Norbergite No. 1.

Norberg, Sweden.
Swedish State Museum of
Natural History No. 217.
Courtesy: Frans-E. Wickman.

minerals, particul... the clinohumites (in six analyses from southern Urals TiO_2 varies from 0·68 to 5·40 per cent.) is of considerable interest. (Clinohumite, anal. 6, Table 9, with 1·48 per cent. TiO_2 is associated with forsterite containing only 0·05 per cent. TiO_2). Although generally the amount of silicon is slightly less than the ideal value there is no evidence as suggested by Machatschki (1930) that Ti replaces Si in the humite series, and humite minerals with a high content of Ti are not deficient in Si. Thus in anal. 5 (Table 9) the

Table 8. NORBERGITE AND CHONDRODITE ANALYSES

	1.	2.	3.	4.	5.
SiO_2	29·60	27·56	33·60	34·27	32·16
TiO_2	—	0·01	0·06	0·36	0·20
Al_2O_3	0·53	0·11	0·24	0·22	0·73
Fe_2O_3	0·60	0·28	0·05	0·36	0·60
FeO	0·96	1·91	0·86	4·36	6·08
MnO	tr.	0·12	0·16	0·003	1·35
MgO	58·70	59·35	59·30	55·01	53·21
CaO	—	—	0·00	0·04	0·00
H_2O^+	1·50	2·68	1·46	0·94	1·20
H_2O^-	0·00	0·00	0·00	—	0·00
F	13·55	13·49	6·61	6·99	7·11
	105·44	105·51	102·34	102·75	102·64
$O \equiv F$	5·71	5·68	2·78	2·94	2·99
Total	99·73	99·83	99·56	99·81	99·65
α	1·563	1·567	1·600	1·602	1·609
β	1·567	1·570	1·609	1·612	1·622
γ	1·590	1·593	1·628	1·633	1·643
$2V_\gamma$	44°	50°	72°	71°	79°
D	3·181	3·153	3·177	3·221	3·241

NUMBERS OF IONS ON THE BASIS OF

	6(O,OH,F)			10(O,OH,F)			
Si	1·012	0·939		1·950	2·019	1·921	
Al	0·021	0·004		0·016	0·015	0·051	
Ti	—	—		0·003	0·016	0·009	
Fe^{+3}	0·015	0·007		0·002	0·016	0·026	
Mg	2·991	3·014	3·08	5·129	4·830	4·739	5·20
Fe^{+2}	0·027	0·054		0·042	0·215	0·304	
Mn	—	0·003		0·008	—	0·068	
Ca	—	—		—	0·002	—	
OH	0·342	0·609	2·06	0·565	0·370	0·480	1·82
F	1·465	1·454		1·213	1·303	1·344	

1. Norbergite, limestone, Piukkala, Finland (Rankama, 1938). Anal. O. Järnefeldt.
2. Norbergite, limestone, Norberg, Sweden (Sahama, 1953). Anal. H. B. Wiik.
3. Chondrodite, limestone, Hangelby, Sibbo, Finland (Sahama, 1953). Anal. H. B. Wiik.
4. Chondrodite, limestone, Ersby, Finland (Rankama, 1938). Anal. K. Rankama (Includes Na_2O 0·13, K_2O 0·07).
5. Chondrodite, in matrix consisting of sphalerite, galena and chalcopyrite, Kafveltorp, Sweden (Sahama, 1953). Anal. H. B. Wiik.

Sahama (1953) The mineralogy of the humite group. Ann. Acad. Sci. Fennicae III. Geol Geogr., v 31, pg 1

divalent ions amount to 8·55, the titanium content is 0·43 and it is p... able that Ti can proxy for Mg in the brucite–sellaite layer. If the replacement of Mg by Ti is restricted to the brucite-sellaite layer a compensation replacement to maintain electrostatic neutrality must occur, and Borneman-Starynkevich and Myasnikov (1950) suggested that the Mg⇌Ti replacement is associated with the substitution of fluorine by oxygen, and gave the general humite formula as

Table 9. HUMITE AND CLINOHUMITE ANALYSES

	1.	2.	3.	4.	5.	6.	7.
SiO_2	35·79	34·73	34·56	37·18	37·65	37·12	36·53
TiO_2	2·00	0·46	—	2·92	5·40	1·48	0·26
Al_2O_3	0·79	0·00	1·46	—	—	0·77	0·22
Fe_2O_3	0·33	0·40	2·66	0·49	—	0·32	0·56
FeO	3·31	4·75	7·77	2·24	3·41	3·44	5·04
MnO	0·84	0·52	0·66	0·04	0·50	0·15	0·34
MgO	54·51	55·51	48·93	55·09	51·74	54·85	54·16
CaO	0·00	tr.	—	—	0·10	—	—
H_2O+	0·91	1·25	1·70	1·30	1·57	0·88	1·52
H_2O-	0·00	0·00	—	0·25	—	0·00	0·04
F	2·77	4·37	3·68	0·95	0·06	1·70	2·74
Cl	—	—	—	—	0·20	—	—
	101·25	101·99	101·42	100·46	100·63	100·71	101·41
$O \equiv F$, Cl	1·17	1·84	1·55	0·40	0·08	0·72	1·15
Total	100·08	100·15	99·87	100·06	100·55	99·99	100·26
α	1·641	1·624	1·643	1·638	—	1·633	1·629
β	1·649	1·633	1·655	1·650	—	1·643	1·641
γ	1·672	1·653	1·675	1·670	—	1·674	1·662
$2V_\gamma$	75°	66°	68°	76°	—	73°	73°
α:z	—	—	—	9°	—	9°	11°
D	3·243	3·245	3·273	3·23	—	3·215	3·260

NUMBERS OF IONS ON THE BASIS OF

	14(O,OH,F)			18(O,OH,F)			
Si	2·974	2·880	2·912	3·956	4·000	3·964	3·889
Al	0·077	—	0·145	—	—	0·097	0·028
Ti	0·125	0·029	—	0·234	0·432	0·119	0·021
Fe^{+3}	0·025	0·025	0·169	0·040	—	0·026	0·044
Mg	6·751	6·860	6·143	8·736	8·192	8·729	8·592
Fe^{+2}	0·230	0·329	0·548	0·200	0·303	0·307	0·448
Mn	0·059	0·036	0·047	0·004	0·045	0·013	0·031
Ca	—	—	—	—	0·011	—	—
OH	0·504	0·692	0·956	0·923	1·112	0·626	1·080
F	0·728	1·146	0·981	0·320	0·020	0·574	0·922
Cl	—	—	—	—	0·036	—	—
	7·27	7·28	7·05	9·21	8·98	9·29	9·16
	1·23	1·84	1·94	1·24	1·17	1·20	2·00

1. Humite, limestone, Lohja, Finland (Sahama, 1953). Anal. H. B. Wiik.
2. Humite, limestone, Sillböle, Finland (Sahama, 1953). Anal. H. B. Wiik.
3. Humite, limestone, Hermala, Finland (Rankama, 1938). Anal. O. Järnefeldt.
4. Clinohumite, with phlogopite and tremolite in marble, Bhandara District, India (Muthuswami, 1958). Anal. J. Ito.
5. Clinohumite, southern Urals (Borneman-Starynkevich & Myasnikov, 1950). Anal. I. D. Borneman-Starynkevich
6. Clinohumite, limestone, Ojamo, Lohja, Finland (Sahama, 1953). Anal. H. B. Wiik (Corrected for 10·1% admixed forsterite).
7. Clinohumite, limestone, Hämeenkylä, Finland (Sahama, 1953). Anal. H. B. Wiik.

$n\mathrm{Mg(OH,F)_2 \cdot 4Mg_2SiO_4} + m\mathrm{TiO_2 \cdot 4Mg_2TiO_2}$. The substitution of (OH,F) by O would account for the low values of univalent anions in many analyses of the minerals of this group.

Humite minerals did not crystallize under the conditions of temperature and pressure used in the experimental investigation of the system SiO_2–MgO–H_2O