impurity detected was gehlenite. The larnite and spurrite rocks are fine-grained with anhedra rarely exceeding 0·03 mm. Rankinite, on the other hand, occurs as large plates up to 8 mm in length. Locally rankinite shows replacement by kilchoanite. Large crystals of rankinite are mottled and edges corroded and replaced by small irregular individual grains (0·2–0·4 mm in diameter) or by granular aggregates of kilchoanite. Kilchoanite has not been observed to completely replace rankinite.

Properties of the Tokatoka rankinite and kilchoanite are: rankinite α 1·640, β 1·644, γ 1·650 (all $\pm$0·002), $2V_\alpha$ 114°, $r > v$ weak, D 2·998$\pm$0·002; kilchoanite α 1·646, β 1·648, γ 1·650 (all $\pm$0·002), $2V_\alpha$ 46 to 54°, $r > v$ strong, D 2·992$\pm$0·002.

Both rankinite and kilchoanite are colourless in thin section and have no observable cleavages. Kilchoanite typically shows abnormal brown and blue interference colours.

Table I lists X-ray powder diffraction data for the Tokatoka rankinite and kilchoanite together with the data of Agrell and Gay (1961) and Roy (1958) for the natural and synthetic kilchoanite ('Phase Z') respectively. The Tokatoka kilchoanite is the third record of kilchoanite and the first outside Great Britain.

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REFERENCES

AGRELL (S. O.) and GAY (P.), 1961. *Nature*, **189**, 743.
MASON (B.), 1957. *Amer. Min.* **42**, 379.
ROY (D.), 1958. Ibid. **43**, 1009.

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Arthurite from Potrerillos, Atacama Province, Chile

THE felicitously named arsenate of copper and iron, arthurite (Davis and Hey, 1964), has been confirmed from a second locality, the Potrerillos porphyry copper deposit (26° 29′ S.; 69° 26′ W.), Atacama Province, northern Chile, in the course of an investigation of supergene sulphide and oxidate mineral assemblages in the copper deposits of the Copiapó region (Sillitoe, Mortimer, and Clark, 1968; Sillitoe, 1969).

The arthurite-bearing specimen was collected in 1966 from a small dump of high-grade ore recently taken from tributers' workings in the uppermost 60 m of the open-pit of the now-abandoned porphyry copper mine (March, 1935). The ore at this level consists of massive djurleïte, formed in the earlier of the two major episodes of supergene enrichment that affected the area in the Lower Eocene to Upper Miocene interval, and subsequently strongly oxidized to malachite, goethite, and minor cuprite.

The arthurite occurs as very thin (0·1–0·5 mm) and sporadic coatings, of a pale

apple-green to bluish-green colour, encrusting the walls of minor fractures cutting the malachite-rich shells around djurleïte masses, and on the walls of small cavities. The formation of the arsenate apparently took place during a second, late phase of oxidation. No crystal forms could be distinguished in the smooth, slightly lustrous crusts at × 1000.

Identification was made on the basis of X-ray powder data and qualitative X-ray fluorescence and electron microprobe examination. The powder pattern, taken with a Guinier focusing camera and Fe-$K\alpha$ radiation, shows no significant variations from that found by Davis and Hey (1964) for two samples of the type-material from the Hingston Down Consols Mine, Calstock, Cornwall, at least up to d 2 Å. No evidence of the presence of pharmacosiderite, intimately associated with the Cornish arthurite, was detected, although an extremely thin surficial coating of brochantite yielded a few weak lines in the powder patterns.

X-ray fluorescence analysis of several small particles of the green crust revealed the presence of major copper, iron, and arsenic, and these three elements were further confirmed by microprobe scanning of an impregnated mount of the same powder.

Arsenates are comparatively rare in the oxidized zones of copper deposits in this region, although Sillitoe (1969) has identified duftite, bayldonite, and conichalcite, each from the near-surface zones of a single mine. This rarity presumably reflects that of hypogene enargite in the majority of the deposits, and the occurrence of arthurite at Potrerillos probably derives from the minor enargite that is present in the ore (March, 1935).

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REFERENCES

DAVIS (R. J.) and HEY (M. H.), 1964. *Min. Mag.* **33**, 937.
MARCH (W. S., Jr.), 1935. In *Copper Resources of the World* (Washington: 16th Int. Geol. Congr.), p. 485.
SILLITOE (R. H.), 1969. Unpublished thesis, University of London.
—— MORTIMER (C.), and CLARK (A. H.), 1968. *Trans. Instn. Min. Metall.* **77**, B166.

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The cell-contents of arthurite redetermined

IN the original description of arthurite (Davis and Hey, 1964), we noted a discrepancy between the X-ray and chemical data: the cell dimensions, chemical analysis, and