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# SOME PROPERTIES OF ALUNOGEN FROM NEW SOUTH WALES

P. BAYLISS, *School of Applied Geology, University of New South Wales.*

Deposits of evaporite, consisting essentially of alunogen as first described by Bayliss (1963), are located near Joadja, 65 miles south-west of Sydney, N.S.W. The deposits occur beneath a calcareous sandstone within the Permian Shoalhaven series, as white, fibrous lenses, which measure up to 9 feet in diameter and 9 inches in depth. Each deposit consists of a sequence of horizontal layers of vertically stacked alunogen fibres with a maximum length of about 5 mm and a thickness of several microns. Small irregular-shaped quartz grains and iron oxide film coatings are also present.

The individual fibers have been identified either as alunogen ($Al_2(SO_4)_3 \cdot 16H_2O$; frequently referred to as alunogenite), or as pickeringite ($MgAl_2(SO_4) \cdot 22H_2O$), by means of *x*-ray diffraction. Confirmation of this identification was first obtained by means of both DTA and thermogravimetric analysis utilizing apparatus described by Warne and Bayliss (1962), and subsequently by both chemical and spectrographic analysis.

The *x*-ray diffraction data for alunogen recorded by Hanawalt *et al.* (1938) and Bassett and Goodwin (1949) lack the detail that has been obtained by means of copper radiation from a diffractometer with a 114.4 mm radius goniometer. Because of this the appropriate data are recorded in Table 1.

TABLE 1. X-RAY DIFFRACTION POWDER PATTERN OF ALUNOGEN.

| dÅ | I | dÅ | I | dÅ | I | dÅ | I |
|---|---|---|---|---|---|---|---|
| 13.34 | 60 | 3.97 | 20 | 2.747 | 3 | 1.884 | 2 |
| 8.96 | 1 | 3.90 | 20 | 2.683 | 3 | 1.858 | 3 |
| 7.56 | 2 | 3.66 | 20 | 2.629 | 5 | 1.820 | 1 |
| 7.34 | 6 | 3.63 | 2 | 2.496 | 10 | 1.769 | 1 |
| 7.14 | 8 | 3.60 | 10 | 2.460 | 2 | 1.758 | 1 |
| 7.02 | 6 | 3.53 | 2 | 2.446 | 8 | 1.725 | 1 |
| 6.71 | 6 | 3.46 | 20 | 2.362 | 1 | 1.700 | 1 |
| 6.54 | 3 | 3.36 | 20 | 2.319 | 2 | 1.685 | 1 |
| 6.00 | 2 | 3.15 | 1 | 2.262 | 3 | 1.651 | 1 |
| 5.59 | 1 | 3.10 | 10 | 2.166 | 2 | 1.624 | 1 |
| 4.89 | 1 | 3.07 | 5 | 2.100 | 1 | 1.597 | 1 |
| 4.48 | 100 | 3.02 | 20 | 2.047 | 2 | 1.587 | 1 |
| 4.39 | 30 | 2.96 | 6 | 2.016 | 3 | 1.549 | 1 |
| 4.32 | 25 | 2.92 | 4 | 1.979 | 4 | 1.539 | 1 |
| 4.23 | 6 | 2.858 | 4 | 1.953 | 1 | 1.523 | 1 |
| 4.19 | 2 | 2.802 | 2 | 1.923 | 4 | 1.504 | 1 |
| 4.14 | 3 | | | | | | |

Palache *et al.* (1951), Rosenzweig and Gross (1955) and Hodgman (1962) all use the formula containing 18 molecules of combined water. However from studies of synthetic material, Bassett and Goodwin (1949) state that from phase equilibrium data, the alunogen unit cell contains exactly 16 molecules of combined water. This has been verified by the present author by means of calculations from the thermogravimetric curve of the alunogen sample (Fig. 1.). In addition, this curve indicates that 14 molecules are released at 150° C. and the remaining 2 molecules at 330° C.; the decomposition temperature of alunogen recorded by Hodgman (1962) is 85.5° C.

The differential thermal curve (Fig. 1) is similar to that of Gruver (1951). However, unlike the latter, there are only two distinct low temperature endothermic peaks at 150° C. and 330° C., which correspond to the thermogravimetric data stated above. The endothermic peak at 800° C. (which may be correlated with the decomposition temperature quoted by Hodgman (1962) at 770° C.) represents the decomposition of aluminum sulfate into aluminum oxide with the loss of sulfur trioxide.

The work of Larsen and Steiger (1928) on the optical properties of dehydrated alunogen was partly repeated in order to confirm the type of decomposition reaction responsible for the change from the anisotropic to the isotropic state at 90° C. In addition, *x*-ray diffraction photographs were taken at regular temperature intervals throughout the

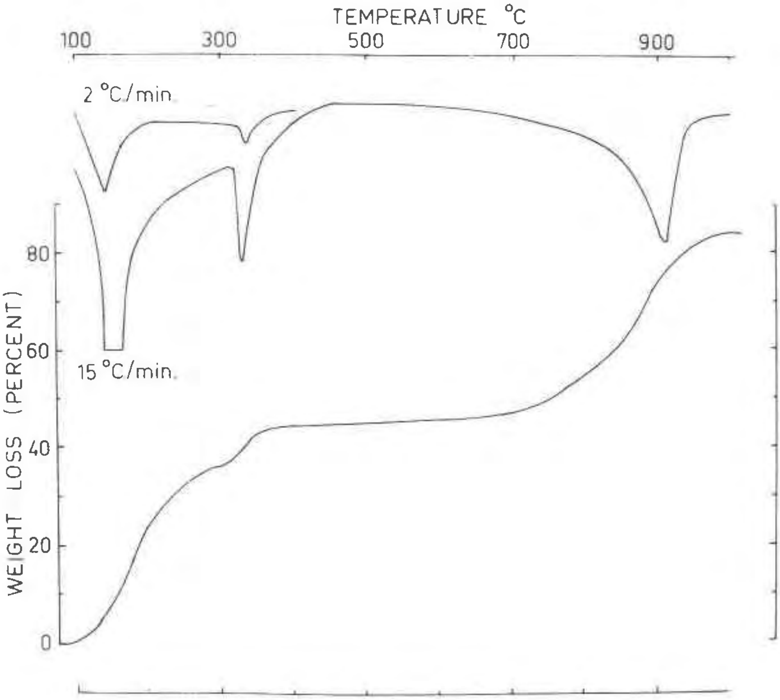


FIG. 1. DTA and thermogravimetric curves of alunogen.

dehydration curve. The diffraction pattern of alunogen persisted till 330° C., at which point that of anhydrous aluminum sulfate first appeared. At higher temperatures, the latter increased in intensity until it was the only compound detectable. From this data, it appears that the major loss of 14 molecules of combined water at 150° C. does not affect the structure, which indicates that the mineral meta-alunogen described by Gorden (1942) has the same basic structure as alunogen. The breakdown of the structure does not occur till 330° C., when the 2 remaining molecules of combined water are released.

The conclusions are that alunogen contains 14 molecules of hydroscopic water and that the other 2 molecules occur in structural positions. These data also suggest that meta-alunogen is not a distinct mineral but is merely a partly dehydrated form of alunogen.

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## FLUORITE FROM THE BADU PEGMATITE, LLANO COUNTY, TEXAS

Robert Greenwood, *Geology Dept., Univ. of Houston, Houston, Texas.*

The Badu pegmatite, chiefly composed of microcline and quartz, intrudes carbonate-rich metasediments of the Packsaddle schist (Precambrian). Its total extent at the surface is about 400 by 350 feet, of which the central part is well exposed in an abandoned open-pit working 200 feet long and about 20 feet deep. The pegmatite is located in Llano County about 4 miles southwest of Buchanan Dam and one mile north of Beverly, on land owned by Dr. H. J. Hoerster of Llano. Published descriptions are concerned with the pegmatite as a source of feldspar (Chelf, 1942; Huseman and McMillan, 1947). Apart from quartz, feldspar, muscovite, kaolinite and pyrite, "two small pieces of rare-earth minerals" (Chelf, 1942) have been the only minerals reported. The geological map of Huseman and McMillan can be interpreted in terms of conventional pegmatite zoning (Cameron *et al.*, 1949) as showing a wall zone of graphic granite, an intermediate zone chiefly of microcline, and discontinuous quartz cores.

During a field trip on 25 April, 1964, I found in the south face of the pit, corresponding to the outer part of the intermediate zone, a reddish friable mass about 40 by 20 cm, enclosed in pink feldspar. It consisted of purple and clear fluorite cut by sparse veins of red feldspar 5 mm thick. Fluorite is reported from 22 pegmatite districts in North America, in 19 of which it is associated with rare-earth minerals (Heinrich, 1948). No