

The decomposition of struvite: further evidence

WHITAKER (1968) has found that synthetic struvite decomposes sub-aerially to newberyite at room temperature, and Whitaker (1965) and Lonsdale and Sutor (1966; cf. Lonsdale, 1968) have recorded similar sub-aerial decomposition of struvite from human excreta and urinary calculi. However, evidence given by Cohen and Ribbe (1966) for struvite decomposition to newberyite in ancient guano deposits at Mono Lake, California clearly indicated a sub-aqueous decomposition: the large (up to 10 cm) struvite morphological relics—now newberyite—were found in diatomaceous ashy mudstone overlain by water-deposited ash and diatomite layers. In addition the thin, bladed crystals of the newberyite, which completely replace struvite, have their long (often 5–8 mm) axes normal to the encasing surfaces in a typical replacement pattern.

A second occurrence of a struvite relic that has decomposed to newberyite was found in the mineralogy collection at the University of California, Los Angeles. The sample (No. MS-1766) is labelled struvite, because the morphology of the 0.5 cm³ euhedral crystal relic is characteristic of struvite (cf. upper-right relic shown in fig. 1, Cohen and Ribbe, 1966). However, the relic was identified by X-ray diffraction to be newberyite—finely powdered and compact, but easily crumbled. At the core of the relic was a small 0.05 cm³ fragment of single-crystal struvite. Interestingly, both the struvite core and the newberyite contain fine-grained inclusions of basaltic rock, which were apparently dispersed in the guano in which the struvite crystal originally grew. Unfortunately, no geologic information is available about this specimen. The locality was simply given as 'Peru', and it can only be presumed that one of the guano islands of Peru is the most likely source (cf. Hutchinson, 1950).

It is perhaps meaningful to speculate on the environment in which this struvite decomposed to newberyite because this relic consists of extremely fine, compacted powder rather than long, bladed single crystals of newberyite as found in the Mono Lake specimens: it is quite likely that the decomposition was sub-aerial, albeit aided by atmospheric moisture. There is certainly no evidence that the Peru struvite–newberyite had been submerged: the newberyite powder disaggregates very easily after 10–20 minutes' soaking in water. Thus it is evident that guano-deposited struvite decomposes in low-temperature natural environments both sub-aerially and subaqueously.

Concerning the powder diffraction pattern of newberyite, Whitaker (1968) concluded that a powder camera mount gives more nearly correct relative intensities. The intensities he records are essentially the same as found for the Peru newberyite, which, unlike the Mono Lake and Skipton Caves single-crystal starting materials, was < 5 μ in grain size and showed little or no preferred orientation, even in a flat diffractometer mount.

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Basaluminite from Cambrian rocks near Harlech

HIGHLY shattered black shales believed to be of the Clogau Group of the Middle Cambrian (Matley and Wilson, 1946) are exposed in a small roadside pit on the slopes of Moel Goedog near Harlech, Merioneth, North Wales (O.S. 1 in./1 ml Sheet 116, grid reference SH 610329). The site lies immediately east of the Moel Goedog West fault mapped by Matley and Wilson on the western fringe of the Harlech Dome. From material sampled in 1964 at this quarry, a piece of strongly iron-stained and iron-oxide encrusted mudstone was found when split to contain a single vesicle (*c.* 2 × 1 cm diameter) filled with a white earthy mineral.

X-ray powder photographs (Phillips 11.48-cm camera) showed the mineral to give a pattern identical with that of basaluminite, $\text{Al}_4\text{SO}_4(\text{OH})_{10} \cdot 5\text{H}_2\text{O}$ (Hollingworth and Bannister, 1950), except for the presence of an additional very weak line at 4.2 Å and barely visible lines at 7.8, 7.4, 4.5, and 2.10 Å; the very weak line observed by Bannister at 7.18 Å was not found.

It is not known whether the additional lines on the Harlech mineral are lines of basaluminite unrecorded in the original data or are due to an unidentified mineral other than basaluminite, present as a minor constituent in the cavity. Some of the additional weak lines might have been attributed to aluminite ($\text{Al}_2\text{SO}_4(\text{OH})_4 \cdot 7\text{H}_2\text{O}$) but other strong aluminite lines are absent. Differential thermal analysis (Netzsch equipment, 10 °C per minute heating rate) of the Harlech material gave a curve with endotherms at 205° (3), 305° (4), 415° (1) and 880 °C (2) (figures in parentheses indicate relative peak height). Recently (Pei-Lin Tien, 1968), what appears to be the first published d.t.a. of basaluminite indicated endotherms at 125° (3=), 170° (3=), 220° (4), 355° (1) and 940° (2). A d.t.a. curve by the same author for hydrobasaluminite shows a very strong endotherm at 155 °C and a weak double endotherm at 890 and 940 °C. Curves published for aluminite (Cocco, 1952, and Gedeon, 1955) are not identical with each other but have similar twin endotherms at *c.* 130-70 °C that are