pyromorphite should not form as a primary mineral, in the absence of sulphide ions.

Pyromorphite crystallizes from dry melts of lead chloride and lead phosphate, presumably at temperatures near the melting-point of lead chloride (501° C); the arsenic-rich variety has been made from solutions of lead arsenate and lead chloride (Palache, Berman, & Frondel, 1951).

Pronounced oxidation of the Skiddaw Slates has taken place near some of the low-temperature veins, with the production of haematite and pyrolusite. Under these conditions, hydrogen sulphide would oxidize to sulphate, leading to the precipitation of insoluble sulphates, such as baryte and anglesite, and the termination of the phase of sulphide deposition. Exhaustion of the sulphate radical could in turn cause the precitation of the insoluble carbonates: cerussite, witherite, and calcite.

Oxidation at low temperatures, estimated at 50–140° C for these veins (Strens, 1962), would probably take place through redox reactions catalysed by manganese or iron. The most likely source of oxygen in these shallow veins would be percolating groundwater.

Whilst it is an undisputed fact that many occurrences of pyromorphite, cerussite, and anglesite are secondary, the possibility of primary origin must also be considered. Similar remarks apply to other secondary minerals, for example, malachite and azurite.

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References

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A natural occurrence of bayerite

BAYERITE, $Al(OH)_3$, is readily prepared by acidification of sodium aluminate solution with carbon dioxide or by ageing of aluminium gels, but no natural occurrence has as yet been reported.

Two samples containing bayerite were found in a sedimentary rock sequence of Cenomanian to Eocene age in Hartrurim, Israel[1] The presence of portlandite and ettringite in these rocks testifies to their

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[1] Y. K. BENTOR, S. GROSS, and L. HELLER, Amer. Min., 1963, vol. 48, p. 924.

high pH. Bayerite, which may have been precipitated on carbonation of aluminium-containing gels, occurs as very fine white fibres with parallel extinction, associated with calcite in one specimen and with calcite and gypsum in the other. It could not be separated and was identified by its X-ray powder pattern, which is sharp and resembles that of synthetic material. Since bayerite constitutes only a minor part of the rock, its powder lines are weak compared with those of the predominant calcite; very weak reflections therefore could not be detected.

X-ray powder photographs were obtained using a Nonius quadruple semi-focusing camera, Cu-$K\alpha$ radiation.

Bayerite, Hartrurim		Bayerite synthetic*		Bayerite Hartrurim		Bayerite, synthetic*	
d	*I*	*d*	*I*	*d*	*I*	*d*	*I*
4·73 Å	s	4·73 Å	100			1·981	20
4·36	ms	4·37	80			1·836	10
3·19	m	3·21	60	1·720	m	1·719	70
2·70	vw	2·70	10			1·691	10
		2·46	10			1·642	10
		2·36	20			1·600	20
2·21	s	2·22	100			1·567	10
2·16	vw	2·16	10			1·555	20
		2·08	10	1·454	vw	1·455	30

* A.S.T.M. card no. 8–96.

The natural mineral has a higher thermal stability than synthetic material: after heating at 230° C its X-ray pattern is not affected, whereas synthetic bayerite is generally decomposed at about 160° C. After heating for periods of 20 minutes at temperatures ranging from 320 to 700° C the natural material is amorphous to X-rays.

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