On a mass of Meteoric Iron from the neighbourhood of Caperr, Rio Senguerr, Patagonia.

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IN the month of September, 1869, Captain Musters, who was at that time making an expedition through Patagonia, had his attention called to a heavy mass of material which he took to be marble. In the account of his journey he afterwards wrote (from memory) as follows[1]:—

"There is in this place, which is called by the Indians Amakaken, a large spherical boulder of marble, which it is the custom of the Indians to try their strength by lifting. Casimiro informed me that this stone had been there for many years, and the custom was very old. It was so large and heavy that I was just able to grasp it with both arms and raise it to the level of my knees, but some of the Indians managed to lift it to their shoulders."

Amakaken is indicated on Musters' map as situated in longitude 71°56′ West of Greenwich, and latitude 48°10′ South. The above-mentioned Casimiro, who accompanied Captain Musters throughout the expedition, had been recognised by the Argentine Government in 1865 as head chief of the Tehuelches,[2] the natives inhabiting the interior of Patagonia. The Tehuelches are by country, race, language and character altogether distinct from the Pampas Indians.[3]

Many years later, on the 4th of April, 1896, the mass was seen by the Director of the State Museum of La Plata, Dr. Fráncisco P. Moreno, then making a voyage of exploration in the interior of Patagonia. Dr. Moreno perceived that the material was not marble but iron, and recognising that it must be of meteoric origin, secured the mass (weighing 114

[1] *At Home with the Patagonians.* By George Chaworth Musters. London, 1871, p. 87.

[2] *Ibid.* p. 46.

[3] *Ibid.* pp. xix, xx.

kilograms, or 251 lbs.) for the La Plata Museum. In January last Dr. Moreno came to London to be at hand to give geographical information on behalf of the Argentine Government to the Commission appointed to settle by arbitration the boundary of Argentina and Chili; and he took the opportunity of bringing with him, in addition to other specimens of scientific interest, a model of the meteorite and a small fragment weighing 78 grams (2¾ oz.) which had been broken by him from a corner of the original mass. These he presented to the British Museum for examination and preservation.

Dr. Moreno reports that the name Amakaken (*i.e.* Emelk'aiken) was given by Captain Musters through a slip of memory, and that the place was really farther north on the plateau south of Rio Senguerr, Chubut Territory, situated about longitude 70°20′ West and latitude 45°15′ South; the nearest place with a name being a tribal encampment called in the Gennaken language Caperr.

According to measurements taken from the model, the mass is 48 cm. (19 in.) long, 31 cm. (12¼ in.) broad, and 27 cm. (10½ in.) high. The shape is irregular, but one side, parallel to the length, is sufficiently flat to afford a convenient base. The surface, like that of most meteoric irons, presents both large and small concavities. One of the former is 10 cm. across; one of the latter, nearly a hemisphere, is 3 cm. across.

That the structure of the material belongs to the kind termed octahedral is very manifest from mere inspection of the surface of fracture of the fragment, for the simple action of air and moisture has already sufficed to differentiate the constituent alloys and reveal their arrangement.

Relative to a solution of copper sulphate, the iron is "active," the reduced copper being visible within one or two minutes from the beginning of contact.

The iron is soft, and is thus easily cut with a hack-saw. No troilite or silicates were to be seen on any of the small faces which were prepared and polished.

A polished face (40 mm. long and 17 mm. wide), the largest which could be got from the fragment, was etched with bromine-water and gave distinct Widmanstätten figures. In this section the beams of dull grey kamacite have an average width of 1 mm. Occasionally there are three or four of them in immediate succession without any evident intervening plessite, their edges being only roughly rectilinear and parallel. As usual, each beam of kamacite is bordered by a thin bright line of tænite, which soon after the etching acquires a yellow tint. The plessite is comparatively plentiful, and occupies a considerable part of the etched surface, one area being 5 mm. long and 5 mm. wide, and a second 8 mm. long and 2½ mm. wide. The ridges or "combs," described by Reichenbach, are very conspicuous, and appear to result from thin and numerous plates of tænite traversing the plessite.

Embedded directly in the kamacite, and not separated therefrom by lines of tænite, are some thicker lustrous steel-gray homogeneous-looking enclosures which were found to be schreibersite. As the latter mineral (phosphide of iron and nickel) is very similar in aspect to cohenite (carbide of iron and nickel) and may easily be mistaken for it, a small piece of iron containing one of these enclosures was cut out and filed down until the greater part of the enclosing iron had been removed. Owing to the probable brittleness of the small enclosure, the mechanical reduction was not carried further, but the fragment was now immersed in cold dilute hydrochloric acid (1 in 20). The enclosure immediately became silver-white, and remained so while in the acid, but the enclosing iron at once became dull black, and continued so during the solution. After two days the enclosure dropped out of the fragment, and could be separately examined. It proved to be a phosphide, and therefore schreibersite. It was unaffected by a solution of copper ammonium chloride.

The etched surface is also speckled with other very minute enclosures which have the same lustre and colour as the larger ones (schreibersite). The small specks and the short thin lines of this material appear here and there to take the place of tænite, while in other parts they lie between tænite and adjacent kamacite.

Small fragments of the iron were allowed to stand for some weeks in cold dilute hydrochloric acid (1 in 20), which was occasionally renewed. The greater part (kamacite) became dull black, and slowly passed into solution. The residue consisted of (1) lustrous thin plates, containing no phosphorus, and quickly attacked by copper ammonium chloride solution (tænite); (2) some dull black material dissolving immediately in *aqua regia* and containing no chromium, copper, sulphur or phosphorus: it is presumably an iron-nickel alloy, possibly another form of the tænite; and (3) schreibersite. There was no graphitic carbon, silica or silicate. The tænite and schreibersite were not sufficient in quantity to allow of their quantitative analysis.

Relative to water at 4° C., and allowing for displaced air, the specific gravity at 18¼° C. of two thin slices, together weighing 4·3424 grams, was determined to be 7·837 (uncorrected 7·86).

These two thin slices were dissolved in *aqua regia*, and left an unweighable residue consisting of a few black particles of almost microscopic size in which no chromium could be detected by the blowpipe. After removal of the nitric acid by evaporation to dryness with hydrochloric acid (when no silica was obtained), the material was brought again into solution and divided into five equal portions, which were analysed according to the methods mentioned in a previous paper,[1] except that the iron was precipitated four times instead of twice by sodium acetate before its final precipitation by ammonia. The phosphorus was determined twice, once from a special portion of the solution by the method previously mentioned, and a second time by separation from the ignited iron precipitate by the ammonium sulphide and molybdic methods: the numerical results were virtually identical. The nickel and cobalt were precipitated twice as higher oxides by sodium hydrate and bromine-water, and weighed together in the metallic state. The cobalt was then separated by the nitrite method, and weighed as potassium cobalt sulphate.

The following numbers were obtained for the percentage composition:—

	Caperr, Patagonia.	The Joel iron, Atacama.
Iron	89·87	90·45
Nickel	9·33	8·80
Cobalt	0·53	0·54
Phosphorus	0·24	0·26
Chromium	trace	—
Copper	trace	trace
Sulphur	nil	nil
	99·97	100·05

For the purpose of comparison, the percentage chemical composition of one of the Atacama meteoric irons,[2] to which there is a considerable resemblance of structure, is given in the last column.

This is the first meteorite found in Patagonia, and its latitude is the most southern yet recorded for any meteoric iron. The next in point of southern latitude was the large Australian mass (now in the British Museum), which was found in latitude 38°11′ S., at Cranbourne, near Melbourne.

[1] *Mineralogical Magazine*, 1887, Vol. VII, p. 124.

[2] *Ibid.* 1889, Vol. VIII, p. 263.