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Vincentite, a new palladium mineral from south-east Borneo

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SUMMARY. Vincentite, a new palladium mineral containing As, Sb, and Te, has been discovered in platinum–gold concentrates from the Riam Kanan River, SE. Borneo. It occurs as small grains (up to 40 μm) in iron-bearing platinum. In reflected light, vincentite is light brownish-grey and in some sections weakly anisotropic. Reflectance at 470, 546, 589, and 650 nm is 46·3–47·5, 49·2–52·8, 51·7–53·9, and 54·9–56·0, respectively. VHN_{15} = 494. Electron probe analysis has been performed on two grains, the compositions of which are $(Pd_{5.32}Pt_{0.68})$ $(As_{0.90}Sb_{0.48}Te_{0.65})$ and $(Pd_{5.17}Pt_{0.83})$ $(As_{0.89}Sb_{0.70}Te_{0.45})$ or, simplified, $(Pd,Pt)_3(As,Sb,Te)$. This is distinctly different from both arsenopalladinite, $Pd_5(As,Sb)_2$ with As > Sb as defined by Clark (1974), and mertieite, $Pd_5(Sb,As)_2$.

The following lines have been observed in the powder pattern: 4·180, 3·950, 3·240, 2·750, 1·997, 1·749, 0·944. This cannot be matched by the patterns of arsenopalladinite, mertieite, isomertieite, stibiopalladinite, atheneïte, or synthetic Pd_3As.

The name is in honour of Prof. E. A. Vincent, of Oxford.

PLATINUM–GOLD concentrates from the Riam Kanan River, SE. Borneo, have previously been investigated by Stumpfl and Clark (1966). New data on natural Pt–Fe and Os–Ir–Ru–Pt alloys from these placers have been reported by Stumpfl and Tarkian (1973). Iron-bearing platinum is the main constituent of the concentrates and makes up about 40 % of the bulk composition; occasionally, it contains small inclusions of vincentite. Their average size is 7 to 10 μm; rarely, grains of up to 40 μm are found (fig. 1).

In reflected light, vincentite is light brownish-grey and in some sections weakly anisotropic. The grains analysed (Table II) did not show anisotropy; this may be due to their optical orientation. Its reflectance is distinctly lower than that of associated natural alloys. The results of measurements on two grains are summarized in Table I. They are of the same order of magnitude as those reported by Genkin (1968) for lead-bearing 'arsenopalladinite', but show slightly higher values. Stibiopalladinite (Genkin, 1968; Desborough *et al.*, 1973) gives higher reflectance values.

Because of the small size of the grains, microhardness measurements had to be performed using a 15 g load: VHN = 494. Desborough *et al.* (1973) quote values ranging from 570 to 593 for mertieite, $Pd_5(Sb,As)_2$. Clark *et al.* (1974) give VHN = 388–425, average 407, for arsenopalladinite.

Electron probe microanalyses of two grains of vincentite are given in Table II. The most significant results are the presence of As, Sb, and Te in almost equal amounts, the partial substitution of Pd by Pt and the distinct (Pd,Pt): (As, Sb, Te) ratio of 6:2.

X-ray powder data have been obtained by removing the platinum grain containing the largest amounts of vincentite from the polished section and running it on a Gandolfi camera (diameter 114·6 mm; Ni-filtered Cu-radiation; exposure 48 hours). In addition to the platinum and osmium patterns, lines have been observed: $d = 4{\cdot}180$, 3·952, 3·240, 2·750, 1·997, 1·749, and 0·944 Å. These cannot be indexed unambiguously, so that it would be unrealistic to attempt to deduce cell dimensions; they cannot be matched by the patterns of arsenopalladinite, stibiopalladinite, mertieite, isomertieite, atheneïte, or synthetic Pd_3As. Desborough *et al.* (1973) have stressed the fact that small changes in the composition of Pd arsenides and antimonides may be attended by substantial changes in structure.

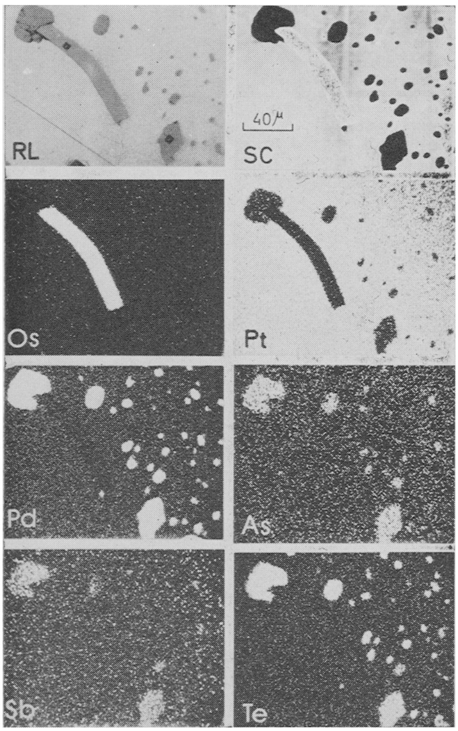

FIG. 1. A new palladium mineral, vincentite, containing about equal amounts of As, Sb, and Te, with a lamella of native osmium, as inclusions in iron-bearing platinum. RL, in reflected light; SC, sample current picture; Os, Pt, Pd, As, Sb, and Te, X-ray scanning pictures for these elements.

Compositions quoted in the literature for arsenopalladinite-type compounds vary widely between Pd_3As and Pd_5As_2 (Cabri, 1972). Pb and Sb have also been recorded as significant constituents. Saini *et al.* (1964) have investigated the system Pd–As and established the following stable binary phases: Pd_3As, $Pd_{2\cdot65}As$, Pd_5As_2, and Pd_2As. Kovalenker *et al.* (1972) have described an unnamed mineral of composition $Pd_3(As,Te)$ from the Norilsk region, Siberia, that may be identical with vincentite; unfortunately no X-ray data are given (reflectivity, Table I; analysis, Table II).

For comparative purposes, Dr. A. M. Clark kindly supplied us with a sample of type arsenopalladinite (B.M. 1934, 72). Analysis with our electron probe (ARL–EMX–SM) revealed a distinct Pd:As ratio of 5:2.

The name vincentite has been approved by the I.M.A and is defined as $(Pd,Pt)_3(As,Sb,Te)$ with $Pd > Pt$ and $As:(Sb,Te) \approx 1:1$, with the appropriate X-ray pattern

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TABLE I. *Spectral reflectance of Pd–As and Pd–Sb minerals*

λnm	1	2	3	4	5	6	λ	7
460	—	—	44·0	46·9	—	—	440	44·1
470	47·0–47·5	46·3–47·0	—	—	45·6–51·7	45·0–54·8	500	47·5
540	—	—	47·0	52·8	—	—	580	54·7
546	49·2–50·0	51·8–52·8	—	—	51·8–55·4	53·3–58·5	640	58·8
580	—	—	48·5	53·4	—	—	700	62·9
589	51·7–52·3	53·1–53·9	—	—	55·1–58·2	56·2–61·4	740	64·3
650	54·9–55·7	55·2–56·0	—	—	—	—		
660	—	—	52·2	56·7	—	—		

1 and 2: Vincentite, SE. Borneo (this investigation).
3: Lead-bearing 'arsenopalladinite', Norilsk, Siberia (Genkin, 1968).
4: Stibiopalladinite, Potgietersrust, Transvaal (Genkin, 1968).
5: Stibiopalladinite, Tweefontein, Transvaal; USNM No. R6483 (Desborough *et al.*, 1973)
6: Mertieite, Goodnews Bay, Alaska (Desborough *et al.*, 1973)
7: Unnamed Pd_3(As,Te), Kovalenker *et al.*, 1972.

TABLE II. *Electron-probe microanalyses of vincentite*

	1	2	3	1′		2′		3′	
Pd	61·3	59·6	72–77	5·32	6·00	5·17	6·00	0·70	0·72
Pt	14·4	17·6	—	0·68		0·83		0·02*	
As	7·3	7·2	10–13	0·90		0·89		0·15	
Sb	6·3	9·3	—	0·48	2·03	0·70	2·04	—	0·25
Te	8·9	6·3	11–14	0·65		0·45		0·10	
Total	98·2	100·0	Pb 0–2					* Pb+Bi	

1, 2. Vincentite. 3. Pd_3(As,Te), Kovalenker *et al.*, 1972; also Bi, 1 to 3%.
1′, 2′, 3′. Atomic ratios to 6 (Pd, Pt).

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