Calciostrontianite in the basal Purbeck beds of Durlston Head, Dorset

By D. L. SALTER and IAN M. WEST

Department of Geology, The University, Southampton

[Read 11 March 1965]

Summary. A spherulitic mineral occurring as veins and nodules in celestine-bearing secondary limestones in the Lower Purbeck Beds at Durlston Head, Swanage, Dorset, is identified as calciostrontianite, a mineral not previously recorded from Britain. Textural relationships indicate that it was formed from the alteration of celestine and was in part converted back into celestine. The calciostrontianite originated as an epigenetic mineral during the tectonic movement that gave rise to the Broken Beds.

VEINS of a spherulitic mineral composed of acicular radiating crystals, soluble in dilute hydrochloric acid and reacting positively to alizarin stains for calcite, were recorded in the basal Purbeck Beds at Durlston Head near Swanage (SZ 035772) and referred to as calcite (West, 1960). X-ray diffractometry by D. L. Salter has since shown them to be of calciostrontianite, a mineral once called emmonite (Thomson, 1836). The Purbeck calciostrontianite here described consists of spherulites or partial spherulites usually ranging from 0·1 to 1·0 mm in diameter (fig. 1) that closely resemble those described by Dietrich (1960) and by Mitchell and Pharr (1961) from Lower Palaeozoic limestones and dolomites from Virginia. In both cases it is also associated with celestine. A stain consisting of 0·02 g of rhodizonic acid (sodium salt) in a 20 % solution of hydrofluoric acid was found useful for staining the hand specimen, when calciostrontianite is stained yellow. Under long-wave ultra-violet light the mineral fluoresces with a white colour.

In Dorset the calciostrontianite is present in a series of secondary limestones and chert attributed to the replacement of anhydrite by calcite and silica respectively (West, 1964). At two horizons (C.3 and C.6, West, 1960) celestine is a major constituent of the rock and calciostrontianite occurs only in these and the immediately adjacent beds. Although celestine is common in the Lower Purbeck Beds unaccompanied by calciostrontianite, no instance of the reverse case has been discovered.

Petrography. The calciostrontianite occurs as veins in the secondary limestones and coats fractures in chert, which it thus postdates in origin. Nodules of calciostrontianite, often connected with veins, are confined

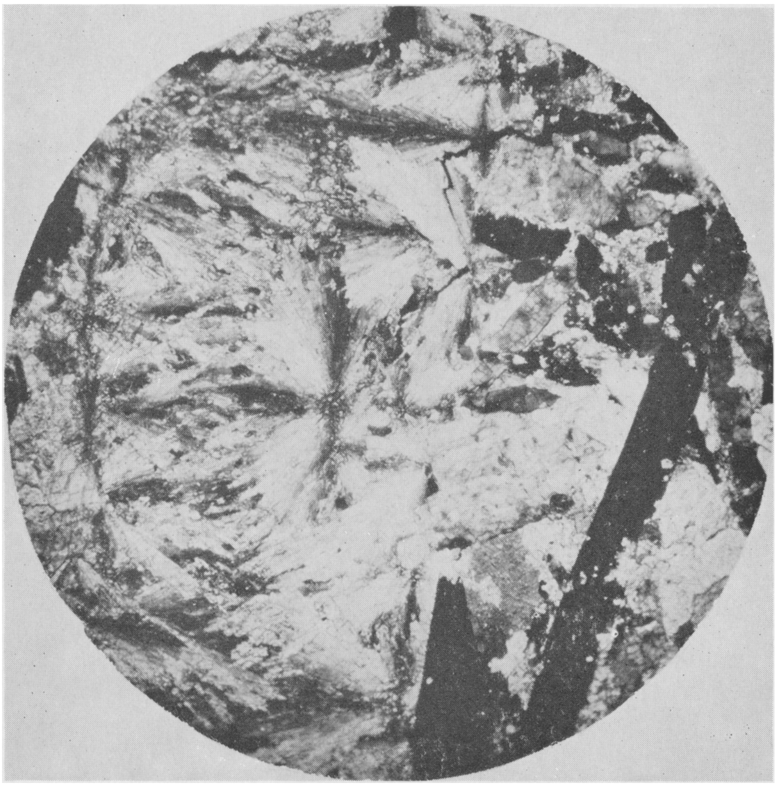

FIG. 1. A vein of spherulitic calciostrontianite in a celestine–calcite replacement of anhydrite. Upper celestine bed, Broken Beds, Durlston Head. Crossed polarisors. × 96.

to the limestone. Neither celestine, nor calciostrontianite, nor pseudomorphs of these have been found in unbroken chert.

Evidence exists for the following diagenetic sequence taking place while the surrounding calcium sulphate was in the state of anhydrite (stage III of West, 1964) and after the formation of the chert: Replacement of anydrite by celestine; development of early celestine veins; calciostrontianite veins and nodules developed, in part by replacement of celestine; and some late celestine formed by replacement of calciostrontianite.

In the secondary limestones the celestine crystals are nearly equigranular with minute inclusions, probably of anhydrite. Occasionally transecting the rock are veins of coarse celestine crystals often closely adpressed and with their greatest length at right angles to the veins. In some cases this celestine has been altered to spherulitic calciostrontianite and only corroded relics of celestine remain in a carbonate matrix. Other calciostrontianite is present in veins or shear planes, breaking earlier celestine crystals, with no evidence of replacement. Finally, in the centre of veins, some of the calciostrontianite has been converted to anhedral celestine with spherulitic inclusions (West, 1960). Similarly some late celestine has developed as outgrowths on early celestine crystals at the expense of a calciostrontianite matrix.

Both types of veins are usually the result of local tectonic movement of the Broken Beds and are themselves sometimes faulted or displaced. Thus the calciostrontianite probably originated during the tectonic movement in anhydrite which gave rise to the breccia. This was the phase of maximum replacement of anhydrite by calcite (West, 1964), a time when carbonate replacement of celestine was presumably also favoured.

X-ray data. The material was prepared for X-ray examination by grinding scrapings from a vein from the upper celestine beds to a fine powder, which was mounted on a glass slide with a little Durofix diluted with amyl acetate. It was assumed that the grinding of the crystals would reduce the risk of preferred orientation effects.

The slide so prepared was scanned with Ni-filtered Cu-$K\alpha$ radiation in a Philips diffractometer incorporating a wide-range goniometer and a Geiger-counter-type detector. A complete scan up to $2\theta = 75°$ was run at a scanning speed of $\frac{1}{2}°$ 2θ/min and the five peaks showing greatest intensities were accurately checked by counting over the peaks at fixed intervals of 0·02°.

The results are set out in table I, where they are compared with averaged data given by Mitchell and Pharr (1961), who report calcium contents of their calciostrontianite ranging from 9·1 to 10·6 % CaO, with d-spacings obtained for a calciostrontianite containing 8·1 % CaO by Dietrich, and also with the A.S.T.M. data for calcium-free strontianite (less than 0·001 % CaO). The decrease in d-spacing with increase in calcium content, due to the substitution of the smaller calcium ion for strontium, is apparent. By analogy, the calciostrontianite from Purbeck

TABLE I. X-ray powder data for calciostrontianite from Purbeck (1) compared with occurrences from Wise County, Virginia, (2; Mitchell and Pharr, *1961*); Pulaski County, Virginia, U.S.A., (3; Dietrich, 1960); and with pure strontianite (A.S.T.M. card 5–0418)

Calciostrontianite								
1		2		3		Strontianite		
d	I (obs.)	*d*	I	*d*	I	*d*	I	*hkl*
4·32 Å	10	4·33 Å	vw	4·34 Å	w	4·367 Å	14	110
4·16	4	4·16	vvw	4·17	vvw	4·206	6	020
3·506	100	3·51	vvs	3·51	vvs	3·535	100	111
3·411	45	3·40	vs	3·41	vs	3·450	70	021
2·98	7	2·98	mw	2·98	w	3·014	22	002
—	—	—	—	—	—	2·859	5	121
2·80	14	2·81	m	2·815	w	2·838	20	012
2·57	7	2·58	w	2·58	vw	2·596	12	102
2·536	30	2·53	mw	2·54	s	2·554	23	200
2·50	4	—	—	—	—	—	—	?
—	—	—	—	—	—	2·481	34	112
2·45	20	2·46	m	2·46	m	2·458	40	130
2·428	48	2·43	s	2·43	vs	2·4511	33	022
2·24	3	2·25	vw	2·25	vw	2·2646	5	211
2·16	22	2·16	mw	2·165	m	2·1831	16	220
2·07	4	2·07	vw	2·075	vw	2·1035	7	040
2·034	36	2·04	s	2·04	s	2·0526	50	221
1·96	15	1·96	mw	1·96	m	1·9860	26	041
1·93	9	1·93	mw	1·935	mw	1·9489	21	202
1·88	13	1·88	m	1·885	m	1·9053	35	132
—	—	—	—	—	—	1·8514	3	141
1·80	7	1·81	mw	1·81	m	1·8253	31	113
		—	—			1·8134	16	023
1·79	4	1·79	w	1·80	mw	1·8023	4	231
1·75	2	1·75	vw	1·75	vvw	1·7685	7	222
1·70	1	1·70	vvw	1·705	vvw	1·7253	5	042
1·65	3	1·65	vw	1·66	vw	1·6684	3	310
—	—	—	—	—	—	1·6236	4	240
1·59	6	1·60	mw	1·60	mw	1·6080	13	311
		—	—			1·5981	3	150
1·54	3	1·55	mw	1·55	mw	1·5676	13	241
1·52	4	1·53	w	1·53	vw	1·5447	11	151
—	—	1·49	vvw	1·49	vvw	1·5072	3	004
—	—	1·47	vvw	1·47	vvw	1·4782	6	223
—	—	—	—	—	—	1·4596	4	312
1·44	4	1·44	vw	1·44	vw	1·4551	9	330
		1·41	vw			1·4293	6	242
1·41	2	—	—	1·41	vvw	1·4246	7	114
		—	—			1·4120	5	152
1·38	2	1·38	vvw	—	—	1·4024	4	060
1·29	3	1·30	mw	1·30	vw	1·3103	10	332
1·28	1	—	—	—	—	—		313
1·26	4	1·27	mw*	1·27	mw	—		134*

* Indices according to Mitchell and Pharr (1961).

can be expected to contain a slightly greater percentage of calcium than the American specimens.

X-ray examination of other specimens from the lower celestine beds shows the presence of calciostrontianite with spacings suggesting even higher calcium contents.

Acknowledgements. The authors are indebted to Prof. F. Hodson for assistance and encouragement. I. M. West acknowledges the loan of a microscope from the Royal Society of London. D. L. Salter was in receipt of a D.S.I.R. Research Studentship while conducting this investigation.

References

DIETRICH (R. V.), 1960. Amer. Min., vol. 45, pp. 1119–1124.
MITCHELL (R. S.) and PHARR (R. F.), 1961. *Ibid.*, vol. 46, pp. 189–195.
THOMSON (T.), 1836. [Rec. Gen. Sci., vol. 3, pp. 415–417]; quoted in Dana, Syst. Min., 7th edn, vol. 2, p. 196.
WEST (I. M.), 1960. Proc. Geol. Assoc., vol. 71, pp. 391–401.
—— 1964. Proc. Yorks. Geol. Soc., vol. 34, pp. 315–330.

[*Manuscript received 23 March 1964.*]