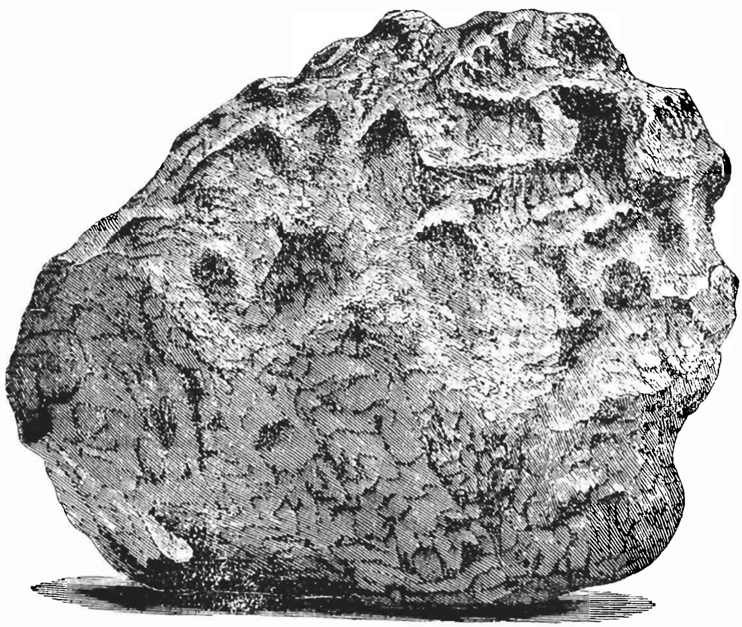
ART. IV.—*On the Meteoric Iron found near Shingle Springs, Eldorado County, California;* by B. SILLIMAN.

(Read before the National Academy of Sciences, Washington, April, 1873.)

AN Eldorado meteoric mass was found by the writer in March, 1872, in the cabinet of Mr. W. H. V. Cronise, of San Francisco, where it was placed by its discoverer, Mr. James H. Crossman, who in 1871 rescued it from the forge of a smith at Shingle Springs, California. It was found in 1869 or '70, in a field belonging to the same smith, about half a mile from the town named. It is said to be the first meteoric mass discovered in California. Mr. C. F. Watkins of San Francisco has photographed this specimen of the natural size, and from this photograph the accompanying figure has been reduced to one-third the linear dimensions of the original.

The mass was intact when I first saw it, and weighed about eighty-five pounds avoirdupois. It was flattened upon one side and presented the usual familiar features of iron meteors. It has since been cut in several sections, one of which (which was exhibited with this communication) shows a cross section measuring 12×18 centimeters. The section is approximately a semicircle, having the flattened side for its diameter, with the outline and exterior coating perfectly preserved on all sides. Its weight was over 800 grams. The largest dimensions of the entire mass were about 24 and 29 centimeters.



This meteoric mass is remarkably homogeneous in structure and singularly free from included minerals. Only two very small masses of pyrites, of 3 and 5 millimeters diameter, are visible on one side of the slab, and exteriorly I could detect no heterogeneous substance. When the surfaces of the section exhibited were reduced in the planing machine, it was observed that the exterior or crust was so much harder than the general surface of the section as to cause the tool to rise a little, thus leaving a distinct margin slightly elevated above the adjacent parts, and of a whiter color. This hardened crust had a depth of four to five millimeters.

The density of this iron, determined on a mass of over 750 grams in weight, is 7·875, while the density of the shavings cut by the planing tool from the same mass is 8·024, showing a condensation of 0·149 by this mechanical process. This density (of the mass) is above the average specific gravity of meteoric iron, owing probably to its large percentage of nickel, which, as will be observed, by reference to the accompanying analysis, is more than twice the average amount of that metal found in other meteoric irons.

The crystalline structure of this mass is obscure. The Widmannstättian figures are not developed on it by etching, although a confused granular structure was evident after this process. Wishing to test this point thoroughly, I consulted Mr. John E. Gavit, of the American Bank Note Company, in New York, who is well known for his microscopic and other scientific tastes. Mr. Gavit very kindly tried all the resources known to the engraver's art with a view to develop, by etching this iron, a surface from which its curious cryptocrystalline structure could be transferred to paper by printing. All these attempts have proved unsuccessful. The etched surface, however, examined with a lens, shows a reticulated structure with numerous brilliant points, and V-shaped lines, but so small that when charged with ink the impression upon paper is only a muddy tint. The specimen exhibited shows this peculiar structure developed in four compartments by different etching agents. Some of the printed impressions taken from this surface were also exhibited.

An attempt to develop this cryptocrystalline structure by the aid of a fine "tint," laid on an etching ground by a ruling machine and bitten in; and also by a medallion ruled in orthographic projection, upon which the crystalline lines, it was hoped, might appear in symmetrical form, was not more successful than the other trials. Thus it appears practically hopeless to transfer to paper, by printing, a structure which may yet be clearly seen by the lens.

The suggestion, made long since by Berzelius, that the Widmannstättian figures were due to the segregation of the nickel alloy, in lines of the octahedron, which the etching developed, owing to the inferior solubility of the alloy as compared with the pure iron, seems to meet no support from this mass, in which the uncommonly high percentage of nickel would naturally lead us to expect a proportionate clear development of the crystalline structure. Is it not rather the probable solution of this structure that it is due to the length of time during which the meteoric mass is kept at a high temperature, while slowly cooling? Under such conditions, the molecules can rearrange themselves in symmetrical forms, and over broad surfaces. In the mass before us, it would appear from what has been said of the crust, that the heat did not penetrate to a greater depth below the surface than 4 or 5 millimeters.

The Cape of Good Hope iron analyzed by Uricochœa resembles this both in the absence of Widmannstättian figures, and in its high proportion of nickel; but its cobalt is much larger, and there are only five elements found, in place of twelve in the California iron.

The following analysis was made upon the clean shavings cut from the entire surface of the section by the planing tool, thus securing a perfectly fair average sample. The analysis was made by Mr. F. A. Cairns, assistant in the School of Mines, Columbia College, whose constant devotion to the analysis of iron gives to his work on this metal great trustworthiness.*

Analysis.

Iron	81·480	Calcium	0·163
Nickel	17·173	Carbon	0·071
Cobalt	0·604	Silicon	0·032
Aluminium	0·088	Phosphorus	0·308
Chromium	0·020	Sulphur	0·012
Magnesium	0·010	Potassium	0·026
		Total,	99·987

Of the twelve elements quantitatively determined by this analysis, aluminium, calcium, and potassium have been rarely observed in meteoric iron—meteors free from silicates—while the absence of copper, tin, manganese and sodium will be noticed.

No room is left, it will be observed, by this analysis for any notable quantity of occluded gases, for which no search was consequently made.

* The plan of analysis adopted by Mr. Cairns was as follows:

For nickel, cobalt, aluminium, magnesium, calcium, silicon, ten grams were dissolved in hydrochloric acid and chlorate of potassa, and the solution evaporated in platinum, etc.

In the filtrate, the iron and alumina were removed by double precipitations by acetate of soda, and the alumina determined by fusion in silver with pure soda, etc.

From the filtrate, the nickel and cobalt were precipitated by sulphide of ammonium, (the filtrate being acidified by acetic acid, and boiled to recover nickel in solution in the sulphide of ammonium). The sulphides were then dissolved, and the cobalt precipitated by nitrite of potassa, and determined as double sulphate of potassa and cobalt, and the nickel precipitated as hydrated protoxide. In the filtrate from the sulphides, the lime and magnesia were determined as usual.

The iron was determined in a separate portion of the sample, volumetrically.

The chromium was determined in the residue of 20 grams, insoluble in cold dilute hydrochloric acid.

The carbon was determined by dissolving 10 grams of iron in neutral sulphate of copper, and then the precipitated copper by chloride of copper and hydrochloric acid; filtering through asbestos and oxidizing the carbon with chromic and sulphuric acids, by what is commonly known as Elliott's process, really a modification of a process adopted by Prof. Rogers, of the University of Virginia, in 1848. (See Am. Jour. of Science for 1848; also Am. Chemist, Oct., 1871, p. 140.)

For the phosphorus and sulphur, 10 grams were dissolved in hydrochloric acid and chlorate of potassa, and evaporated to extract silica. The solution was then divided, and in one half the sulphuric acid was precipitated by chloride of barium, as usual. In the other half, the phosphoric acid was determined by molybdate of ammonia, after expelling all chlorine, as usual.

The potassium was determined in 10 grams of the iron by the usual process for alkalies; dissolving, precipitating by baryta, etc.

The amount of nickel in this iron is exceptionally large. In comparing all the analyses conveniently accessible, I find only one other meteoric iron showing so much nickel. That of Greenville, Tenn., by Clark, has Ni 17·10 Co 2·04=19·14, which is the highest before recorded, so far as I can discover. That of Tazewell County, Tenn., by Smith (this Jour., II, xix, 155), has Ni 14·62 — 15·02 and Co 0·43 to 0·50 ; that of Cape of Good Hope, by Uricochœa (*Rammelsberg*, *Mineralchemie*, pp. 919–920), contains Ni 15·09 and Co 2·56 = 17·65, almost identical with the sum of Ni and Co in the Shingle Springs=17·777 per cent.

The Clairborne, Ala., iron, analyzed by Jackson (this Jour., I, xxxix, 335, and quoted by Gmelin, v, 395 of Cavendish ed.), gave him Ni 24·708—27·708, but this was subsequently reduced by A. A. Hayes (this Jour., I, xlviii, 153) to Ni 12·665 per cent. Very few of the analyses have obtained over 10 per cent of Ni, and an average of this element in some 80 analyses compared by me, is not over seven and a quarter per cent.*