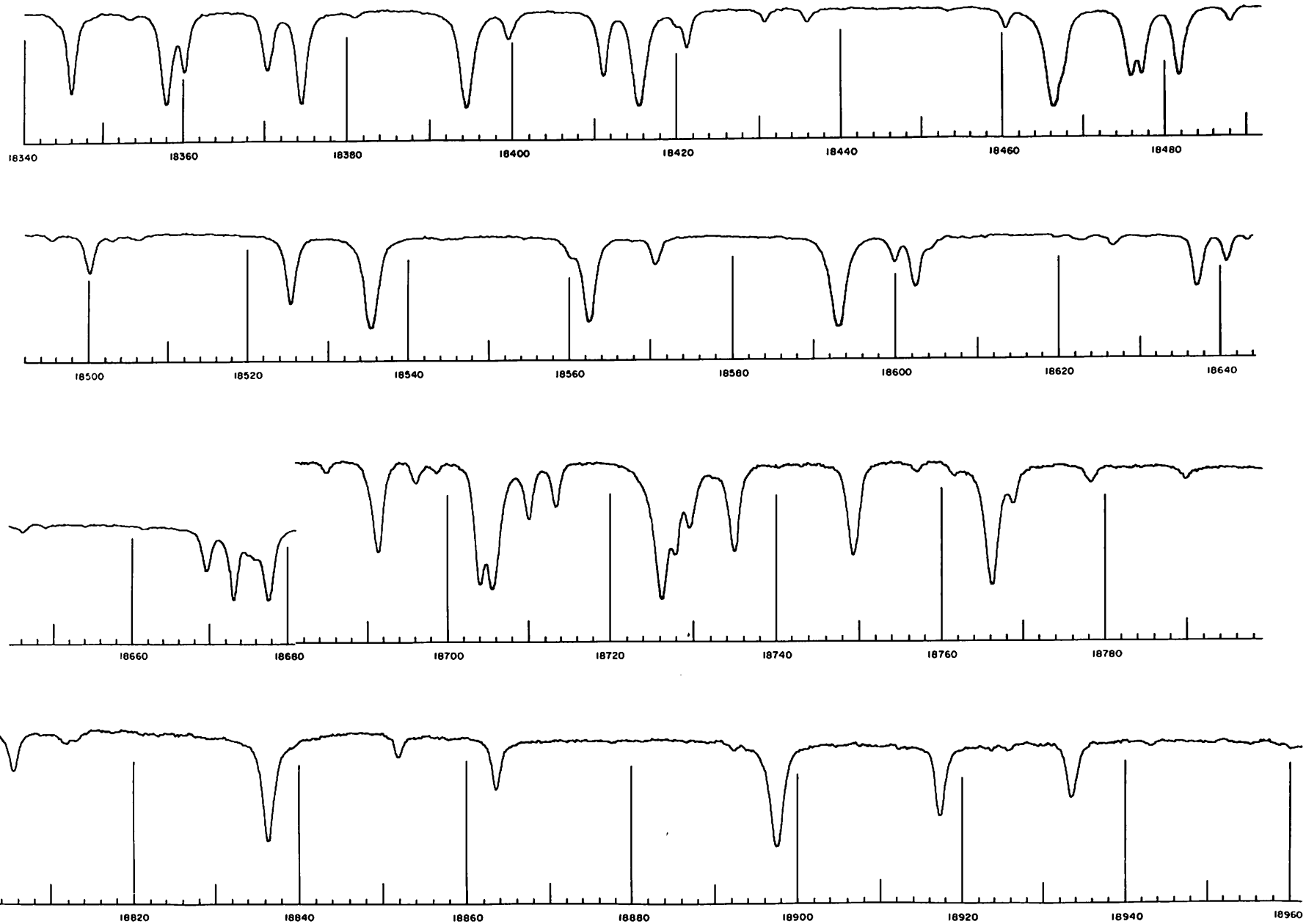

Fig. 12 Laboratory Spectrum of water vapor λλ 18340–18962, that matches the solar spectrum *Figs. 2c, d, 3.*

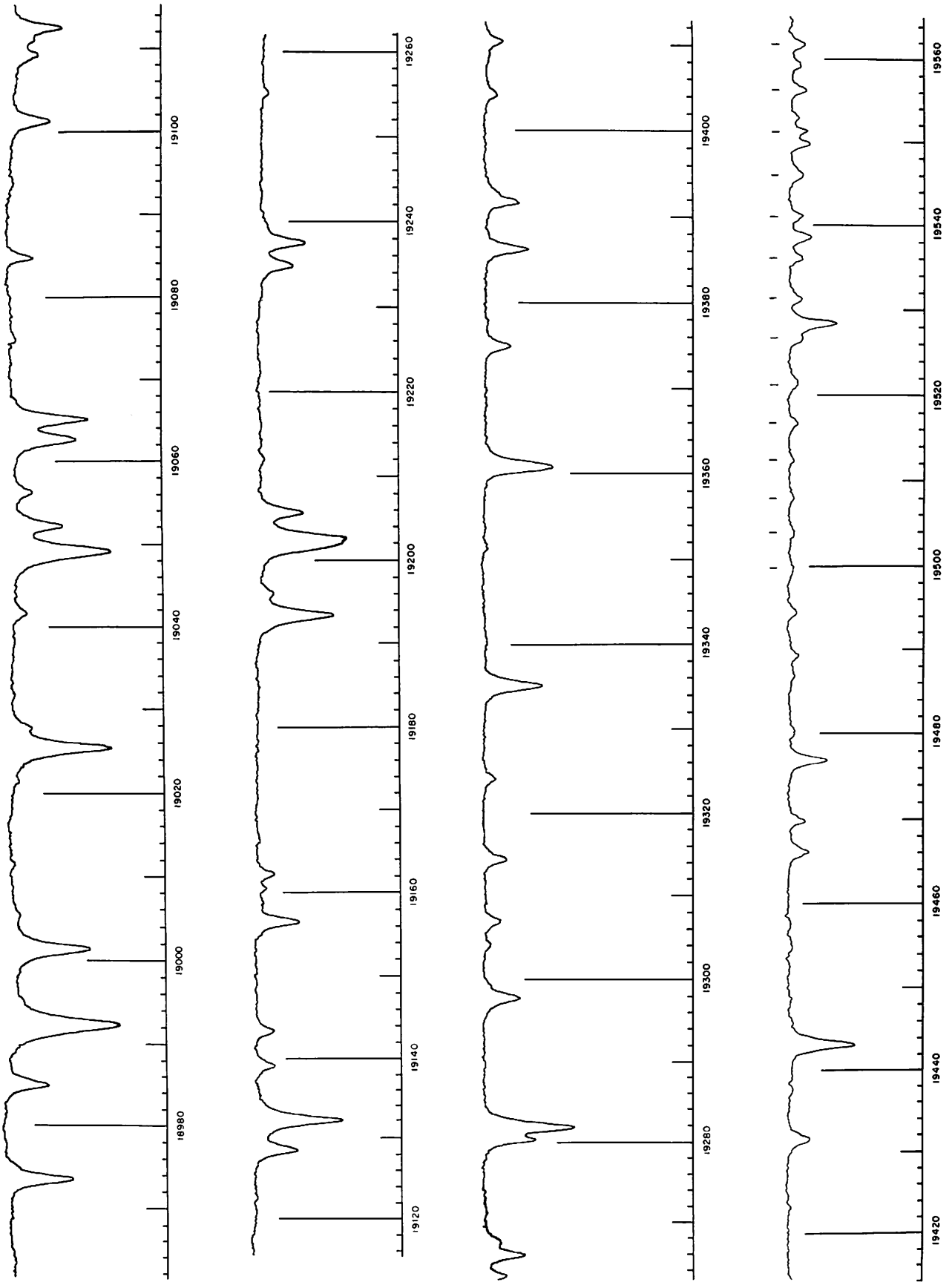

Fig. 13 Laboratory Spectrum of water vapor λλ 18962–19565, that matches the solar spectrum *Fig. 4*.
Strip *a*, *b* and *c*: spectrometer flushed with dry nitrogen.
Strip *d*: Spectrometer not flushed; some CO_2 lines.

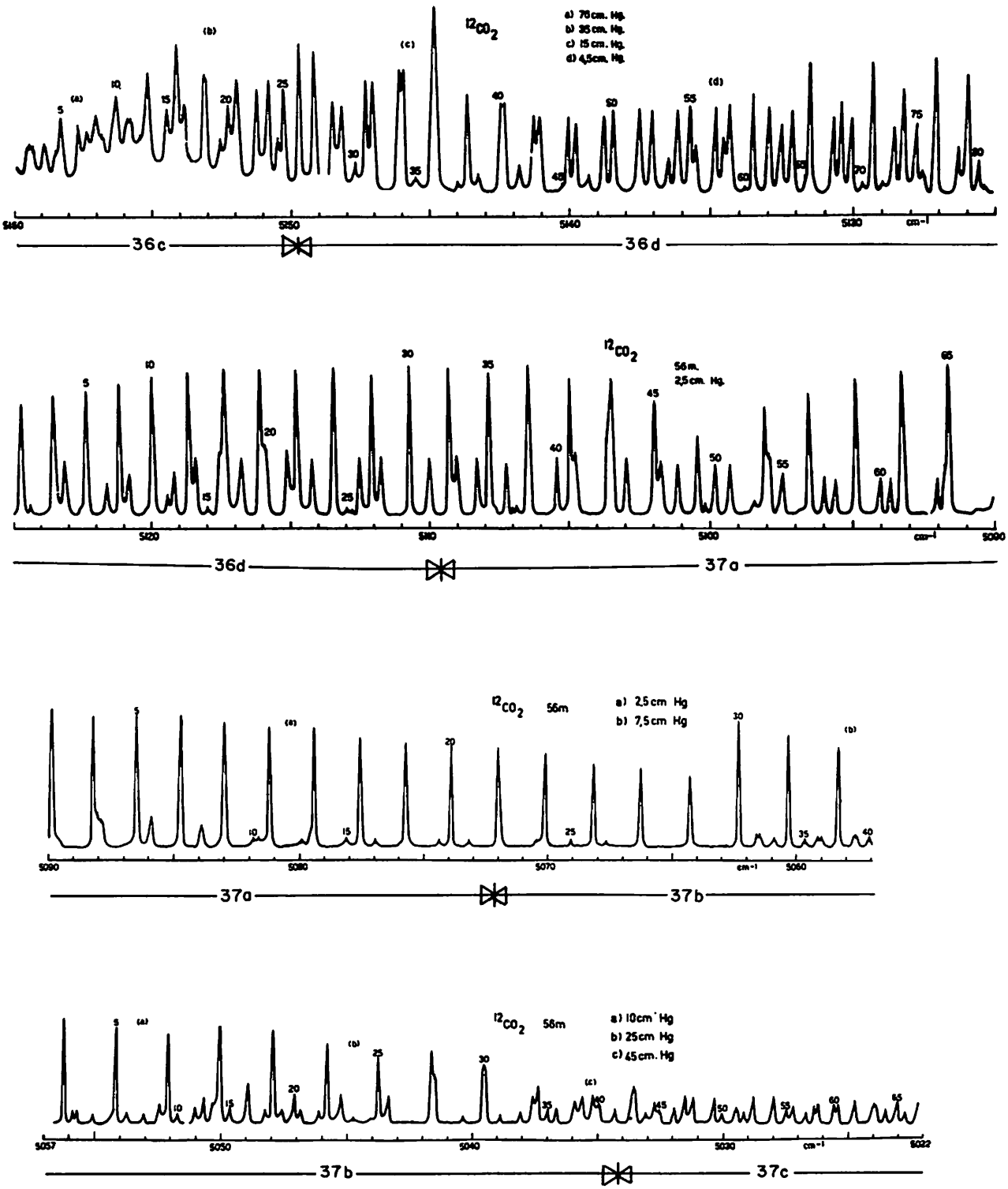

Fig. 14 Courtoy's laboratory spectrum of CO_2, natural isotopic mixture. Scale in wavenumbers. Arrows give chart number of corresponding part of solar spectrum. (Reproduced with permission)

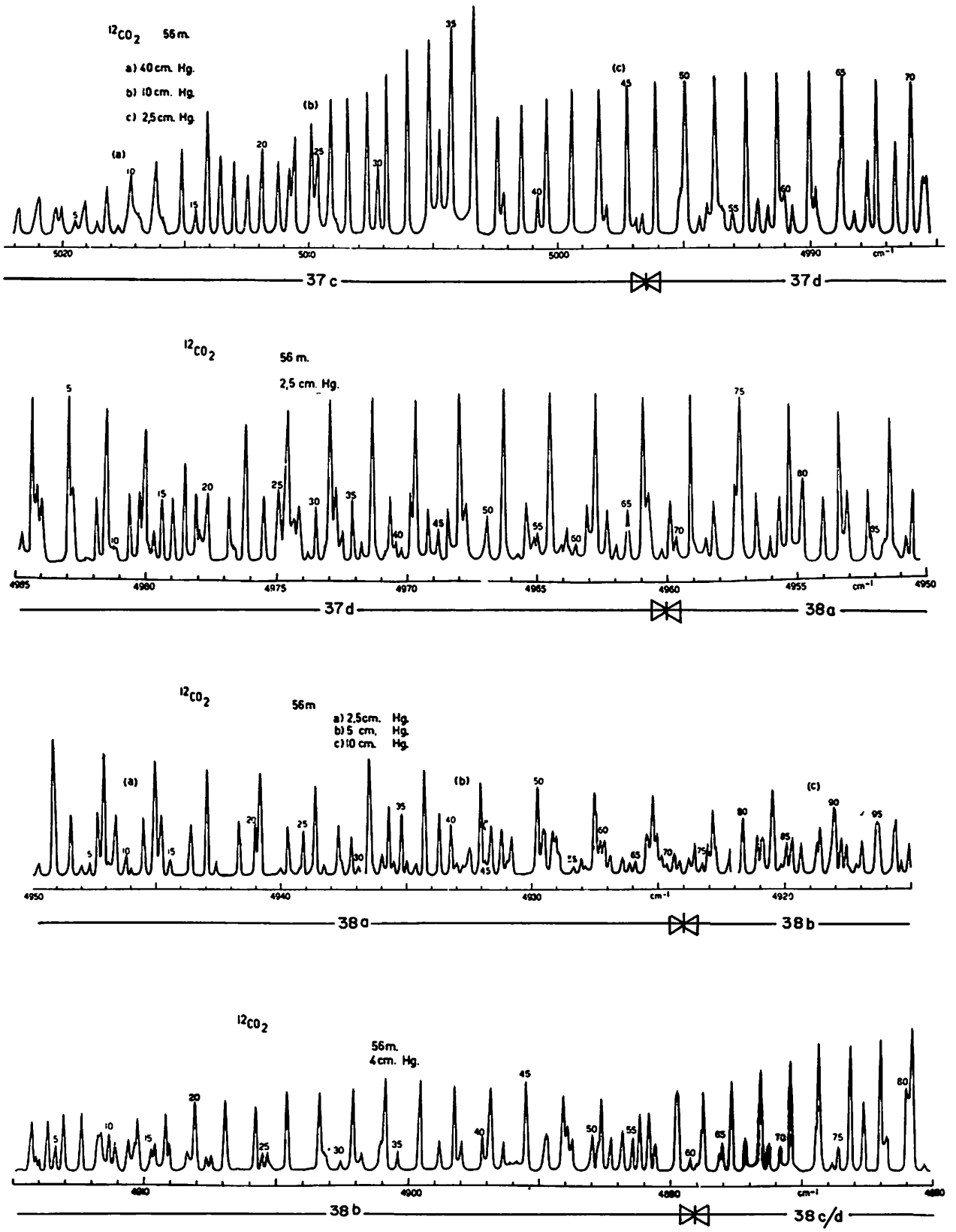

Fig. 15 Courtoy's laboratory spectrum of CO_2, natural isotopic mixture. Scale in wavenumbers. Arrows give chart number of corresponding part of solar spectrum. (Reproduced with permission)

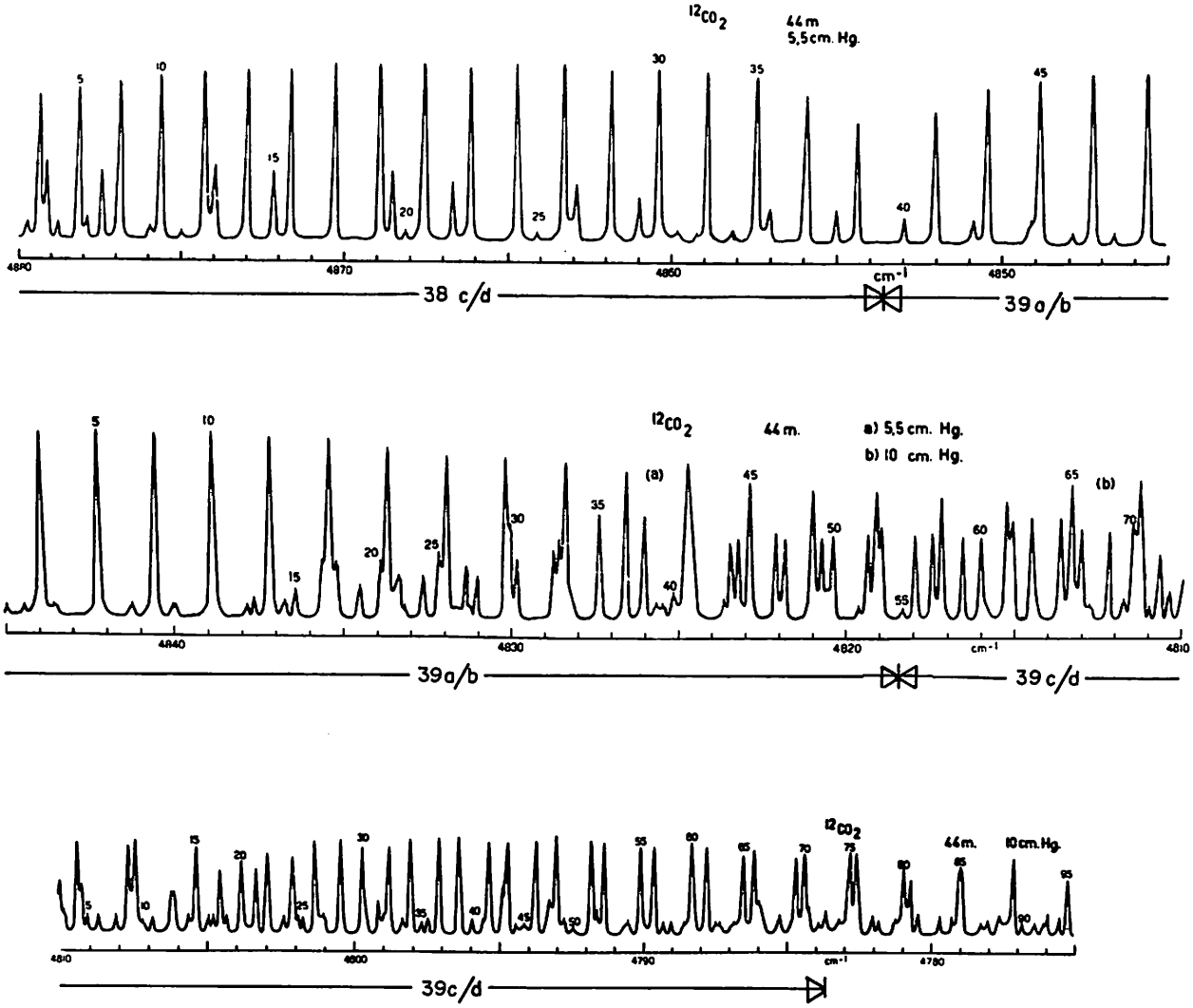

Fig. 16 Courtoy's laboratory spectrum of CO_2, natural isotopic mixture. Scale in wavenumbers. Arrows give chart number of corresponding part of solar spectrum. (Reproduced with permission)