

6f. Optical Characteristics of Various Uniaxial  
and Biaxial Crystals

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TABLE 6f-1. INDEX OF REFRACTION OF SELECTED UNIAXIAL MINERALS\*

Mineral	Formula	Index of refraction	
		Ordinary ray	Extraordinary ray
Uniaxial Positive Minerals			
Ice	H <sub>2</sub> O	1.309	1.313
Sellaite	MgF <sub>2</sub>	1.378	1.390
Chrysocolla	CuO·SiO <sub>2</sub> ·2H <sub>2</sub> O	1.460 ±	1.570 ±
Laubanite	2CaO·Al <sub>2</sub> O <sub>3</sub> ·5SiO <sub>2</sub> ·6H <sub>2</sub> O	1.475	1.486
Chabazite	(Ca, Na <sub>2</sub> )O·Al <sub>2</sub> O <sub>3</sub> ·4SiO <sub>2</sub> ·6H <sub>2</sub> O	1.480 ±	1.482 ±
Douglasite	2KCl·FeCl <sub>2</sub> ·2H <sub>2</sub> O	1.488	1.500
Hydronephelite	2Na <sub>2</sub> O·3Al <sub>2</sub> O <sub>3</sub> ·6SiO <sub>2</sub> ·7H <sub>2</sub> O	1.490	1.502
Apophyllite	K <sub>2</sub> O·8CaO·16SiO <sub>2</sub> ·16H <sub>2</sub> O	1.535 ±	1.537 ±
Quartz	SiO <sub>2</sub>	1.544	1.553
Coquimbite	Fe <sub>2</sub> O <sub>3</sub> ·3SO <sub>3</sub> ·9H <sub>2</sub> O	1.550	1.556
Brucite	MgO·H <sub>2</sub> O	1.559	1.580
Alunite	K <sub>2</sub> O·3Al <sub>2</sub> O <sub>3</sub> ·4SO <sub>3</sub> ·6H <sub>2</sub> O	1.572	1.592
Penninite	5(Mg, Fe)O·Al <sub>2</sub> O <sub>3</sub> ·3SiO <sub>2</sub> ·4H <sub>2</sub> O	1.576	1.579
Cacoxenite	2Fe <sub>2</sub> O <sub>3</sub> ·P <sub>2</sub> O <sub>5</sub> ·12H <sub>2</sub> O	1.582	1.645
Eudialite	6Na <sub>2</sub> O·6(Ca, Fe)O·20(Si, Zr)O <sub>2</sub> ·NaCl	1.606	1.611
Diopase	CuO·SiO <sub>2</sub> ·H <sub>2</sub> O	1.654	1.707
Phenacite	2BeO·SiO <sub>2</sub>	1.654	1.670
Parisite	2CeOF·CaO·3CO <sub>2</sub>	1.676 ±	1.757
Willemite	2ZnO·SiO <sub>2</sub>	1.691	1.719
Vesuvianite	2(Ca, Mn, Fe)O·(Al, Fe) (OH, F)O·2SiO <sub>2</sub>	1.716 ±	1.721
Xenotime	Y <sub>2</sub> O <sub>3</sub> ·P <sub>2</sub> O <sub>5</sub>	1.721	1.816
Connellite	20CuO·SO <sub>3</sub> ·2CuCl <sub>2</sub> ·20H <sub>2</sub> O	1.724	1.746
Benitoite	BaO·TiO <sub>2</sub> ·3SiO <sub>2</sub>	1.757	1.804
Ganomalite	6PbO·4(Ca, Mn)O·6SiO <sub>2</sub> ·H <sub>2</sub> O	1.910	1.945
Scheelite	CaO·WO <sub>3</sub>	1.918	1.934
Zircon	ZrO <sub>2</sub> ·SiO <sub>2</sub>	1.923 ±	1.968 ±
Powellite	CaO·MoO <sub>3</sub>	1.974	1.978
Calomel	HgCl	1.973	2.650
Cassiterite	SnO <sub>2</sub>	1.997	2.093
Zincite	ZnO	2.013	2.029
Phosgenite	PbO·PbCl <sub>2</sub> ·CO <sub>2</sub>	2.114	2.140
Penfieldite	PbO·PbCl <sub>2</sub>	2.130	2.210
Iodyrite	AgI	2.210	2.220
Tapiolite	FeO·(Ta, Nb) <sub>2</sub> O <sub>6</sub>	2.270	2.420 (Li line)
Wurtzite	ZnS	2.356	2.378
Derbylite	6FeO·Sb <sub>2</sub> O <sub>3</sub> ·5TiO <sub>2</sub>	2.450	2.510 (Li line)
Greenockite	CdS	2.506	2.529
Rutile	TiO <sub>2</sub>	2.616	2.903
Moissanite	CSi	2.654	2.697
Cinnabar	HgS	2.854	3.201

TABLE 6f-1. INDEX OF REFRACTION OF SELECTED UNIAXIAL MINERALS\* (Continued)

Mineral	Formula	Index of refraction	
		Ordinary ray	Extraordinary ray
Uniaxial Negative Minerals			
Chiolite.....	2NaF·AlF <sub>3</sub>	1.349	1.342
Hanksite.....	11Na <sub>2</sub> O·9SO <sub>3</sub> ·2CO <sub>2</sub> ·KCl	1.481	1.461
Thaumasite.....	3CaO·CO <sub>2</sub> ·SiO <sub>2</sub> ·SO <sub>3</sub> ·15H <sub>2</sub> O	1.507	1.468
Hydrotalcite.....	6MgO·Al <sub>2</sub> O <sub>3</sub> ·CO <sub>2</sub> ·15H <sub>2</sub> O	1.512	1.498
Cancrinite.....	4Na <sub>2</sub> O·CaO·4Al <sub>2</sub> O <sub>3</sub> ·2CO <sub>2</sub> ·9SiO <sub>2</sub> ·3H <sub>2</sub> O	1.524	1.496
Milairite.....	K <sub>2</sub> O·4CaO·2Al <sub>2</sub> O <sub>3</sub> ·24SiO <sub>2</sub> ·II <sub>2</sub> O	1.532	1.529
Kaliophilite.....	K <sub>2</sub> O·Al <sub>2</sub> O <sub>3</sub> ·2SiO <sub>2</sub>	1.537	1.533
Mellite.....	Al <sub>2</sub> O <sub>3</sub> ·C <sub>12</sub> O <sub>9</sub> ·18H <sub>2</sub> O	1.539	1.511
Marialite.....	"Ma" = 3Na <sub>2</sub> O·3Al <sub>2</sub> O <sub>3</sub> ·18SiO <sub>2</sub> ·2NaCl	1.530	1.527
Nephelite.....	Na <sub>2</sub> O·Al <sub>2</sub> O <sub>3</sub> ·2SiO <sub>2</sub>	1.542	1.538
Wernerite.....	Me <sub>1</sub> Ma <sub>1</sub> ±	1.578	1.551
Beryl.....	3BeO·Al <sub>2</sub> O <sub>3</sub> ·6SiO <sub>2</sub>	1.581 ±	1.575 ±
Torbernite.....	CuO·2UO <sub>3</sub> ·P <sub>2</sub> O <sub>5</sub> ·8H <sub>2</sub> O	1.592	1.582
Meionite.....	"Me" = 4CaO·3Al <sub>2</sub> O <sub>3</sub> ·6SiO <sub>2</sub>	1.597	1.560
Melilite.....	Contains Na <sub>2</sub> O, CaO, Al <sub>2</sub> O <sub>3</sub> , SiO <sub>2</sub> , etc.	1.634	1.629
Apatite.....	9CaO·3P <sub>2</sub> O <sub>5</sub> ·Ca(F, Cl) <sub>2</sub>	1.634	1.631
Calcite.....	CaO·CO <sub>2</sub>	1.658	1.486
Gehlenite.....	2CaO·Al <sub>2</sub> O <sub>3</sub> ·SiO <sub>2</sub>	1.669	1.658
Tourmaline.....	Contains Na <sub>2</sub> O, FeO, Al <sub>2</sub> O <sub>3</sub> , B <sub>2</sub> O <sub>3</sub> , SiO <sub>2</sub> , etc.	1.669 ±	1.638 ±
Dolomite.....	CaO·MgO·2CO <sub>2</sub>	1.681	1.500
Magnesite.....	MgO·CO <sub>2</sub>	1.700	1.509
Pyrochroite.....	MnO·H <sub>2</sub> O	1.723	1.681
Corundum.....	Al <sub>2</sub> O <sub>3</sub>	1.768	1.760
Smithsonite.....	ZnO·CO <sub>2</sub>	1.818	1.618
Rhodochrosite.....	MnO·CO <sub>2</sub>	1.818	1.595
Jarosite.....	K <sub>2</sub> O·3Fe <sub>2</sub> O <sub>3</sub> ·4SO <sub>3</sub> ·6H <sub>2</sub> O	1.820	1.715
Siderite.....	FeO·CO <sub>2</sub>	1.875	1.635
Pyromorphite.....	9PbO·3P <sub>2</sub> O <sub>5</sub> ·PbCl <sub>2</sub>	2.050	2.042
Barysilite.....	3PbO·2SiO <sub>2</sub>	2.070	2.050
Mimetite.....	9PbO·3As <sub>2</sub> O <sub>3</sub> ·PbCl <sub>2</sub>	2.135	2.118
Matlockite.....	PbO·PbCl <sub>2</sub>	2.150	2.040
Stolzite.....	PbO·WO <sub>3</sub>	2.269	2.182
Geikielite.....	(Mg, Fe)O·TiO <sub>2</sub>	2.310	1.950
Vanadinite.....	9PbO·3V <sub>2</sub> O <sub>5</sub> ·PbCl <sub>2</sub>	2.354	2.299
Wulfenite.....	PbO·MoO <sub>3</sub>	2.402	2.304 (Li line)
Octahedrite.....	TiO <sub>2</sub>	2.554	2.493
Massicotite.....	PbO	2.665	2.535 (Li line)
Proustite.....	3Ag <sub>2</sub> S·As <sub>2</sub> S <sub>3</sub>	2.979	2.711 (Li line)
Pryargyrite.....	3Ag <sub>2</sub> S·Sb <sub>2</sub> S <sub>3</sub>	3.084	2.881 (Li line)
Hematite.....	Fe <sub>2</sub> O <sub>3</sub>	3.220	2.940 (Li line)

\* "Smithsonian Physical Tables," 1954, Table 546. Selected by Edgar T. Wherry from a private compilation of Esper S. Larsen, of the U.S. Geological Survey.

TABLE 6f-2. INDEX OF REFRACTION OF SELECTED BIAXIAL MINERALS\*

Mineral	Formula	Index of refraction		
		$n_\alpha$	$n_\beta$	$n_\gamma$
Biaxial Positive Minerals				
Stercorite.....	$\text{NaO} \cdot (\text{NH}_4)_2\text{O} \cdot \text{P}_2\text{O}_5 \cdot 9\text{H}_2\text{O}$	1.439	1.441	1.469
Aluminite.....	$\text{Al}_2\text{O}_3 \cdot \text{SO}_3 \cdot 9\text{H}_2\text{O}$	1.459	1.464	1.470
Tridymite.....	$\text{SiO}_2$	1.469	1.470	1.473
Thenardite.....	$\text{Na}_2\text{O} \cdot \text{SO}_3$	1.464	1.474	1.485
Carnallite.....	$\text{KCl} \cdot \text{MgCl}_2 \cdot 6\text{H}_2\text{O}$	1.466	1.475	1.494
Alunogen.....	$\text{Al}_2\text{O}_3 \cdot 3\text{SO}_3 \cdot 16\text{H}_2\text{O}$	1.474	1.470	1.483
Melanterite.....	$\text{FeO} \cdot \text{SO}_3 \cdot 7\text{H}_2\text{O}$	1.471	1.478	1.486
Natrolite.....	$\text{Na}_2\text{O} \cdot \text{Al}_2\text{O}_3 \cdot 3\text{SiO}_2 \cdot 2\text{H}_2\text{O}$	1.480	1.482	1.493
Arcanite.....	$\text{K}_2\text{O} \cdot \text{SO}_3$	1.404	1.405	1.407
Struvite.....	$(\text{NH}_4)_2\text{O} \cdot 2\text{MgO} \cdot \text{P}_2\text{O}_5 \cdot 12\text{H}_2\text{O}$	1.495	1.496	1.500
Heulandite.....	$\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot 6\text{SiO}_2 \cdot 3\text{H}_2\text{O}$	1.498	1.499	1.505
Thomsonite.....	$(\text{Na}_2, \text{Ca})\text{O} \cdot \text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 3\text{H}_2\text{O}$	1.497	1.503	1.525
Harmotome.....	$(\text{K}_2, \text{Ba})\text{O} \cdot \text{Al}_2\text{O}_3 \cdot 5\text{SiO}_2 \cdot 5\text{H}_2\text{O}$	1.503	1.505	1.508
Petalite.....	$\text{Li}_2\text{O} \cdot \text{Al}_2\text{O}_3 \cdot 8\text{SiO}_2$	1.504	1.510	1.516
Monetite.....	$2\text{CaO} \cdot \text{P}_2\text{O}_5 \cdot \text{H}_2\text{O}$	1.515	1.518	1.525
Newberyite.....	$2\text{MgO} \cdot \text{P}_2\text{O}_5 \cdot 7\text{H}_2\text{O}$	1.514	1.519	1.533
Gypsum.....	$\text{CaO} \cdot \text{SO}_3 \cdot 2\text{H}_2\text{O}$	1.520	1.523	1.530
Mascagnite.....	$(\text{NH}_4)_2\text{O} \cdot \text{SO}_3$	1.521	1.523	1.533
Albite.....	"Ab" = $\text{Na}_2\text{O} \cdot \text{Al}_2\text{O}_3 \cdot 6\text{SiO}_2$	1.525	1.529	1.536
Hydromagnesite..	$4\text{MgO} \cdot 3\text{CO}_2 \cdot 4\text{H}_2\text{O}$	1.527	1.530	1.540
Wavellite.....	$3\text{Al}_2\text{O}_3 \cdot 2\text{P}_2\text{O}_5 \cdot 12(\text{H}_2\text{O}, 2\text{HF})$	1.525	1.534	1.552
Kieserite.....	$\text{MgO} \cdot \text{SO}_3 \cdot \text{H}_2\text{O}$	1.523	1.535	1.586
Copiapite.....	$2\text{Fe}_2\text{O}_3 \cdot 5\text{SO}_3 \cdot 18\text{H}_2\text{O}$	1.530	1.550	1.592
Whewellite.....	$\text{CaO} \cdot \text{C}_2\text{O}_4 \cdot \text{H}_2\text{O}$	1.491	1.555	1.650
Variscite.....	$\text{Al}_2\text{O}_3 \cdot \text{P}_2\text{O}_5 \cdot 4\text{H}_2\text{O}$	1.551	1.558	1.582
Labradorite.....	$\text{Ab}_2\text{An}_3$	1.559	1.563	1.568
Gibbsite.....	$\text{Al}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$	1.566	1.566	1.587
Wagnerite.....	$3\text{MgO} \cdot \text{P}_2\text{O}_5 \cdot \text{MgF}_2$	1.569	1.570	1.582
Anhydrite.....	$\text{CaO} \cdot \text{SO}_3$	1.571	1.576	1.614
Colemanite.....	$2\text{CaO} \cdot 3\text{B}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$	1.586	1.592	1.614
Fremontite.....	$\text{Na}_2\text{O} \cdot \text{Al}_2\text{O}_3 \cdot \text{P}_2\text{O}_5 \cdot (\text{H}_2\text{O}, 2\text{HF})$	1.594	1.603	1.615
Vivianite.....	$3\text{FeO} \cdot \text{P}_2\text{O}_5 \cdot 8\text{H}_2\text{O}$	1.579	1.603	1.633
Pectolite.....	$\text{Na}_2\text{O} \cdot 4\text{CaO} \cdot 6\text{SiO}_2 \cdot \text{H}_2\text{O}$	1.595	1.604	1.633
Calamine.....	$2\text{ZnO} \cdot \text{SiO}_2 \cdot \text{H}_2\text{O}$	1.614	1.617	1.636
Chondrodite.....	$4\text{MgO} \cdot \text{SiO}_2 \cdot \text{Mg}(\text{F}, \text{OH})_2$	1.604	1.617	1.636
Turquoise.....	$\text{CuO} \cdot 3\text{Al}_2\text{O}_3 \cdot 2\text{P}_2\text{O}_5 \cdot 9\text{H}_2\text{O}$	1.610	1.620	1.650
Topaz.....	$2\text{AlO} \cdot \text{SiO}_2$	1.619	1.620	1.627
Celestite.....	$\text{SrO} \cdot \text{SO}_3$	1.622	1.624	1.631
Prehnite.....	$2\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot 3\text{SiO}_2 \cdot \text{H}_2\text{O}$	1.616	1.626	1.649
Barite.....	$\text{BaO} \cdot \text{SO}_3$	1.636	1.637	1.648
Anthophyllite....	$\text{MgO} \cdot \text{SiO}_2$	1.633	1.642	1.657
Sillimanite.....	$\text{Al}_2\text{O}_3 \cdot \text{SiO}_2$	1.638	1.642	1.653
Forsterite.....	$2\text{MgO} \cdot \text{SiO}_2$	1.635	1.651	1.669

TABLE 6f-2. INDEX OF REFRACTION OF SELECTED BIAxIAL MINERALS\* (Continued)

Mineral	Formula	Index of refraction		
		$n_{\alpha}$	$n_{\beta}$	$n_{\gamma}$
Biaxial Positive Minerals				
Enstatite.....	MgO·SiO <sub>2</sub>	1.650	1.653	1.658
Euclase.....	2BeO·Al <sub>2</sub> O <sub>3</sub> ·2SiO <sub>2</sub> ·H <sub>2</sub> O	1.653	1.656	1.673
Triplite.....	3MnO·P <sub>2</sub> O <sub>5</sub> ·MnF <sub>2</sub>	1.650	1.660	1.672
Spodumene.....	Li <sub>2</sub> O·Al <sub>2</sub> O <sub>3</sub> ·4SiO <sub>2</sub>	1.660	1.666	1.676
Diopside.....	CaO·MgO·2SiO <sub>2</sub>	1.664	1.671	1.694
Olivine.....	2(Mg, Fe)O·SiO <sub>2</sub>	1.662	1.680	1.699
Triphylite.....	Li <sub>2</sub> O·2(Fe, Mn)O·P <sub>2</sub> O <sub>5</sub>	1.688	1.688	1.692
Zoisite.....	4CaO·3Al <sub>2</sub> O <sub>3</sub> ·6SiO <sub>2</sub> ·H <sub>2</sub> O	1.700	1.702	1.706
Strengite.....	Fe <sub>2</sub> O <sub>3</sub> ·P <sub>2</sub> O <sub>5</sub> ·4H <sub>2</sub> O	1.708	1.708	1.745
Diaspore.....	Al <sub>2</sub> O <sub>3</sub> ·H <sub>2</sub> O	1.702	1.722	1.750
Staurolite.....	2FeO·5Al <sub>2</sub> O <sub>3</sub> ·4SiO <sub>2</sub> ·H <sub>2</sub> O	1.736	1.741	1.746
Chrysoberyl.....	BeO·Al <sub>2</sub> O <sub>3</sub>	1.747	1.748	1.757
Azurite.....	3CuO·2CO <sub>2</sub> ·H <sub>2</sub> O	1.730	1.758	1.838
Scorodite.....	Fe <sub>2</sub> O <sub>3</sub> ·As <sub>2</sub> O <sub>5</sub> ·4H <sub>2</sub> O	1.765	1.774	1.797
Olivenite.....	4CuO·As <sub>2</sub> O <sub>5</sub> ·H <sub>2</sub> O	1.772	1.810	1.863
Anglesite.....	PbO·SO <sub>3</sub>	1.877	1.882	1.894
Titanite.....	CaO·TiO <sub>2</sub> ·SiO <sub>2</sub>	1.900	1.907	2.034
Claudetite.....	As <sub>2</sub> O <sub>3</sub>	1.871	1.920	2.010
Sulfur.....	S	1.950	2.043	2.240
Cotunnite.....	PbCl <sub>2</sub>	2.200	2.217	2.260
Huebnerite.....	MnO·WO <sub>3</sub>	2.170	2.220	2.320
Manganite.....	Mn <sub>2</sub> O <sub>3</sub> ·H <sub>2</sub> O	2.240	2.240	2.530 (Li)
Raspite.....	PbO·WO <sub>3</sub>	2.270	2.270	2.300
Mendipite.....	2PbO·PbCl <sub>2</sub>	2.240	2.270	2.310
Tantalite.....	(Fe, Mn)O·Ta <sub>2</sub> O <sub>5</sub>	2.260	2.320	2.430 (Li)
Wolframite.....	(Fe, Mn)O·WO <sub>3</sub>	2.310	2.360	2.460 (Li)
Crocoite.....	PbO·CrO <sub>3</sub>	2.310	2.370	2.660 (Li)
Pseudobrookite.....	2Fe <sub>2</sub> O <sub>3</sub> ·3TiO <sub>2</sub>	2.380	2.390	2.420 (Li)
Stibiotantalite.....	Sb <sub>2</sub> O <sub>3</sub> ·Ta <sub>2</sub> O <sub>5</sub>	2.374	2.404	2.457
Montroydite.....	HgO	2.370	2.500	2.650 (Li)
Brookite.....	TiO <sub>2</sub>	2.583	2.586	2.741
Massicot.....	PbO	2.510	2.610	2.710
Biaxial Negative Minerals				
Mirabilite.....	Na <sub>2</sub> O·SO <sub>3</sub> ·10H <sub>2</sub> O	1.394	1.396	1.398
Thomsenolite.....	NaF·CaF <sub>2</sub> ·AlF <sub>3</sub> ·H <sub>2</sub> O	1.407	1.414	1.415
Natron.....	Na <sub>2</sub> O·CO <sub>2</sub> ·10H <sub>2</sub> O	1.405	1.425	1.440
Kalinite.....	K <sub>2</sub> O·Al <sub>2</sub> O <sub>3</sub> ·4SO <sub>3</sub> ·24H <sub>2</sub> O	1.430	1.452	1.458
Epsomite.....	MgO·SO <sub>3</sub> ·7H <sub>2</sub> O	1.433	1.455	1.461
Sassolite.....	B <sub>2</sub> O <sub>3</sub> ·H <sub>2</sub> O	1.340	1.456	1.459
Borax.....	Na <sub>2</sub> O·2B <sub>2</sub> O <sub>3</sub> ·10H <sub>2</sub> O	1.447	1.470	1.472

TABLE 6f-2. INDEX OF REFRACTION OF SELECTED BIAxIAL MINERALS\* (Continued)

Mineral	Formula	Index of refraction		
		$n_{\alpha}$	$n_{\beta}$	$n_{\gamma}$
Biaxial Negative Minerals				
Goslarite.....	ZnO·SO <sub>3</sub> ·7H <sub>2</sub> O	1.457	1.480	1.484
Pickeringite.....	MgO·Al <sub>2</sub> O <sub>3</sub> ·4SO <sub>3</sub> ·22H <sub>2</sub> O	1.476	1.480	1.483
Bloedite.....	Na <sub>2</sub> O·MgO·2SO <sub>3</sub> ·4H <sub>2</sub> O	1.483	1.487	1.486
Trona.....	3Na <sub>2</sub> O·4CO <sub>2</sub> ·5H <sub>2</sub> O	1.410	1.492	1.542
Thermonatrite...	Na <sub>2</sub> O·CO <sub>2</sub> ·H <sub>2</sub> O	1.420	1.495	1.518
Stilbite.....	(Ca, Na <sub>2</sub> )O·Al <sub>2</sub> O <sub>3</sub> ·6SiO <sub>2</sub> ·5H <sub>2</sub> O	1.494	1.498	1.500
Niter.....	K <sub>2</sub> O·N <sub>2</sub> O <sub>5</sub>	1.334	1.505	1.506
Kainite.....	MgO·SO <sub>3</sub> ·KCl·3H <sub>2</sub> O	1.494	1.505	1.516
Gaylussite.....	Na <sub>2</sub> O·CaO·2CO <sub>2</sub> ·5H <sub>2</sub> O	1.444	1.516	1.523
Scolecite.....	CaO·Al <sub>2</sub> O <sub>3</sub> ·3SiO <sub>2</sub> ·3H <sub>2</sub> O	1.512	1.519	1.519
Laumontite.....	CaO·Al <sub>2</sub> O <sub>3</sub> ·4SiO <sub>2</sub> ·H <sub>2</sub> O	1.513	1.524	1.525
Orthoclase.....	K <sub>2</sub> O·Al <sub>2</sub> O <sub>3</sub> ·6SiO <sub>2</sub>	1.518	1.524	1.526
Microcline.....	Same as preceding	1.522	1.526	1.530
Anorthoclase.....	(Na, K) <sub>2</sub> O·Al <sub>2</sub> O <sub>3</sub> ·6SiO <sub>2</sub>	1.523	1.529	1.531
Glauberite.....	Na <sub>2</sub> O·CaO·2SO <sub>3</sub>	1.515	1.532	1.536
Cordierite.....	4(Mg, Fe)O·4Al <sub>2</sub> O <sub>3</sub> ·10SiO <sub>2</sub> ·H <sub>2</sub> O	1.534	1.538	1.540
Chalcanthite....	CuO·SO <sub>3</sub> ·5H <sub>2</sub> O	1.516	1.539	1.546
Oligoclase.....	Ab, An	1.539	1.543	1.547
Beryllonite.....	Na <sub>2</sub> O·2BeO·P <sub>2</sub> O <sub>5</sub>	1.552	1.558	1.561
Kaolinite.....	Al <sub>2</sub> O <sub>3</sub> ·2SiO <sub>2</sub> ·2H <sub>2</sub> O	1.561	1.563	1.565
Biotite.....	K <sub>2</sub> O·4(Mg, Fe)O·2Al <sub>2</sub> O <sub>3</sub> ·6SiO <sub>2</sub> ·H <sub>2</sub> O	1.541	1.574	1.574
Autunite.....	CaO·2UO <sub>3</sub> ·P <sub>2</sub> O <sub>5</sub> ·8H <sub>2</sub> O	1.553	1.575	1.577
Anorthite.....	"An" = CaO·Al <sub>2</sub> O <sub>3</sub> ·2SiO <sub>2</sub>	1.576	1.584	1.588
Lanthanite.....	La <sub>2</sub> O <sub>3</sub> ·3CO <sub>2</sub> ·9H <sub>2</sub> O	1.520	1.587	1.613
Pyrophyllite....	Al <sub>2</sub> O <sub>3</sub> ·4SiO <sub>2</sub> ·H <sub>2</sub> O	1.552	1.588	1.600
Talc.....	3MgO·4SiO <sub>2</sub> ·H <sub>2</sub> O	1.539	1.589	1.589
Hopeite.....	3ZnO·P <sub>2</sub> O <sub>5</sub> ·4H <sub>2</sub> O	1.572	1.590	1.590
Muscovite.....	K <sub>2</sub> O·Al <sub>2</sub> O <sub>3</sub> ·6SiO <sub>2</sub> ·2H <sub>2</sub> O	1.561	1.590	1.594
Amblygonite....	Al <sub>2</sub> O <sub>3</sub> ·P <sub>2</sub> O <sub>5</sub> ·2LiF	1.579	1.593	1.597
Lepidolite.....	Al <sub>2</sub> O <sub>3</sub> ·3SiO <sub>2</sub> ·2(K, Li)F	1.560	1.598	1.605
Phlogopite.....	K <sub>2</sub> O·6MgO·Al <sub>2</sub> O <sub>3</sub> ·6SiO <sub>2</sub> ·2H <sub>2</sub> O	1.562	1.606	1.606
Tremolite.....	CaO·3MgO·4SiO <sub>2</sub>	1.600	1.616	1.627
Actinolite.....	CaO·3(Mg, Fe)O·4SiO <sub>2</sub>	1.614	1.630	1.641
Wollastonite....	CaO·SiO <sub>2</sub>	1.620	1.632	1.634
Lazulite.....	(Fe, Mg)O·Al <sub>2</sub> O <sub>3</sub> ·P <sub>2</sub> O <sub>5</sub> ·H <sub>2</sub> O	1.612	1.634	1.643
Danburite.....	CaO·B <sub>2</sub> O <sub>3</sub> ·2SiO <sub>2</sub>	1.632	1.634	1.636
Glaucophane....	Na <sub>2</sub> O·2FeO·Al <sub>2</sub> O <sub>3</sub> ·6SiO <sub>2</sub>	1.621	1.638	1.638
Andalusite.....	Al <sub>2</sub> O <sub>3</sub> ·SiO <sub>2</sub>	1.632	1.638	1.643
Hornblende.....	Contains Na <sub>2</sub> O, MgO, FeO, SiO <sub>2</sub> , etc.	1.634	1.647	1.652
Datolite.....	2CaO·2SiO <sub>2</sub> ·B <sub>2</sub> O <sub>3</sub> ·H <sub>2</sub> O	1.625	1.653	1.669
Erythrite.....	3CoO·As <sub>2</sub> O <sub>3</sub> ·8H <sub>2</sub> O	1.626	1.661	1.699
Monticellite....	CaO·MgO·SiO <sub>2</sub>	1.651	1.662	1.668

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TABLE 6f-2. INDEX OF REFRACTION OF SELECTED BIAxIAL MINERALS\* (Continued)

Mineral	Formula	Index of refraction		
		$n_\alpha$	$n_\beta$	$n_\gamma$
Biaxial Negative Minerals				
Strontianite.....	SrO·CO <sub>2</sub>	1.520	1.667	1.667
Witherite.....	BaO·CO <sub>2</sub>	1.529	1.676	1.677
Aragonite.....	CaO·CO <sub>2</sub>	1.531	1.682	1.686
Axinite.....	6(Ca, Mn)O·2Al <sub>2</sub> O <sub>3</sub> ·B <sub>2</sub> O <sub>3</sub> ·8SiO <sub>2</sub> ·H <sub>2</sub> O	1.678	1.685	1.688
Dumortierite.....	8Al <sub>2</sub> O <sub>3</sub> ·B <sub>2</sub> O <sub>3</sub> ·6SiO <sub>2</sub> ·H <sub>2</sub> O	1.678	1.686	1.689
Cyanite.....	Al <sub>2</sub> O <sub>3</sub> ·SiO <sub>2</sub>	1.712	1.720	1.728
Epidote.....	4CaO·3(Al, Fe) <sub>2</sub> O <sub>3</sub> ·6SiO <sub>2</sub> ·H <sub>2</sub> O	1.729	1.763	1.780
Atacamite.....	3CuO·CuCl <sub>2</sub> ·3H <sub>2</sub> O	1.831	1.861	1.880
Fayalite.....	2FeO·SiO <sub>2</sub>	1.824	1.864	1.874
Caledonite.....	2(Pb, Cu)O·SO <sub>3</sub> ·H <sub>2</sub> O	1.818	1.866	1.909
Malachite.....	2CuO·CO <sub>2</sub> ·H <sub>2</sub> O	1.655	1.875	1.909
Lanarkite.....	2PbO·SO <sub>3</sub>	1.930	1.990	2.020
Leadhillite.....	4PbO·SO <sub>3</sub> ·2CO <sub>2</sub> ·H <sub>2</sub> O	1.870	2.000	2.010
Cerussite.....	PbO·CO <sub>2</sub>	1.804	2.076	2.078
Laurionite.....	PbCl <sub>2</sub> ·PbO·H <sub>2</sub> O	2.077	2.116	2.158
Matlockite.....	PbO·PbCl <sub>2</sub>	2.040	2.150	2.150
Baddeleyite.....	ZrO <sub>2</sub>	2.130	2.190	2.200
Lepidocrocite.....	Fe <sub>2</sub> O <sub>3</sub> ·H <sub>2</sub> O	1.930	2.210	2.510
Limonite.....	2Fe <sub>2</sub> O <sub>3</sub> ·3H <sub>2</sub> O in part	2.170	2.290	2.310
Goethite.....	Fe <sub>2</sub> O <sub>3</sub> ·H <sub>2</sub> O	2.210	2.350	2.350 (Li)
Valentinite.....	Sb <sub>2</sub> O <sub>3</sub>	2.180	2.350	2.350
Turgite.....	2Fe <sub>2</sub> O <sub>3</sub> ·H <sub>2</sub> O in part	2.450	2.550	2.550 (Li)
Realgar.....	AsS	2.460	2.590	2.610 (Li)
Terlinguaite.....	Hg <sub>2</sub> OCl	2.350	2.640	2.660 (Li)
Hutchinsonite.....	(Tl, Ag) <sub>2</sub> S·PbS·2As <sub>2</sub> S <sub>3</sub>	3.078	3.176	3.188
Stibnite.....	Sb <sub>2</sub> S <sub>3</sub>	3.194	4.303	4.460

\* "Smithsonian Physical Tables," 1954, Table 548. The values are arranged in the order of increasing  $\beta$  index of refraction and are for the sodium D line except where noted. Selected by Edgar T. Wherry from private compilation of Esper S. Larsen, of the U.S. Geological Survey.