ART. XLIII.—*On the Natural Iron-Nickel Alloy, Awaruite*;
by GEORGE S. JAMIESON.

Two terrestrial iron-nickel alloys from adjoining localities will be described in this paper. One from Josephine Co., Oregon, which has already been investigated by Mr. W. H. Melville,* came through Mr. Maynard Bixby of Salt Lake City, Utah. The other, found at South Fork, Smith River, Del Norte Co., California, was from Dr. David T. Day, Chief of the Division of Mining and Mineral Resources of the United States Geological Survey. Both specimens had been sent to Professor S. L. Penfield, at whose advice this investigation was undertaken.

The specimens from Josephine County were water-worn, bean-shaped pebbles, varying in size from a few millimeters to two centimeters in diameter and were composed not only of the alloy, but also of more or less siliceous matter. Thin sections showed that the alloy was of a spongy nature, binding together and enclosing particles of silicate, which had the appearance of serpentine and gave the chemical reactions for that substance. In a steel mortar, the pebbles were easily broken into a powder and no mechanical method of making a separation of the metal from the serpentine seemed possible. A chemical separation, however, was easily effected by treating the powder with water and iodine at ordinary temperature. A complete solution of the alloy was thus obtained in about a day, while the siliceous matter was not dissolved by this treatment. The insoluble silicate was filtered on asbestos, air dried, and weighed. Duplicate analyses were made with the following results:

Insoluble silicate	24·15	24·55
Iron	19·17	18·95
Nickel	56·30	56·07
Cobalt	·35	·35
Phosphorus	·04	·04
Sulphur	·09	·09
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	100·10	100·05

Deducting the insoluble silicate and recalculating the remaining constituents to one hundred parts, the following percentages were obtained:

Iron	25·24	25·11
Nickel	74·17	74·30
Cobalt	·46	·46
Phosphorus	·04	·04
Sulphur	·09	·09
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	100·00	100·00

* This Journal [3], xliii, 509.

These results differ but slightly from those obtained by Melville, who found iron 23·22, nickel 60·45, and 15·83 per cent of other constituents. The metals calculated to 100 per cent equal, iron 27·75, and nickel 72·25.

The sample of iron-nickel alloy which came from Smith River, California, was in the form of grains of remarkably uniform size, about 0·15 millimeters in diameter, with an occasional larger grain, up to 1·5 millimeters. The metallic sand, for that is what it appears to be, was obtained from gold washings and was chiefly composed of the alloy, but mixed with magnetite, and a very little chromite. As no mechanical method for separating the alloy from the magnetite seemed to give satisfaction, a separation by chemical means was again resorted to. The size of the grains, which could not be reduced to powder, made the solution in iodine altogether too slow for practical purposes. The alloy was found, however, to be easily soluble in warm dilute nitric acid (one part conc. HNO_3 : two parts H_2O), while the magnetite was not appreciably attacked, if at all. Duplicate analyses were made with the following results:

Insoluble matter	9·45	9·97
Iron	19·21	18·97
Nickel	68·61	68·46
Cobalt	1·07	1·07
Copper	·59	·56
Sulphur	·05	·05
Phosphorus	·04	·04
Silica	·10	·19
Magnesium oxide	·50	·44
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	99·62	99·75

The specific gravity was found to be 7·45 or, allowing for 9·7 per cent of magnetite, the value 7·85 is obtained for the alloy.

Deducting the insoluble matter, consisting of the magnetite, a small amount of chromite and the traces of silica and magnesium oxide, and recalculating the remaining constituents for one hundred parts, the following percentages were obtained:

Iron	21·45	21·28
Nickel	76·60	76·79
Cobalt	1·19	1·20
Copper	·66	·63
Phosphorus	·04	·04
Sulphur	·06	·06
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	100·00	100·00

In dissolving the alloys in hydrochloric acid, it was noted that there was no odor of hydrocarbons, such as is observed when iron and steel are dissolved, nor was there any evidence of graphitic carbon.

These two iron-nickel alloys are quite similar in composition to those which have already been described from other localities, and for comparison, a table has been arranged to show percentages of iron and nickel which these various alloys contain. The first analysis is that of an alloy found at Gorge River, which flows into Awarua Bay on the west coast of South Island, New Zealand, described by W. Skey* in 1885 and to which the name awaruite was given. The second analysis, by A. Sella,† is of an alloy from the gold-bearing sand of the Elvo River, near Biella, Piedmont, Italy. The third analysis, by Melville, is of material from Josephine Co., for which the name Josephinite was suggested. No. 4 is a recent analysis by F. G. Wait, quoted by G. C. Hoffmann,‡ of a similar alloy from Fraser River, British Columbia, to which Hoffmann has given the name sonesite, as stated by him, "to distinguish this find from that of other naturally occurring iron-nickel alloys." The last two analyses are those of the present writer.

Locality.	Analyst.	Fe.	Ni.	Co.	Cu.	Other constituents.
1. New Zealand	Skey	31.02	67.63	.70	none	.63
2. Piedmont, Italy	Mattiolo	26.60	75.20§	--	none	--
3. Josephine Co.	Melville	27.41	71.35	.65	.59	--
4. British Columbia	Waite	22.30	76.48	none	1.22	--
5. Josephine Co.	Jamieson	25.24	77.17	.46	--	.13
6. Del Norte Co.	"	21.45	76.60	1.19	.59	.10

It is seen from a glance at the analyses of the alloys from the five different localities, that there is a certain uniformity in composition, but that they are not a definite compound of iron and nickel is evident, nor would this be expected; with Fe:Ni = 1:3, the percentages are Fe 24.00 and Ni 76.00, to which most of the analyses approximate, while for the ratio 1:2 the values are Fe 32.19 and Ni 67.81. It seems unfortunate that so rare a substance should have received three distinct names, awaruite, josephinite, and sonesite, and it is urged that awaruite, which has priority, should alone be used.

As regards the occurrence of the alloy, its association at Josephine Co., Oregon, with serpentine, and at New Zealand, Piedmont, Frazer River, and Del Norte Co., Cal., with chromite, suggests that it is a material which has separated from basic peridotite rocks, and, as it seems to have no tendency to deteriorate by oxidation, it is found as a heavy constituent in adjacent river sands.

In closing, it is desired to thank Mr. Bixby and Dr. Day for the material which they had sent to the laboratory for investigation, and also Professor S. L. Penfield for his help and valuable suggestions.

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* Trans. N. Zeal. Inst., xviii, 401.

† Comp. Rend., cxii, 171.

‡ This Journal (4), xix, 319, 1905.

§ Contains cobalt.