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DISCUSSION OF "COULSONITE" BY ARTHUR S. RADTKE, *AM. MINERAL.*, 47, 1284-1291.

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I was most interested to see the paper on coulsonite from Lovelock, Nevada, by Mr. Arthur S. Radtke (1962, pp. 1284-1291), but feel that certain comments are in order to insure that readers of the paper do not receive erroneous impressions from the photomicrographs (Figs. 1-4) which Mr. Radtke apparently excerpted from two closed-file reports prepared at the Colorado School of Mines Research Foundation, Inc. (Perry, 1959 and 1960).

Mr. Radtke's Fig. 1 shows the somewhat "feathery" appearance of the coulsonite from this locality (as at the tip of the arrow). However, his caption identifying the thin lamellae along octahedral planes in the magnetite as being exsolved coulsonite is erroneous; the oriented lamellae along the octahedral planes are hematite, not coulsonite (Perry, 1959, p. 15, Fig. 1). This writer's work has included examination in polished section and otherwise of iron ores from deposits of various origins from four continents, and have included many hundreds of composite samples, beneficiation test products, mill products, and many thousands of feet of diamond drill cores from iron deposits. This writer thus feels fully qualified to identify hematite in polished section, and contends that Mr. Radtke failed to correctly distinguish between hematite and coulsonite when he labeled the thin lamellae along octahedral planes in the magnetite as coulsonite.

Figure 2 shown by Mr. Radtke is another portion of the same polished section, Sample RF-2099 (Perry, 1959, p. 21, fig. 7) shown in his Figure 1. However, the hematite lamellae do not show in this photomicrograph, because the section was etched with 2:1 hydrochloric acid prior to photography. Such etching facilitates identification of the coulsonite for modal analyses.

Figure 3 in Mr. Radtke's paper shows a polished surface of Sample BVD-2-3 (Perry, 1960, p. 64, fig. 38). The writer must take exception with Mr. Radtke's identification of the metallic mineral as coulsonite. The crystals shown are actually magnetite containing exsolution(?) lamellae of hematite. The fact that the copy of the photomicrograph which he submitted for publication was apparently overexposed, with the result that the euhedral to subhedral opaque grains appear to be monomineralic, does not alter the fact that two mineral phases are present in these metallic grains. The writer is not saying that Mr. Radtke

may not have found samples containing coulsonite crystallized separately from magnetite during his sampling of the deposit; only that such a situation was never observed in any of the samples examined at this laboratory, including the many samples studied during the second project. Indeed, the writer would very much appreciate receiving a sample of Mr Radtke's coulsonite concentrate for an *x*-ray standard.

Figure 4 in Mr. Radtke's paper shows a view of a thin section of Sample BV-7(b), (Perry, 1960, p. 53, fig. 27). The veinlet shown was identified by this writer as magnetite. The writer must admit that he never prepared a polished section corresponding to the same portion of the specimen shown by the thin section; however, a polished section of a nearby area disclosed that the opaque mineral was magnetite, again with ex-solved hematite.

Since this discussion contests certain of Mr. Radtke's identifications, some background information concerning the unpublished work done at the Research Foundation will be given. Two special samples were furnished by the sponsor for the study directed at the problem of identifying the vanadium mineral in the magnetite from Lovelock, Nevada. One of these was a bulk sample which obviously contained pieces of five distinct types, and was immediately sorted accordingly. A large number of polished sections was prepared from these samples and various tests products therefrom. A recent count shows that 54 of these polished sections are still in this writer's possession as of this date, including the sections used to make the photomicrographs shown as Figs. 1 and 2 (Radtke, 1962). In addition, the original photomicrograph negatives are also in this writer's possession. Thus, Mr. Radtke has never had an opportunity to examine any of these particular samples, other than on the basis of the information and photomicrographs shown in this writer's report (Perry, 1959).

The samples, thin and polished sections and photomicrograph negatives used for a subsequent study directed at other mineralogical problems (Perry, 1960) were returned to the sponsor, and included the sections shown in Figs. 3 and 4 (Radtke, 1962). However, examination of a large number of samples during the second study disclosed no situation which would require revision of any of the conclusions reached during the first study (Perry, 1960).

It was positively concluded during the first study (Perry, 1959) that the vanadium was present as coulsonite, but *x*-ray powder data for coulsonite were not given by this writer because a concentrate could not be obtained from the samples examined. Physical beneficiation methods failed because of the extremely small liberation size of the coulsonite (minus-one-micron to 50.4 microns, average 6.0 microns), and in this

case preferential leaching was also unsuccessful. If one considers *x*-ray powder data essential for a positive identification, then this identification was not positive. The writer used an indirect method to positively conclude that vanadium was present as coulsonite. The feathery-appearing mineral in Figs. 1 and 2 (Radtke, 1962) was first tentatively identified as coulsonite by mineralography, including microchemical etch reactions.

Two samples with high vanadium content were then selected for an indirect test of the tentative identification. They had previously been chemically assayed for iron and vanadium. Many polished sections of reject splits were prepared, and very accurate modal analyses were made by Chayes point counting (0.25 mm traverse spacing), while being certain that a statistically reliable number of points was identified and counted. This work was done using a high power oil immersion objective on a Leitz Panphot microscope. Percentages of iron and vanadium were then calculated from the modes by using published formulae for the minerals involved. The formula for coulsonite was taken as that given by Dunn (1937, p. 21).

For Sample RF-2099 the following mode was obtained:

<i>Mineral</i>	<i>Modal Per Cent</i>
Magnetite	83.94
Hematite	7.11
Coulsonite (tentative)	1.22
Gangue	7.72
	<u>99.99</u>

The following comparison of chemical analyses and the analyses calculated from the mode was then made:

<i>Source</i>	<i>Per Cent Iron</i>	<i>Per Cent Vanadium</i>	<i>Iron:Vanadium Ratio</i>
Chemical Assay	65.2	0.277	235:1
Modal Analysis	63.3	0.274	231:1

The two sets of results are remarkably similar, far too much so, in fact, to be merely fortuitous, and it was concluded that the tentative mineralographic identification of coulsonite was indeed correct. Further it was also concluded that the results were highly suggestive that little or no vanadium remained in solid solution in the magnetite. The comparatively low iron percentage calculated from the mode for this sample can be attributed to failure to account for any iron contained in certain of the silicate gangue minerals. Incidentally, the iron-vanadium ratios for the other sample tested by this technique (RF-2100(c)) were 251:1 via modal analysis and 248:1 via chemical analysis.

This writer doubts that he is the first person to use the technique de-

scribed above, but some of the readers of *The American Mineralogist* who might be unfamiliar with it may find a published example helpful. The method has been used successfully in connection with many difficult identification problems, and an identification based in part on this technique has withstood the test of presentation in a U. S. District Court trial.

This writer must also take exception to the scales for the photomicrographs as given in Mr. Radtke's paper, although this is a rather insignificant point. The scales were originally obtained by photographing a Bausch & Lomb stage micrometer with the Panphot for each combination of objectives and eyepieces used. An enlargement factor was then applied to correct for the difference between the negatives and the enlarged prints. An additional correction was also made for the figures given below for the slight difference in scale between the original prints and the published cuts. Mr. Radtke's failure to use the original data is particularly puzzling with respect to his Figs. 1 and 2, since not only the polished sections, but also the negatives are still in this writer's possession.

Figure (Radtke, 1962, p. 1285)

	1	2	3	4
Correct scale of published cut, 1" =	0.177 mm	0.057 mm	0.072 mm	0.344 mm
Magnification as diameters	144X	446X	353X	74X

In summary, the most pertinent comment that might be made is that during examination of this ore this writer never observed any coulsonite that was not intimately intergrown with magnetite. Thus, the caption for Mr. Radtke's Fig. 3 is particularly misleading, as well as certain of his comments and conclusions concerning direct crystallization of coulsonite unrelated to exsolution from or replacement of magnetite (Radtke, 1962, p. 1290).

Permission to publish this portion of data from closed-file reports was kindly given by Mr. K. W. Mote, Columbia-Geneva Steel Division, United States Steel Corporation.

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RADTKE, A. S. (1962) Coulsonite, FeV_2O_4 , a spinel-type mineral from Lovelock, Nevada. *Am. Mineral.* **47**, 1284-1291.

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REPLY TO "DISCUSSION OF 'COULSONITE' "

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I will comment very briefly on Mr. J. Kent Perry's article concerning my paper "Coulsonite, FeV_2O_4 . A Spinel Type Mineral from Lovelock, Nevada"; *The American Mineralogist*, **47**. The material used in the study was in part collected by myself and in part provided by a mining company for the expressed purpose of determining the source of vanadium. The samples from the company were obtained from Mr. Perry's group by the company for my study and represent material originally used and studied by the Colorado School of Mines Research Foundation. This is now a part of the ore deposits collection at Stanford University.

The photomicrographs were used in the publication with no reference to the closed-file reports by Mr. Perry by prior agreement with the mining company for whom he studied the ores. This agreement specifically stated no reference should be made to previous material within their files. The fact that Mr. Perry was not given credit for his photography is recognized and his name was omitted from the bibliography for the above reason.

The study of coulsonite was concluded with the publication in *The American Mineralogist* and was carried out independently of previous work. Certainly no slight to Mr. Perry or his earlier works was intended.

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NOTE ON ISHIGANEITE AND YOKOSUKAITE

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Ishiganeite and yokosukaite were first named by K. Kani and T. Tanaka (*Bull. Electrotechnical Lab. Japan*, **1**, 459-497, 553-555, 1937; **2**, 19-24, 291-295, 1938; *Electrochem. Japan*, **6**, 366-370, 1938; **7**, 7-16, 1939); and their mineralogical and electrochemical characters were described.