Pseudomesolite is mesolite

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ABSTRACT. Pseudomesolite from Carlton Peak, described by Winchell (1900), is shown to be mesolite by means of chemical and X-ray data. A proposal to this effect has been accepted by the International Mineralogical Association's Commission on New Minerals and Mineral Names. Electron microprobe analysis revealed variations in the composition of pseudomesolite and showed the presence of faroelite. The X-ray powder diffraction pattern is similar to that of mesolite. Single-crystal Weissenberg photographs showed a twinning intergrowth which is explained by a 90° rotation of 50 % of the unit cells about the c-axis, so that the a- and b-axes of rotated cells coincide with the b- and a-axes respectively of the unrotated cells. This twinning can not be detected optically. Mesolite has recently been proved to be ortho-rhombic, contrary to the long-held view that it is mono-clinic.

Pseudomesolite from Oregon is also shown to be mesolite by single crystal Weissenberg photographs. A wet chemical analysis shows this material to be extremely silica-rich.

KEYWORDS: mesolite, pseudomesolite, zeolite, Carlton Peak, Minnesota, Oregon.

PSEUDOMESOLITE, described as a new zeolite from Carlton Peak, Minnesota, USA, was named by Winchell (1900) in allusion to its chemical (Table I) similarity with mesolite, from which it differs optically. Its optical orientation is γ: elongation = 0-20° (variable), whereas mesolite has $\beta \parallel$ elongation. Until 1972 mesolite was considered to be a monoclinic mineral with $\beta = 90.00°$ (Hey, 1933); this view being entrenched in the literature by Hey's work on zeolites. Adiwidjaja (1972) determined the crystal structure of mesolite and proved that its monoclinic nature, evident from Hey's (1933) optical work, could not be detected by X-ray examination.

The type specimen of pseudomesolite, which we

obtained from the National Mineralogy Museum, Paris (No. 100917), exhibits optical behaviour as reported by Winchell (1900). The X-ray powder pattern matches that of mesolite, whilst the single crystal diffraction pattern is complex, due to twinning intergrowths. This paper presents our chemical and X-ray data which indicate that pseudomesolite is mesolite. A recommendation to this effect has been accepted by the International Mineralogical Association's Commission on New Minerals and Mineral Names.

A specimen of Oregon pseudomesolite, obtained from Sorbonne, was also shown to be mesolite by chemical analysis and by single crystal X-ray diffraction.

Carlton Peak material

Description. A few fragments comprising the zeolite and plagioclase were available for this study. The zeolite was in the form of fibrous aggregates with no form of regular intergrowth evident under optical examination. Optically the fibres were length-slow. Because of divergence in the alignment of fibres, it was not possible to ascertain if the fibres had straight or inclined extinction.

Chemical composition. The zeolite was analysed at the Grant Institute, Edinburgh, using an electron microprobe fitted with EDS. The analyses and atoms per 80 oxygen cell are listed in Table I (cols. 3, 4, 5), and show a considerable compositional variation from mesolite (cols. 4, 5) to thomsonite (variety faroelite, col. 3). Winchell's (1900) analysis (cols. 1, 2) may be considered an average of the whole zeolite sample.

X-ray single crystal data, mesolite standard. A specimen of Bombay mesolite was used as a

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TABLE I. *Chemical composition of pseudomesolite*

	Carlton Peak material					Oregon material		
	1	2	3	4	5	6	7*	8
SiO_2	45.25	45.99	40.95	46.12	43.77	43.80	48.5	49.08
Al_2O_3	25.69	26.11	28.55	25.86	27.13	28.20	24.2	24.49
Fe_2O_3	1.40	—	—	0.11	—	—	—	—
CaO	9.75	9.91	11.33	9.64	10.27	10.48	8.54	8.12
MgO	T	—	—	—	—	0.04	0.03	0.03
Na_2O	4.24	4.31	5.06	5.39	5.20	3.22	5.91	5.98
K_2O	0.47	0.48	—	—	0.08	1.46	0.06	0.06
H_2O	12.99	13.20	[14.11]	[12.88]	[15.56]	13.24	12.1	12.24
Total	99.76	100.00	100.00	100.00	100.00	100.44	99.75	100.00
Si		24.01	21.93	24.02	23.10	22.93		25.16
Al		16.06	18.02	15.88	16.87	17.40		14.80
Fe		—	—	0.07	—	—		—
Ca		5.54	6.50	5.38	5.81	5.88		4.46
Mg		—	—	—	—	0.03		0.02
Na		4.36	5.25	5.44	5.32	3.27		5.95
K		0.32	—	—	0.05	0.98		0.04
H_2O		22.98	[25.20]	[22.37]	[27.39]	23.12		20.93

T = Trace * Total includes 0.41 % CO_2 [ ] = $H_2O$by difference
1. Analysis by A. N. Winchell (1900).
2. Analysis (1) calculated to 100% after deducting Fe_2O_3.
3–5. Electron microprobe analyses of various parts of one splinter. H_2O by difference. Analyst N. Moles.
6. Analysis by Hewett *et al.* (1928).
7. Wet chemical analysis, analyst V. K. Din.
8. Analysis (7) calculated to 100% after deducting CO_2 and CaO assuming calcite impurity.

standard for single-crystal work to compare with both the powder pattern and the single-crystal data obtained for Carlton Peak pseudomesolite. The unit-cell orientation given by Adiwidjaja (1972) and illustrated by Gottardi (1978, Fig. 10), was adopted for this work. Consequently the short axis (6.54 Å) of mesolite parallel with elongation, is labelled as the *c*-axis whereas Hey (1933) labelled this axis as the unique *b*-axis of the monoclinic cell. The space group of the Bombay mesolite was confirmed to be *Fdd2*.

X-ray powder data, pseudomesolite. The X-ray powder pattern obtained using a Weissenberg camera and Ni-filtered copper radiation is listed in Table II. This pattern is very similar to the data for mesolite obtained by Alberti *et al.* (1982). A Weissenberg camera was used, at the cost of resolution, so that the powder pattern could be compared with rotation and zero-level Weissenberg films of mesolite to verify the indexing of Alberti *et al.* (1982).

X-ray single crystal data, pseudomesolite. The pseudomesolite sample selected for single crystal

work comprised a thin bundle of fibres. Both the zero-level and first-level Weissenberg photographs show doubling of spots. On the zero level photograph *h*00 and 0*k*0 show maximum separation (along the 2θ axis), *hh*0 show minimum separation (coincident) and *hk*0 show intermediate separation. Another feature of the photographs is that individual spots are elongated along the ω film direction because the *c*-axes of the fibres in the bundle were not quite coincident. Consequently the very small separation of some *hk*0 spots in the 2θ direction is masked.

Superficially, the zero-level photograph is similar to a zero-level photograph of natrolite because, in general, the *hk*0 reflections having *k* ≠ 3*n* are either very weak or absent. However, closer inspection reveals spots such as 6.14.0 and 2.22.0 which are not possible for natrolite because *k* should be divisible by 3. Comparison of the zero-level axial reflections for mesolite and pseudomesolite suggests that the splitting mentioned above may be due to the rotation through 90° about the *c*-axis of half the

TABLE II. *X-ray powder pattern of pseudomesolite*

d(Å)	I	d(Å)	I
6.63	40	2.232	5
6.13	5	2.195	50
5.87	60	2.171	20
5.49	10	2.121	5
4.72	40	2.036	10
4.64	30	1.991	10
4.41	60	1.948	15
4.18	30	1.869	15
3.96	10	1.850	15
3.22	40	1.800	50
3.17	50	1.750	15
3.09	50	1.710	5
2.99	10	1.683	15
2.93	30	1.653	5
2.86	100	1.634	20
2.74	5	1.610	5
2.573	20	1.586	5
2.473	30	1.537	10
2.415	30	1.519	10
2.311	10	1.486	5
2.270	10		

unit cells, such that the a- and b-axes of unrotated cells coincide with the b- and a-axes respectively, of rotated cells. This suggestion has been proved by measurement of the zero-level film and by geometrical construction. The cell dimensions of the Carlton Peak pseudomesolite are a 18.39, b 56.64 and c 6.53 Å and extinctions are consistent with the space group $Fdd2$: therefore pseudomesolite is a mesolite. The low intensity of the $hk0$ spots having $k \neq 3n$ suggests that Na and Ca are somewhat disordered in the Carlton Peak material.

Unit-cell rotation of the type described has been noted in other minerals such as natrolite (Pabst, 1971) and gobbinsite and garronite (Nawaz and Malone, 1982; Nawaz, 1983).

Oregon pseudomesolite

Hewett *et al.* (1928) described a further occurrence of pseudomesolite from Ritter Hot Springs, Oregon, USA. Their chemical analysis is given in Table I (col. 6). Our analysis of material from the same locality, obtained from Sorbonne and analysed by wet methods, is given in Table I (col. 8). This material contains more Na and Si but less Ca, Al, and H_2O than that examined by Hewett *et al.* (1928). The Weissenberg zero-level and first-level photographs prove it to be mesolite with space group $Fdd2$, and devoid of the intergrowth occurring in Carlton Peak pseudomesolite.

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