No. 164 ARIZONA-NASA ATLAS OF THE INFRARED SOLAR SPECTRUM, REPORT VIII

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ABSTRACT

In this paper we reproduce the solar spectrum $\lambda\lambda$ 21492–25583 Å, as obtained from the NASA CV-990 Jet at high altitude. The paper is a continuation of *Comm. LPL* Nos. 161 and 163. Included are laboratory spectra of the 2.20, 2.32, and 2.37 μ bands of methane and of the wings of the water-vapor bands at 2.7 μ. The 8–6 and 9–7 solar CO bands are found to be present in the spectra.

The solar records reproduced in this paper were obtained on high-altitude flights with the NASA CV-990 Jet, using the LPL 4-m spectrometer with a 600 l/mm grating. They are a continuation of the records in *Comm. LPL* 161 and 163. Observing data are listed in Table 1. The upper wavelength limit in this report was chosen near λ 25578 Å, the upper limit of Mohler's *Table* (1955), which was used in the identification of the lines in the solar spectrum and the construction of the wavelength scale. Additionally, near the end of the *Table*, we consulted the measurements by Plyler and Tidwell (1957) and the line parameters for water vapor at 2.7 μ by Gates *et al.* (1964). For the conversion of wave numbers to wavelengths, we used Coleman's *Table of Wavenumbers* (NBS 1960). As before, we have included the matching parts of the Michigan *Atlas* (1950).

In order to be able to separate the methane absorptions from solar absorptions, we obtained laboratory spectra of the 2.20, 2.32, and 2.37 μ methane bands. To this end, we placed a 10-cm cell in the beam between the light source and entrance slit of the 4-m spectrometer. For the spectra reproduced here (Figs. 10–14), the cell was filled with methane to a pressure of about 4.8 cm Hg, corresponding to 6.3 mm atm. of methane in the path. The 4-m spectrometer was not flushed with dry nitrogen, so that some water-vapor absorptions appear in Fig. 14.

Further included is a laboratory spectrum for the wings of the H_2O bands at 2.7 μ. Because of high humidity in the laboratory, we were unable to reduce the absorptions below the intensities shown (Fig. 15–17), even though the 4-m spectrometer was flushed with dry nitrogen and the light path outside the spectrometer was relatively short.

In his *Table* Mohler gives the line positions of many of the lines in the 2–0, 3–1, 4–2, 5–3, 6–4, 7–5 solar CO bands. Because of the low telluric absorptions in our spectra, these CO bands are shown more completely here. Positions of lines not listed in Mohler's *Table* were interpolated or calculated from the constants for the CO molecule, as given by Goldberg and Müller (1953). In our spectra we also found the 8–6 and 9–7 solar CO bands present, not observed before, of which the positive branch is complete from $J = 22$ to $J = 54$, so that the bandheads at λ 24781 Å and λ 25116 Å are easily recognized. The CO lines are marked with asterisks above the spectral traces. All CO lines recorded are believed to be solar, not telluric, except possibly for lines of the 2–0 CO band with low rotational quantum numbers, which might be telluric in part, though this is not considered likely, in view of the extremely low telluric CO abundance and the high altitude at which the solar spectra were taken.

As before, a dot above the spectral trace indicates a water-vapor absorption; a triangle, a methane absorption. A symbol placed in parentheses indicates that the absorption line is considered only partly telluric.

The water-vapor absorptions in the spectrometer during the flights are not negligible. For an evaluation of their contribution, 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 performed by Mr. Bijl, who also obtained the laboratory spectra of the 2.20, 2.32, and 2.37 μ bands of methane and the 2.7 μ bands of H_2O; he further prepared all 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. Mr. D. C. Benner constructed the wavelength scales for the laboratory spectra and assisted in the calculation of the CO line positions. 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.

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SOLAR SPECTRUM RECORDS, 4-M SPECTROMETER NASA CV-990 JET
600 l/mm GRATING; GRATING BLAZE, 1.6 μ, JUL. 18, 19; 2.5 μ, AUG. 1; DETECTOR 0.10 MM
$\tau = 0.12$ SEC., FILTER 1.8 μ

FIG.	CHART		1968 DATE	UT	ALT. (FT)	OUTSIDE TEMP. (°C)	CABIN ALT. (FT)	GAIN	SLIT (MM)
1.	42 a	21492–21639	Aug. 1	20:14	41,800	−58	9300	5–3	0.12
	b	21639–21787	Aug. 1	20:18	41,800	−58	9300	5–3	0.12
	c	21787–21931	Aug. 1	20:21	41,800	−58	9300	5–3	0.12
	d	21931–22075	Aug. 1	20:24	41,800	−58	9300	5–3	0.12
2.	43 a	22075–22223	Aug. 1	20:28	41,800	−58	9300	5–3	0.12
	b	22223–22367	Aug. 1	20:31	41,800	−58	9300	5–3	0.12
	c	22367–22509	Aug. 1	20:34	41,800	−58	9300	5–3	0.12
	d	22509–22653	Aug. 1	20:38	41,800	−57	9300	5–3	0.12
3.	44 a	22653–22798	Aug. 1	20:41	41,800	−56	9300	5–3	0.12
	b	22798–22940	Aug. 1	20:45	41,800	−55	9300	5–3	0.12
	c	22940–23073	Aug. 1	20:48	41,800	−55	9300	5–3	0.12
	d	22940–23073	Jul. 18	20:03	39,000	−54	8500	5–6	0.09
4.	45 a	23073–23204	Aug. 1	20:51	41,800	−54	9300	5–3	0.12
	b	23073–23204	Jul. 18	20:06	39,000	−54	8500	5–6	0.09
	c	23204–23333	Jul. 18	20:09	39,000	−54	8500	5–6	0.09
	d	23204–23271	Aug. 1	20:54	41,800	−55	9300	5–3	0.12
5.	46 a	23333–23465	Jul. 18	20:13	39,000	−54	8500	5–6	0.09
	b	23465–23594	Jul. 18	20:16	39,000	−54	8500	5–6	0.09
	c	23594–23731	Jul. 18	20:19	39,000	−54	8500	5–6	0.09
	d	23594–23731	Jul. 19	18:13	39,000	−53	8500	5–4	0.18
6.	47 a	23731–23871	Jul. 19	18:17	39,000	−53	8500	5–4	0.18
	b	23871–24007	Jul. 19	18:21	39,000	−53	8500	5–4	0.18
	c	24007–24140	Jul. 19	18:24	39,000	−53	8500	5–4	0.18
	d	24140–24276	Jul. 19	18:27	39,000	−53	8500	5–4/5–5	0.18
7.	48 a	24276–24413	Jul. 19	18:31	39,000	−53	8500	5–5	0.18
	b	24413–24543	Jul. 19	18:34	39,000	−53	8500	5–5	0.18
	c	24543–24680	Jul. 19	18:37	39,000	−53	8500	5–5	0.18
	d	24680–24813	Jul. 19	18:41	39,000	−53	8500	5–5	0.18
8.	49 a	24813–24942	Jul. 19	18:44	39,000	−53	8500	5–5	0.18
	b	24942–25072	Jul. 19	18:47	39,000	−53	8500	5–5	0.18
	c	25072–25202	Jul. 19	18:51	39,000	−53	8500	5–5/5–6	0.18
	d	25202–25324	Jul. 19	18:54	39,000	−53	8500	5–6	0.18
9.	50 a	25324–25456	Jul. 19	18:57	39,000	−53	8500	5–6	0.18
	b	25456–25583	Jul. 19	19:01	39,000	−53	8500	5–6	0.18

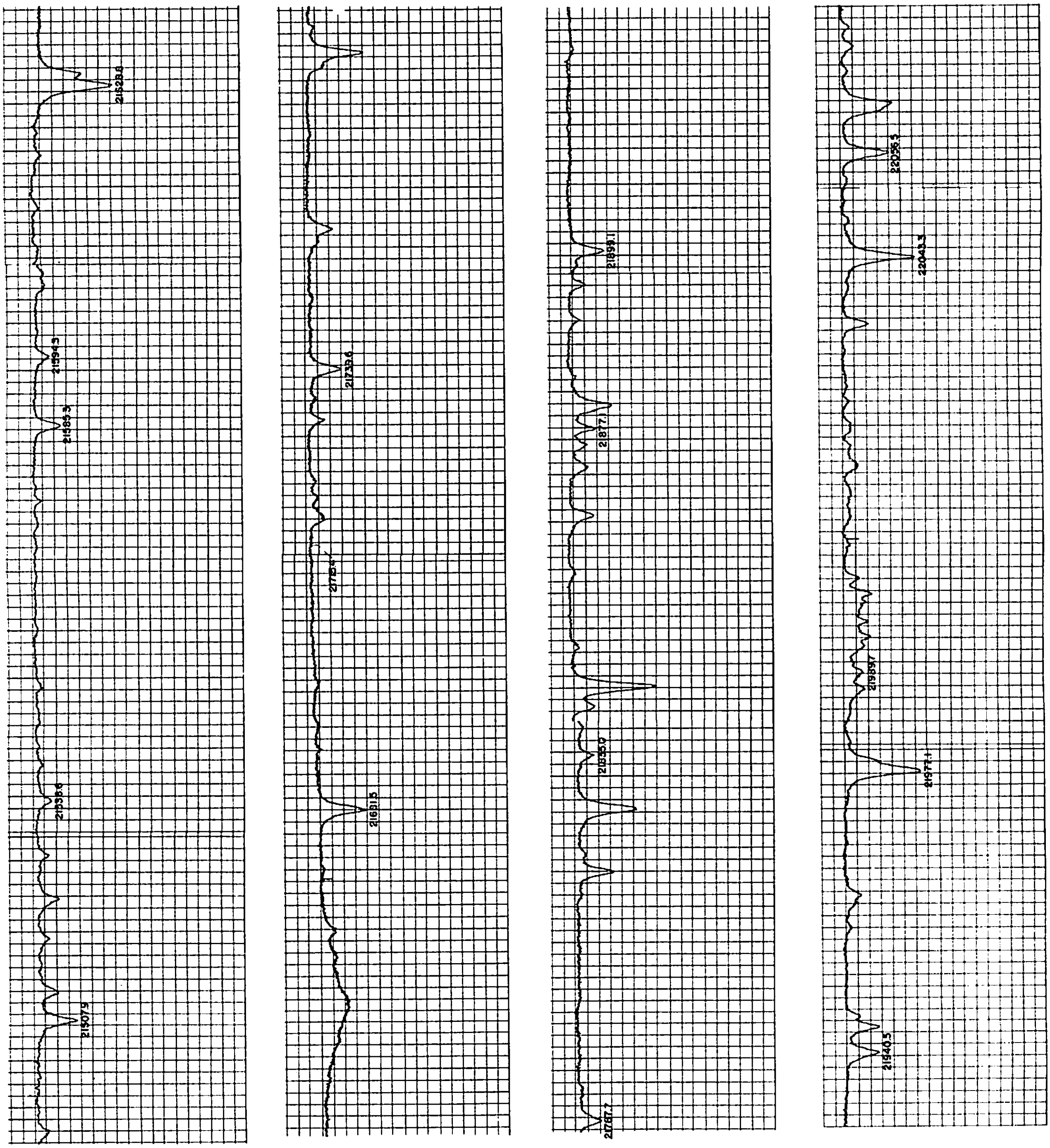

Fig. 1M Part of Michigan Atlas, that matches Fig. 1 (Reproduced with permission).

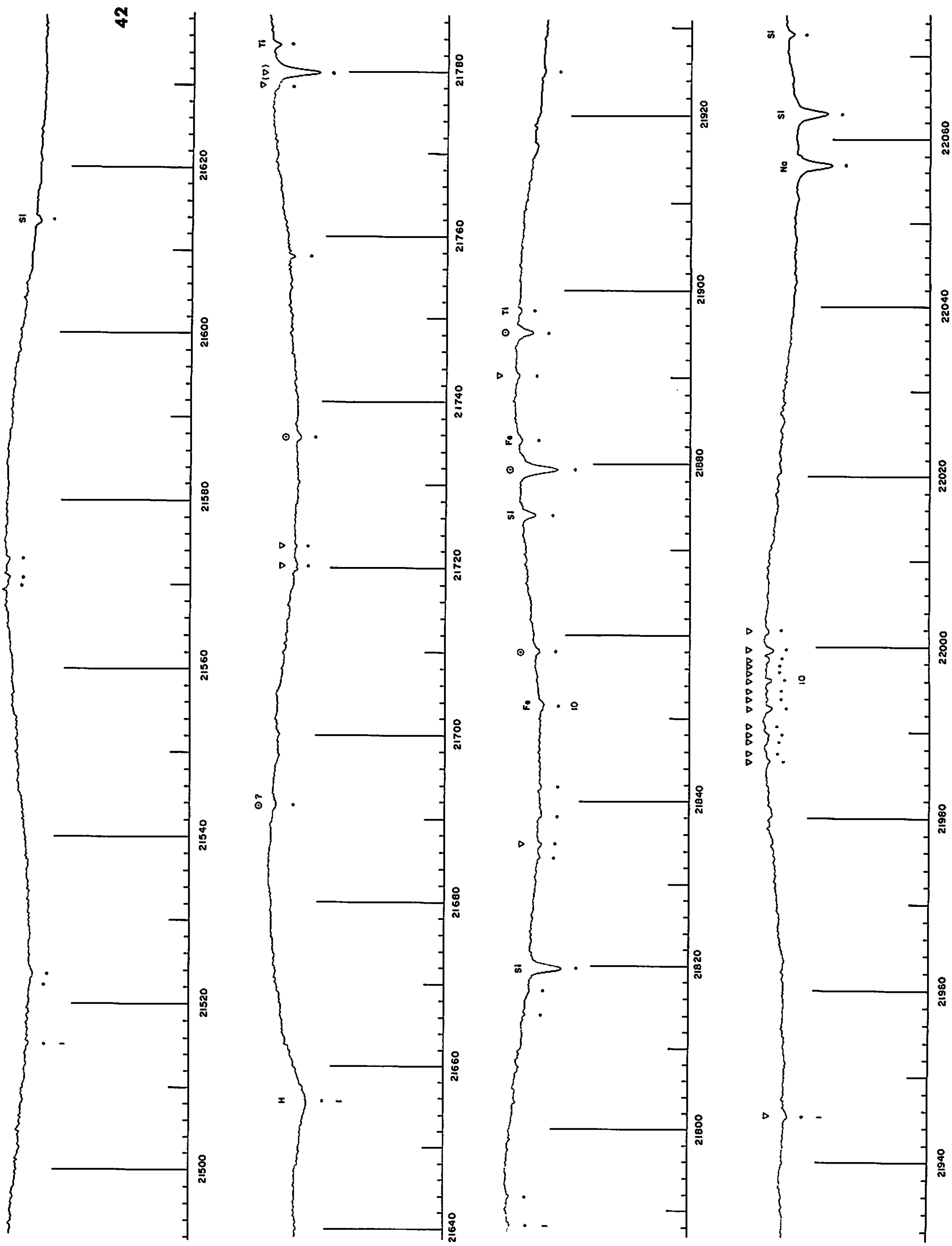

Fig. 1 Solar Spectrum λλ 21492–22075, in four strips (cf. Table 1).

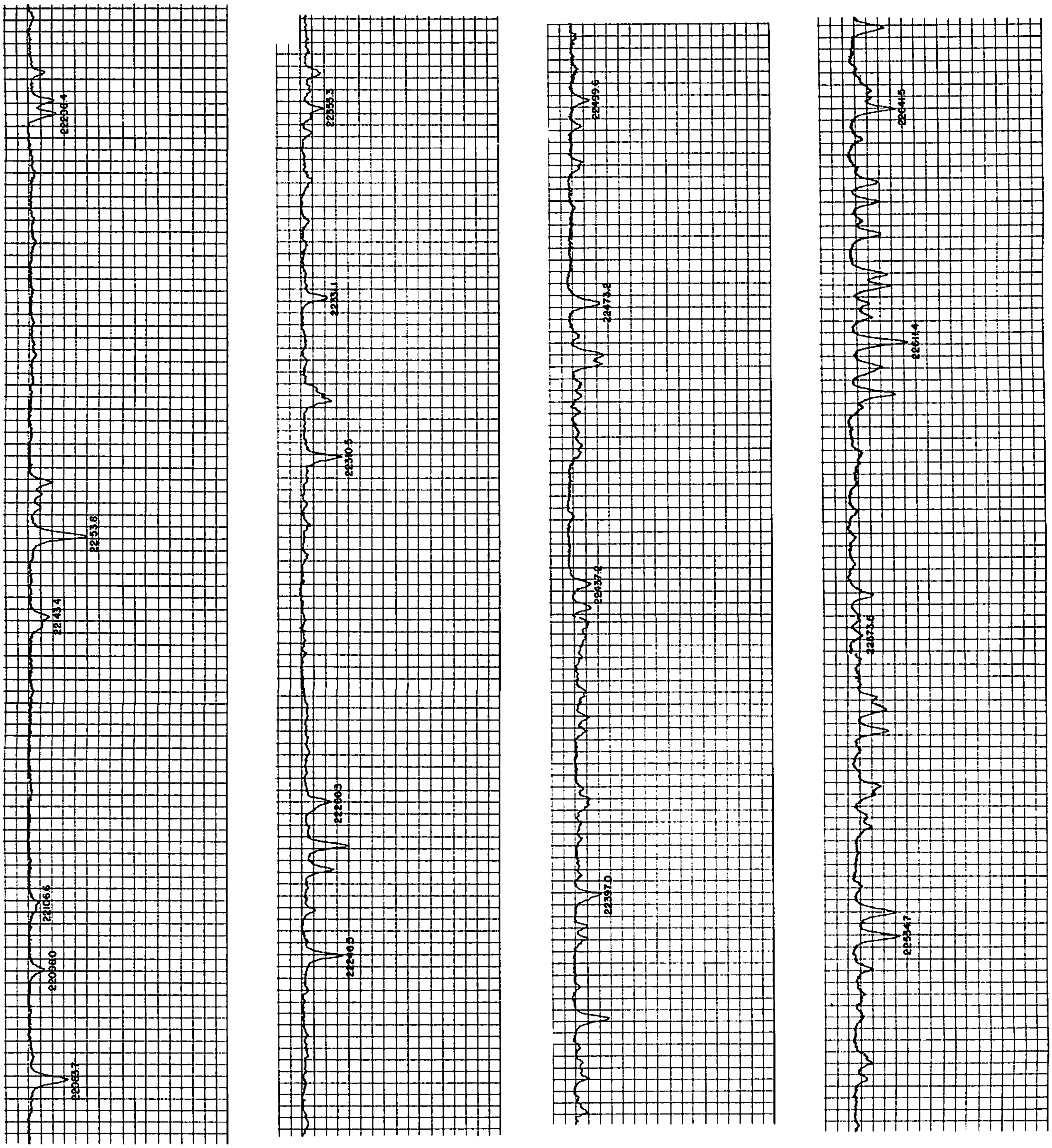

Fig. 2M Part of Michigan Atlas, that matches Fig. 2 (Reproduced with permission).

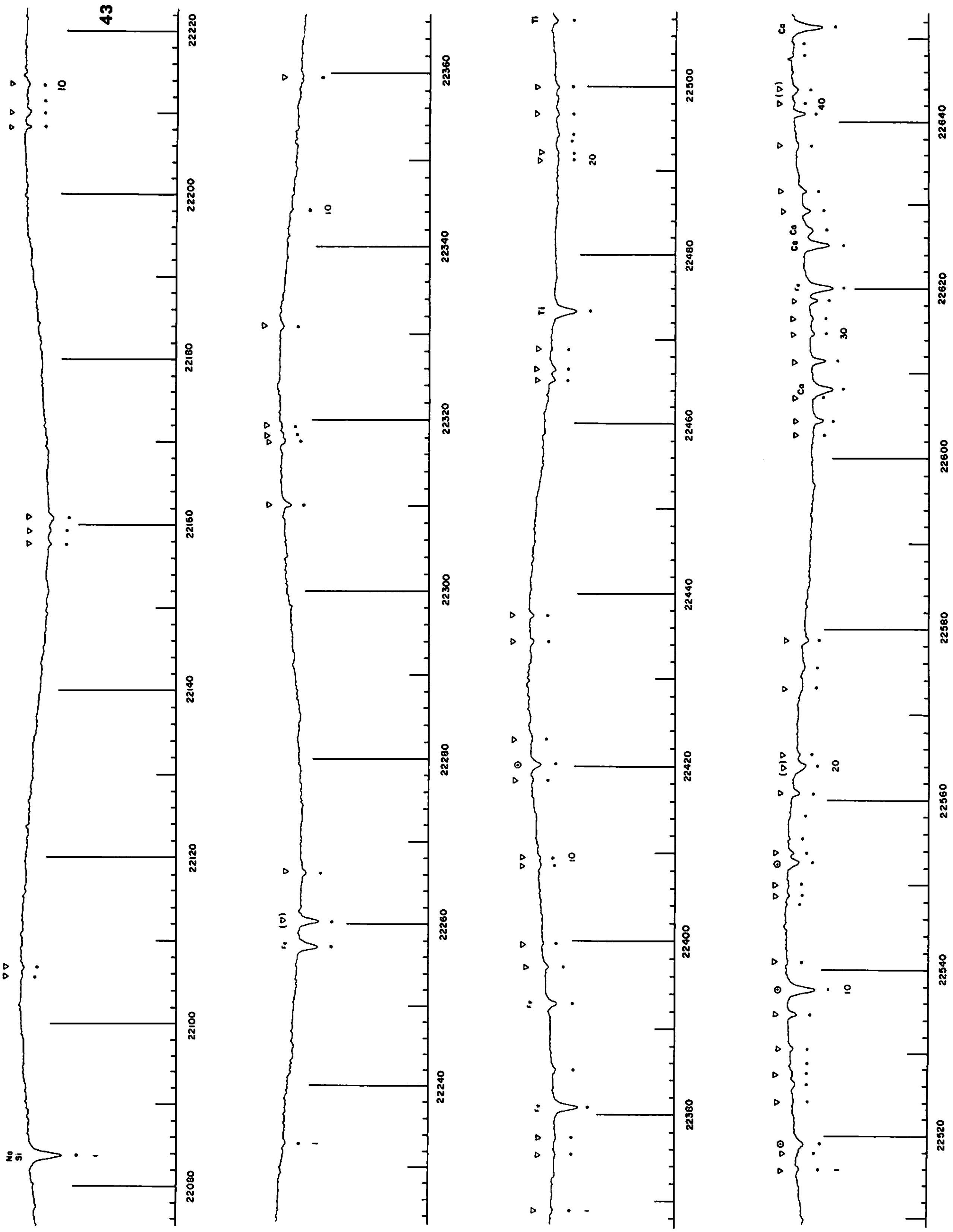

Fig. 2 Solar Spectrum λλ 22075–22653, in four strips (cf. Table 1).

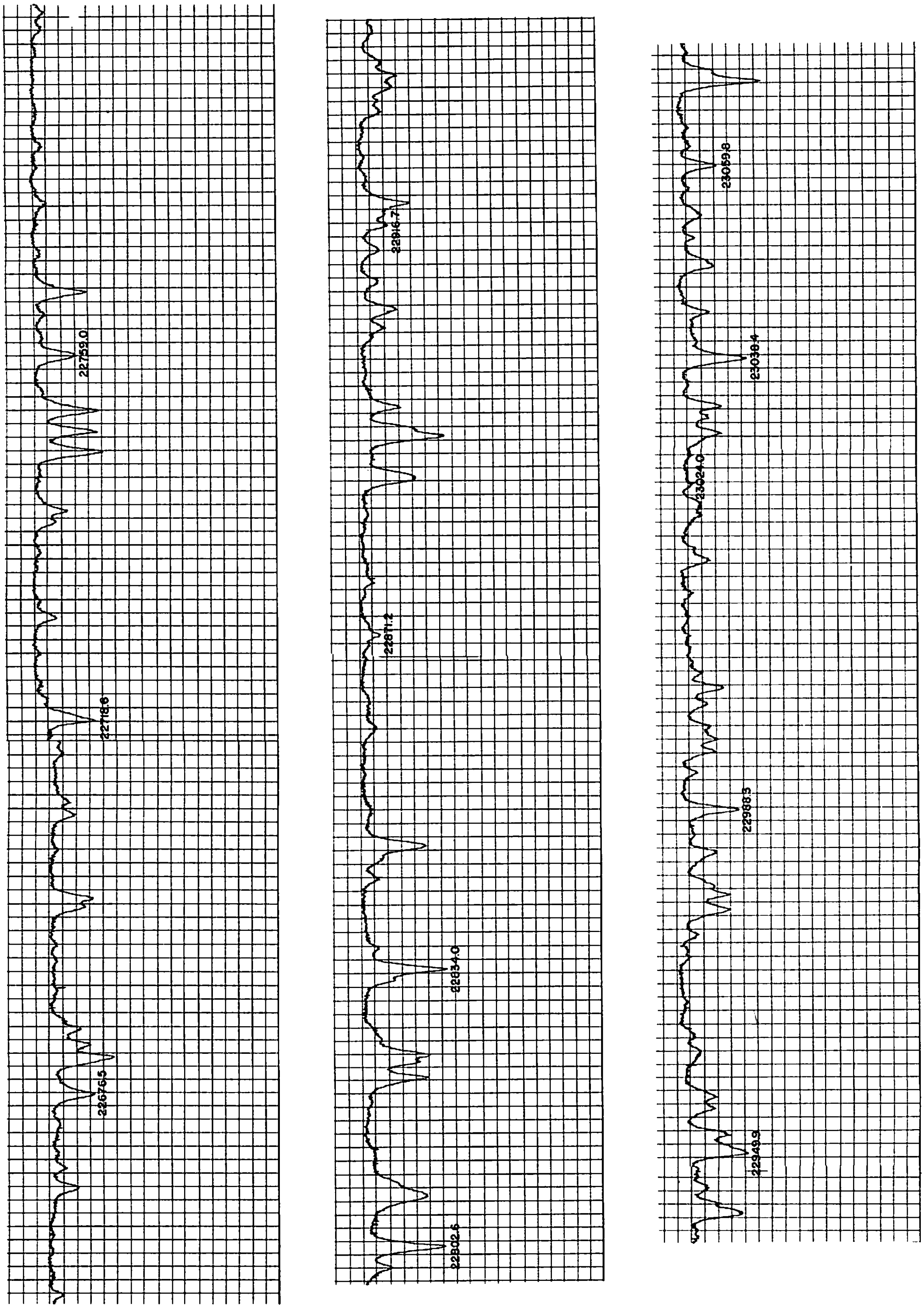

Fig. 3M Part of Michigan Atlas, that matches Fig. 3 (Reproduced with permission).

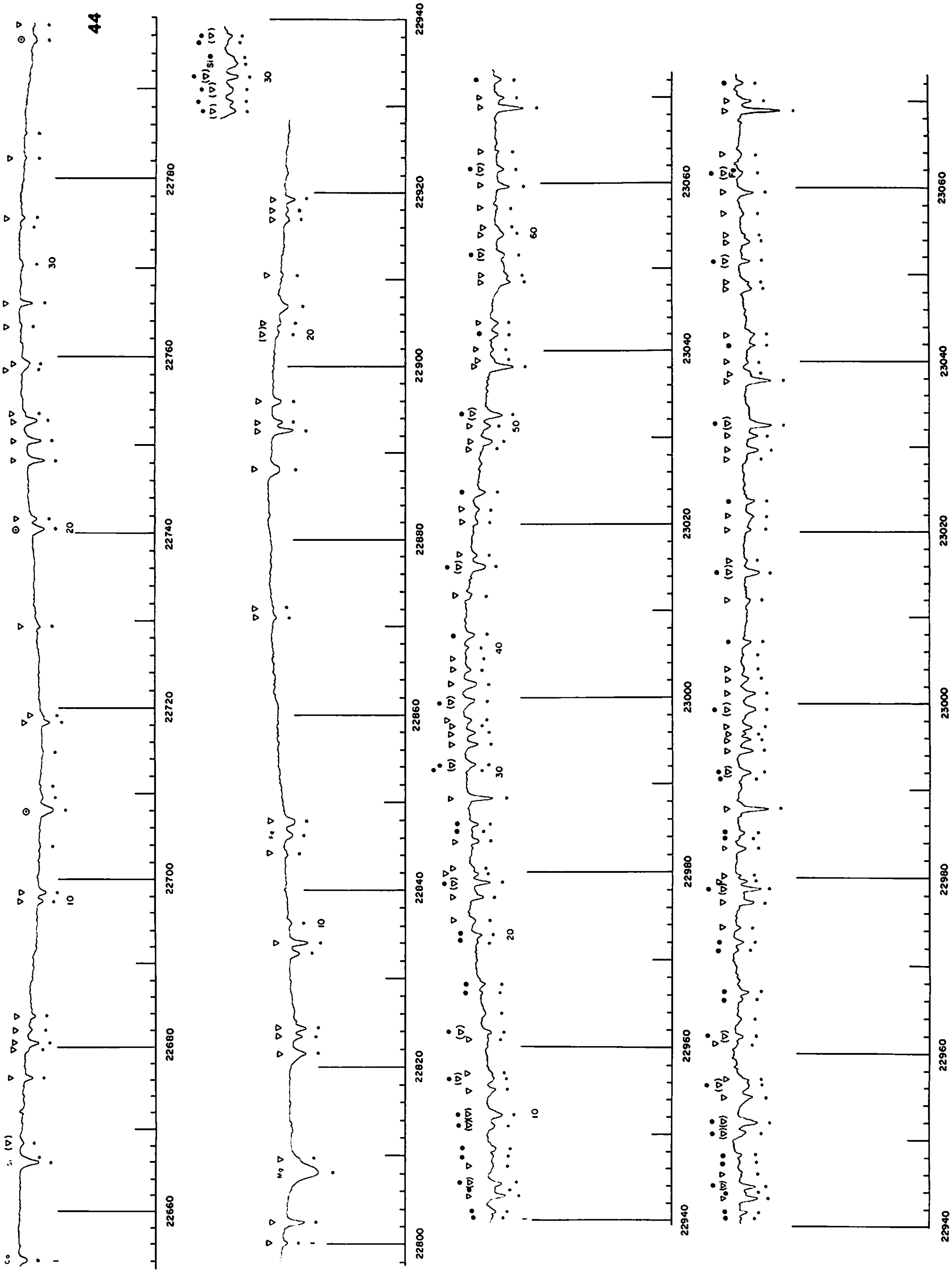

Fig. 3 Solar Spectrum λλ 22653–23073, in four strips (cf. Table 1).

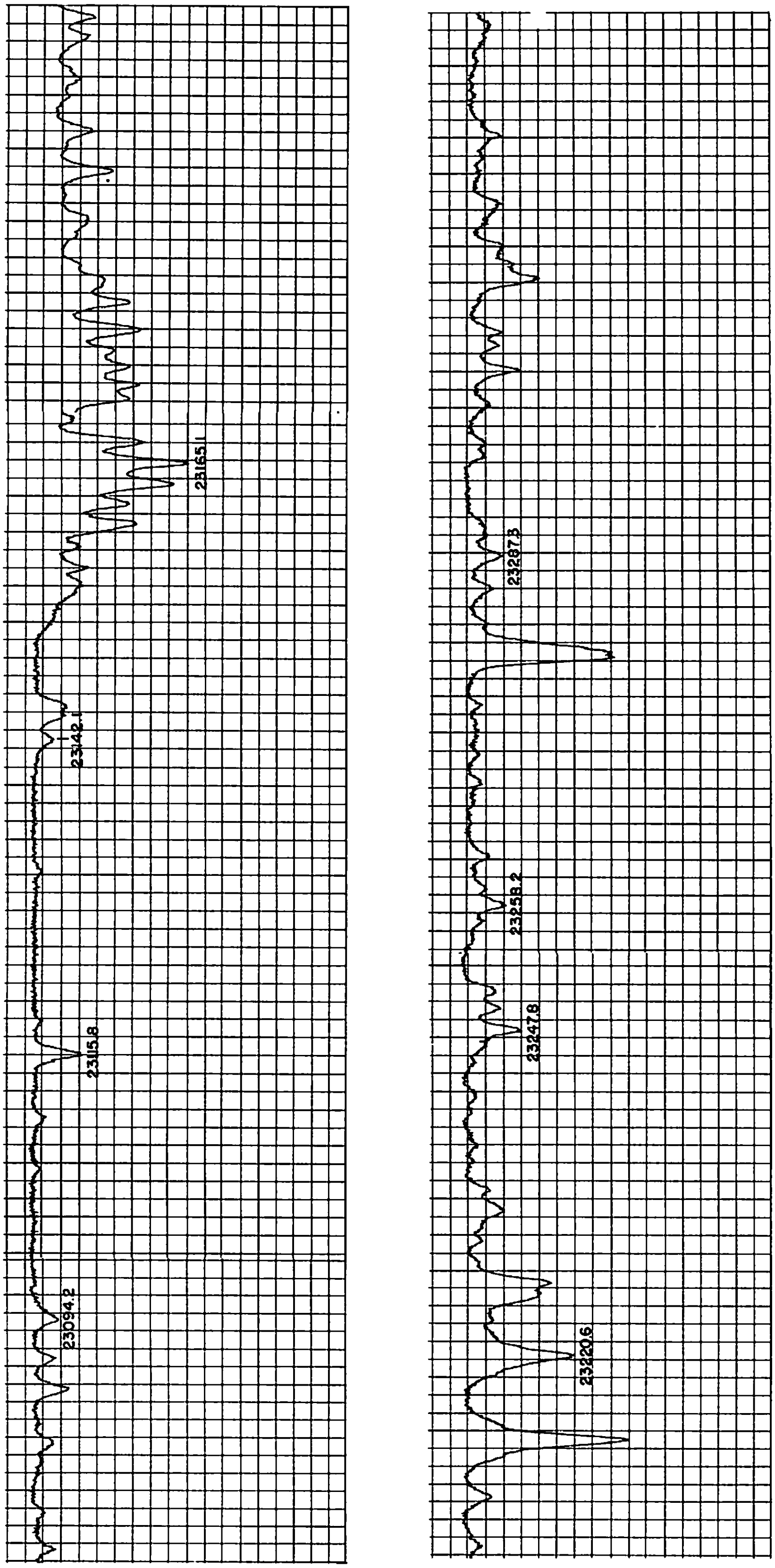

Fig. 4M Part of Michigan Atlas, that matches Fig. 4 (Reproduced with permission).

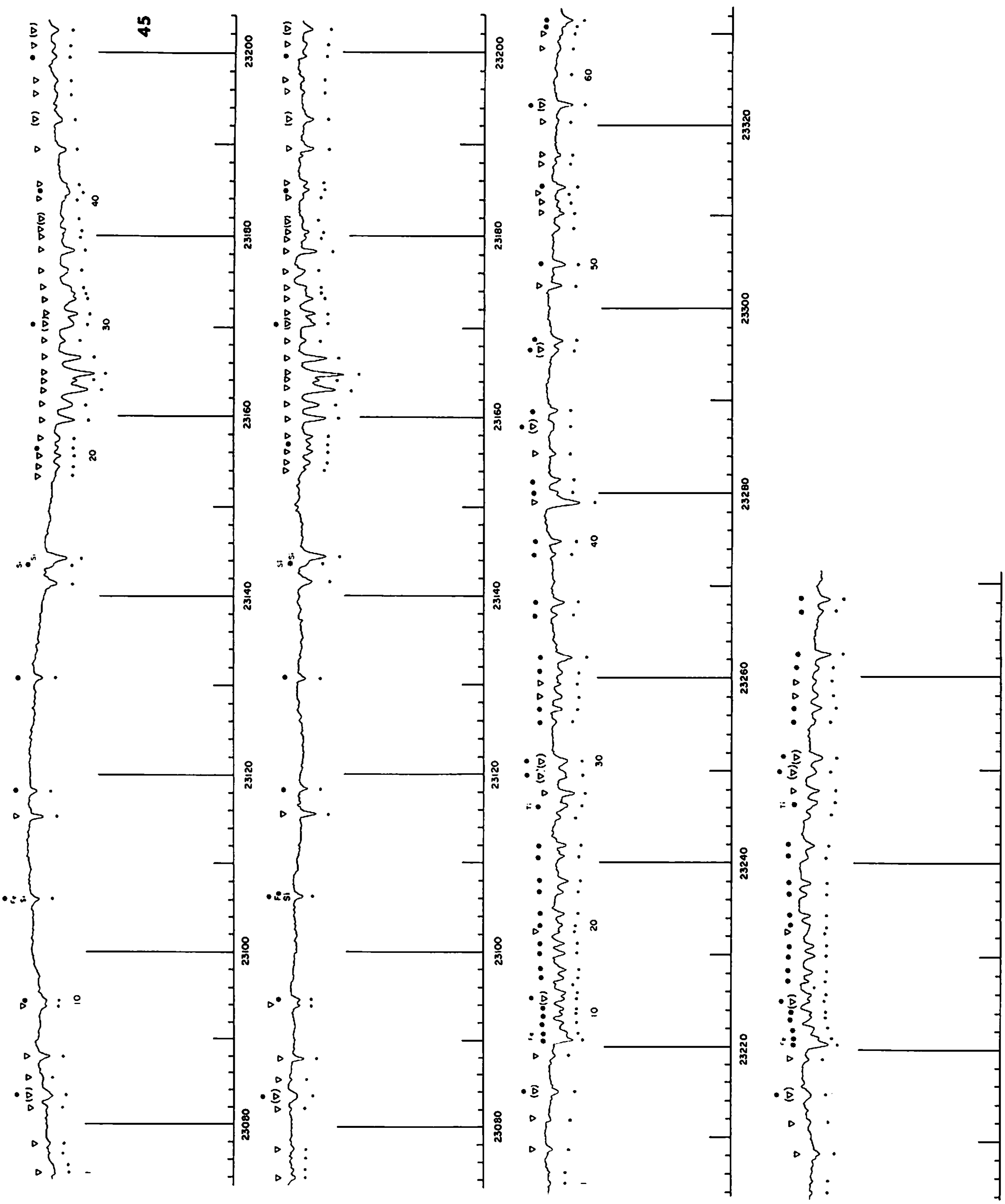

Fig. 4 Solar Spectrum λλ 23073–23333, in four strips (cf. Table 1).

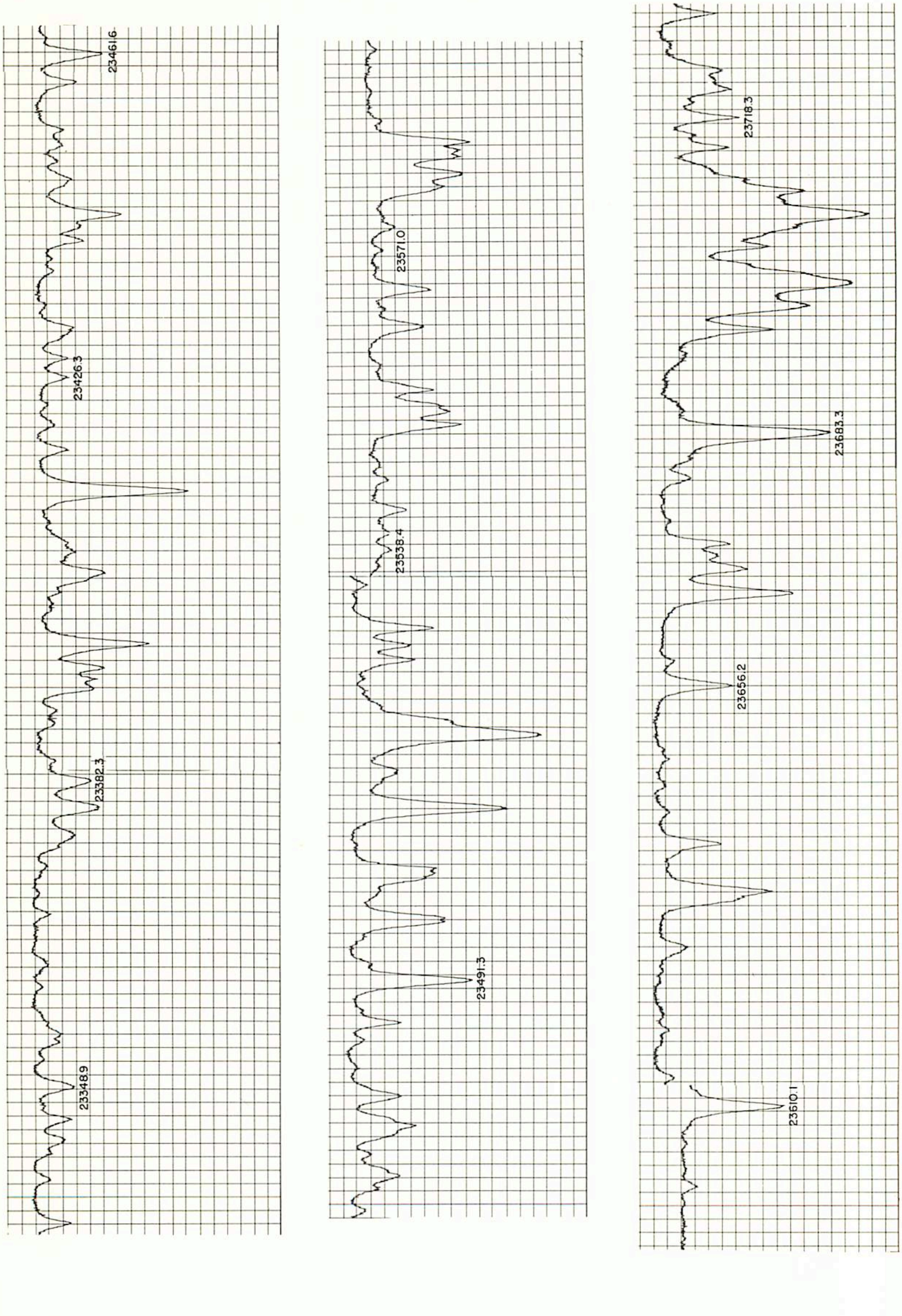

Fig. 5M Part of Michigan Atlas, that matches Fig. 5 (Reproduced with permission).

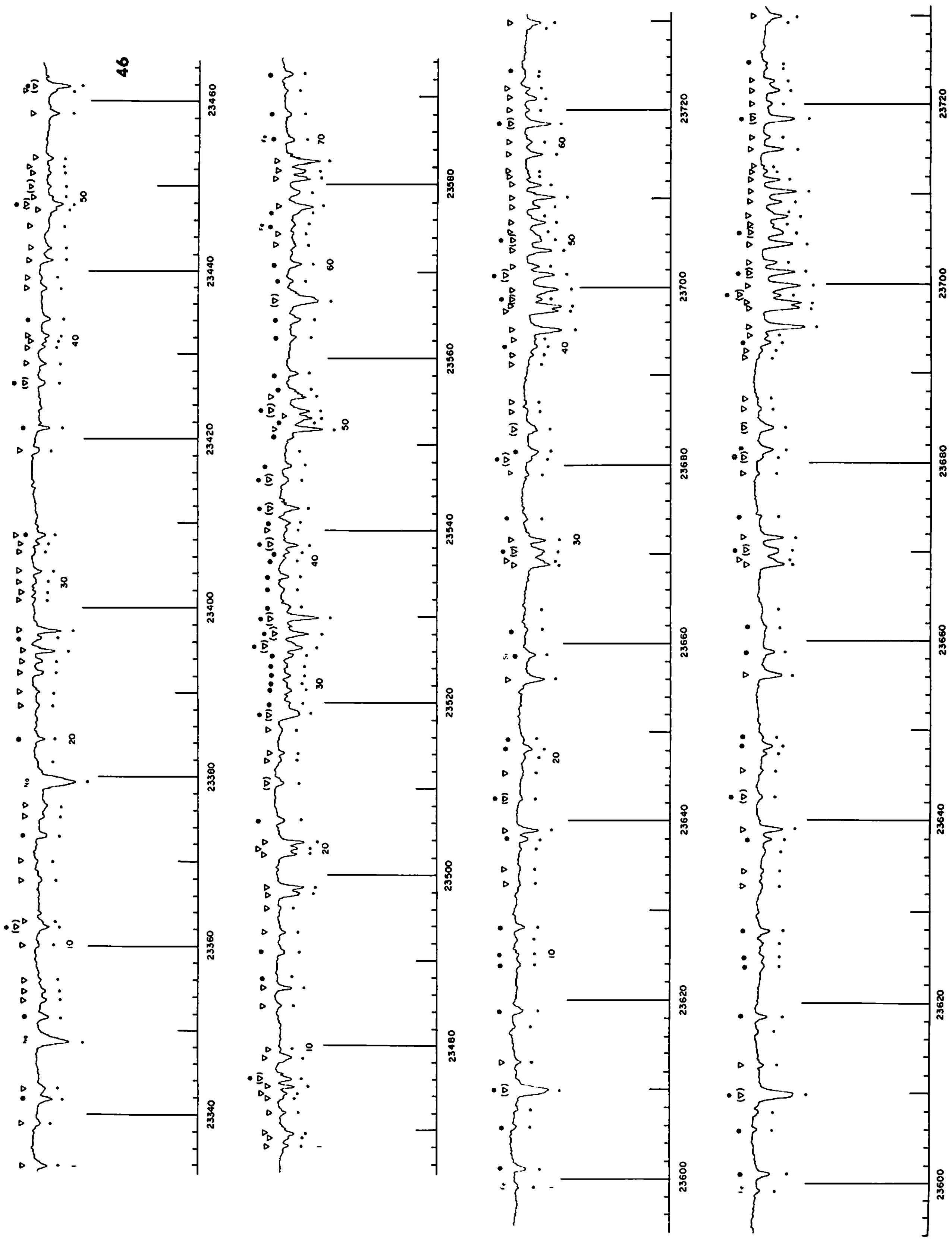

Fig. 5 Solar Spectrum λλ 23333–23731, in four strips (cf. Table 1).

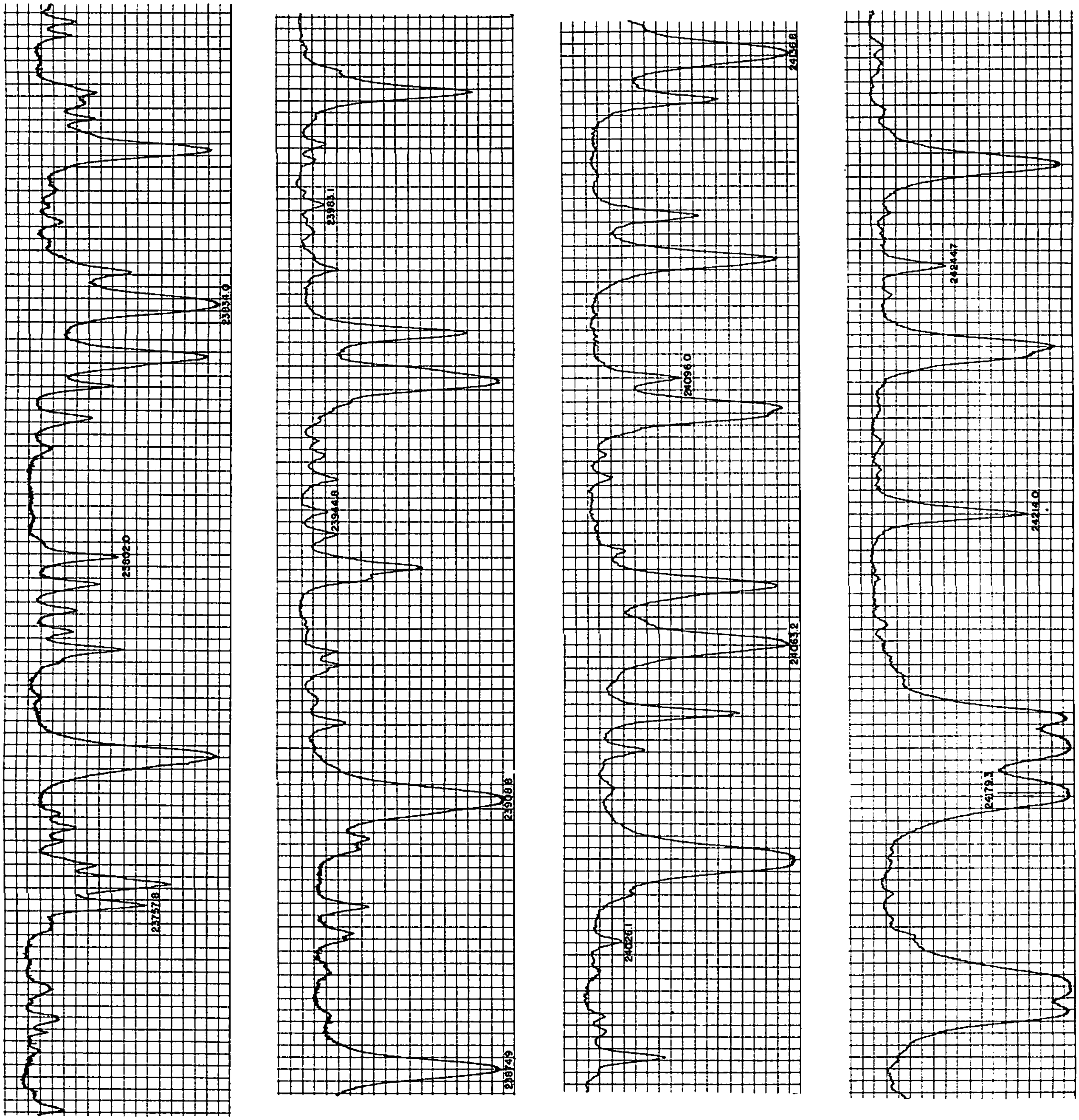

Fig. 6M Part of Michigan Atlas, that matches Fig. 6 (Reproduced with permission).

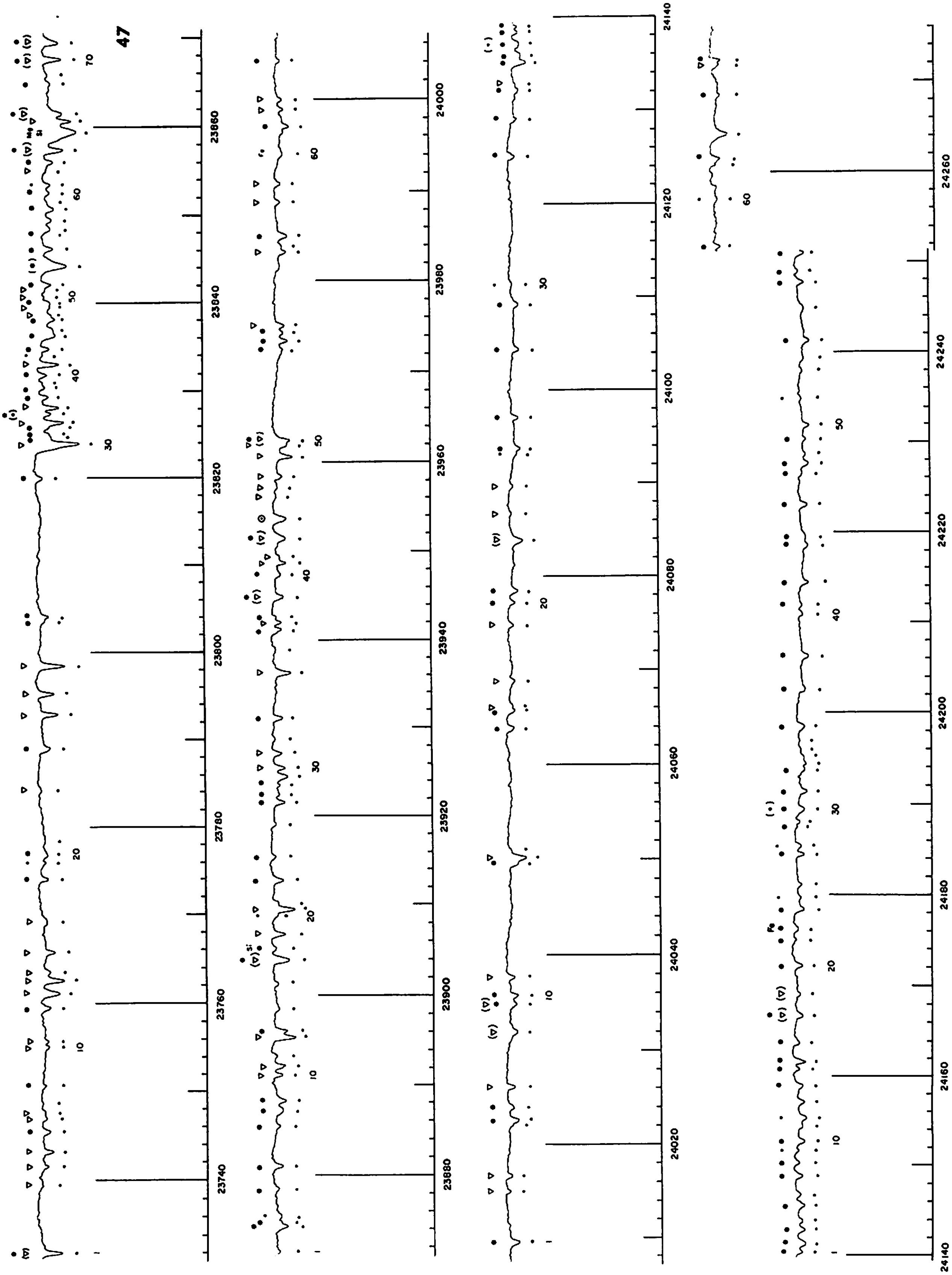

Fig. 6 Solar Spectrum λλ 23731–24276, in four strips (cf. Table 1).

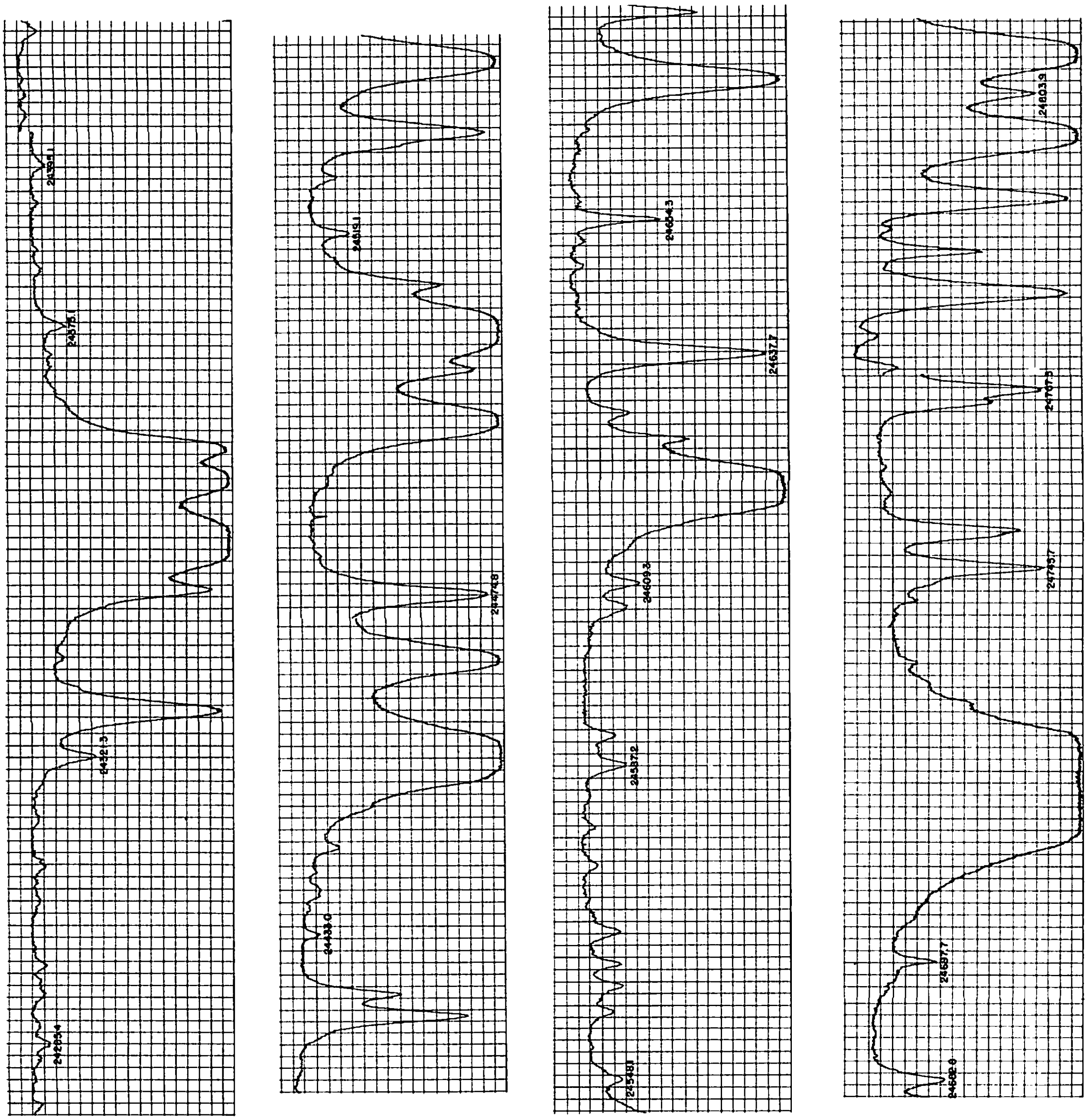

Fig. 7M Part of Michigan Atlas, that matches Fig. 7 (Reproduced with permission).

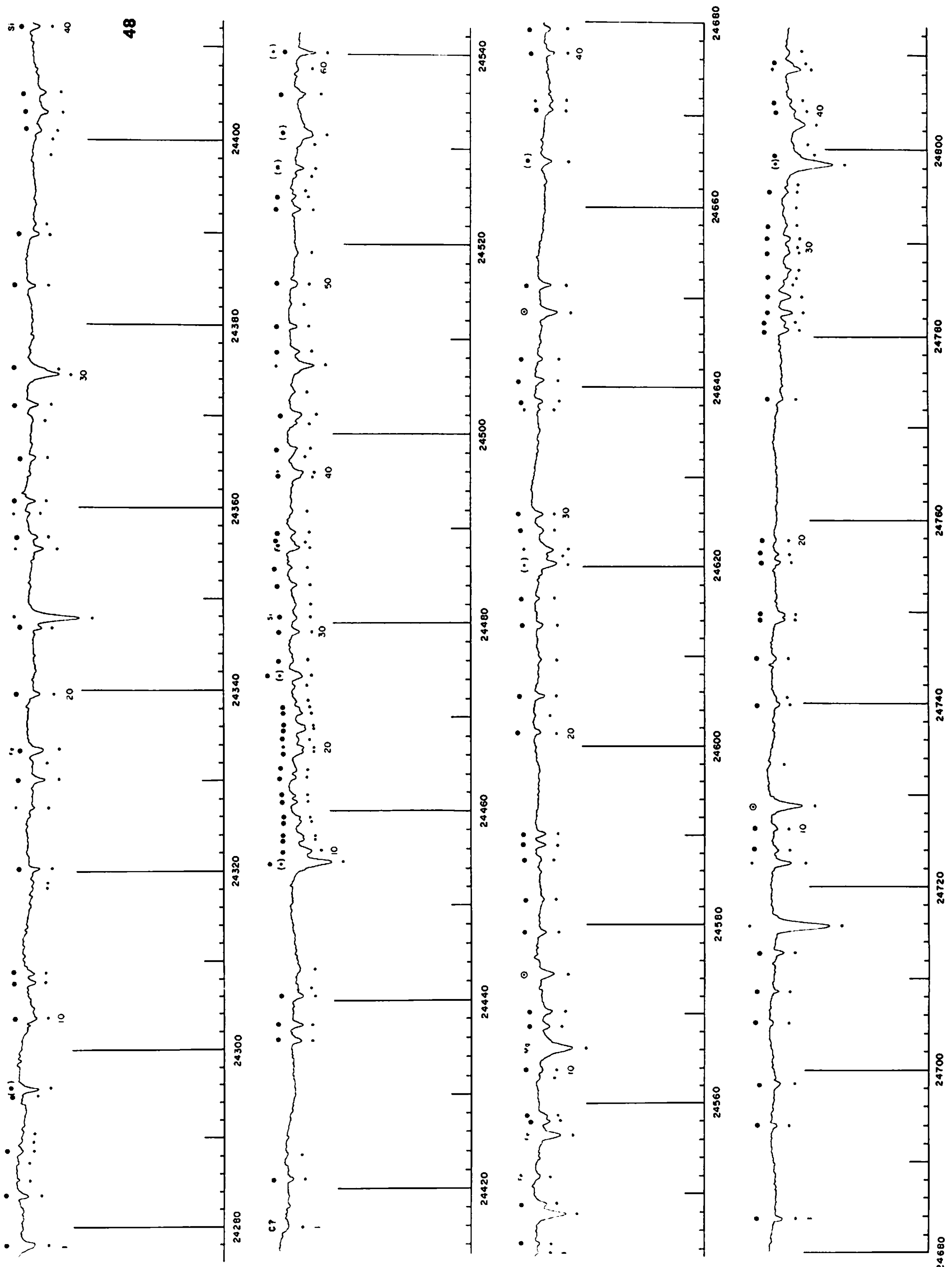

Fig. 7 Solar Spectrum λλ 24276–24813, in four strips (cf. Table 1).

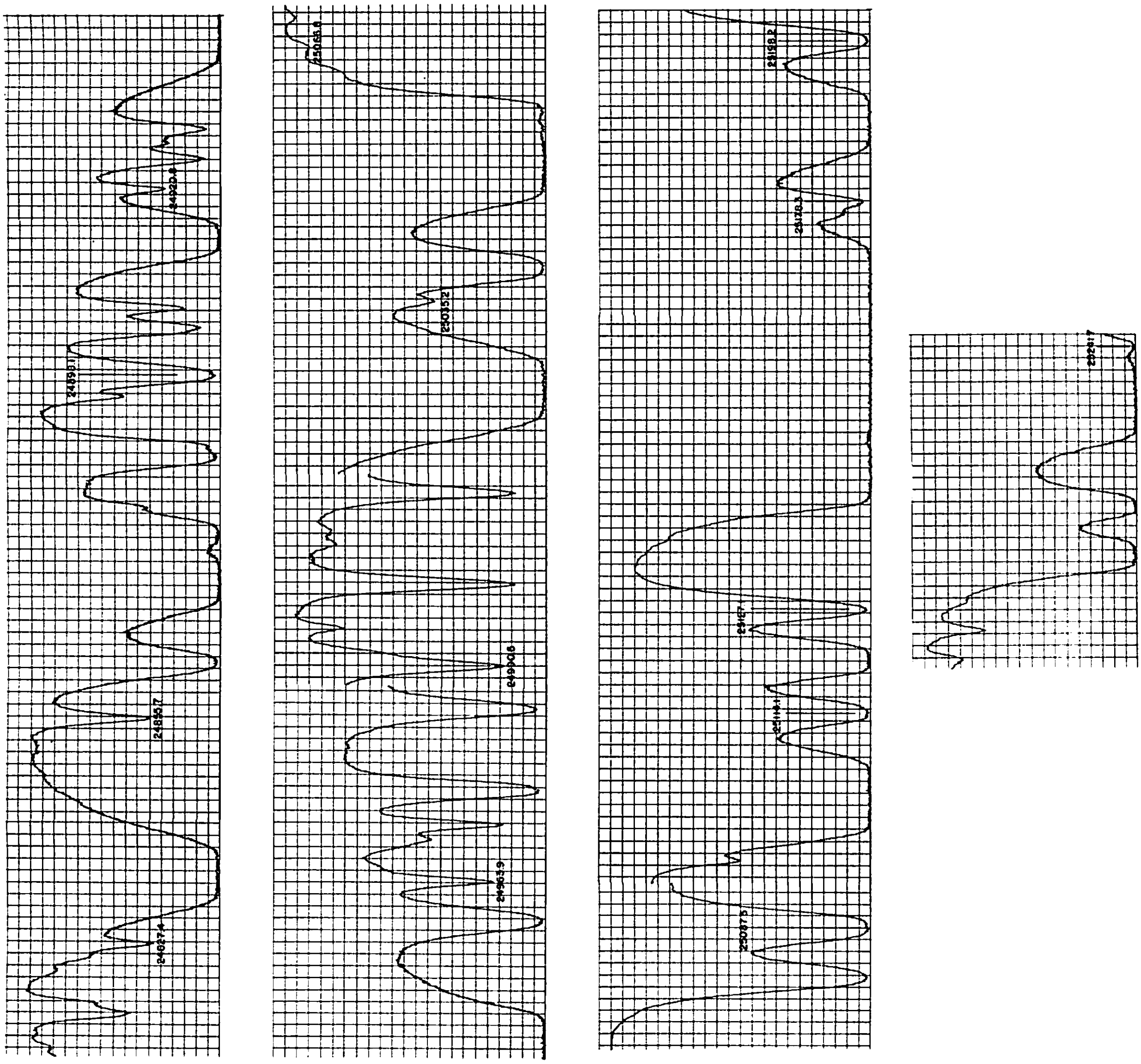

Fig. 8M Part of Michigan Atlas, that matches Fig. 8 (Reproduced with permission).

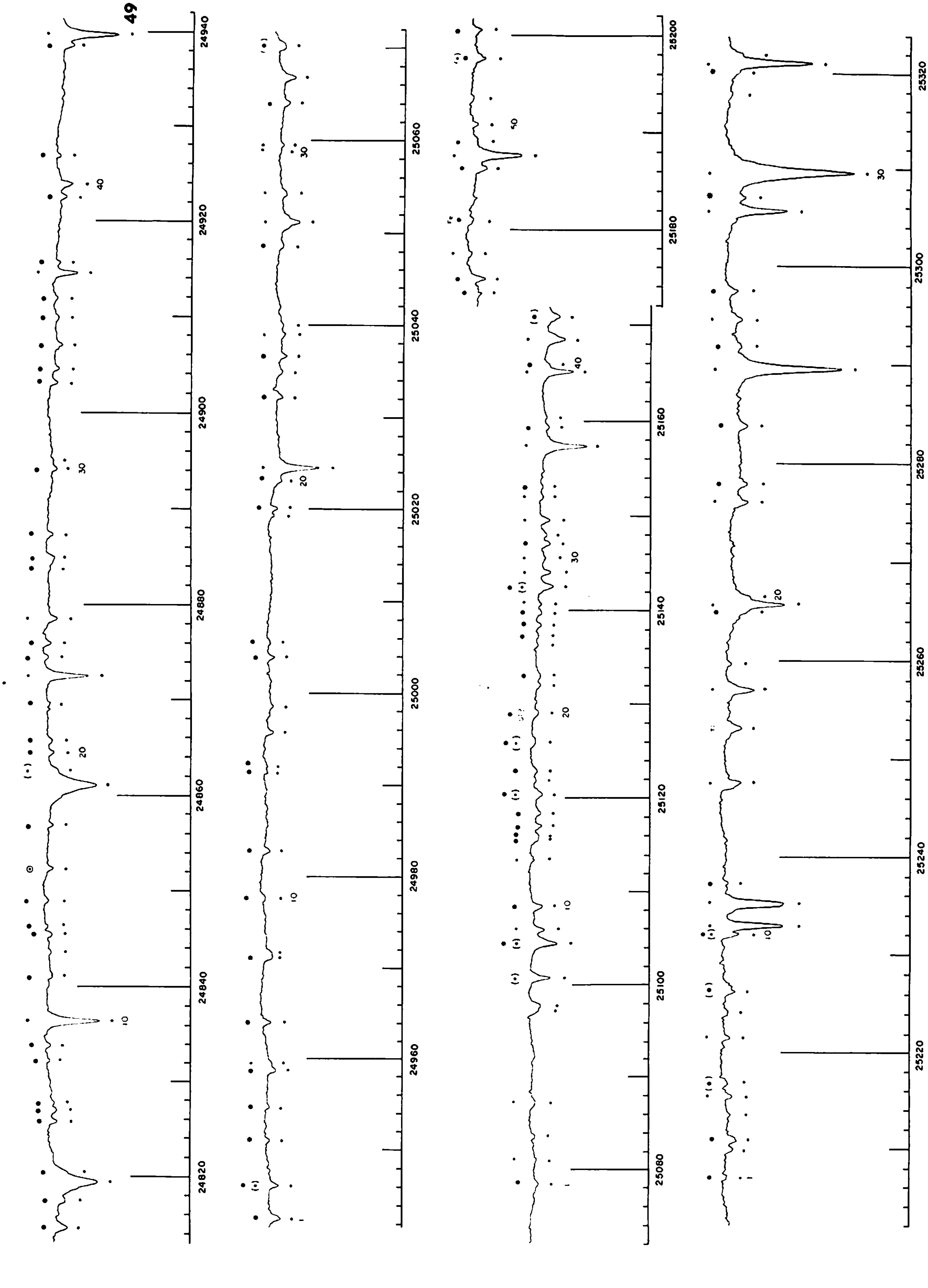

Fig. 8 Solar Spectrum λλ 24813–25324, in four strips (cf. Table 1).

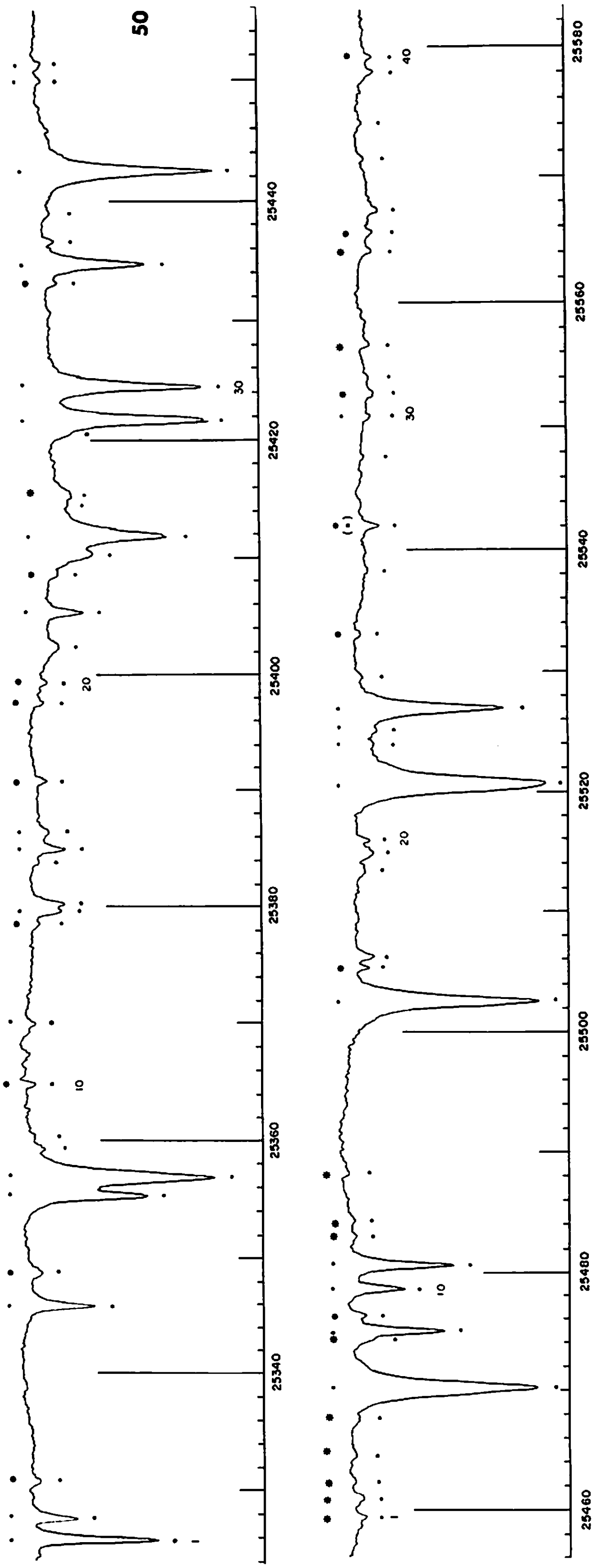

Fig. 9 Solar Spectrum λλ 25324–25583, in two strips (cf. Table 1).

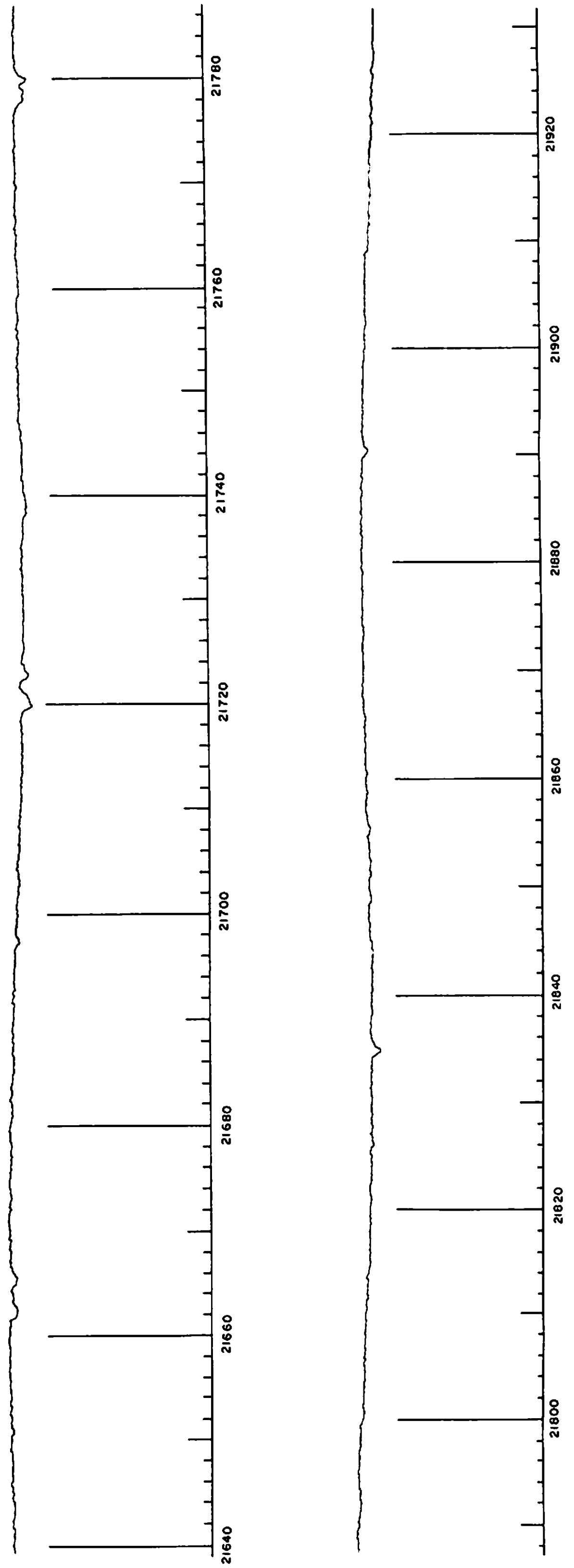

Fig. 10 Laboratory spectrum of methane, covering the same spectral interval as Fig. 1*b*, *c*.

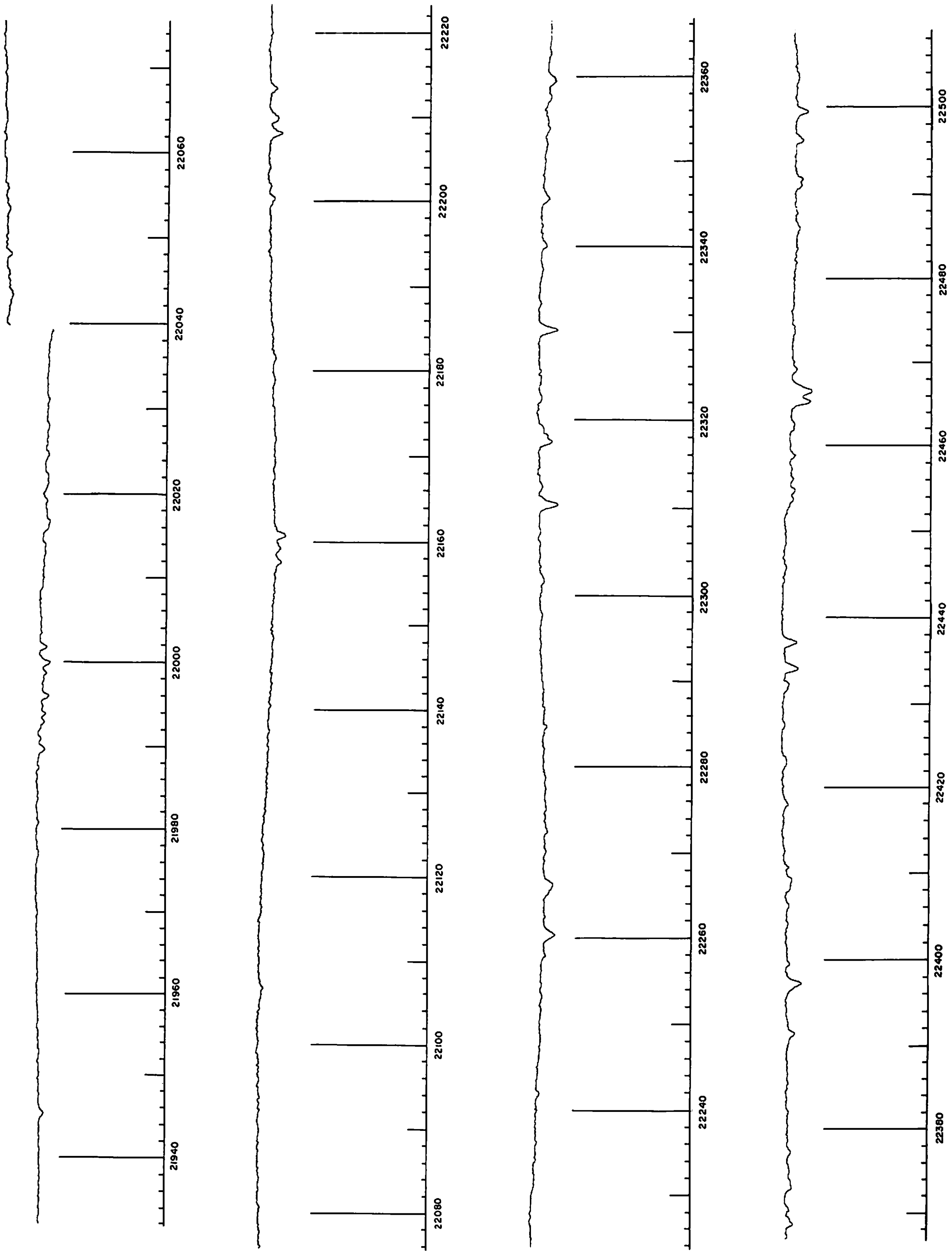

Fig. 11 Laboratory spectrum of methane, covering the same spectral interval as Figs. 1*d*, 2*a*, *b*, *c*.

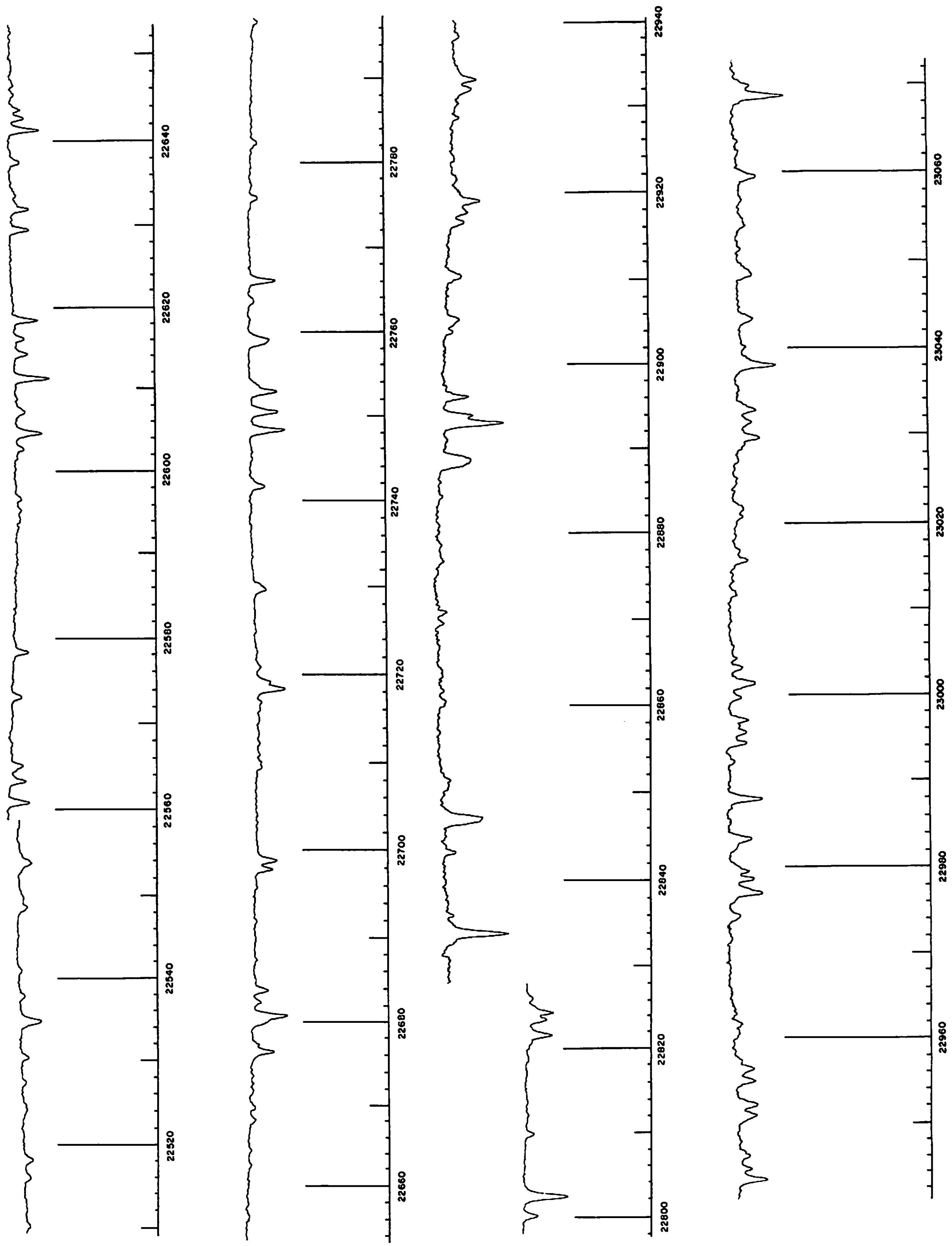

Fig. 12 Laboratory spectrum of methane, covering the same spectral interval as Figs. 2*d*, 3.

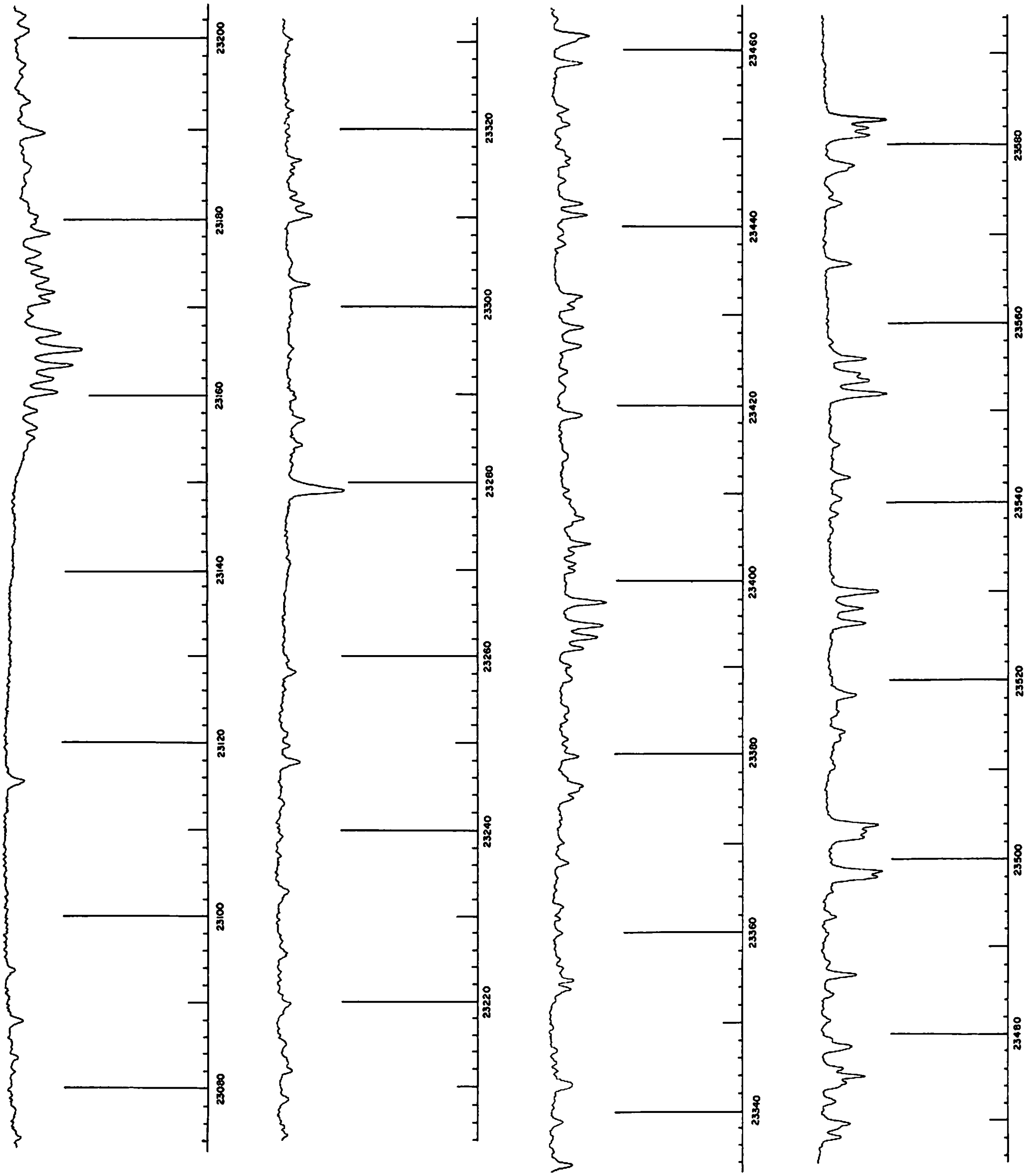

Fig. 13 Laboratory spectrum of methane, covering the same spectral interval as Figs. 4, 5*a*, *b*.

Fig. 14 Laboratory spectrum of methane, covering the same spectral interval as Figs. 5*c*/*d*, 6*a*, *b*, *c*.

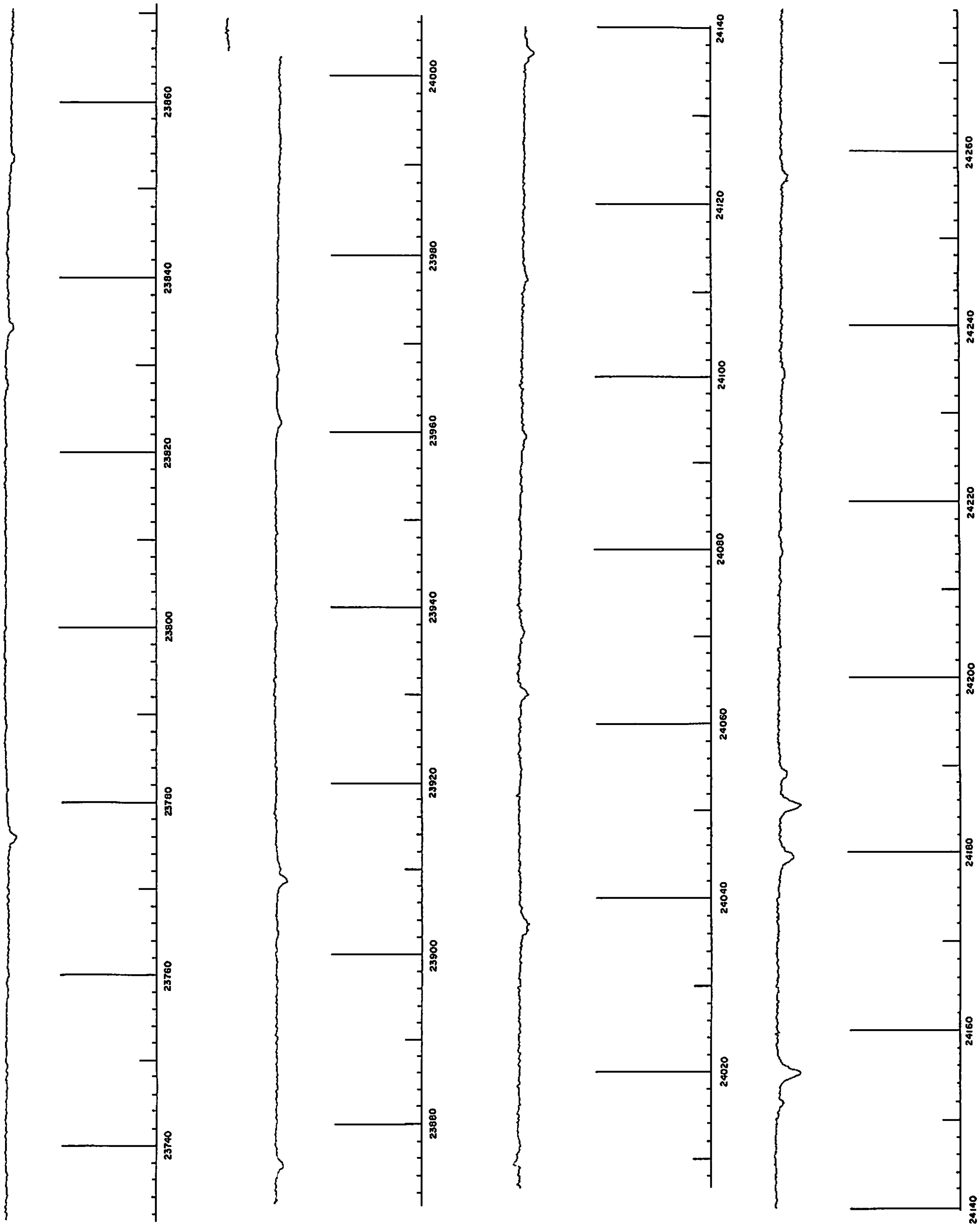

Fig. 15 Laboratory spectrum of water vapor, covering the same spectral interval as Fig. 6.

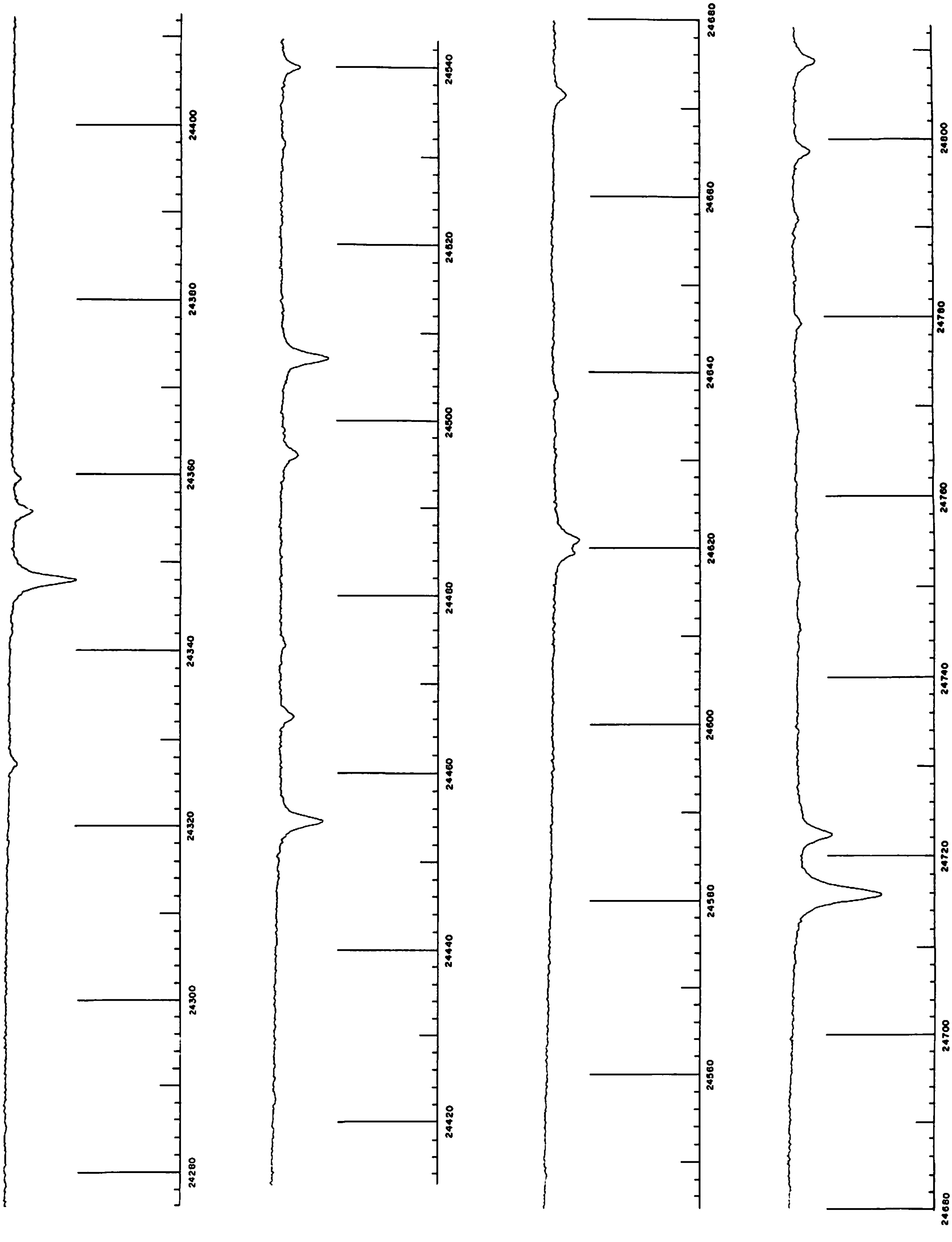

Fig. 16 Laboratory spectrum of water vapor, covering the same spectral interval as Fig. 7.

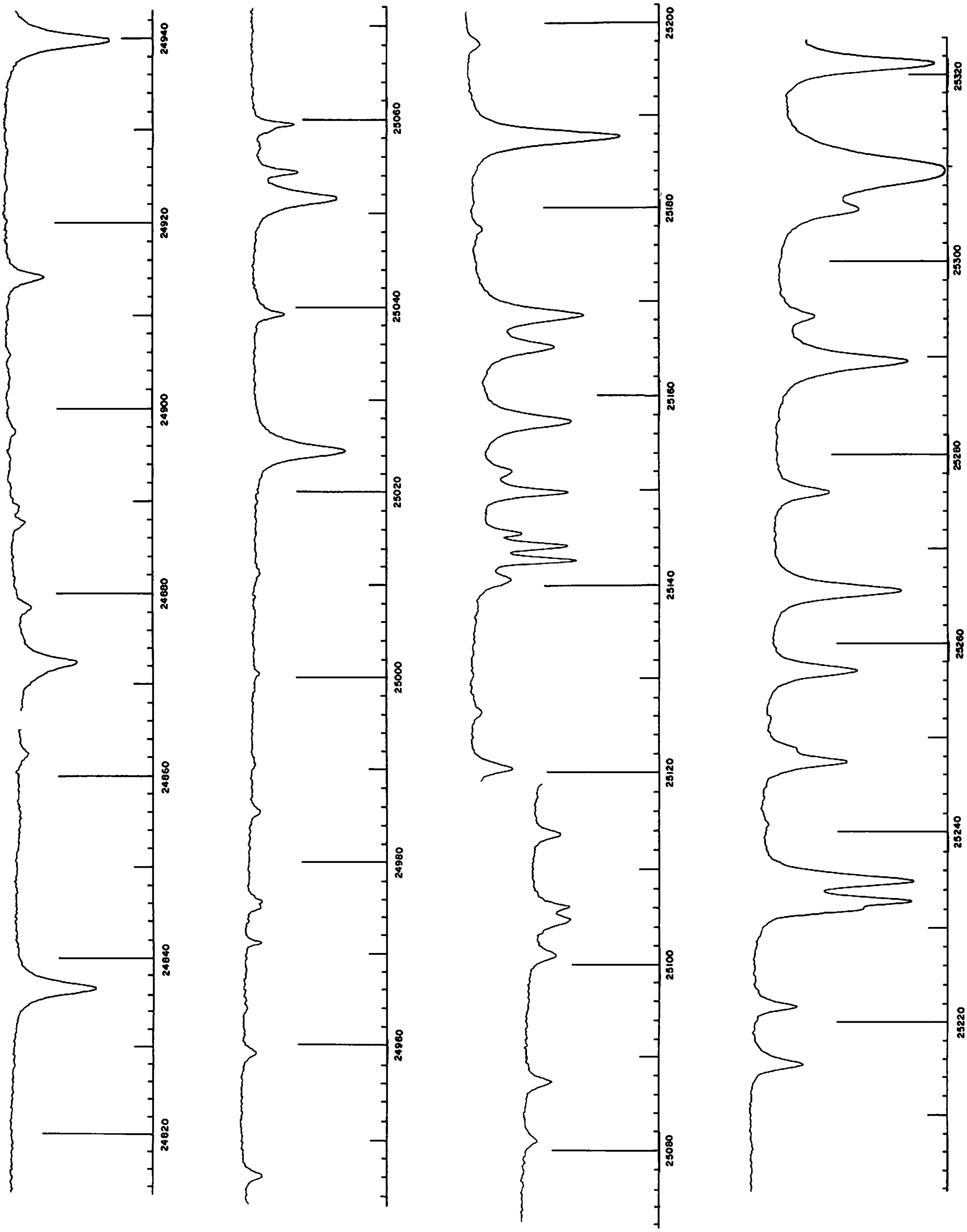

Fig. 17 Laboratory spectrum of water vapor, covering the same spectral interval as Fig. 8.

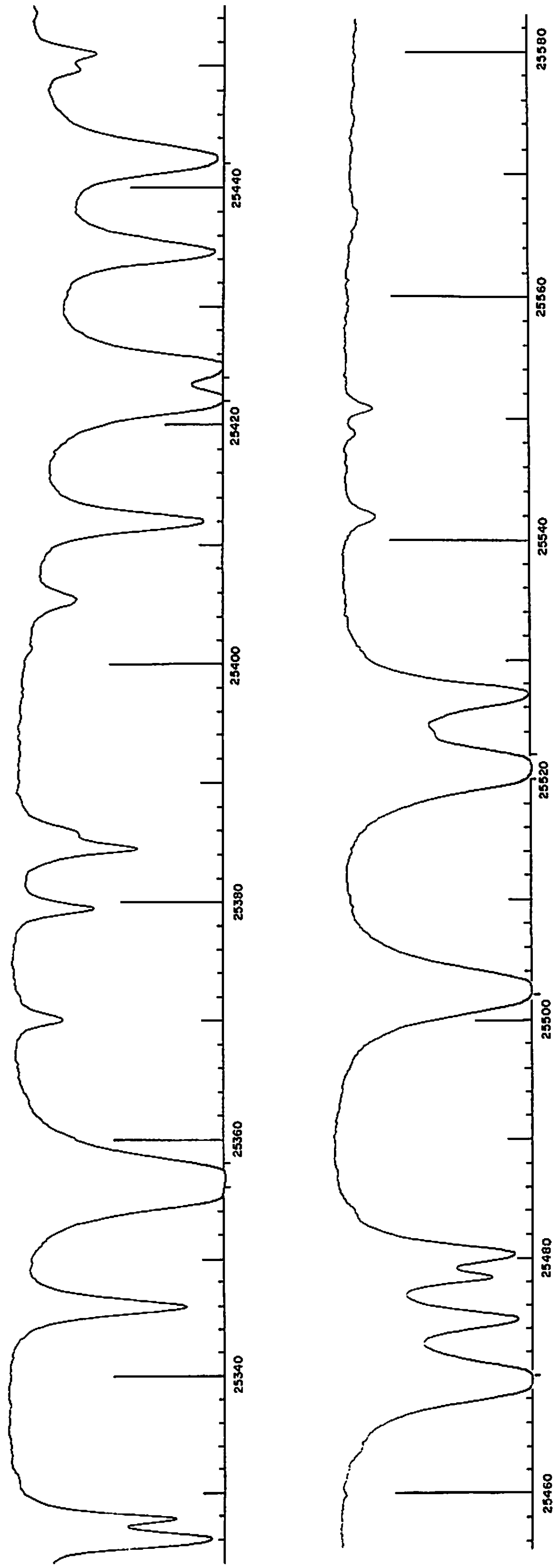

Fig. 18 Laboratory spectrum of water vapor, covering the same spectral interval as Fig. 9.