

McConnell. On the basis of our studies of type kehoeite we have proved that the substance, whether classed as an amorphous mineral or a non-mineral, has no identifiable crystal structure, but is instead a heterogeneous mixture of many phases, none of which bear any relationship to analcime. Kehoeite is not a valid species.

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Occurrence of bassanite in Lower Lias rocks of the Lyme Regis area, England*

REPORTED occurrences of bassanite ($\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$) are rare, and are of two principal kinds. The first is related to the precipitation of sulphate minerals in arid or semi-arid environments, where its genesis is controlled by climate. Bundy (1975) found bassanite as a very minor component of some gypsum and anhydrite deposits in south-western Indiana. He believed it to be a metastable mineral in the transition zone between gypsum and anhydrite. It has also been reported as an evaporite mineral from the coastal sabkhas of Baja California and Abu Dhabi (Kinsman, 1969). Gunatilaka *et al.* (1985) have described a significant occurrence of bassanite

from the continental sabkha zone pans and gypsum dune complexes of Al-Khiran, Kuwait. It is considered as practically topotactic after gypsum and occurs as a dissolution and reprecipitation product.

The second main mode of occurrence of bassanite is associated with leaching products of sulphides. Palache *et al.* (1951) reported bassanite in cavities of leucite-tephrite blocks ejected during the April 1906 eruption of Vesuvius. It also occurs with gibbsite in fumaroles as a reaction product of sulphurous vapours with calcium-bearing minerals.

The Lower Lias, extensively exposed along the English Channel in the Lyme Regis area, is dominantly composed of alternating beds of

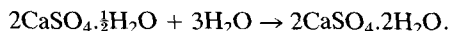
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limestone and shale or mudstone, the latter often being associated with pyrite concretions. Representative samples were collected from the section between Lyme Regis and Charmouth for mineralogical analysis.

Methods

Samples were stored after collection in sealed plastic bags at room temperature, and hand-ground in agate to a fine powder for analysis. The mineralogy was determined by X-ray diffraction (XRD) using a Philips PW1130 diffractometer with Cu-K α radiation at 35 kV, 55 mA. Bassanite was identified (using data from Brown, 1980) in shale samples from the Blue Lias and Shales-with-Beef, and in part of a concretion from the Birchi Nodule bed in the Shales-with-Beef. Gypsum was common in other parts of the section.

As a check for the presence of bassanite, the samples were soaked in water for a few hours, which led to the formation of gypsum, also identified by XRD:



It was attempted to reverse this reaction by heating (110°C for 3 hours), but no change was observed in the XRD trace.

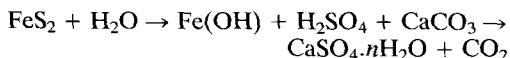
Discussion

From thermodynamic considerations, primary formation of gypsum is more likely than bassanite precipitation (Yamamoto and Kennedy, 1969). In the system CaSO₄-H₂O, bassanite starts to appear above 2 kbar and 85°C, and occurs as a metastable phase between gypsum and anhydrite. The neoformation of bassanite after gypsum can be explained by partial removal of water. Conditions for the removal of water from gypsum are not certain, but once the bassanite has formed, the reverse reaction



is very slow, and bassanite in nature might be expected to remain as a metastable phase over a reasonably long period of time.

Is the bassanite in the Lyme Regis area a result of direct precipitation or is it an alteration product? In clays or marls, acid solutions may be produced by the weathering and oxidation of sulphides. The reaction that takes place can be summarised as follows:



Under evaporation in the non-saturated zone,

where water is limited and permeability low, bassanite may thus be formed by the action of sulphuric acid on calcite. In the Lower Lias at Lyme Regis, where pyrite is readily available, this appears far more likely a mechanism than primary precipitation, which has only been recorded in quite different environments.

Bassanite has been reported as an artefact of oil-shale fires on the Dorset coast (Cole, 1975), but there is no evidence of such events in the section sampled here.

Conclusions

In the Lower Lias of the Lyme Regis area, bassanite probably formed as a result of the reaction of calcite with sulphuric acid produced by weathering of sulphides. This is a very unusual mode of occurrence in temperate climates.

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Comment on 'zoned hibonites from Punalur, South India'

SANTOSH *et al.* (1991) did not cite any of a large number of 'materials-science' papers on magnetoplumbites (the crystal class of which they rightly state hibonite is a member). Many papers cover the kinds of coupled-ion substitutions that they have observed in their mineral case. Thus we read, 'The theoretical (sic) REE end-member composition is *therefore* (my italics) REE $R^{2+}Al_{11}O_{19}$ ', when, indeed, not only is this a known structure, but $LaR^{2+}Al_{11}O_9$, where $R = Mg, Co, Mn, Cu$ etc., have actually been refined by Gasperin *et al.* (1984) and site occupancies of the divalent atom were determined. Early work on these compounds was carried out at the Philips Lab. in Eindhoven for the purpose of making better phosphors for fluorescent lamps; these are now used world-wide and are probably right above the authors heads in their laboratories. One mini-review (Morgan and Miles, 1986,

containing 27 references) exists to more of these coupled-substitutions.

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