Kellog, H. H., and Basu, S. K. (1960) *Trans. Metall. Soc. A.I.M.E.* **218**, 70–81.
Latimer, W. M. (1952) *Oxidation Potentials.* Prentice-Hall.
Perrin, D. D., and Sayce, I. G. (1967) *Talanta* **14**, 833–42.
Temple, A. K. (1956) *Trans. R. Soc. Edin.* **63**, 85–114.
Wagman, D. D., Evans, W. H., Parker, U. B., Halow, I., Bailey, S. M., and Schumm, R. H. (1968) *Nat. Bur. Standards, Tech. Note* 270-3.
Wilson, G. V. (1921) *The Lead, Zinc, Copper and Nickel Ores of Scotland.* Special Rep. Min. Res. Great Britain, 17.

[*Manuscript received 8 December 1981*]

Dept. of Chemistry, University College, Cardiff CF1 1XL FAWZY A. ABDUL-SAMAD
JOHN H. THOMAS
PETER A. WILLIAMS

Dept. of Mineralogy, British Museum (Natural History), London SW7 5BD ROBERT F. SYMES

MINERALOGICAL MAGAZINE, DECEMBER 1982, VOL. 46, PP. 501–2

A pectolite sedimentary xenolith from kimberlite, Sierra Leone

THE Archaean granitoid basement complex of eastern Sierra Leone is cut by numerous dykes and a few small pipes of kimberlite of Cretaceous age. The pipes carry a suite of unmetamorphosed volcanic and sedimentary rock xenoliths which are the only evidence remaining of a cover sequence now removed from the region by erosion. Such xenoliths from the Koidu pipe (11° 6′ W., 8° 40′ N.) have been briefly described and the possible correlation of the parent sequence with either the Upper Proterozoic Rokel River Series or the Palaeozoic Saionya Scarp Series of western and northern Sierra Leone discussed (Hubbard, 1967).

A white porcellanous rock from the suite of accidental xenoliths in the Koidu kimberlite pipe has an unusual composition and an uncertain origin. The rock is uniformly composed of rounded, monomineralic, polycrystalline grains, 0.2–0.4 mm diameter, in a coarse-grained, poikilotopic, calcite matrix. A few, isolated, sub-rounded grains of microcline and quartz serve only to emphasize the striking compositional homogeneity of the rock. Strong compaction is indicated by the tight packing of the grains with long intergrain contacts, some straight, some concave-convex. Aggregates of compacted grains, rather than isolated grains, are enclosed in the poikilotopic calcite grains of the matrix.

The polycrystalline grains are composed of non-oriented, felted aggregates of mineral fibres and thin plates. The grains are monomineralic and there is no indication that they are the products of secondary replacement. The colourless mineral has a dusty appearance, the interference colours range up to blue of the second order, the fibres are length slow, and the extinction to elongation is near parallel. It was not found possible to obtain satisfactory interference figures.

Optical and routine XRD data suggested that the mineral of the grains was pectolite. Since this is an unusual paragenesis for pectolite a more detailed examination was undertaken to test the identification. Slow scan ($\frac{1}{2}°$ 2θ/min) X-ray diffraction runs were made on untreated and HCl-treated powder mounts. The HCl treatment removed the calcite peaks from the diffractograms but also appeared to affect the crystallinity of the pectolite, reducing intensities and causing peak broadening. Reflections in the range 5–50° 2θ were measured and indexed by reference to the data for pectolite in Borg and Smith (1969). The derived cell constants ($a = 7.998$, $b = 7.039$, $c = 7.041$ Å, $\alpha = 90.50°$, $\beta = 95.20°$, $\gamma = 102.40°$) compare rather closely with those published for pectolite by Prewitt (1967).

TEM-ED thin film analyses were made on finely powdered mineral material by the method of Cliff and Lorimer (1975) using element k-values determined from silicate mineral standards (McGill and Hubbard, 1981). A nominal 3% water content was assumed for normalization and the analyses were recalculated on the basis of 18(O,OH) (Table I). The derived formula closely corresponds with the theoretical formula for pectolite $(Ca,Fe)_4Na_2H_2(SiO_3)_6$ and serves to confirm the identification.

No literature reference to pectolite occurring in the mode described for the xenolith from the Sierra

TABLE I. *TEM-ED thin film analysis of pectolite**

	Wt. %	S.D. (n = 6)	No of ions on basis of 18(O,OH)		
SiO_2	54.8	0.17	Si	6.02	
Al_2O_3	n.d.	—	Fe^{2}†	0.05	3.86
FeO†	0.5	0.30	Ca	3.81	
MnO	n.d.	—	Na	1.99	
MgO	n.d.	—	OH	2.20	
CaO	32.3	0.69	$(Ca,Fe)_{3.9}Na_{2.0}H_{2.2}(SiO_3)_6$		
Na_2O	9.3	0.66			
K_2O	n.d.	—			
H_2O‡	3.0	—			

* The anhydrous analysis was normalized after addition of a nominal 3% water to allow calculation of a hydrous formula (see pectolite analyses in Deer *et al.*, 1963, pp. 178, 179, and Leach and Rodgers, 1978, p. 50).
† Total Fe as FeO.
‡ Nominal value.

Leone kimberlite has been found. Pectolite parageneses are reviewed in Deer *et al.* (1963). Its most common occurrence is as a hydrothermal mineral in cavities and veins in basalts and dolerites. Its occurrence in zones and veins in serpentinites has recently been reported by Leach and Rodgers (1978).

The xenolith rock must, on the basis of its petrography, be classified as a lithified sediment. The accidental xenolith suite of the Koidu kimberlite includes, in addition to wall rock granite, a variety of basaltic lavas which are characterized by zeolitic and calcareous amygdales and veins. The less numerous sedimentary rock xenoliths are feldspathic arenites and siltstones. None of the surface rock xenoliths show any sign of regional metamorphism but the sediments are well lithified. There has been only very limited surface reaction between the xenoliths and the kimberlite host. Many of the basalts are bleached and carbonatized but this pervasive alteration is believed to be associated with the source volcanism. The mineralogy of the amygdales and veins of the basalts has been examined optically and, although it is difficult to identify unequivocally fine, fibrous pectolite, some veins and amygdale coatings are believed to include this mineral.

It is presumed that the pectolite arenite is a member of the same volcanosedimentary assemblage as the other surface rock xenoliths. The parent rock sequence has been totally removed from the land surface by erosion and is known only from the preserved kimberlite xenoliths (Hubbard, 1967). No detail of the association is therefore available.

The polycrystalline pectolite grains wholly dominate the apparently mature, compacted, late-cemented sedimentary rock. A clastic sedimentary origin for the rock requires a source of pectolite of sufficient homogeneity, extent, and isolation to produce the virtually monophasal sediment load demanded. Transportation to achieve the indicated grain roundness without significant contamination by admixture with other sediment is a further requirement. The improbability of frequent satisfaction of these stringent conditions supports the apparent rarity of this rock but also requires consideration of possible alternative modes of formation.

The volcanic rocks of the suite show evidence of significant gas activity. Sub-aqueous venting of gases of suitable composition might lead to globular precipitation of pectolite. Bottom accumulations of these pectolite globules could locally survive and retain their compositional integrity to produce rocks with the mineralogical and petrographic characters of the xenolith rock. This alternative volcano-exhalative sedimentary origin hypothesis is speculative but avoids the very real difficulties inherent in a normal clastic sedimentary interpretation.

REFERENCES

Borg, I. Y., and Smith, D. K. (1969) *Geol. Soc. Am. Mem.* **122.**
Cliff, G., and Lorimer, G. W. (1975) *J. Microscopy* **103,** 203–7.
Deer, W. A., Howie, R. A., and Zussman, J. (1963) *Rock-forming minerals.* Vol. 2. Longmans, London.
Hubbard, F. H. (1967) *Nature,* **214,** 1004–5.
Leach, T. M., and Rodgers, K. A. (1978) *Mineral. Mag.* **42,** 45–62.
McGill, R. J., and Hubbard, F. H. (1981) *Quantitative Microanalysis with High Spatial Resolution,* G. W. Lorimer, M. Jacobs, and P. Doig (eds), Metals Society, London, 30–4.
Prewitt, C. T. (1967) *Z. Kristallogr.* **125,** 298–316.

[*Manuscript received 17 March 1981; revised 11 May 1981*]

Department of Geology, The University, Dundee

F. H. HUBBARD
R. J. MCGILL