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MINERALOGICAL EVIDENCE FOR THE PENECONTEMPORANEOUS LATERITIZATION OF THE BASALTS FROM NEW ENGLAND, N.S.W.

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During a recent visit to a number of disused shafts and open-cuts in the New England district of New South Wales, it was noticed that well-developed bauxite profiles are rare, whereas most of the exposures appear to be a succession of profiles commonly superimposed on one another. Moreover, contrasting thin bands of light-colored and often highly-siliceous sediments are commonly interstratified with the weathered horizons. These observations suggest that the individual basalt flows were lateritized soon after emplacement and that successive outpourings covered previously weathered flows.

In a description of these bauxite deposits, Hanlon (1945) and Owen (1954) have implied that the lavas were lateritized during a period subsequent to emplacement.

Since the field observations appear incompatible with the implications of the above mentioned workers, it was decided to investigate the problem by specific mineralogical examinations of a few representative sections through the New England bauxites.

Three bauxite sequences, exposed in a shaft near Emmaville, N.S.W., an open-cut west of Inverell, N.S.W., and a shaft north of Tingha, N.S.W., were sampled and subjected to detailed mineralogical analyses by the techniques of Loughnan and Bayliss (1961). The mineralogical results are quoted in Table 1. In addition, thin section studies were made to locate generic features such as relict textures and micro-structures.

Figures 1 and 2 are graphical representations of the mineralogy from Table 1 for the Emmaville shaft and the Inverell open-cut respectively.

TABLE 1. MINERALOGY

Sample	Boehmite	Gibbiste	Kaolinite	Halloysite	Montmorillonite	Mica	Goethite	Hematite	Anatase	Quartz
					Emmaville					
E1	5	60	5	—	—	—	—	25	5	—
E2	—	30	40	—	—	—	10	15	4	—
E3	—	10	65	—	—	—	10	10	3	—
E4	—	5	75	—	—	—	10	7	2	—
E5	—	5	75	—	—	—	15	—	4	—
E6	—	20	65	—	—	—	10	2	4	—
E7	—	—	80	—	—	—	15	2	3	—
E8	—	—	85	—	—	—	7	—	3	—
E9	—	—	90	—	—	—	5	—	2	—
E10	—	—	20	—	—	5	4	2	—	70
E11	—	—	15	—	—	5	—	—	—	75
E12	—	—	25	—	—	5	—	—	—	65
E13	—	—	—	40	50	—	5	—	4	—
					Inverell					
I1	5	45	15	—	—	—	—	25	8	—
I2	—	45	20	—	—	—	—	25	8	—
I3	—	65	15	—	—	—	—	15	6	—
I4	5	40	25	—	—	—	12	10	7	—
I5	20	65	5	—	—	—	10	—	3	—
I6	—	20	65	—	—	—	7	—	6	—
I7	—	—	75	—	—	—	20	—	6	—
					Tingha					
T1	—	5	35	—	—	—	7		1	50
T2	—	—	45	—	—	—	8		1	45
T3	—	—	40	—	—	—	10		1	45
T4	—	—	45	—	—	—	7		1	45
T5	—	—	50	—	—	—	1		—	50
T6	—	—	40	—	—	—	3		1	60
T7	—	—	70	—	—	—	2		1	25
T8	—	—	40	—	—	—	7		1	50
T9	—	—	65	—	—	—	1		2	30
T10	—	—	30	—	—	—	1		1	70

In these diagrams the mineralogy, expressed as a cumulative percentage of the total is plotted against depth, also a stratigraphic column and zone number are given.

The Emmaville shaft, which is located on Portion 38, Parish Strathbogie, County Gough, N.S.W., extends to a depth of 65 feet. The 4 feet of clay (zone 1) exposed at the bottom of the shaft contains remnants of the original vesicular basalt structures and consists essentially of montmorillonite and fully-hydrated halloysite (endellite). The presence of hydrated halloysite (endellite) is interesting since this mineral is stable only in water-saturated environments (Bates, 1952) and hence is restricted to the zone of permanent saturation. The clay is overlain by 15 feet of light-colored kaolinitic sand (zone 2) of sedimentary origin. The sediments in turn, are overlain by 11 feet of clay (zone 3), which although closely resembling zone 1 in physical appearance, consists predominantly of kaolin-

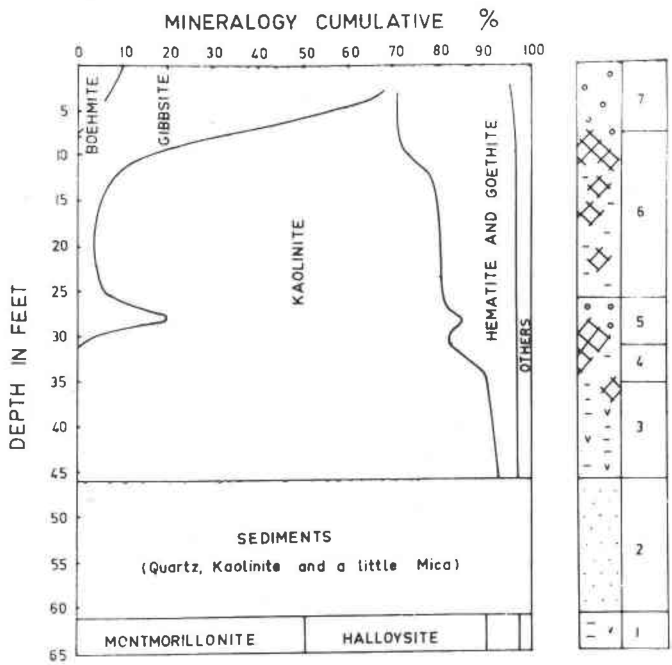

FIG. 1. Mineralogy in relation to depth at Emmaville together with a stratigraphic column and zone number.

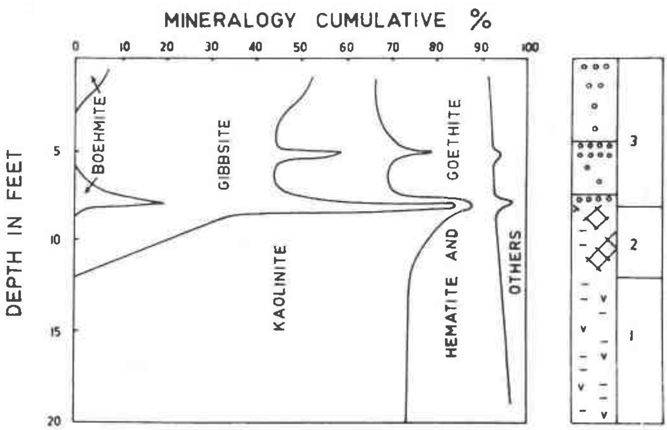

FIG. 2. Mineralogy in relation to depth at Inverell together with a stratigraphic column and zone number.

ite. Zone 3 grades imperceptibly into a 4 feet thick light-colored mottled zone (zone 4), which is succeeded by 5 feet of yellow bauxitic clay (zone 5). A well-defined boundary at the 26-foot level separates the top of zone 5 from 18 feet of light-red mottled clay (zone 6), which grades upwards into 8 feet of deep-red pisolitic material (zone 7).

The Inverell open-cut occurs adjacent to the Warialda road, approximately 4 miles from Inverell on Portion 109, Parish Byron, County Hardinge, N.S.W. The 8 feet of basal clay (zone 1) exposed at the base of the 20 feet high worked face has a spheroidal structure characteristic of the decomposition of basalt. This is succeeded by a clearly-defined 4 feet thick mottled zone (zone 2) which in turn is overlain by an 8 feet thick deep-red surface pisolitic material (zone 3). Two well-defined nodular bands occur within the pisolitic zone at depths of $4\frac{1}{2}$ to $5\frac{1}{2}$ feet and $7\frac{1}{2}$ to 8 feet. These bands consist of dense, hard, light-colored nodules, which range up to 4 in. in diameter, set in a deep-red argillaceous matrix. The nodules are composed essentially of bauxite minerals.

The shaft north of Tingha is located on Portion ML158, Parish Herbert, County Gough, N.S.W. The mottled sediments at the base of the 50 feet deep shaft are divided into five zones. From the base, these are 2 feet of fine sand with a little clay, 6 feet of sandy clay, 6 feet of argillaceous fine sand, 1 foot of clay with sand and $1\frac{1}{2}$ feet of argillaceous sand. The color of the mottled sediments contrasts with the over-lying 6 inch thick white kaolinitic sand. The top 33 feet of sediments grade from mottled to a red pisolitic surface zone.

In addition to the expected maximum concentration of bauxite minerals at the surface, maxima occur at the 26-foot level in the Emmaville shaft and at depths of $4\frac{1}{2}$ to $5\frac{1}{2}$ feet and $7\frac{1}{2}$ to 8 feet in the Inverell open-cut. The profile continuity is also broken by sediments at a depth of 46 to 61 feet in the Emmaville shaft and the 33-foot level in the Tingha shaft. A third type of vertical variation occurs in the Inverell open-cut. Boehmite is not detected in the $4\frac{1}{2}$- to $5\frac{1}{2}$-foot central pisolitic zone, although it is significant in the surface and $7\frac{1}{2}$- to 8-foot zones.

The hypothesis that the weathered sequences are the result of penecontemporaneous alteration of the individual flows would account for each of the mineralogical variations noted.

An alternative explanation that the mineralogical fluctuations with depth are the product of variations in the composition and/or structure of the parent material appears unfavorable for the following reasons: Immature soils characteristically reflect the composition and structure of the parent material but with increasing weathering intensity and greater maturity, the climatic factors tend to annul the influence of the parent material. The particularly "aggressive" climate necessary to convert basalt to deeply-weathered bauxite profiles would be expected to neutralize the effects of possible variations in the composition and/or structure of the parent material.

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CELL DIMENSIONS OF DEHYDRATED NATROLITE

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Dehydration studies of natrolite ($Na_2Al_2Si_3O_{10}\cdot 2H_2O$) have been carried out by a number of researchers in the past to delimit its dehydration temperature using DTA and thermogravimetric methods (Milligan and Weiss, 1937; Koizumi and Kiriyama, 1953; Peng, 1955). However, with regard to structural change accompanying the dehydration, little has been done. In view of this, the present work was carried out in the hope of obtaining data on the cell dimensions of dehydrated natrolite and perhaps also information concerning possible mechanism of dehydration.

Two furnace attachments were constructed to be used with the Unicam type oscillation and the Buerger precession cameras, respectively (Dent and Taylor, 1956; Smith and Brown, 1959). A specially constructed cassette was employed in the oscillation method. The cassette had a slit having a width of 4.00 cm, and film was wrapped outside. Natrolite crystals used in the experiment were selected from the Genth Collection of the Pennsylvania State University. The crystals were needle-shaped, 1.0 mm in length and 0.3 mm in cross-section. The locality of the crystals was given as Bergen Hill, N. J. The chemical composition of natrolite from the same locality is given below (Hey, 1932):

SiO_2	47.22	K_2O	1.27
Al_2O_3	26.94	CaO	1.05
Na_2O	14.45	H_2O	9.28
		Total	100.21