

Synthesis of Benstonite at Room Temperature

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Abstract

Benstonite, $\text{MgCa}_6\text{Ba}_6(\text{CO}_3)_{13}$, has been synthesized at room temperature by mixing a solution containing 12.5 ml of 0.2 molar MgCl_2 , 12.5 ml of 0.2 molar BaCl_2 , and 5.0 ml of 0.1 molar CaCl_2 with 25 ml of 0.5 molar sodium carbonate solution and allowing the precipitate to age in contact with the remaining solution for two weeks.

During the course of an investigation of mineral relationships in the system Ba-Mg-Ca- CO_3 in aqueous solution at room temperature, the mineral benstonite was synthesized. This mineral has not previously been synthesized, so we report here the condition under which it was formed.

Benstonite was first described by Lippmann (1961a, 1961b, 1962) from the barite mine near Magnet Cove, Arkansas. It has since been identified at Langban, Sweden (Sundius, 1964; Moore, 1970) and at the Minerva Mine near Cave-in-Rock, Illinois (White and Jarosewich, 1970). The chemical formula is not yet known with certainty. Lippmann (1962) suggested either $(\text{Ca},\text{Mg},\text{Mn})_7(\text{Ba},\text{Sr})_6(\text{CO}_3)_{13}$ or possibly $\text{MgCa}_6\text{Ba}_6(\text{CO}_3)_{13}$. The material from Illinois contains 2.1 wt percent magnesium, which corresponds very closely to one magnesium per formula, so White and Jarosewich (1970) strongly suggest that magnesium is an essential constituent and does not substitute for calcium. In view of the composition of the solution from which we synthesized the mineral, we are inclined to agree with this interpretation.

Benstonite was precipitated from aqueous solution by first mixing together 12.5 ml of 0.2 molar MgCl_2 , 12.5 ml of 0.2 molar BaCl_2 , and 5.0 ml of 0.1 molar CaCl_2 . To this cation-bearing solution 25 ml of 0.5 molar sodium carbonate solution was added while stirring with a magnetic stirrer. A white precipitate formed immediately. After approximately two minutes of stirring, the beaker containing the solution and suspended precipitate was covered and allowed to sit for two weeks at room temperature. At the end of this time, the aqueous solution was decanted off

and a smear mount was made of the precipitate. The material was identified as benstonite by X-ray diffraction. All of the more intense diffraction peaks, as well as many of the minor ones, reported by Lippmann (1962) and Sundius (1964) are present on diffraction traces made from the artificial material (Table 1). Intensities of the peaks are in general agreement with those reported by Lippmann. No other peaks are present on the diffractometer trace, so the benstonite seems to be present in relatively pure forms.

The composition of the solution and the method of precipitation of the mineral is very similar to that used in a study of Mg-Ba- CO_3 in aqueous solution (Hood and Steidl, in preparation), the only difference being the presence of calcium and a longer aging period. The magnesium, barium, and carbonate concentrations are such that norsethite ($\text{BaMg}(\text{CO}_3)_2$) plus witherite would have formed in the absence of calcium. The presence of calcium allowed the formation of benstonite rather than norsethite and perhaps explains the apparent absence of norsethite in the Southern Illinois fluorspar district. The assemblage witherite, benstonite, and calcite is present in the Minerva Mine (White and Jarosewich, 1970) and the assemblage benstonite, barite, and calcite is present in the Magnet Cove locality (Lippmann, 1962). Calcite, benstonite, norsethite, and barytocalcite ($\text{BaCa}(\text{CO}_3)_2$) have all been reported from Langban, Sweden (Moore, 1970). Relations among these various minerals are not clear. Study of the system Ba-Mg-Ca- CO_3 at room temperature is continuing in this laboratory.

TABLE 1. X-ray Powder Data for Natural and Artificial Benstonite

Magnet Cove, Ark.		Langban, Sweden		Artificial	
d (Å)	I	d (Å)	I	d (Å)	I
9.21	3				
7.63	3				
5.83	2				
5.28	3			5.34	5
4.57	3				
4.19	16	4.21	50	4.21	13
3.92	38	3.89	60	3.92	67
3.80	1				
3.60	9			3.60	6
3.45	4				
3.35	10	3.37	40	3.37	3
3.09	95	3.07	100	3.10	100
2.98	1	3.00	60	3.01	7
2.89	1				
2.755	3				
2.637	1			2.62	10
2.557	2			2.55	3
2.536	28	2.52	70	2.52	50
2.495	1				
2.46	1				
2.445	9			2.45	10
2.38	2				
2.327	2				
2.28	1				
2.233	5				
2.217	10	2.21	20	2.19	12
2.19	4				
2.15	?			2.15	3
2.123	23	2.11	60	2.12	45
2.113	4				
2.097	4				
2.042	2	2.03	1
2.006	3				
1.994	3				
1.973	?				
1.957	10			1.98	23
1.945	11	1.948	40	1.96	20
1.905	17	1.902	50	1.92	25
1.886	5				
1.863	4	1.869	40		
1.834	1				
1.757	1			1.764	3
1.746	1				
1.728	2				
1.698	1				
1.692	1			1.691	7
1.670	1				
1.664	1				
1.645	1			1.651	3
1.630	7			1.630	18
1.616	2	1.620	10	1.626	7
1.547	6	1.548	30	1.556	17

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