New data on wittichenite

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SUMMARY. The wittichenite (BM 1977, 172) discovered in the course of a reflected light study of polished sections from the Seathwaite deposit, Cumbria (described earlier in this journal by Stanley and Criddle), is the first authenticated occurrence of the species in Great Britain; for this reason it was examined in detail and compared with a specimen (BM 1437) from Wittichen, the type locality. Chemical analyses, cell dimensions, visible-spectrum reflectances, quantitative colour values, and VHN's are provided. They are in agreement with previously published data for the species.

Specimen preparation. Specimens from both localities were mounted in epoxy resin and ground by hand on water-lubricated glass plates with 600grade and 800-grade carborundum and 1200-grade alumina. Grinding was continued with 14 μ m, 6 μ m, and 3 μ m diamond on water-lubricated Hyprocel laps on Engis machines. A thick paste of MgO in distilled water was used on a stationary cloth lap for the final stage of polishing, which was by hand. This was found preferable to the finer grades of diamond in that a 'perfect' polish was achieved in less than 30 seconds, thus reducing polishing relief induced by the extended polishing times needed for finishing with diamond.

Measurement procedure. Six specimens labelled as wittichenite, from Wittichen, in the BM (NH) collection were examined, but only one was found suitable for measurement. In this, and in the Seathwaite specimens, the areas measured were examined for freedom from inclusions and surface imperfections with a $\times 40$ Nomarski objective. Three areas were selected for measurement on each of the Wittichen and Seathwaite mounts.

Measurements were made with a Zeiss Universal microscope equipped with \times 16 air and \times 16 oil objectives, immersion oil (Zeiss) $n_{\rm D}$ = 1.5150 at 23 °C and a SiC standard no. 232. This equipment is semi-automated. A step driven, wavelength scanning, line-interference filter and a digital voltmeter

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are 'on line' to a Hewlett Packard 9830 programmable calculator. An unpublished program written by G. S. Bearne was used to make measurements at 10 nm intervals from 400–700 nm and to derive from the measured reflectances the absorption coefficients, refractive indices, and quantitative colour values with respect to the CIE illuminants A, D_{65} , and C.

A modified Lanham stage was used to level and to interchange the specimens and the standard, which were focused in white light. As the precision of this apparatus was poor below 450 nm, at least two spectral scans were made for each grain measured and the results averaged. These data were plotted on a scale of I % R = 20 nm, and the curves smoothed graphically. The smoothed values (Tables I and II) differ from the measured values by no more than 0.2% (absolute) at any wavelength. The quantitative colour values, Table III, were derived from these data by the weighted-ordinate method. The ordinates used were weighted for the wavelength range commonly employed in ore microscopy, that is, 400-700 nm, and not for the range generally used in colorimetry of 380-770 nm. The two-dimensional colour-space coordinates (polar) were derived mathematically from the rectangular chromaticity coordinates. Table III includes colour values with respect to the two illuminants recommended by the CIE, A, and D_{65} and for the C illuminant used in the IMA/COM Quant. Data File.

Optical characteristics. In plane-polarized light (colour temperature c. 3000 °K), wittichenite from Seathwaite is white to creamy-white; there is no change in its colour in oil. Under the same conditions of illumination the wittichenite from Wittichen appeared greyish-white and to have a lower reflectance. Neither reflectance-pleochroism nor bireflectance were discernible. However, all the grains examined were weakly anisotropic; between crossed polars the rotation tints are varying shades of dark brown.

The spectral reflectance curves for the species, from both localities, are similar and are weakly dispersed. For this reason individual curves have not been plotted; instead, the extreme *R*-values, in air and in oil, for each wavelength were selected, tabulated (Table IV), and plotted (fig. 1). It will be seen that the data for Seathwaite material are in good agreement with those obtained from the topotype specimen. Both are in excellent agreement with Caye and Pasdeloup's data quoted in the IMA/COM card 1.9760 (1977), for the species (from Butte, Montana, USA). The complete reflectance data for each grain (Tables I and II) reveal that the R_2 curves for grain I from Seathwaite and grains 4 and 6 from Wittichen cross the corresponding R_1 curves at c.420 nm in air. In oil, R_2 crosses R_1 at c.400 nm for the Seathwaite grain I as it does for grain 6 from Wittichen. The trend of these curves is shown for the wavelength range 400-500 nm for both media (fig. I). In the absence of oriented sections we cannot explain the consistent crossover at c.420 nm.

The reflectance curves and tables show that the difference in colour and brightness between the Seathwaite and Wittichen wittichenites, noted



FIG. 1. Reflectance of wittichenite.

earlier, is not real. It is a result of the eyes' poor memory for brightness and colour, particularly where, as in this case, the associated minerals in the two mounts are different. In the Seathwaite specimens many of the associated minerals, including bornite, digenite, djurleïte, hematite, and covelline, are more strongly saturated, differ in hue and, in general, have lower brightness levels than has wittichenite. Hence, the wittichenite appears white to creamy-white, and to have a relatively high reflectance. In comparison, in the Wittichen mount, it appears greyish-white and not as highly reflecting. This is because it is associated with other copper bismuth and bismuth sulphides, which are similar in hue and saturation, but have higher reflectances. For these reasons, identification of the species from subjective optical criteria is difficult, but preliminary identification (as was the case with the topotype material in this study) may be made with some confidence from a few reflectance measurements.

Microhardness. The Vickers hardness number was measured on twelve grains from both Seathwaite and Wittichen material. Wittichenite from Seathwaite had VHN₁₀₀180 (standard error of the mean ± 2.04) with a range of 170 to 187. Topotype material had VHN₁₀₀186 (standard error of the mean ± 1.58) and range 178 to 197.

The indentations were slightly fractured at their corners, had concave sides, and were almost square in outline. For each measurement the final value was calculated by using the averages of the two diagonals of the quadrilaterals. Results from both Seathwaite and Wittichen wittichenite are in agreement with previously published data by Pärnamaa (1963), Young and Millman (1964), and Nordrum (1972).

Structure. 11.483 cm diameter powder patterns (Cu-K α radiation, Ni filter) were obtained with material removed from polished mounts from Seathwaite and topotype wittichenite. The *d*-values are in excellent agreement with Berry and Thompson's (1962) data for wittichenite from the type locality. Cell parameters were calculated from the first 28 lines using an unpublished computer program for the orthorhombic system:

Wittichen BM 1437 Seathwaite BM 1977, 172

a 7.677±0.010Å	7.657±0.015
b 10.349±0.015	10.308±0.022
c 6.706±0.009	6.707±0.013

Chemistry. Six areas of wittichenite on the Seathwaite sections and seven on the Wittichen section were analysed by electron probe. In both cases three of the analyses were on scribed areas previously used for reflectance measurements. A Cambridge Microscan 5 operated at 20 kV was used, the radiations measured being Bi- $L\alpha$, Cu- $K\alpha$, S- $K\alpha$ and using standards Bi₂S₃, Cu, and FeS₂. The results (Table VI) were corrected using a computer program devised by Duncumb and Jones (1969).

The average compositions Cu 38.0; Bi 42.8; S 18.3% for Seathwaite and Cu 37.7; Bi 43.4; S 18.7% for Wittichen material compare well with published data (Sugaki *et al.* 1974; Kocman and Nuffield, 1973) and the stoichiometric composition. Wittichenite from both localities is chemically homogeneous. Solid solution with silver, which has been previously reported (Oen and Kieft, 1976, and Sugaki *et al.*), was not found.

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REFERENCES

- Berry (J.) and Thompson (R.), 1962. Geol. Soc. Am. Mem. 85.
- Caye (R.) and Pasdeloup (J.), 1977. In IMA/COM Quantitative Data File, ed. N. F. M. Henry.
- Duncumb (P.) and Jones (E. M.), 1969. Tube Investments Research Labs., Report no. 260.
- Kocman (V.) and Nuffield (E. W.), 1973. Acta crystallogr. **B29**, 2528-35.
- Nordrum (F. S.), 1972. Norsk. Geol. Tidsskr. 52, 257-71.
- Oen (I. S.) and Kieft (C.), 1976. Can. Mineral. 14, 185-93.
- Pärnamaa (E.), 1963. Lunds. Univ. Årsskrift, 59.
- Sugaki (A.), Shima (H.), and Kitakaze (A.), 1974. J. Japan Assoc. Mineral. Petr. Econ. Geol. 69, 32-43.
- Young (B. R.) and Millman (A. P.), 1964. Bull. Inst. Min. Metall. Trans. 73, 437-66.

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			Seath	Seathwaite			w.			Wittichen		
Grains -			2			3		4	5		6	
λnm	R1	R ₂	R ₁	R ₂	Rl	R ₂	R	R ₂	R ₁	R ₂	R	R2
100	33 62	24 77	34 93	34 10	34 38	32 02	33 36	34 65	34 02	31.31	33.58	34.
400	33.66	34.77	34.03	33.80	34.30	32.02	33,50	34.15	34.03	31.37	33.54	34.
420	33.68	33.68	34.64	33.54	34,30	32.09	33.67	33.68	34.05	31.45	33.52	33.
430	33.71	33.22	34.57	33.27	34.30	32.11	33.85	33.23	34.08	31.55	33,51	33.
440	33.75	32.82	34.53	33.03	34.30	32.16	34.03	32.86	34.14	31.67	33,51	32.
				20.07		20.02	24.26	22 60	24 22	21 79	33 63	32
450	33,81	32,51	34.50	32.8/	34.31	32.23	34.25	32.00	34.22	31,70	33.60	32
450	33.88	32.33	34,53	32.70	34.37 24 AF	32.30	34.30	32.40	34 50	32 04	33.72	32
470	33.98	32.20	34.50	32.75	24.45	32.39	34.73	32.40	34 67	32.18	33.88	32.
480 490	34.20	32.27	34.67	32.88	34.01	32.50	35.12	32.62	34.88	32.36	34.08	32.
											24.07	20
500 510	34.37 34.50	32.46	34,98 35,17	33.01 33.14	34.90	32.67	35.31 35.47	32.77	35.06	32.55	34.27	32.
520	34.50	32.50	35 31	33.26	35.24	33.00	35.60	33.06	35.38	32.91	34.58	32.
530	34.69	32.03	35 40	33 37	35.40	33.12	35.70	33.22	35.49	33.06	34.69	32
540	34.80	32.91	35.47	33,47	35.49	33.28	35.77	33,38	35.56	33,19	34.77	32.
							25.02	22.50	26 60	22.24	34 82	33
550	34.88	33.00	35.55	22.05	30.51	33.32	35.83 35.87	33,50	35 62	33 44	34 86	33
50U 670	34.95	33.09	30.58	33.01	30.59	33.40	35.62 35.70	33.67	35 62	33 42	34 .87	33
590	35 03	33.17	35 61	33.00	36 64	33 47	35.70	33.70	35.59	33,56	34.87	33
590	35.01	33.22	35.58	33.72	35.50	33.46	35.65	33.70	35.55	33.56	34,84	33
								22.00	25 46	33 63	34 90	37
600	35.00	33,24	35.55	33.71	35.50	33.41	35.56	33.66 33.50	35.40	33.53	34.00	33
610 620	34.96	33.20	35,50	33,64	35.42	33.38	35.44	33.58	35.3/	33.4/	, 34.73 34.68	33
620 620	34.90	33.14	35.43	33,56	35,33	33.30	35.33	33.98	30.24 36 11	33, 40	34.54	33
640	34.85 34.79	33.07	35.34	33.98 33.37	35.13	33.13	35.20	33.22	34.98	33.19	34.42	32
										23.05	24 20	20
650	34.73	32.94	35.16	33.26	34.98	33.00	34.93	33.06	34.84	33.06	34.30	32
660	34.65	32.86	35.05	33.14	34.88	32.82	34.//	32.91	34.72	32.92	34.10	32
b/U	34.56	32.77	34.94	33.02	34.80	32./1	34.03	32.13	94.90 N. N.	32 58	33 92	32
690	34.4/ 34.37	32.60	34.83	32.90	34.72	32.49	34.47	32.42	34.30	32.43	33.79	32
				-								
700	34.25	32.47	34.63	32.58	34.53	32.38	34.14	32.24	34.18	32.27	33.67	32
Jable II					Ref	lectance da	ata (0il)					
			Seath	waite					Witti	Wittichen		
Grains -		1		2		3		4		5		6
Grains - λnm	R1	1 R ₂	R ₁	2 R ₂	R1	3 R ₂		4 R ₂	RI	5 R ₂	R ₁	6 R
Grains - λnm	R1	1 R ₂ 21.04	R1 21 15	2 R ₂	R ₁	3 R ₂ 18.42	R ₁	4 R ₂ 19.38	R ₁ 20.36	5 R ₂ 18 20	R ₁	6 R 19
Grains - λnm 400 410	R ₁ 21.00 20.70	1 R ₂ 21.04 20.45	R ₁ 21.15 20.78	2 R ₂ 19.25 18.95	R ₁ 20.52 20.37	3 R ₂ 18.42 18.38	R ₁ 20.08 19.89	4 R ₂ 19.38 18.98	R1 20.36 20.18	5 R ₂ 18.20 18.04	R ₁ 19.16 19.14	6 R 19 18
Grains - λnm 400 410 420	R1 21.00 20.70 20.37	1 R ₂ 21.04 20.45 19.85	R1 21.15 20.78 20.47	2 R ₂ 19.25 18.95 18.67	R ₁ 20.52 20.37 20.19	3 R ₂ 18.42 18.38 18.28	R ₁ 20.08 19.89 19.77	4 R ₂ 19.38 18.98 18.61	R1 20.36 20.18 20.03	5 R ₂ 18.20 18.04 17.89	R ₁ 19.16 19.14 19.11	6 R 19 18 18
Grains - λnm 400 410 420 430	R ₁ 21.00 20.70 20.37 20.08	1 R ₂ 21.04 20.45 19.85 19.23	R ₁ 21.15 20.78 20.47 20.20	2 R ₂ 19.25 18.95 18.67 18.40	R ₁ 20.52 20.37 20.19 20.00	3 R ₂ 18.42 18.38 18.28 18.12	R ₁ 20.08 19.89 19.77 19.70	4 R ₂ 19.38 18.98 18.61 18.32	^R 1 20.36 20.18 20.03 19.90	5 R ₂ 18.20 18.04 17.89 17.76	R ₁ 19.16 19.14 19.11 19.10	6 R 19 18 18 18
Grains - λnm 400 410 420 430 440	R ₁ 21.00 20.70 20.37 20.08 19.85	1 R ₂ 21.04 20.45 19.85 19.23 18.68	R ₁ 21.15 20.78 20.47 20.20 20.00	2 R ₂ 19.25 18.95 18.67 18.40 18.22	R ₁ 20.52 20.37 20.19 20.00 19.90	3 R ₂ 18.42 18.38 18.28 18.12 18.03	R 20.08 19.89 19.77 19.70 19.70	4 R ₂ 19.38 18.98 18.61 18.32 18.10	^R 1 20.36 20.18 20.03 19.90 19.80	5 R ₂ 18.20 18.04 17.89 17.76 17.66	R ₁ 19.16 19.14 19.11 19.10 19.12	6 R 19 18 18 18 18 18
Grains - λnm 400 410 420 430 440 450	R ₁ 21.00 20.70 20.37 20.08 19.85	1 R ₂ 21.04 20.45 19.85 19.23 18.68	R ₁ 21.15 20.78 20.47 20.20 20.00	2 R ₂ 19.25 18.95 18.67 18.40 18.22 18.07	R ₁ 20.52 20.37 20.19 20.00 19.90	3 R ₂ 18.42 18.38 18.28 18.12 18.03	R ₁ 20.08 19.89 19.77 19.70 19.70	4 R ₂ 19.38 18.98 18.61 18.32 18.10 17.95	R ₁ 20.36 20.18 20.03 19.90 19.80	5 R ₂ 18.20 18.04 17.89 17.76 17.66	R ₁ 19.16 19.14 19.11 19.10 19.12 19.15	6 R 19 18 18 18 18 17 17
Grains - Anm 400 410 420 430 440 450 460	R1 21.00 20.70 20.37 20.08 19.85 19.65	1 R ₂ 21.04 20.45 19.85 19.23 18.68 18.27 18.05	R ₁ 21.15 20.78 20.47 20.20 20.00 19.89 19.84	2 R ₂ 19.25 18.95 18.67 18.40 18.22 18.07 18.00	R ₁ 20.52 20.37 20.19 20.00 19.90 19.87 19.81	3 R ₂ 18.42 18.38 18.28 18.12 18.03 17.94 17.88	R ₁ 20.08 19.89 19.77 19.70 19.70 19.75 19.85	4 R ₂ 19.38 18.98 18.61 18.32 18.10 17.95 17.85	R ₁ 20.36 20.18 20.03 19.90 19.80 19.73 19.70	5 R ₂ 18.20 18.04 17.89 17.76 17.66 17.60 17.56	R ₁ 19.16 19.14 19.11 19.10 19.12 19.15 19.21	6 R 19 18 18 18 17 17 17
Grains - λnm 400 410 420 430 440 450 450 460 470	R ₁ 21.00 20.70 20.37 20.08 19.85 19.65 19.56 19.49	1 R ₂ 21.04 20.45 19.85 19.23 18.68 18.27 18.05 17.92	R ₁ 21.15 20.78 20.47 20.20 20.00 19.89 19.84 19.83	2 R ₂ 19.25 18.95 18.67 18.40 18.22 18.07 18.00 17.97	R ₁ 20.52 20.37 20.19 20.00 19.90 19.87 19.81 19.78	3 R ₂ 18.42 18.38 18.28 18.12 18.03 17.94 17.88 17.81	R ₁ 20.08 19.89 19.77 19.70 19.70 19.75 19.85 19.95	4 R ₂ 19.38 18.98 18.61 18.32 18.10 17.95 17.85 17.88	^R 1 20.36 20.18 20.03 19.90 19.80 19.73 19.70 19.75	5 R ₂ 18.20 18.04 17.89 17.76 17.66 17.66 17.56	R ₁ 19.16 19.14 19.11 19.10 19.12 19.15 19.21 19.24	6 R 19 18 18 18 18 17 17 17 17
Grains - ληπ 400 410 420 430 440 450 450 450 450 450 450 450 480	R ₁ 21.00 20.70 20.37 20.08 19.85 19.67 19.56 19.49 19.49	1 R ₂ 21.04 20.45 19.85 19.23 18.68 18.27 18.05 17.92 17.90	R ₁ 21.15 20.78 20.47 20.20 20.00 19.89 19.84 19.83 19.84	2 R ₂ 19.25 18.95 18.67 18.40 18.22 18.07 18.00 17.97 17.97	R ₁ 20.52 20.37 20.19 20.00 19.90 19.87 19.81 19.78 19.80	3 R ₂ 18.42 18.38 18.28 18.12 18.03 17.94 17.88 17.81 17.83	R ₁ 20.08 19.89 19.70 19.70 19.75 19.85 19.95 20.10	4 R ₂ 19.38 18.98 18.61 18.32 18.10 17.95 17.85 17.88 17.93	R ₁ 20.36 20.18 20.03 19.90 19.80 19.73 19.75 19.84	5 R ₂ 18.20 18.04 17.89 17.76 17.66 17.60 17.56 17.54 17.55	R ₁ 19.16 19.14 19.11 19.10 19.12 19.15 19.21 19.24 19.32	6 R 19 18 18 18 18 17 17 17 17 17 17
Grains - λna 400 410 420 420 420 440 450 460 470 480 480 490	R ₁ 21.00 20.70 20.37 20.08 19.85 19.67 19.56 19.49 19.49 19.55	1 R ₂ 21.04 20.45 19.85 19.23 18.68 18.27 18.05 17.92 17.90 17.94	R ₁ 21.15 20.78 20.47 20.20 20.00 19.89 19.84 19.83 19.86 19.92	2 R ₂ 19.25 18.96 18.67 18.40 18.22 18.07 18.07 17.97 17.97 18.04	R ₁ 20.52 20.37 20.19 20.00 19.90 19.87 19.81 19.78 19.80 19.91	3 R ₂ 18.42 18.38 18.28 18.12 18.03 17.94 17.81 17.81 17.83 17.88	R ₁ 20.08 19.89 19.77 19.70 19.75 19.85 19.95 20.10 20.23	4 R ₂ 19.38 18.98 18.61 18.32 18.10 17.95 17.85 17.88 17.93 18.01	R ₁ 20.36 20.18 20.03 19.90 19.80 19.73 19.75 19.84 19.97	5 R ₂ 18.20 18.04 17.89 17.76 17.66 17.56 17.54 17.54 17.54	R ₁ 19.16 19.14 19.11 19.10 19.12 19.15 19.21 19.24 19.32 19.43	6 R 19 18 18 18 18 18 18 17 17 17 17 17 17
Grains - ληπ 400 410 420 430 430 440 450 460 470 480 490 500	R ₁ 21.00 20.70 20.37 20.08 19.85 19.67 19.56 19.49 19.49 19.55	1 R ₂ 21.04 20.45 19.85 19.23 18.68 18.27 18.05 17.92 17.90 17.94	R ₁ 21.15 20.78 20.47 20.20 20.00 19.89 19.84 19.86 19.92 20.04	2 R ₂ 19.25 18.96 18.67 18.40 18.22 18.07 18.00 17.97 17.97 18.04	R ₁ 20.52 20.37 20.19 20.00 19.90 19.87 19.81 19.81 19.80 19.91	3 R ₂ 18.42 18.38 18.28 18.12 18.03 17.94 17.88 17.81 17.88	R ₁ 20.08 19,89 19.77 19.70 19.75 19.85 19.95 20.10 20.23	4 R ₂ 19.38 18.98 18.61 18.32 18.10 17.95 17.88 17.93 18.01 18.11	R ₁ 20.36 20.18 20.03 19.90 19.80 19.73 19.75 19.84 19.97 20.10	5 R ₂ 18.20 18.04 17.89 17.76 17.66 17.66 17.54 17.54 17.54 17.54	R ₁ 19.16 19.14 19.11 19.10 19.12 19.15 19.21 19.24 19.32 19.43	6 R 19 18 18 18 18 18 17 17 17 17 17 17 17 17
Grains - λna 400 410 420 430 430 440 450 460 450 460 470 480 490 500 510	R ₁ 21.00 20.70 20.37 20.08 19.85 19.67 19.56 19.49 19.49 19.55 19.66 19.77	1 R ₂ 21.04 20.45 19.85 19.23 18.68 18.27 18.05 17.92 17.90 17.94 18.00 18.08	R ₁ 21.15 20.78 20.20 20.00 19.89 19.84 19.83 19.86 19.99 20.04	2 R ₂ 19.25 18.95 18.67 18.40 18.22 18.07 18.00 17.97 18.04 18.15 18.28	R ₁ 20.52 20.37 20.00 19.90 19.87 19.81 19.78 19.80 19.90 19.91 20.03	3 R ₂ 18.42 18.38 18.28 18.12 18.03 17.94 17.88 17.81 17.83 17.28 17.98 18.10	R ₁ 20.08 19.89 19.77 19.70 19.75 19.86 19.95 20.10 20.23 20.38 20.50	4 R ₂ 19.38 18.98 18.61 18.32 18.10 17.95 17.85 17.88 17.93 18.01 18.11 18.24	R ₁ 20.36 20.18 20.03 19.90 19.80 19.73 19.75 19.84 19.97 20.10 20.24	5 R ₂ 18.20 18.04 17.89 17.76 17.66 17.56 17.56 17.56 17.56 17.56 17.54	R ₁ 19.16 19.14 19.11 19.10 19.12 19.15 19.21 19.24 19.32 19.43 19.58 19.73	6 R 19 18 18 18 18 18 18 17 17 17 17 17 17 17 17 17 17
Grains - ληπ 400 410 420 430 440 450 460 470 480 470 480 490 500 510 520	R ₁ 21.00 20.70 20.37 20.08 19.85 19.67 19.56 19.49 19.55 19.66 19.77 19.87	1 R ₂ 21.04 20.45 19.23 18.68 18.27 18.05 17.92 17.90 17.94 18.00 18.08 18.17	R ₁ 21.15 20.78 20.47 20.20 20.00 19.89 19.84 19.86 19.92 20.04 20.14 20.25	2 R ₂ 19.25 18.35 18.67 18.40 18.22 18.07 18.00 17.97 17.97 18.04 18.15 18.28 18.38	R ₁ 20.52 20.37 20.19 20.00 19.90 19.87 19.88 19.80 19.91 20.03 20.12 20.21	3 R ₂ 18.42 18.38 18.28 18.12 18.03 17.94 17.88 17.81 17.88 17.98 17.98 17.98 17.98 18.10 18.23	R ₁ 20.08 19.89 19.70 19.70 19.75 19.85 19.95 20.10 20.23 20.38 20.50 20.65	4 R ₂ 19.38 18.98 18.61 18.32 18.10 17.95 17.85 17.88 17.93 18.01 18.11 18.21 18.38	R ₁ 20.36 20.18 20.03 19.90 19.80 19.73 19.70 19.75 19.84 19.97 20.10 20.24	5 R ₂ 18.20 18.04 17.89 17.76 17.66 17.66 17.56 17.54 17.56 17.64 17.77 17.93 18.08	R ₁ 19.16 19.14 19.11 19.10 19.12 19.15 19.21 19.24 19.32 19.43 19.56 19.73 19.68	6 R 19 18 18 18 18 18 18 18 18 17 17 17 17 17 17 17 17 17 17
Grains - λmm 400 410 420 430 440 450 450 450 450 500 510 520 530	R ₁ 21.00 20.70 20.37 20.08 19.85 19.67 19.56 19.49 19.49 19.55 19.66 19.77 19.85	R2 21.04 20.45 19.85 19.23 18.66 18.27 18.05 17.90 17.90 17.90 17.94 18.00 18.08 18.17 18.25	R ₁ 21.15 20.78 20.47 20.20 20.00 19.89 19.84 19.86 19.92 20.04 20.14 20.14 20.25 20.25	2 R ₂ 19.25 18.67 18.40 18.22 18.07 18.07 17.97 17.97 17.97 18.04 18.15 18.28 18.38 18.47	R ₁ 20.52 20.37 20.19 20.00 19.90 19.87 19.81 19.80 19.91 20.03 20.12 20.21 20.21	3 R ₂ 18.42 18.38 18.28 18.28 18.23 17.94 17.81 17.83 17.88 17.98 17.98 18.10 18.23 18.39	R ₁ 20.08 19.89 19.77 19.70 19.70 19.75 19.85 20.10 20.23 20.18 20.50 20.65 20.65	4 R ₂ 19.38 18.61 18.32 18.61 18.32 18.10 17.95 17.88 17.93 18.01 18.11 18.24 18.28 18.51	R1 20.36 20.18 20.03 19.90 19.80 19.73 19.70 19.75 19.84 19.97 20.10 20.24 20.34 20.34	5 R ₂ 18.20 18.04 17.89 17.76 17.66 17.66 17.56 17.56 17.56 17.56 17.56 17.93 18.08 18.23	R ₁ 19.16 19.14 19.11 19.10 19.12 19.15 19.21 19.22 19.43 19.58 19.73 19.88 19.73	6 R 19 18 18 18 18 18 18 18 18 17 17 17 17 17 17 17 17 17 17 17 17 17
Grains - λnm 400 410 420 430 440 450 440 450 440 500 510 520 530 540	R1 21.00 20.70 20.37 20.08 19.85 19.67 19.56 19.49 19.49 19.55 19.66 19.77 19.85 19.66 20.04	1 R ₂ 21.04 20.45 19.85 19.23 18.66 18.27 18.05 17.90 17.90 17.90 17.94 18.00 18.08 18.17 18.25 18.33	R ₁ 21.15 20.78 20.47 20.07 20.00 19.89 19.84 19.83 19.86 19.92 20.04 20.14 20.14 20.25 20.05	2 R ₂ 19.25 18.95 18.67 18.40 18.22 18.07 18.00 17.97 18.04 18.15 18.28 18.38 18.47 18.53	R ₁ 20.52 20.37 20.19 20.00 19.96 19.87 19.81 19.78 19.80 19.91 20.03 20.12 20.21 20.21 20.23	3 R ₂ 18.42 18.38 18.28 18.28 18.03 17.94 17.88 17.81 17.83 17.83 17.88 17.98 18.10 18.23 18.50	R ₁ 20.08 19.89 19.77 19.70 19.75 19.86 19.95 20.10 20.23 20.38 20.50 20.50 20.65 20.75	4 R ₂ 19.38 18.99 18.61 18.32 18.10 17.95 17.85 17.88 17.93 18.01 18.11 18.24 18.35 18.62	R ₁ 20.36 20.18 20.03 19.90 19.73 19.70 19.75 19.84 19.77 20.10 20.24 20.34 20.34 20.34	5 R ₂ 18.20 18.04 17.89 17.76 17.66 17.66 17.56 17.56 17.56 17.56 17.56 17.56 17.64 18.23 18.35	R ₁ 19.16 19.14 19.11 19.10 19.15 19.21 19.24 19.43 19.43 19.58 19.73 19.88 19.73 19.88 19.97	6 R 19 18 18 18 18 18 17 17 17 17 17 17 17 17 17 17 17 18 18
Grains - λna 400 410 420 430 440 450 460 470 480 490 500 510 520 530 540 550	R1 21.00 20.70 20.37 20.08 19.85 19.67 19.56 19.49 19.49 19.55 19.66 19.77 19.96 19.77 19.96 20.04	1 R ₂ 21.04 20.45 19.85 19.23 18.66 18.27 18.05 17.92 17.92 17.94 18.00 18.08 18.17 18.23 18.33 18.3	R ₁ 21.15 20.78 20.47 20.20 20.047 20.20 20.04 19.89 19.84 19.83 19.86 20.25 20.04 20.14 20.14 20.25 20.35 20.35	2 R ₂ 19.25 18.65 18.67 18.67 18.22 18.07 18.22 18.07 18.22 18.07 18.94 18.38 18.38 18.47 18.53 18.57	R ₁ 20.52 20.37 20.19 20.00 19.87 19.81 19.78 19.80 19.90 19.91 20.03 20.12 20.21 20.21 20.23	3 R ₂ 18.42 18.38 18.28 18.03 17.94 17.88 17.81 17.88 17.81 17.88 17.98 18.10 18.23 18.50 18.50	R ₁ 20.08 19.89 19.77 19.70 19.75 19.86 19.95 20.10 20.23 20.38 20.56 20.65 20.65 20.75	4 R ₂ 19.38 18.99 18.61 18.10 17.95 17.85 17.88 17.98 19.01 18.11 18.24 18.38 18.51 18.62 18.70	R ₁ 20.36 20.18 20.03 19.90 19.73 19.70 19.75 19.84 19.97 20.10 20.24 20.34 20.34 20.42 20.44	5 R ₂ 18.20 18.04 17.89 17.76 17.66 17.56 17.54 17.54 17.64 17.64 17.77 17.93 18.08 18.35 18.43	R ₁ 19.16 19.14 19.11 19.15 19.21 19.24 19.32 19.43 19.58 19.73 19.88 19.97 20.02 20.02	6 R 19 18 18 18 18 17 17 17 17 17 17 17 17 17 17 17 17 17
Grains - λna 400 410 420 430 440 450 440 450 460 470 480 490 500 510 520 530 540 550 550	R 21.00 20.70 20.08 19.85 19.67 19.56 19.49 19.55 19.66 19.77 19.87 19.87 19.96 20.04 20.08 20.08 20.04	1 R ₂ 21.04 20.45 19.85 19.23 18.68 18.27 18.05 17.92 17.90 17.94 18.00 18.08 18.17 18.25 18.33 18.33 18.34	R ₁ 21.15 20.78 20.47 20.20 20.00 19.89 19.84 19.86 19.92 20.04 20.14 20.25 20.32 20.35 20.35	2 R ₂ 19.25 18.95 18.40 18.40 18.22 18.07 18.00 17.97 18.04 18.15 18.38 18.47 18.53 18.57 18.51	R ₁ 20.52 20.37 20.19 20.00 19.90 19.87 19.88 19.80 19.91 20.03 20.12 20.21 20.21 20.23 20.23	3 R ₂ 18.42 18.38 18.28 18.12 18.03 17.94 17.88 17.88 17.88 17.88 17.88 17.98 18.10 18.23 18.39 18.50 18.50	R ₁ 20.08 19.89 19.77 19.70 19.75 19.86 19.95 20.10 20.23 20.38 20.50 20.65 20.75 20.75	4 R ₂ 19.38 18.98 18.61 18.32 18.10 17.95 17.85 17.85 17.88 17.93 18.01 18.11 18.24 18.38 18.51 18.62 18.70 18.74	R ₁ 20.36 20.18 20.03 19.90 19.73 19.70 19.75 19.84 19.97 20.10 20.24 20.34 20.38 20.42 20.44 20.44	5 R ₂ 18.20 18.04 17.89 17.76 17.66 17.56 17.56 17.56 17.56 17.56 17.56 17.77 18.08 18.23 18.35 18.43 18.50	R ₁ 19.16 19.14 19.11 19.15 19.21 19.21 19.24 19.32 19.43 19.56 19.73 19.68 19.97 20.02 20.04 20.05	6 R 19 18 18 18 18 18 17 17 17 17 17 17 17 17 17 17 17 17 18 18 18 18
Grains - λnm 400 410 420 430 440 450 440 450 450 550 550 550 550 55	R1 21.00 20.70 20.37 20.08 19.85 19.67 19.56 19.49 19.49 19.55 19.66 19.77 19.87 19.96 20.04 20.08 20.14	1 R ₂ 21.04 20.45 19.85 19.85 19.85 18.68 18.27 18.05 17.90 17.90 17.90 17.94 18.00 18.08 18.17 18.25 18.33 18.39 18.44 18.47	R ₁ 21.15 20.78 20.20 20.00 19.89 19.83 19.83 19.86 19.93 20.04 20.14 20.25 20.35 20.35 20.36 20.36 20.36	2 82 19.25 18.96 18.67 18.40 18.22 18.00 17.97 17.97 18.00 18.28 18.28 18.28 18.37 18.53 18.57 18.64	R ₁ 20.52 20.37 20.19 20.00 19.90 19.87 19.81 19.78 19.80 19.90 20.03 20.12 20.21 20.23 20.23 20.29 20.31 20.31 20.31	3 R ₂ 18.42 18.38 18.28 18.21 18.03 17.94 17.88 17.88 17.88 17.88 17.88 17.98 18.50 18.50 18.50 18.50 18.50	R ₁ 20.08 19.89 19.77 19.70 19.75 19.86 19.95 20.10 20.23 20.38 20.50 20.65 20.57 20.75 20.75 20.75	4 R ₂ 19.38 18.61 18.61 18.32 18.10 17.95 17.88 17.93 18.01 18.11 18.24 18.36 18.51 18.62 18.70 18.74 18.74	R ₁ 20.36 20.03 19.90 19.80 19.73 19.73 19.75 19.84 20.42 20.10 20.24 20.34 20.44 20.44 20.44	5 R ₂ 18.20 18.04 17.89 17.76 17.66 17.56 17.56 17.56 17.56 17.56 17.64 17.77 17.93 18.23 18.35 18.43 18.52	R ₁ 19.16 19.14 19.11 19.10 19.12 19.21 19.24 19.32 19.43 19.56 19.73 19.88 19.97 20.02 20.04 20.05 20.05	6 R 19 18 18 18 18 18 17 17 17 17 17 17 17 17 17 17 17 17 17
Grains - ληπ 400 410 420 430 430 440 450 450 450 450 510 510 510 520 530 530 540 550 550 550 550 550 550 550 550	R ₁ 21.00 20.70 20.37 20.38 19.67 19.56 19.49 19.49 19.55 19.66 19.77 19.59 20.04 20.04 20.04	1 R ₂ 21,04 20,45 19,23 18,68 18,27 18,05 17,90 17,90 17,90 17,94 18,00 18,08 18,17 18,25 18,39 18,44 18,49	R ₁ 21.15 20.78 20.47 20.20 20.00 19.89 19.84 19.84 19.86 19.92 20.04 20.14 20.15 20.32 20.32 20.32 20.36 20.36 20.36 20.36	2 R ₂ 19.25 18.95 18.40 18.40 18.22 18.07 18.07 17.97 17.97 17.97 18.04 18.53 18.53 18.57 18.61 18.64 18.65	R ₁ 20.52 20.37 20.19 20.00 19.90 19.87 19.81 19.78 19.80 19.91 20.03 20.12 20.21 20.21 20.21 20.21 20.21 20.23 20.31 20.32 20.32	3 R ₂ 18.42 18.38 18.22 18.03 17.94 17.88 17.88 17.88 17.88 18.10 18.23 18.39 18.50 18.50 18.54 18.63	R ₁ 20.08 19.89 19.77 19.70 19.70 19.75 19.86 19.95 20.10 20.23 20.10 20.23 20.38 20.55 20.75 20.75 20.75 20.75 20.70 20.75	4 R ₂ 19.38 18.98 18.61 18.32 18.10 17.95 17.95 17.88 17.93 18.01 18.11 18.24 18.36 18.51 18.62 18.70 18.74 18.73	R ₁ 20.36 20.18 20.03 19.80 19.73 19.70 19.75 19.84 19.97 20.10 20.24 20.38 20.24 20.38 20.44 20.38 20.44 20.43 20.43	5 R ₂ 18.20 18.04 17.89 17.76 17.66 17.56 17.56 17.54 17.57 17.54 17.79 18.08 18.23 18.23 18.50 18.53	R ₁ 19.16 19.14 19.11 19.10 19.15 19.21 19.21 19.32 19.43 19.58 19.73 19.88 19.97 20.02 20.04 20.05 20.04	6 R, 19 18 18 18 18 18 17 17 17 17 17 17 17 17 17 17 17 17 17
Grains - λ ma - 400 - 410 - 420 - 430 - 430 - 440 - 500 - 510 - 520 - 530 - 540 - 550 - 550 - 550 - 550 - 550 - 550 - 550 - 550 - 550 - 550 - 550 - 550 - 550 -	R ₁ 21.00 20.70 20.37 20.08 19.67 19.56 19.49 19.59 19.66 19.77 19.96 20.04 20.04 20.04 20.03 20.13	1 R ₂ 21.04 20.45 19.85 18.23 18.68 18.27 18.05 17.90 17.90 17.90 17.94 18.00 18.17 18.25 18.33 18.39 18.44 18.47 18.48	R ₁ 21.15 20.78 20.47 20.20 20.00 19.89 19.84 19.83 19.86 19.92 20.04 20.14 20.15 20.35 20.35 20.35 20.36 20.36 20.36 20.35	2 R ₂ 19.25 18.95 18.40 18.40 18.22 18.07 18.07 18.07 18.07 18.07 18.04 18.57 18.57 18.61 18.64 18.64 18.63	R ₁ 20.52 20.37 20.19 20.00 19.90 19.87 19.81 19.78 19.80 19.91 20.03 20.12 20.21 20.21 20.21 20.23 20.23 20.32 20.31	3 R ₂ 18.42 18.38 18.23 18.03 17.94 17.88 17.88 17.88 17.88 17.88 18.39 18.50 18.54 18.62 18.62 18.60	R ₁ 20.08 19.89 19.77 19.70 19.75 19.85 20.10 20.23 20.10 20.23 20.38 20.50 20.65 20.75 20.75 20.75 20.75 20.70 20.65	4 R ₂ 19.38 18.96 18.32 18.10 17.95 17.85 17.88 17.93 18.01 18.01 18.11 18.24 18.38 18.51 18.62 18.70 18.74 18.74 18.74 18.74	R ₁ 20.36 20.18 20.03 19.90 19.80 19.73 19.75 19.84 19.77 20.10 20.24 20.34 20.38 20.42 20.44 20.43 20.43	5 R ₂ 18.20 18.04 17.89 17.76 17.66 17.56 17.56 17.56 17.56 17.56 17.56 17.93 18.08 18.23 18.43 18.50 18.52	R ₁ 19.16 19.14 19.11 19.10 19.21 19.21 19.24 19.32 19.43 19.56 19.73 19.88 19.97 20.02 20.04 20.05 20.04 20.05	6 R 19 18 18 18 18 18 17 17 17 17 17 17 17 17 17 17 17 17 17
Grains - ima 400 410 420 420 420 420 440 450 500 510 500 550 550 570 550 550 570 550 570 550 570 550 570 550 570 550 570 57	R1 21.00 20.37 20.08 19.65 19.49 19.56 19.77 19.96 20.04 20.04 20.04 20.04 20.13 20.14 20.15	1 R ₂ 21,04 20,45 19,85 19,85 19,23 18,66 18,27 18,05 17,90 17,90 17,94 18,00 18,10 18,17 18,25 18,33 18,33 18,39 18,44 18,44 18,44 18,44 18,44 18,44 18,45 18,44 18,44 18,45 18,44 18,44 18,45 18,44 18,44 18,45 18,44 18,44 18,45 18,44 18,44 18,45 18,44 18,44 18,45 18,45 18,45 18,45 18,45 18,45 18,45 18,45 18,45 18,45 18,45 18,45 18,55 18,55 18,55 18,55 17,95 17,96 17,96 18,17 18,55 18,45 18,45 18,45 18,45 18,44 18,44 18,45	R ₁ 21.15 20.78 20.47 20.20 20.00 19.89 19.84 19.86 19.92 20.04 20.14 20.25 20.35 20.35 20.35 20.36 20.36 20.35 20.35	2 R ₂ 19.25 18.67 18.40 18.67 18.00 17.97 17.97 18.04 18.15 18.28 18.38 18.47 18.53 18.57 18.64 18.65 18.65 18.65	R ₁ 20.52 20.37 20.19 20.00 19.90 19.87 19.81 19.78 19.80 19.91 20.03 20.12 20.21 20.21 20.23 20.29 20.31 20.31 20.31 20.31 20.31	3 R ₂ 18.42 18.28 18.28 18.22 18.03 17.94 17.88 17.81 17.88 17.81 17.88 17.98 18.10 18.50 18.50 18.50 18.50 18.50 18.62 18.63 18.63	R ₁ 20.08 19.89 19.77 19.70 19.75 19.86 19.95 20.10 20.23 20.38 20.50 20.65 20.75 20.75 20.75 20.75 20.75 20.75 20.75	4 R ₂ 19.38 18.61 18.61 18.32 18.10 17.95 17.85 17.88 17.95 17.88 17.95 18.01 18.11 18.24 18.36 18.51 18.62 18.70 18.74 18.73 18.73 18.73 18.73 18.73	R ₁ 20.36 20.03 19.90 19.80 19.73 19.75 19.84 19.97 20.10 20.24 20.38 20.42 20.44 20.43 20.43 20.43 20.43 20.43 20.43	5 R ₂ 18.20 18.04 17.89 17.76 17.66 17.66 17.54 17.54 17.54 17.54 17.64 17.77 17.93 18.03 18.35 18.43 18.52 18.53 18.53 18.53 18.53	R ₁ 19.16 19.14 19.11 19.10 19.21 19.21 19.24 19.32 19.43 19.56 19.73 19.68 19.97 20.02 20.04 20.05 20.05 20.04 20.04 20.05	6 R 19 18 18 18 18 18 17 17 17 17 17 17 17 17 17 17 17 17 17
Grains - ima 400 410 420 430 440 450 440 500 510 520 550 550 550 550 550 550 55	R1 20.00 20.70 20.37 20.38 19.65 19.49 19.55 19.69 19.59 19.59 19.60 19.77 19.37 20.04 20.04 20.04 20.14 20.15 20.15	1 R ₂ 21.04 20.45 19.23 18.68 18.27 18.06 17.92 17.90 17.94 18.00 18.00 18.08 18.17 18.33 18.33 18.39 18.44 18.44 18.44 18.44 18.45 18.48 18.47 18.48	R ₁ 21.15 20.78 20.20 20.00 19.89 19.84 19.83 19.86 19.92 20.04 20.04 20.14 20.25 20.35 20.35 20.35 20.36 20.36 20.36 20.36 20.36	2 R ₂ 19.25 18.95 18.67 18.40 18.22 18.07 18.00 17.97 17.97 18.06 18.53 18.53 18.57 18.61 18.63 18.63 18.57 18.63	R ₁ 20.52 20.37 20.19 20.00 19.90 19.87 19.80 19.91 20.03 20.03 20.22 20.21 20.23 20.23 20.31 20.31 20.30 20.31 20.30	3 R ₂ 18.42 18.38 18.12 18.03 17.94 17.81 17.83 17.83 17.98 17.98 18.20 18.50 18.50 18.54 18.63 18.60 18.54 18.63 18.60	R ₁ 20.08 19.89 19.77 19.70 19.70 19.75 19.85 20.10 20.23 20.38 20.50 20.65 20.75 20.75 20.75 20.75 20.75 20.75 20.75 20.75 20.53	4 R ₂ 19.38 18.93 18.61 18.32 18.10 17.95 17.68 17.93 18.01 18.11 18.24 18.35 18.62 18.62 18.70 18.74 18.73 18.70 18.74 18.73 18.70 18.74	R ₁ 20.36 20.03 19.90 19.80 19.73 19.70 19.75 19.84 19.97 20.04 20.24 20.34 20.34 20.42 20.44 20.43 20.42 20.44 20.38 20.33	5 R ₂ 18.20 18.04 17.89 17.76 17.66 17.54 17.54 17.54 17.54 17.54 17.56 17.77 17.93 18.08 18.23 18.35 18.50 18.52 18.52 18.52	R ₁ 19.16 19.14 19.11 19.10 19.22 19.21 19.24 19.32 19.43 19.58 19.73 19.88 19.73 20.02 20.04 20.05 20.04 20.05 20.04 20.05 20.04 20.05	6 R, 19 18 18 18 18 18 18 17 17 17 17 17 17 17 17 17 17 17 17 17
Gratins - Ama Ama Ama Ama Ama Ama Ama Ama	R 21.00 20.70 20.37 19.55 19.67 19.59 19.49 19.59 19.59 19.77 19.97 19.97 19.97 19.97 20.04 20.08 20.13 20.14 20.13 20.13 20.13	1 R ₂ 21.04 20.45 19.85 18.27 18.66 18.27 18.05 17.90 17.90 17.94 18.00 18.00 18.17 18.25 18.39 18.44 18.47 18.48 18.47 18.43 10.75 18.43 10.75	R ₁ 21.15 20.78 20.47 20.20 20.00 19.89 19.84 19.83 19.86 19.92 20.04 20.14 20.15 20.35 20.35 20.35 20.36 20.36 20.36 20.36 20.35	2 R ₂ 19.25 18.95 18.40 18.40 18.22 18.07 18.07 18.07 18.07 18.07 18.04 18.53 18.53 18.53 18.55 18.64 18.64 18.63 18.57 18.57 18.55 18.57 18.55	R ₁ 20.52 20.37 20.19 20.00 19.90 19.87 19.81 19.78 19.80 19.91 20.03 20.12 20.21 20.21 20.23 20.32 20.32 20.32 20.32 20.32 20.32	3 R ₂ 18.42 18.38 18.22 18.03 17.94 17.88 17.88 17.88 17.88 18.39 18.50 18.54 18.62 18.62 18.65 18.66 18.55 18.48 18.62	R ₁ 20.08 19.89 19.77 19.70 19.75 19.85 20.10 20.23 20.10 20.23 20.38 20.55 20.75 20.75 20.75 20.75 20.75 20.75 20.75 20.75 20.75 20.75 20.70 20.53	4 R ₂ 19.38 18.96 18.32 18.10 17.95 17.88 17.93 18.01 18.01 18.11 18.24 18.36 18.51 18.62 18.70 18.74 18.74 18.74 18.74 18.77 18.62 18.70 18.74 18.75	R ₁ 20.36 20.18 20.03 19.90 19.80 19.73 19.75 19.84 19.77 20.10 20.24 20.34 20.38 20.42 20.44 20.43 20.44 20.43 20.44 20.43 20.44	5 R ₂ 18.20 18.04 17.96 17.76 17.66 17.56 17.54 17.54 17.57 17.54 17.53 18.08 18.23 18.43 18.50 18.52 18.52 18.50 18.50 18.50 18.50	R ₁ 19.16 19.14 19.11 19.10 19.21 19.21 19.23 19.43 19.32 19.43 19.58 19.73 19.88 19.97 20.04 20.05 20.04 20.05 20.04 20.05 20.04 20.05	6 R R 19 18 18 18 18 18 17 17 17 17 17 17 17 17 17 17 17 17 18 18 18 18 18 18 18 18 18 18 18 18 18
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Grains - λm 400 410 420 420 430 440 460 450 500 500 510 520 550 550 550 550 550 550 550 550 550 550 550 550 550 550 550 600 610 610 620 630 640	R 21.00 20.70 20.37 19.56 19.67 19.49 19.49 19.49 19.77 19.37 19.96 20.08 20.13 20.14 20.15 20.13 20.03 19.55 19.77	1 R2 21.04 20.45 19.23 18.68 18.27 18.68 18.77 17.92 17.90 17.94 18.08 18.17 18.33 18.39 18.44 16.47 18.48 18.33 18.39 18.34 18.31 18.33	R ₁ 21.15 20.78 20.47 20.20 20.00 19.89 19.84 19.83 19.86 19.92 20.04 20.14 20.25 20.35 20.35 20.36 20.36 20.36 20.36 20.36 20.36 20.31 20.25 20.31 20.25 20.31	2 R ₂ 19.25 18.95 18.67 18.40 18.22 18.07 17.97 17.97 17.97 18.04 18.15 18.28 18.38 18.47 18.53 18.57 18.61 18.64 18.65 18.63 18.57 18.57 18.51 18.53 18.57 18.53 18.57 18.53 18.57 18.53 18.57 18.53 18.57 18.53 18.57 18.53 18.57 18.53 18.57 18.55	R ₁ 20.52 20.37 20.19 21.00 19.90 19.87 19.80 19.91 20.03 20.12 20.21 20.21 20.21 20.23 20.31 20.32 20.31 20.32 20.31 20.32 20.31 20.32 20.31 20.32 20.31 20.32 20.31 20.32 20.31 20.32 20.31 20.32 20.31 20.32 20.31 20.32 20.31 20.32 20.32 20.32 20.32 20.33 20.32 20.33 20.32 20.33 20.32 20.33 20.35 20.32 20.32 20.32 20.32 20.32 20.32 20.32 20.32 20.32 20.32 20.32 20.32 20.32 20.22 20.32 20.32 20.32 20.22 20.32 2	3 R ₂ 18.42 18.38 18.12 18.03 17.94 17.81 17.81 17.83 17.98 18.10 18.23 18.50 18.50 18.50 18.54 18.63 18.60 18.55 18.63 18.60 18.55 18.43 18.39 18.31 18.19	R ₁ 20.08 19.89 19.77 19.70 19.70 19.75 19.85 20.10 20.23 20.38 20.50 20.65 20.75 2	4 R ₂ 19.38 18.98 18.61 18.32 18.10 17.95 17.93 18.01 18.11 18.24 18.38 18.51 18.62 18.70 18.74 18.73 18.70 18.73 18.70 18.63 18.54 18.33 18.33 18.21	R ₁ 20.36 20.18 20.03 19.90 19.80 19.73 19.70 19.75 19.84 19.97 20.10 20.24 20.34 20.34 20.42 20.44 20.44 20.44 20.43 20.42 20.44 20.43 20.33 20.25 20.16 20.16 20.16 20.65 20.16 20.65 20.16 20.65 20.16 20.65 20.16 20.65 20.16 20.65 20.16 20.65 20.16 20.65 20.16 20.65 20.16 20.65 20.16 20.65 20.16 20.65 20.16 20.65 20.16 20.65 20.16 20.65 20.16 20.65 20.16 20.55 20.16 20.65 20.16 20.55 20.16 20.55 20.16 20.55 20.16 20.55 20.16 20.55 20.16 20.55 20.16 20.55 20.16 20.55 20.16 20.55 20.16 20.55 2	5 R ₂ 18.20 18.04 17.89 17.76 17.66 17.54 17.54 17.54 17.54 17.54 17.54 17.55 17.66 17.54 17.55 18.43 18.35 18.43 18.50 18.52 18.52 18.50 18.52 18.50 18.52 18.50 18.52 18.50 18.52 18.50 18.52 18.50 18.52 18.50 18.52 18.50 18.52 18.50 18.52 18.50 18.55 1	R ₁ 19.16 19.14 19.11 19.10 19.22 19.43 19.32 19.43 19.58 19.73 20.62 20.04 20.05 20.05 20.05 20.05 20.05 20.06 20.05 20.55 2	6 R R 199 188 188 188 188 187 177 177 177 177 177
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Gratins - Ama 400 410 420 420 440 440 440 440 450 460 450 550 550 550 550 550 550 55	R 21.00 20.70 20.37 19.55 19.67 19.49 19.49 19.55 20.04 20.08 20.08 20.13 20.14 20.16 20.13 20.14 20.15 19.96 19.97 19.87 19.98 19.99 19.87 19.99 19.99 19.97 19.87 19.87 19.87 19.99 19.87 19.87 19.87 19.99 19.87 19.87 19.87 19.87 19.87 19.87 19.99 19.87 19.99 19.87 19.87 19.87 19.87 19.87 19.87 19.87 19.87 19.87 19.87 19.87 19.99 19.87 19.99 19.87 19.99 19.99 19.99 19.99 19.99 19.99 19.99 19.99 19.99 19.99 19.99 19.99 19.99 19.99 19.97 19.99 19.97 19.87 19.87 19.83 19.54 19.63 19.54 19.54 19.55 19.55 19.57 19.55	1 R2 21.04 20.45 19.83 18.66 18.27 18.66 18.27 18.05 17.90 77.94 18.08 18.17 18.25 18.39 18.44 18.44 18.45 18.39 18.48 18.43 18.43 18.48 18.71 18.23 18.14 18.73 18.71 18.73	R ₁ 21.15 20.78 20.47 20.20 20.00 19.89 19.84 19.84 19.86 19.92 20.04 20.14 20.15 20.32 20.32 20.32 20.36 20.36 20.36 20.36 20.36 20.36 20.36 20.36 20.36 20.31 20.25 20.31 20.25 20.31 20.25 20.31 20.25 20.31 20.55 20.31 20.55 20.31 20.55 20.31 20.55 20.31 20.55 20.31 20.55 20.32 20.55 2	2 R ₂ 19.25 18.67 18.67 18.40 18.07 18.00 17.97 17.97 18.04 18.15 18.38 18.47 18.53 18.47 18.53 18.47 18.51 18.64 18.65 18.63 18.57 18.50 18.43 18.57 18.50 18.43 18.57 18.50 18.43 18.57 18.50 18.43 18.57 18.50 18.43 18.57 18.50 18.43 18.57 18.50 18.57 18.50 18.57 18.55 18.57 18.50 18.57 18.55 18.57 18.57 18.55 18.57 18.55 18.57 18.55 18.57 18.57 18.55 18.57 18.57 18.55 18.57 18.57 18.57 18.53 18.57 18.57 18.53 18.57 18.57 18.53 18.57 18.57 18.53 18.57 18.57 18.50 18.57 18.78 18.77 17.77	R ₁ 20.52 20.37 20.19 20.00 19.90 19.87 19.81 19.78 19.80 19.91 20.03 20.12 20.21 20.21 20.21 20.21 20.31 20.32 20.32 20.31 20.32 20.31 20.32 20.31 20.32 20.12 20.12 20.11 9.90 19.81 19.90 19.91 20.32 20.12 20.12 20.12 20.12 20.12 20.12 20.12 20.12 20.13 20.32 20	3 R ₂ 18.42 18.38 18.28 18.22 18.03 17.94 17.88 17.81 17.88 17.81 17.88 17.98 18.10 18.23 18.50 18.50 18.50 18.55 18.63 18.63 18.63 18.48 18.31 18.31 18.31 18.31 18.31 18.31 18.32 18.55 18.48 18.31 18.31 18.32 18.55 18.48 18.31 18.31 18.32 18.55 18.48 18.31 18.31 18.32 18.55 18.48 18.31 18.31 18.32 18.55 18.48 18.31 18.31 18.32 18.55 18.48 18.33 18.55 18.48 18.33 18.39 18.55 18.48 18.31 18.31 18.32 18.55 18.48 18.31 18.32 18.55 18.48 18.31 18.31 18.32 18.55 18.48 18.31 18.32 18.32 18.55 18.48 18.31 18.32 18.32 18.55 18.48 18.31 18.32 18.32 18.55 18.48 18.31 18.32 18.32 18.55 18.55 18.55 18.55 18.55 18.55 18.55 18.55 18.57 18.77 17.77	R ₁ 20.08 19.89 19.77 19.70 19.70 19.75 19.86 19.95 20.10 20.23 20.38 20.55 20.75 2	4 R ₂ 19.38 18.61 18.61 18.32 18.10 17.95 17.85 17.88 17.98 17.98 18.01 18.11 18.24 18.36 18.51 18.62 18.70 18.74 18.73 18.74 18.73 18.74 18.73 18.74 18.73 18.54 18.54 18.54 18.54 18.54 18.53 18.54 18.54 18.54 18.54 18.54 18.54 18.54 18.54 18.55 18.55 18.55 18.55 18.55 18.75 17.80 17.80 17.85 17.85 17.85 17.85 17.85 17.85 17.55	R ₁ 20.36 20.03 19.90 19.80 19.73 19.75 19.84 20.32 20.10 20.24 20.38 20.42 20.44 20.43 20.38 20.42 20.44 20.43 20.38 20.42 20.44 20.43 20.38 20.42 20.44 20.43 20.38 20.25 20.16 20.06 19.93 19.56 19.43	5 R ₂ 18.20 18.04 17.89 17.76 17.66 17.56 17.54 17.54 17.57 17.54 17.54 17.54 18.23 18.08 18.23 18.50 18.52 18.55	R ₁ 19.16 19.14 19.11 19.10 19.21 19.21 19.23 19.43 19.58 19.73 19.88 19.97 20.02 20.04 20.05 20.04 20.05 20.04 20.05 20.04 20.05 20.04 20.05 20.04 20.05 20.04 20.05 20.04 20.05 20.04 20.05 20.04 20.05 20.04 20.05 20.04 20.05 20.04 20.05 20.04 20.05 20.04 20.05 20.04 20.05 2	6 R R 19 18 18 18 18 17 17 17 17 17 17 17 17 17 17 17 18 18 18 18 18 18 18 18 18 18 18 18 18
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Gratins - λm 400 410 420 420 430 440 460 450 500 500 510 520 530 540 550 550 550 550 550 600 610 610 640 640 650 650 660 650 650 7700 700	R 21.00 20.70 20.37 19.56 19.67 19.49 19.49 19.77 19.73 19.73 19.73 19.73 19.73 19.73 19.74 19.75 19.75 19.75 19.75 19.75 19.75	1 R2 21.04 20.45 19.23 18.68 18.27 18.68 18.77 18.08 18.08 18.33 18.08 18.33 18.33 18.34 18.44 18.43 18.48 18.43 18.31 18.23 18.16 17.97 17.97 17.97	R ₁ 21.15 20.78 20.47 20.20 20.00 19.89 19.84 19.84 19.86 19.92 20.04 20.14 20.25 20.35 20.35 20.36 20.36 20.36 20.36 20.36 20.36 20.36 20.36 20.36 20.36 20.36 20.36 20.31 20.25 20.17 20.00 19.91 19.91 19.91 19.91	2 R ₂ 19.25 18.95 18.40 18.40 18.22 18.07 17.97 17.97 18.04 18.15 18.28 18.38 18.47 18.53 18.57 18.61 18.65 18.63 18.57 18.63 18.57 18.50 18.65 18.63 18.57 18.57 18.65 18.77 18.77 17.97 17.97 17.97 18.64 18.65 18.65 18.65 18.65 18.65 18.65 18.65 18.65 18.65 18.77 18.65 18.65 18.65 18.65 18.65 18.65 18.77 18.77 18.65 18.65 18.65 18.65 18.65 18.65 18.65 18.77 18.77 18.65 18.65 18.65 18.77 18.79 17.97 17.97 17.97 17.97 17.97 17.97 17.97 17.97 17.97 17.97 17.97 17.97 17.97 17.97 17.97 17.97 17.97 17.97 17.97 17.99 17.69	R ₁ 20.52 20.37 20.19 21.00 19.90 19.87 19.80 19.91 20.03 20.12 20.21 20.21 20.21 20.23 20.31 20.32 20.31 20.32 20.31 20.32 20.31 20.32 20.31 20.32 20.31 20.32 20.31 20.32 20.31 20.32 20.31 20.32 20.31 20.32 20.31 20.32 20.31 20.32 20.32 20.33 20.32 20.32 20.32 20.33 20.32 20.33 20.32 20.33 20.32 20.32 20.33 20.32 20.33 20.32 20.33 20.32 20.33 20.32 20.33 20.32 20.33 20.32 20.33 20.33 20.33 20.32 20.33 20.32 20.33 20.33 20.32 20.33 20.33 20.33 20.32 20.33 20.32 20.33 20.33 20.33 20.32 20.33 20.33 20.32 20.33 20.32 20.33 20.32 20.33 20.32 20.33 20.33 20.33 20.33 20.33 20.33 20.33 20.33 20.33 20.33 20.33 20.33 20.33 20.32 20.32 20.33 20.33 20.33 20.32 20.33 20.33 20.33 20.33 20.33 20.33 20.33 20.33 20.33 20.33 20.33 20.32 2	3 R ₂ 18.42 18.38 18.12 18.03 17.94 17.81 17.81 17.83 17.98 18.50 18.50 18.50 18.50 18.50 18.50 18.54 18.63 18.60 18.55 18.63 18.60 18.55 18.43 18.39 18.31 18.19 18.19 18.11 18.79 18.75 18.55 18.63 18.63 18.60 18.55 18.63 18.63 18.60 18.55 18.63 18.60 18.55 18.63 18.12 18.63 18.60 18.55 18.63 18.60 18.55 18.63 18.60 18.55 18.55 18.63 18.79 18.75 18.79 18.75 18.75 18.79 18.75 18.79 18.75 18.75 18.79 18.75 18.79 18.75 18.79 18.75 18.79 18.75 18.79 18.75 18.79 18.79 18.75 18.79 18.79 18.79 18.77 18.75 18.79 18.79 18.79 18.77 18.77 18.77 18.77 18.77 18.77 18.77 18.77 18.75 19.77 17.70 17.61	R ₁ 20.08 19.89 19.77 19.70 19.70 19.75 19.85 19.95 20.10 20.23 20.38 20.65 20.75 2	4 R ₂ 19.38 18.61 18.32 18.10 17.95 17.88 17.93 18.01 18.11 18.24 18.38 18.51 18.62 18.70 18.74 18.73 18.70 18.74 18.73 18.70 18.74 18.73 18.70 18.74 18.73 18.70 18.63 16.53 18.70 18.63 18.70 18.63 18.70 18.70 18.74 18.73 18.70 18.74 18.75 18.75 18.75 18.75 18.75 18.75 18.75 18.75 17.80 17.52 17.37	R ₁ 20.36 20.18 20.03 19.90 19.80 19.73 19.70 19.75 19.84 19.97 20.10 20.24 20.34 20.34 20.34 20.44 20.44 20.44 20.44 20.44 20.44 20.43 20.42 20.16 20.16 20.16 20.16 20.16 20.16 20.16 20.16 20.10 20.24 20.44 20.44 20.33 20.25 20.16 20.16 20.69 19.83 19.95 19.83	5 R ₂ 18.20 18.04 17.89 17.76 17.66 17.54 17.54 17.54 17.54 17.54 17.54 17.56 17.64 17.77 17.93 18.08 18.35 18.43 18.35 18.52 18.52 18.52 18.52 18.52 18.52 18.52 18.52 18.54 18.36 18.28 18.36 18.36 18.52 18.52 18.50 18.52 18.50 18.52 18.52 18.50 18.52 18.52 18.55 18.56 18.55 18.55 18.55 18.55 18.55 18.55 18.55 18.55 18.55 18.56 18.55 18.55 18.55 18.55 18.56 18.55 18.55 18.55 18.55 18.56 18.56 18.56 18.55 18.56 18.56 18.56 18.55 18.56 18.56 18.56 18.56 18.56 18.56 18.56 18.56 18.56 18.56 17.64 17.56 17.55 17.56 17.55 1	R ₁ 19.16 19.14 19.11 19.10 19.12 19.15 19.21 19.23 19.43 19.58 19.73 20.62 20.04 20.05 20.05 20.05 20.05 20.05 20.06 20.05 20.06 20.05 2	

WITTICHENITE

Tabl	e III				Quan	titative Colour	Values				
SEAT	HWAITE										
AIR						_	OIL				
		x	¥	λ _D	P_%	¥.	æ	у	λ_D	P _e %	¥
	R.	0.4483-0.4489	0.4094-0.4098	576-579	1.9-2.2	34.5-35.4	0.4470-0.4481	0,4088-0,4094	560-576	0.8-1.3	20.0-20.2
A	R2	0.4484-0.4489	0.4082-0.4096	578-582	1.1-2.3	33.0-33.5	0.4475-0.4485	0.4076-0.4096	518-577	0.0-2.1	18.4-18.5
n	R,	0.3146-0.3151	0.3323-0.3329	569-572	1.4-1.7	34.8-35.4	0.3132-0.3141	0.3307-0.3314	561-575	0.7-0.9	20.0-20.2
65	R ₂	0.3142-0.3152	0.3330-0.3310	574-582	D.7-1.8	33.0-33.5	0.3130-0.3149	0.3279-0.3322	-534-572	0.5-1.5	18.3-18.5
	R	0.3120-0.3125	0.3194-0.3201	570-573	1.4-1.6	34.8-35.4	0.3106-0.3115	0.3178-0.3185	562-576	0.7-0.8	20.0-20.2
С	R2	0.3116-0.3127	0.3172-0.3201	572-585	0.6-1.7	33.0-33.5	0.3103-0.3123	0.3150-0.3194	-542-573	0.6-1.4	18.3-18.5
<u>WIT</u> T	ICHEN										
	RT	0.4480-0.4485	0.4099-0.4105	573-576	2.1-2.4	34.7-35.6	0,4463-0,4480	0.4102-0.4113	561-573	1.4-2.5	19.9-20.5
A	R2	0.4486-0.4499	0.4086-0.4101	579-582	1.7-3.4	33.0-33.4	0.4480-0.4491	0.4090-0.4101	574-581	2.1-3.2	18.2-18.6
	R,	0.3146-0.3149	0.3332-0.3343	565-569	1.8-2.1	34.7-35.6	0.3135-0.3149	0.3327-0.3344	558-567	1.3-2.0	19.9-20.5
⁰ 65	R2	0.3147-0.3165	0.3308-0.3344	572-579	1.1-2.6	32.9-33.4	0.3147-0.3162	0.3313-0.3336	570-578	1.4-2.3	18.2-18.5
	R,	0.3121-0.3124	0,3204-0.3215	566-570	1.7-2.0	34,7-35.6	0.3110-0.3123	0.3198-0.3215	559-567	1.2-1.9	19.9-20.5
¢	R2	0.3121-0.3139	0.3179-0.3216	573-581	1.0-2.5	32.9-33.4	0.3121-0.3136	0.3185-0.3209	571-580	1.3-2.2	18.2-18.5

The values are relative to the CIE illuminants A, D_{65} and C, having colour temperatures of 3300°K, 6500° K and 6750° K respectively. The rectangular coordinates are z and y from which were derived the polar coordinates λ_{ρ} , the dominant wavelength, and P_{ϕ} s, the excitation purity. I is the 'luminance'. As the colour values were so similar for all the grains measured the range of values is shown rather than individual grain values.

Tab1e	IV		Reflec	tance Di	ata					
λημη		Seath	waite		Wittichen					
	A	IR	DI	IL.	A	LR	OIL			
	R1	R2	RJ	R ₂	R1.	^R 2	R	R2		
400	34.8	32.0	21.2	18.4	34.0	31.3	20.4	18.		
420	34.6	32.1	20.5	18.3	34.1	31.5	20.0	17.		
440	34.5	32.2	20.0	18.0	34.1	31.7	19.8	17.		
460	34.5	32.3	19.8	17.9	34.5	31.9	19.9	17.		
470	84.6	32.3	19.9	27.9	34.7	32.0	20.0	17.		
480	34.7	32.3	19.9	17.8	34.9	32.1	20.1	17.		
500	35.0	32.5	20.0	18.0	35.3	32.3	20.4	17.		
520	35.3	32.7	20.3	18.2	35.6	32.6	20.7	18,		
540	35.5	32.9	20.4	18.3	35.8	32.9	20.8	18.		
546	35.6	83.0	20.4	18.3	35.8	33.0	20.8	18.		
560	35.6	33.1	20.4	18.4	35.8	33.1	20.8	18.		
580	35.6	33.2	20.4	18.5	35.7	33.3	20.6	18.		
589	35.6	33.2	20.4	28.5	35.7	33.3	20.5	28.		
600	35.6	33.2	20.3	18.5	35.6	33.3	20.3	18.		
620	35.4	33.1	20.1	18.4	35,3	33.1	20.1	18.		
640	35.3	33.0	19:9	18.2	35.1	32.9	19.9	18.		
650	36.2	32.9	29.8	18.1	35.0	32.8	29.7	18.		
66D	35.1	32.8	19.7	18.0	34.8	32.7	19.6	17.		
680	34.8	32.6	19.5	17.8	34.5	32.4	19.3	17.		
700	34.6	32.4	19.4	17.6	34,2	32.1	19.0	17.		

These values are the R maxima and minima from the three groups of measurements made on specimens from both localities. (Tables I and II). They include graphically interpolated values for the 4 COM wavelengths 470, 548, 589 and 650 nm.

Table VI Chemica							cal analyses								
	Seathwa	ite					Wittichen								
Cu	37,80	38.11	37.37	1 38.26	2 38.18	3 38.32	4 37.77	5 37.58	6 37.83	37.41	37.48	37.71	37.85		
Bi	43,17	42.90	43.16	42.01	42.70	42.93	43.06	43.76	43,46	43.47	43.38	43.24	43.73		
s	18,49	18.37	18.50	18.06	17.96	17.94	19.06	19.07	19.02	18.16	18.23	18.51	19.11		
TOTAL	99,45	99.38	99.03	98.33	98.84	99.19	99.89	100.41	100.31	99.04	99.09	99.46	100.69		

Numbers 1-6 correspond to the areas measured in the reflectance study.