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*The meteoric stone seen to fall near Crumlin, Co. Antrim,
on September 13, 1902.¹*

(With Plate III.)

By the late Sir LAZARUS FLETCHER, M.A., LL.D., F.R.S.
Formerly Director of the British Museum (Natural History).

With Chemical Analysis by G. T. PRIOR, M.A., D.Sc., F.R.S.

ON Saturday, September 13, 1902, at 10.30 a.m. (Irish time), a stone coming from the sky struck the earth (lat. $54^{\circ} 38' 20''$ N., long. $6^{\circ} 12' 10''$ W. of Greenwich) at a farm, belonging to Mr. Andrew Walker, situated in the district termed Crosshill, a mile to the north of the village of Crumlin, in which there is a station of the same name on the line of railway between Lisburn and Antrim. The place of fall is $3\frac{1}{2}$ miles east of Lough Neagh, the largest lake in the British Isles, and 12 miles almost due west of Belfast, in which city nearly two thousand members of the British Association were then assembled for the annual meeting (September 10-17).

The fall first became known to people outside the immediate district of Crumlin through unsigned paragraphs which appeared in the Belfast 'Evening Telegraph' of Tuesday, September 16, and the Belfast 'Northern Whig' of the following morning; the news had been sent by

¹ [The author had left the MS. of this paper in a finished state, as here printed, up to the end of the paragraph headed 'specific gravity'.]

Mr. S. R. Millar, who had heard at Killead the noise as of explosion, and had afterwards been to view the fallen stone at Crosshill, where he had been told the particulars of its arrival by Mr. A. Walker himself. On September 20, Mr. W. H. Milligan of Belfast, in his hours of leisure an enthusiastic and skilful observer of luminous meteors, and therefore particularly interested in the bodies which produce them, went to Crumlin to get more precise information than had yet been published relative to the stone and the phenomena connected with its fall. Later, the particulars of the fall reached the present writer, who, having learned through a telegram sent by him to Mr. Milligan that the stone was still in the hands of Mr. Walker, and from the latter that it had not been seen by any one familiar with the characters of such natural objects, left London immediately and arrived at the farmhouse on the morning of September 26. Recognizing at once that the stone was undoubtedly of celestial origin, he acquired it for the British Museum and sailed for Liverpool the same day with the stone in his care. The particulars given at the farm to Mr. Milligan and the present writer, and a preliminary description of the stone, were published immediately afterwards in 'Nature' (October 9, 1902).¹

Mr. Milligan, then residing at Belfast within easy reach of Crumlin, was conveniently placed for continuing the inquiries relative to the circumstances of the fall, and for this purpose published in the Belfast 'Newsletter' (September 26) and the Belfast 'Northern Whig' (October 14) appeals for communication to him of any observations which might throw light on the path of the stone in the earth's atmosphere. He also called attention to the fact that a fall of stone, due to the same meteor, might have occurred elsewhere in the district at the same time; and he addressed special letters of inquiry to railway station-masters and to clergymen in the region concerned. Further, Miss A. Black, living at

¹ [L. Fletcher, Fall of a meteoric stone near Crumlin (Co. Antrim) September 18. 'Nature', London, 1902, vol. 66, pp. 577-579, 2 figs. Another short account written by Sir L. Fletcher appeared in the 'Globe' newspaper, and was reprinted in Geol. Mag., 1902, pp. 521-522.]

[A note of the fall was also given by W. E. Bealey, 'The Crumlin Meteorite', Mem. Brit. Astron. Assoc., 1908, vol. 12, pp. 29-31, being included in the Eleventh Report of the Section for the Observation of Meteors. In this account, which varies slightly in some of the details, the conclusion drawn is: 'A consideration of the mapped places whence the detonation was heard indicates that, as Mr. Milligan remarks, "It would appear that the aërolite entered the denser strata of the atmosphere apparently at a high angle over the centre of Co. Down"'.]

the farm, acted as secretary in this matter for her uncle, Mr. Walker, and forwarded to the writer accounts given by those who were near the spot at the time when the stone fell and by others, farther away, who had heard the noise and afterwards gone to the farmhouse to see and handle, or inquire about, the fallen stone. The information thus obtained has been incorporated in the present paper.

It may be added that no other stone belonging to the fall was ever found.

The fall of the Stone.

The essential particulars of the fall of the stone at Crosshill may be briefly summarized as follows:—At 10.30 a.m. on September 13, 1902, W. Walker, M. Montgomery, and W. John Adams were at work on Mr. Andrew Walker's farm: Walker and Montgomery were stacking hay in the farmyard, the former arranging the hay at the top of the stack, the latter forking it from the ground; Adams was only a few yards from them and was gathering apples beneath a tree near to a hedge which separated the farmyard from the cornfield in which he was himself standing. All of them heard a loud noise, but Walker was the only one of the three to catch sight of anything in the air; the stack being nearly finished, he was high above the ground and exceptionally well placed for getting a good view of the immediate neighbourhood. He states that after the noise he saw something like a 'whirl' come through the air with the speed of lightning and strike the ground at a spot about 30 yards from the stack, the soil being thrown up at once to a considerable distance above the standing corn, then 3 or 4 feet high and ready for the reaper. Adams likewise saw the cloud of dust rising about 20 yards away from where he was at work. He at once ran through the standing corn towards the dust-cloud and found that a hole appeared to have just been made in the ground; it was clear to him that, if any material body had entered, it must have been immediately covered by soil which had fallen over it and have gone to an unknown and perhaps considerable depth. Adams therefore hastened to the farmyard to get a spade, and in less than a quarter of an hour from the instant of fall had dug out a black, dense stone, different in aspect from any of the known stones of the district; it had penetrated the soil about $1\frac{1}{2}$ feet, at which depth further progress had been stopped by an ordinary but much larger stone already in the ground. After the use of the spade, it was impossible for any one to determine later, from examination of the hole, the precise direction in which the stone had entered the earth, and

thus the final direction of its path in the atmosphere, but according to Adams it must have gone vertically downwards. That this was the case, approximately at least, is confirmed by an observation of Mr. Andrew Walker who, immediately after the fall, sought carefully, though without avail, for signs of injury to the standing corn, such as would be expected to have been produced by a dense stone travelling through it at a great speed in a direction inclined to the vertical.

It may be mentioned that a boy about 14 years old, who was 200 yards away, told his father at the time that he had seen a dark body, like a crow, pass through the air into Mr. Walker's field and that a 'mist' (Miss Black) or 'smoke or sparks' (Mr. Milligan) followed in its path. But the line of flight indicated by him, some time after the event, to Mr. Milligan was nearly horizontal and almost from east to west, a direction which seems inconsistent with other observations; the boy was possibly too much confused or frightened at the time to be able to recall afterwards exactly what had happened. Nor would this be surprising, for a neighbouring farmer, working in the fields, was so impressed by the strange noise that he threw away his rake and called out to his men 'All is up now!' meaning that the end of all things was come; and he said afterwards that he had really thought it.

The stone was hot when extracted, and according to Mr. Andrew Walker was still warm to the touch nearly an hour after its fall, for which length of time it had been lying on the window-sill and in the open air. The present writer, remarking the position of the window-sill on which the stone had lain, asked Mr. Walker, who seemed certain of the accuracy of the observation, if the continued warmth might not have been due to directly incident sunshine, but was told that such an explanation was impossible of acceptance for the morning of September 18 had been cloudy.

It was recorded in the account forwarded to 'Nature' that a sulphurous odour had been noticed after the fall. A copy of the published account having been sent by the writer to Mr. Walker for his observations, the niece of the latter, in acknowledging the receipt of it, corrected a misapprehension. It appears that Mr. Walker had intended to convey to the writer the idea, that when the stone was dug out it had, not a sulphurous odour, but a sulphurous look. She added in explanation: 'there were one or two spots of something like sulphur on the stone; the best description I can give of them is that it looked as if a thin mixture of sulphur and water had dried on it'. It was perhaps this appearance that led to the statement in the newspaper account that 'the stone is of a dark metallic colour tinged with gold'.

In answer to an inquiry as to how it came about that the stone was quite clean although it had been buried in the ground, Miss Black wrote that when the stone was dug out scarcely any soil was adherent to it; the little which adhered was on the lower side against which the soil caught between the two stones had been violently pressed, and it was easily removed. The ground was quite dry at the time of the fall and the stone was never washed. Thus neither at the time of the fall nor afterwards had the stone been exposed to the action of water.

No luminous meteor seen.

As fireballs and shooting-stars, produced by the entry of quickly moving celestial matter into the earth's atmosphere, are found to die out when still some miles above the height to which clouds are observed to reach, they are only visible so long as they are travelling across a cloudless part of the sky. In the case of the Crumlin stonefall no luminous meteor is reported to have been seen by any one. That there was no rift in the clouds to make a view of the luminous meteor possible to terrestrial observers is evident from the following reports relative to the state of the sky at 10.30 o'clock on the morning of September 18 :

Crumlin : 'The morning was cloudy'.

Killead : 'The sky at the time was cloudy, with a slight breeze blowing'.

Ardmore : 'The sky appeared dark and inky-coloured, and I concluded we might have some thunder during the day'.

Between Brookmont and Moira : 'There were some very heavy-looking clouds but there was no appearance of rain'.

Loughbrickland : 'The sky was dull, and no thunderclouds, or any clouds, were in sight at the time'.

Sounds heard by observers.

(a) At the place of fall and its immediate neighbourhood.

1. *Crosshill, near Crumlin.*—Adams heard a peculiar rumbling noise followed by a sound like that of escaping steam; he thought it must be due to a boiler-explosion at the mill which is a mile distant to the south and near to Crumlin railway station; the sound preceded the arrival of the stone. Montgomery, on hearing the noise, thought that a train had run off the line; he walked to the hedge about a dozen yards away, looked over it towards the railway to see if any accident had happened, and still had time to walk back to the stack and put up a fork of hay to Walker before the cessation of the sound. Walker himself compared the noises with the hiss and explosion of a rocket.

Mr. James Davison, farmer, who was reaping about 300 yards away and was SSW. of the spot of fall, heard two distinct reports, like quarry blasts or cracks of thunder, followed immediately by a squealing noise overhead; he thinks it lasted 10-20 seconds; the sound seemed to him to come from the south-west. He followed with his eye the changing position of the apparent source of the sound until the sound itself ceased, but failed to see any object in motion; the sound seemed to increase in loudness as it came nearer and to pass away towards Carrickfergus; there was no 'rolling' noise suggestive of the rolling of thunder. About three minutes after the cessation of the sound a blast of wind caused a motion in the neighbouring trees.

Mr. Mackey, farmer, loading hay in a NNE. direction from the spot of fall, likewise noticed the blast, and states that he expected to see the haystacks blown over.

Mr. A. Scott, a friend of Miss Black, after imitating the noise in the presence of a few of those who had heard it, came to the conclusion that it must have lasted about half-a-minute, though the observers themselves think the time was much longer.

Miss Harkness was coming down the road at Crosshill and heard a sound as of something passing overhead; she thought it came from the direction of Lisburn or Divis, the latter being a hill nearly due east of Crumlin.

On the other hand, Mr. Andrew Walker himself, though good of hearing, remarked no sound at all; he had just gone into the farmhouse about 40 yards away from the place of fall. His wife was in the open air, in the lane on the farther side of the farmhouse; she heard a noise which she compared with that made by a swarm of bees, though much louder, and also with that made by a reaping machine; others, she said, had likened it to the quick rattling noise made by a reaping machine which 'has run away'. As the harvest was then in progress in the district, the sound of the reaping machine was a familiar one to the inhabitants.

(b) *Places south of the place of fall.*

2. *Ligoniel* (Co. Antrim).—Mr. A. Walker had been told that the sound was heard at Ligoniel (Legoniel).

3. *Glenavy*.—Mr. Hendron, school teacher, living about 1½ miles above Glenavy, heard a twofold report and then a rumbling noise followed by another report; the sound seemed to come from Lurgan way (Miss Black).

4. *Stoneyford*.—Miss Black says that her cousin living near Stoneyford heard the roar of the stone as it came down.

5. *Brookmount* (three miles from).—A man cutting down wheat in a field about

3 miles above Brookmount and between Brookmount and Moira, heard a number of very loud reports right overhead, the first one louder than the others (Miss Black).

6. *Lisburn*.—Mr. A. Walker had been told that the sound was heard at Lisburn and seemed to be travelling in the direction of Crumlin.

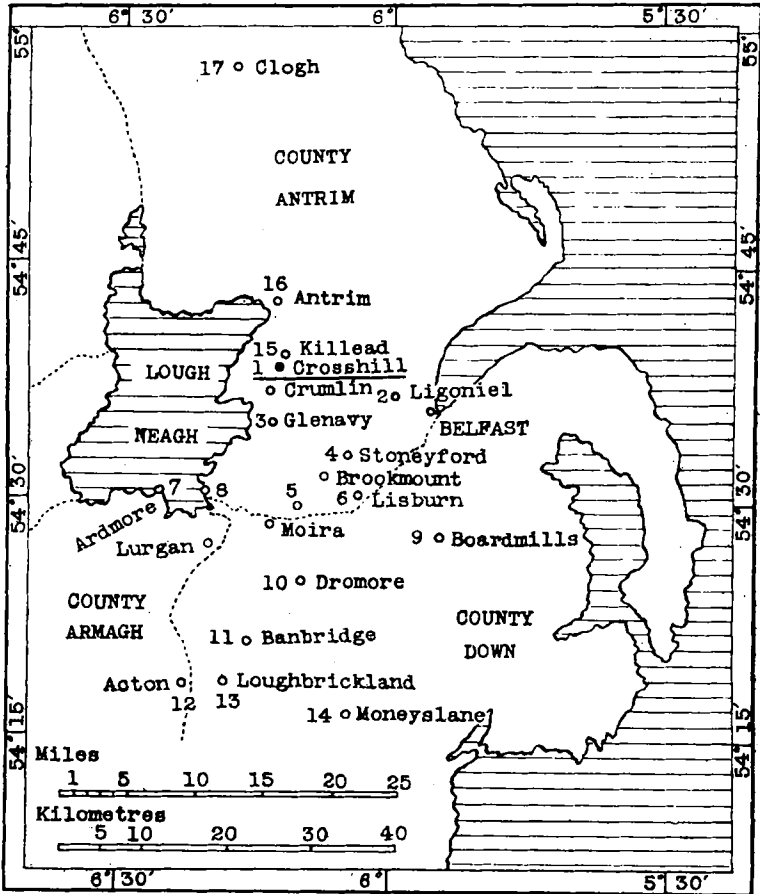


Fig. 1.—Map of the district around Crumlin, marking places at which detonations were heard.

7. *Ardmore* (Co. Armagh).—Mr. R. Jackson, principal teacher at Ardmore National School, writes as follows: 'I heard a sharp sudden report and a rumbling noise that lasted fully 2½ minutes. The noise resembled that of a carriage passing over a wooden pavement. I was standing on an elevated position adjacent to Lough Neagh, and the noise appeared to travel from north to south. Before I heard that a meteoric stone had fallen, I remarked to some person that

I had never heard thunder having such a peculiar noise ; of course I thought it was thunder at the time'.

8. *Lurgan* (four miles north of).—Mr. Robert McClure of Whitehall, Lurgan, is said to have heard a double report, apparently high up ; it seemed to come from a south-east direction ; he was at the Lough side, about 4 miles north of Lurgan (Mr. Milligan).

9. *Carricknaveigh*, near Boardmills (Co. Down).—The Reverend C. H. Waddell, B.D., had been told that some one at Carricknaveigh, near Boardmills, was said to have heard it.

10. *Dromore*.—Miss Black had been told that the sound had been heard at Dromore. The Dromore station-master stated, in a letter to Mr. Milligan, that he himself had not heard it and that he knew of no one who had done so.

11. *Banbridge*.—'It was just like the roar of a cannon, but rattled greatly' (James Mayne). The station-master at Banbridge did not know of any one who had heard the noise.

12. *Acton* (Co. Armagh) [24 miles SSW. of Crosshill].—The Reverend W. F. Johnson, M.A., in a letter to Mr. Milligan says : 'I was in my yard at the time. I heard a loud noise followed by a rumbling sound. I thought that it was thunder, and ran out to see whether the storm was coming my way, so that I might be prepared for it. Of course, when I looked, there was no sign of anything of the kind, and I was consequently very much puzzled to know what was the cause of the noise. People who were working in the fields within half-a-mile of Acton Glebe also heard the same noise and thought a boiler had burst. To all the sound appeared to come from the direction of Banbridge'.

13. *Loughbrickland* (Co. Down).—In a letter from Canon H. W. Lett to Mr. Milligan the following information was given : 'Andrew Bryson, George Bride, junr., and Hamilton Blemings, all resident at Loughbrickland, were reaping oats on the land of Canon Lett. They heard a loud noise of what they thought was a very big blast in a quarry, but as there is no quarry anywhere in the neighbourhood they concluded that a steam-boiler in one of the factories near Banbridge had blown up, as the sound seemed to come from that direction'.

Miss Mary Lett, daughter of Canon Lett, was standing in front of Arghaderg Glebe House, Loughbrickland, and 'heard what she thought was a very loud clap of thunder ; it seemed to be over the house, or somewhat in the direction of Banbridge. She noticed that there was only the one clap, and that it was very loud'.

Mr. A. Campbell in a letter to Canon Lett says : 'the fall was heard by John Alexander Buller and also by his son Sandy, both being together at the time. Sandy asked his father if he heard the peal of thunder. He said it was not thunder but an explosion and probably in the gasworks. Sandy told me that although he called it thunder, it was very unlike it, not coming gradually, but with a loud noise'.

14. *Moneyshane* (Co. Down) [26 miles S. by E. of Crosshill].—Mr. G. Finlay, station-master at Ballyronev, had been told that the sound was heard at Moneyshane ; he had not met any one who had heard it at Ballyronev, two miles away.

(c) *Places north of the place of fall.*

15. *Killead*.—Mr. S. R. Millar, who was at Killead, says : 'At three miles distance (from Crosshill) I heard in the sky, immediately above where the stone fell, three loud reports resembling the discharge of cannon, a low rumbling

noise intervening between the reports. The sounds seemed to travel in a western direction. The part of the sky from which the sounds proceeded appeared (metaphorically speaking) to be in a wild troubled state. The occurrence lasted about three minutes'.

16. *Antrim*.—Mr. A. Walker said that he had been told that the noise had been heard at Antrim: it is possible that he had in his mind only the above statement of Mr. S. R. Millar, who had called to see him and was closely connected with Muckamore, near Antrim.

17. *Clogh* (Co. Antrim) [22 miles N. by W. of Crosshill].—Mr. Robert McKendry, farmer, told Canon Lett during a visit made by the latter to Clogh in the month after the fall, that he had heard a great noise some time before, possibly when the meteorite fell. Later, Canon Lett, who had known him from his birth, wrote to ask for a record of the observation and received the following: 'I heard a noise, as you say I mentioned to you, but paid so little attention to it that I could not tell you even the date or anything else particular: (1) the sound came, as I thought, from Belfast or its vicinity; (2) the sound resembled an enormous blast or explosion; (3) there was a long and loud rumbling sound, as if huge stones had been rolling down a steep place on some hard substance, as for instance the bottom of a quarry; in fact, the whole resembled blasting operations'. Having regard to the uncertainty of the date, and to the distance of Clogh from the other localities, it is possible that the sound heard by Mr. McKendry was independent of the Crumlin fall.

*British Meteorites.*¹

Including that of Crumlin, there are only twelve British meteorites represented by material preserved in collections; of these five have fallen in England, five in Ireland, two in Scotland, and none in Wales. The districts and dates have been as follows:

<i>English Falls.</i>	Wold Cottage, Yorkshire	December 13, 1795.
	Launton, Oxfordshire	February 15, 1830.
	Aldsworth, Gloucestershire	August 4, 1835.
	Rowton, Shropshire	April 20, 1876.
	Middlesbrough, Yorkshire	March 14, 1881.
<i>Irish Falls.</i>	Mooresfort, Tipperary	August, 1810.
	Adare, Limerick	September 10, 1818.
	Killeter, Tyrone	April 29, 1844.
	Dundrum, Tipperary	August 12, 1865.
<i>Scotch Falls.</i>	Crumlin, Antrim	September 13, 1902.
	High Possil, Glasgow	April 5, 1804.
	Perth	May 17, 1830.

In every case except Rowton, the material has been essentially stony in character.

¹ [Since this was written there have been two more falls: a stone of 33 lb. at Appley Bridge, Wigan, Lancashire, on October 13, 1914; and three stones of 22½, 2½, and 2¼ lb. at Strathmore, Perthshire, on December 3, 1917.]

Weight of the Crumlin Stone.

The Crumlin stone weighs 9 lb. 5½ oz. (4239 grams); it is 7½ inches (185 mm.) long, 6½ inches (160 mm.) wide, 3½ inches (84 mm.) thick. Though small, it is the largest stone which has been seen to fall from the sky to the British Isles since the year 1813, and is larger than any which has fallen in England or Scotland since 1795, in which year a stone weighing 56 lb. fell in Yorkshire. The heaviest stone known to have fallen in the British Isles weighs 65 lb.; it fell near the town of Adare in County Limerick in 1813; several other stones fell at the same time, two of them weighing 24 lb. and 17 lb. respectively.

Form ; Surface ; Crust ; Crack.

The form of the Crumlin stone is irregular and distinctly fragmental; there are nine or ten faces, each of them slightly concave or convex; the edges are somewhat rounded. Five of the faces are similar to each other in character, and, except for minute pittings and projecting points, are smooth; they show those large shallow concavities which are common on meteoric stones, and have been likened in shape to 'thumb-marks'; the remaining faces are different from the others in aspect and have a low ridge-and-furrow development.

The stone is covered with a crust formed during the flight through the air. The crust is in parts black, in parts brown, the latter colour being perhaps a result of the action of the soil into which the stone penetrated; it is generally dull, but here and there lustrous; in one part it is iridescent in purple, blue, and pink colours. On the smoother faces already referred to, it is uniform in aspect, and where broken is seen to be in places 0.5 mm. thick, the greatest observed thickness being 1 mm.; that on the faces which have a ridge-and-furrow development is different in aspect and seems to be much thinner. A fresh surface of fracture is quite light in colour. From these characters it is inferred that the meteorite broke up in an early part of its course through the atmosphere, at a time when the speed was still so enormous that the heat produced by the compression of the air in front of the quickly moving stone was sufficient to scorch completely and form a crust on the newly broken ridge-and-furrow surfaces.

Small portions of the crust are missing here and there, and the fresh-looking interior is then visible; at first the breakages were thought to be results of injury after the stone had struck the ground, but on close examination it becomes manifest that the bits of crust must have flaked off during the flight of the stone through the air; for on several of the

fresh-looking surfaces there is a reticulated black material which has been in a fused state and occasionally has formed a spherical drop, 0.25 mm. in diameter.

Here and there, bright particles of metal (nickel-iron) interrupt the continuity of the dark crust. On one of the surfaces of latest fracture there is visible a section of a large flat nodule of troilite, the bronze-coloured protosulphide of iron; the section is 13 mm. long and its greatest width is 3 mm.

A crack extending nearly halfway through the meteorite at a distance of an inch from an outer face was probably caused by the impact on the larger stone met with in the soil; the crack, where it comes to the surface, is a millimeter wide.

Magnetic Constituent.

The stone contains a distinctly magnetic constituent (nickel-iron), for when brought near a compass-needle it affects the position of the latter perceptibly, though not to a great extent.

Photography ; Modelling ; Cutting.

It being desirable to have a record of the size, shape, and general aspect of the fallen stone, the latter was photographed and modelled before being cut. To prevent injury being caused to the stone by the action of water during the making of the mould, the part being moulded was protected by a layer of thin tissue paper; against this moist clay was closely pressed, the clay being finally backed up with plaster of Paris. After the mould had been made, the stone was cut with a hack-saw worked by hand, no water or lubricant being used; owing to the great hardness of the crust there was some difficulty in making a start with the cutting. When the saw was halfway through the stone, a vein was reached which extended to the outside of the stone; thereupon part of the material broke off at the vein; each of the two surfaces of fracture was seen to be covered with a black material, polished and striated as if slipping under pressure.

Specific gravity.

The specific gravity was determined for a partly encrusted fragment (all the fragments were very similar to each other) weighing 28.3502 grams. The air was expelled from the pores by boiling the distilled water in which the fragment was immersed. Daily corrected for displaced air, the weight of a cubic centimeter at 16° C. is 3.558 grams.

It was desirable to determine the specific gravity of the whole stone, if this could be done without immersion of the stone in water. It may therefore be recorded that one of the models, apparently a very exact one, was weighted with shot, varnished to make it impervious, and then weighed in water. The loss of weight, 1816 grams, corresponds to a specific gravity of 3.22, which is less than that of the stony part of meteorites; it is therefore clear that the volume of the model is too much in excess of that of the original for the indirect method of determination of the specific gravity to have any value at all.

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Chemical Composition and Microscopic Characters. (G.T.P.)

Soon after the meteorite had been secured for the British Museum collection Sir Lazarus Fletcher began its chemical analysis, and had made considerable progress when illness supervened and prevented him from bringing it to a successful conclusion. The description of the stone was therefore indefinitely postponed, and eventually the writer was asked by him to make an independent analysis.

Sir Lazarus Fletcher had determined the composition of the soluble silicate as follows under I, and towards the bulk-analysis had obtained the results given under II.

I (Soluble silicate).	II (Bulk-analysis).
SiO ₂ ... 89.39	SiO ₂ ... 40.28
Al ₂ O ₃ ... 0.20	Al ₂ O ₃ + FeO + Cr ₂ O ₃ 16.02
FeO ... 21.32	MnO ... 0.81
MnO ... 0.33	MgO ... 26.16
MgO ... 37.05	CaO ... 2.16
CaO ... 1.43	Na ₂ O ... 0.98
	K ₂ O ... 0.06
	P ₂ O ₅ ... 0.15
	Fe + (Ni, Co) ... 9.14
	FeS ... 4.86
	Cu ... trace
99.72	100.07

The composition of the soluble silicate corresponds to an olivine having approximately the formula $3Mg_2SiO_4 \cdot Fe_2SiO_4$.

The results obtained by the writer, employing the methods of analysis described in previous papers on about 14 grams of the meteorite separated by the magnet into 1.7993 gram of attracted and 11.9863 of unattracted, are as follows:

	Attracted.		Unattracted.		Bulk-analysis.
{ Fe ...	57.86	...	(0.19)	...	7.75
{ Ni ...	8.54	...	0.03	...	1.15
{ Co ...	0.59	...	—	...	0.08
{ Fe ...	1.03	...	(8.61)	...	3.34
{ S ...	0.59	...	2.06	...	1.91
SiO ₂ ...	6.24	...	44.89	...	40.73
TiO ₂ ...	—	...	0.19	...	0.17
Al ₂ O ₃ ...	—	...	2.41	...	2.14
Cr ₂ O ₃ ...	—	...	0.68	...	0.60
FeO ...	(8.74)	...	14.84	...	13.24
MnO ...	—	...	0.80	...	0.27
CaO ...	0.46	...	2.23	...	2.04
MgO ...	6.09	...	27.63	...	25.86
Na ₂ O ...	—	...	1.21	...	1.07
K ₂ O ...	—	...	0.13	...	0.11
P ₂ O ₅ ...	—	...	0.29	...	0.26
Insoluble ...	15.86	...	—	...	—
	<hr/>		<hr/>		<hr/>
	100.50		100.19		100.22

The approximate mineral composition of the meteorite deduced from these results and making use of the known composition of the soluble silicate ($\text{MgO} : \text{FeO} = 3$) is as follows :

NaAlSi ₃ O ₈ ...	9.06	}	...	10.38	...	Felspar.
KAlSi ₃ O ₈ ...	0.56					
CaAl ₂ Si ₂ O ₈ ...	0.76					
FeO.Cr ₂ O ₃ ...	...	...	...	0.87	...	Chromite.
FeO.TiO ₂ ...	...	...	...	0.32	...	Ilmenite ?
3 Ca ₃ P ₂ O ₈ .CaO ...	...	...	...	0.59	...	Apatite ?
CaSiO ₃ ...	3.24	}	...	30.15	}	Pyroxene
FeSiO ₂ ...	5.64					
MgSiO ₃ ...	21.27					
Fe ₂ SiO ₄ ...	14.22	}	...	43.67	...	Olivine
Mg ₂ SiO ₄ ...	29.45					
Fe ...	7.75	}	...	8.98	}	Nickel-Iron
Ni ...	1.15					
Co ...	0.08					
Fe ...	3.34	}	...	5.25	...	Troilite.
S ...	1.91					
				<hr/>		
				100.21		

Examination of thin sections under the microscope shows that the meteorite is a chondrite, similar to Homestead (Amana) and Chandakapur. Chondrules are numerous and of varied type but often ill-defined and merging into the matrix. Perhaps the most common are polysomatic olivine chondrules in which sharply defined crystals of olivine occur in a grey matrix consisting of fibres of pyroxene, some giving

straight but others oblique extinction as high as 80° and over. Fibrous and grated pyroxene chondrules are also frequent, in some cases with fibres and bars at varying angles. Small patches occur of colourless material having a low double-refraction but refraction much higher than that of the Canada balsam and comparable with that of the pyroxenes: they show cleavages inclined at about 60° , and are presumably to be referred to merrillite.¹ Occasionally, grains of what appear to be the same material with refraction greater than Canada balsam are practically isotropic. Colourless, doubly-refracting material having a refraction about that of the Canada balsam and thus presumably a felspar near to oligoclase, is seen in some of the pyroxene chondrules: a few better defined chondrules consist mainly of this felspar with only one or two porphyritic crystals of pyroxene.

The result of the chemical and microscopic investigation shows that the Crumlin meteorite may be classed as a grey hypersthene- (to bronzite-) chondrite containing about 9 per cent. of nickel-iron in which the ratio of iron to nickel is about 7.

¹ G. P. Merrill, Proc. Nat. Acad. Sci. U.S.A., 1915, vol. 1, p. 302; Amer. Journ. Sci., 1917, vol. 43, p. 322; and E. T. Wherry, Amer. Min., 1917, vol. 2, p. 119. See Min. Abstr., vol. 1, p. 41.

EXPLANATION OF PLATE III.

Meteoric Stone weighing 9 lb. 5½ oz. (4239 grams) which fell at Crumlin, Co. Antrim, on September 13, 1902. Reduced to about one-half the natural size.

FIG. 1.—View showing the smoother faces, the concavities ('thumb-marks'), and the crack probably caused when the meteorite struck a still larger, terrestrial stone buried in the soil.

FIG. 2.—View showing the two dominant kinds of surface. The face on the right was probably produced by the breakage of the meteorite at an early part of its journey through the earth's atmosphere.



FIG. 1

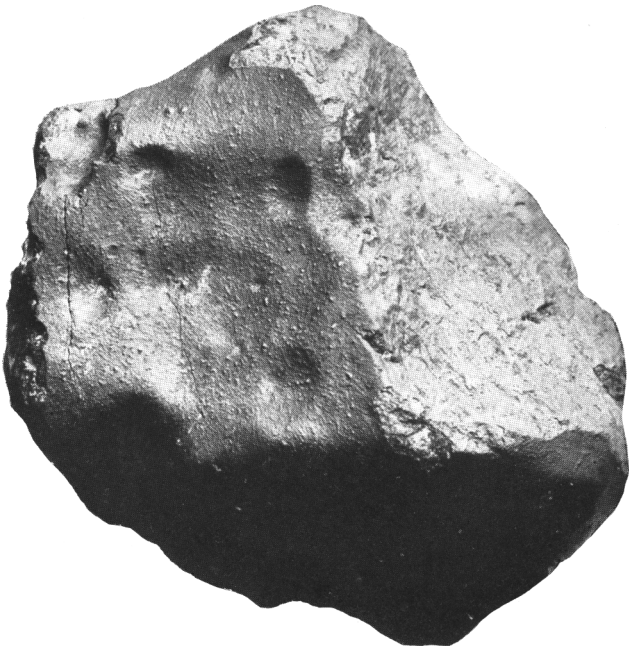


FIG. 2