doubt that the U. S. National Museum sample was considered as the type sample by him.

Microscopic and X-ray diffraction examinations of the type specimen show it to be an exceedingly complex intergrowth of minerals, principally chalcocite and native silver (Fig. 1), but with lesser amounts of native copper and a trace of cuprite. The native silver is so intergrown with the chalcocite, and on such a fine scale, as to preclude any possibility of mineral separation. The state of the microscopic art in 1901, and the equipment available to Hough at the time, were possibly too crude to reveal the complex mineral intergrowths in the material being analyzed. It is quite apparent that cocinerite is such a mixture, that the proposed formula is spurious, and that the name should be discarded.

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DAWSONITE IN THE GRETA COAL MEASURES AT MUSWELLBROOK, NEW SOUTH WALES

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Dawsonite is a relatively rare, basic carbonate of sodium and aluminium ($NaAlCO_3(OH)_2$) which, according to Smith and Milton (1966), has been found in only seven localities in the world. Palache *et al.*, (1960) considered the mineral to be of low temperature hydrothermal origin but the recent work of Hay (1964) and Smith and Milton (1966) indicates that it may also form by sedimentary diagenesis. Hay found dawsonite altering from nepheline in arid, saline soils at Olduvai Gorge, Tanganyika, and Smith and Milton described the occurrence of the mineral in fissures, vugs, and generally disseminated in beds of the Green River Formation in Colorado. In both cases carbonates and authigenic silicates, including zeolites, are associated with the dawsonite and the origin was attributed to the influence of a high soda-concentration in the environmental waters.

The discovery of dawsonite in the Permian Coal Measures of the Sydney Basin was made during an X-ray examination of core samples obtained from the Joint Coal Board's B.C. 20 diamond drill bore, put down in the Balmoral area near Muswellbrook on Portion 179, Parish Wynn,

County Durham. The mineral forms a minor constituent of a soft, friable sandstone which is located 20 feet below a thin unnamed coal seam and 50 feet above the Brougham Seam.

Microscopic examination of thin sections indicated the rock is a quartz-lithic sandstone with an argillaceous matrix of approximately 20 percent. Much of the quartz is clear and angular but corroded boundaries and secondary overgrowths are evident in places. The rock fragments are more rounded that the quartz and, for the most part, are unidentifiable although a few possess definite relict volcanic textures. A few grains of angular feldspar and a small amount of dolomite are also present. The

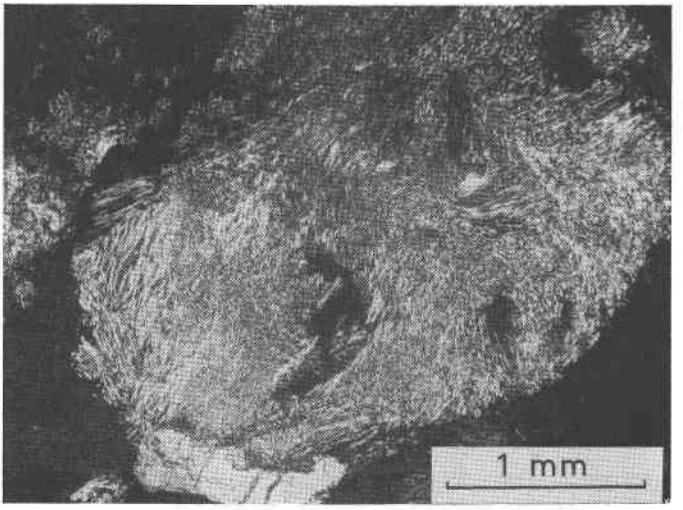

FIG. 1. Dawsonite aggregate in a quartz-lithic sandstone from Muswellbrook, N.S.W. Crossed polars.

dawsonite occurs in the form of tufts and aggregates of very fine needles (see Fig. 1). The aggregates are comparable in size to the quartz and rock fragments and possibly represent pseudomorphs after feldspar but no alteration of feldspar to dawsonite was observed.

The dawsonite was carefully hand picked from freshly cut surfaces of the rock by the use of a fine needle under a stereomicroscope and sufficient material was recovered by this means to permit a powder X-ray examination using film and a camera of 11.4 cm. diameter. As shown in Table 1, apart from a few very weak lines, the results are in quite good agreement with the data given by Smith and Milton (1966).

Quantitative determination of the dawsonite content of the sandstone was made by chemical means. Treatment of the pulverised rock with

warm, dilute (0.5N) hydrochloric acid caused the complete destruction of the mineral with the liberation of 2.91 percent carbon dioxide while analyses of the filtrate revealed the presence of 1.59 percent Na_2O, 2.27 percent Al_2O_3, 0.52 percent CaO, 0.44 percent MgO and 0.49 percent FeO. Moreover, thermogravimetric analysis of the rock, using a heating rate of 5°C per minute, also brought about complete destruction of the mineral in the temperature range of 290–330°C with a corresponding weight loss

TABLE 1. A COMPARISON OF THE X-RAY POWDER DATA FOR DAWSONITE FROM MUSWELLBROOK WITH THAT FROM THE GREEN RIVER FORMATION

A		B		C	
d	*I*	*d*	*I*	*d*	*I*
		6.59	vvw		
5.70	vs	5.69	vvs	5.634	100
5.16	vvw				
4.91	vvw				
4.49	vvw				
4.31	vvw				
3.36	s	3.37	vs	3.368	19
		3.10	vvw	3.080	6
2.78	ms	2.79	vs	2.781	52
2.61	mw	2.60	s	2.605	16
		2.51	vw	2.502	10
		2.22	vvw	2.222	4
		2.15	vw	2.149	15
		2.06	vvw	2.066	3
2.00	w	1.99	ms	1.991	14

A. Dawsonite from Muswellbrook, N.S.W.
B. Dawsonite from Colorado
C. after Smith and Milton (1966)

of 2.15 percent. Presumably, this weight loss represented by the following reaction:

$$2NaAlCO_3(OH)_2 \rightarrow Na_2CO_3 + Al_2O_3 + \underbrace{CO_2 + 2H_2O}_{\text{lost}}$$

dawsonite — sodium carbonate — alumina

Acid treatment of the heated sample liberated a further 1.79 percent carbon dioxide. On this basis therefore, it would appear that the sandstone contains approximately 7 percent dawsonite and 2 percent dolomite.

According to Beck (1950), the differential thermal curve for dawsonite has the principal endothermic reaction at 440°C. However, the material from the Greta Coal Measures, which was run at 15°C per minute, shows

a double peak in the range 350–390°C (Fig. 2). The reason for this discrepancy is not known. Dr. J. W. Smith (priv. commun.) has suggested the small endothermic reaction above 700°C is due to the reaction of the sodium carbonate and alumina to form sodium aluminate. X-ray examination of the material preheated to this temperature failed to verify the presence of sodium aluminate but possibly this can be attributed to the relatively low concentration of dawsonite in the original sample.

Following the discovery of the widespread distribution of authigenic analcite in the Newcastle Coal Measures (Loughnan, 1966a, 1966b), the presence of dawsonite in the Greta Coal Measures tends to support the

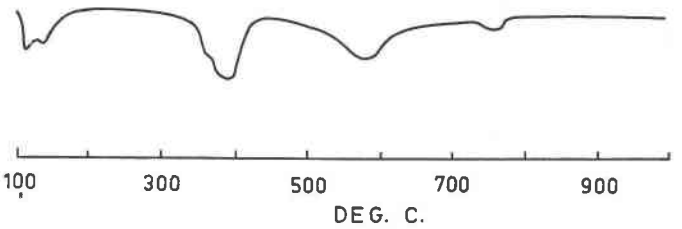

FIG. 2. Differential thermal curve for the Dawsonite-bearing sediment.

concept that periods of aridity and high soda-concentrations accompanied the laying down of the Permian coal measures of the Sydney Basin.

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