THE METEOR CRATERS IN HÉRAULT, FRANCE

By C. Luplau Janssen

IN the following I shall try to give some information of a crater field, which has recently been discovered in southern France. The discovery was first announced by Mrs. Bernard Gèze and André Cailleux in the *Comptes rendus* of the Paris Academy in April 1950. Having read this notice, I resolved to visit these craters in connection with a stay at the Observatory of Pic-du-Midi in September 1950. It is only a few hours by train from Bagnères-de-Bigorre, near Pic-du-Midi, to Béziers, which is situated near the crater field in question, in a region with a rather dense population and easily reached by rail and motor. In view of the great interest which formations of this kind have aroused, I should think that a little more detailed description, as a supplement to the discoverers' report, should be of interest. The following account is based on the description given in the article published by the discoverers and on my own observations. Curiously enough the Cabrerolles Crater presents some similarity to a very well-known lunar crater, a circumstance which has not been commented upon by the two French discoverers.

It is worth while to remark, as has also been pointed out by the discoverers, that these craters were first detected through an examination of some aerial photographs of the region in question, by the stereoscopic method. We remember that the Chubb Crater, investigated by V. B. Meen, was first discovered on aerial photographs. Thus, we must be aware of the high importance of aerial surveys of the terrestrial surface when we are searching for phenomena of this kind. This line must be followed closely in the future.

As we cannot suppose that the general character of the region in question is generally known, some introduction should be given. Our crater field is situated in the department Hérault, which is in southern France; it takes its name from the river Hérault, which, coming from the "montagne noire", flows into the Mediterranean Sea. The south-eastern part of Hérault is a part of the Languedoc plain, while the north-western half is occupied by the south-eastern

slope of the "montagne noire", which is connected with Auvergne. The capital of Hérault is the well-known university town of Montpellier; Béziers is another large town. The coastal plain as well as the slopes of the mountains are very fertile and completely covered by vineyards, a very great part of the wine consumed in France being produced here. The trunk line through Toulouse, Narbonne, Sète, Nîmes and Marseilles runs through Hérault. A secondary line starts from Béziers and runs to Bédarrieux, an industrial town producing cloth, linen and leather. A visitor to the crater field, which is situated in the villages of Faugères and Cabrerolles, should make his headquarters in the last named town where cars may be hired. The nearest railway station to the craters is Faugères on the line Béziers-Bédarrieux, but in Faugères no hotel accommodation is available and no cars can be hired. Naturally it is quite possible to reach Faugères by train and visit the craters on foot, but, as the terrain at some places is rather difficult, the walk is rather tiresome, especially in hot weather, and we think it better to cover the small distances (Bédarrieux, Faugères, Cabrerolles—15 km.) by means of a car hired in Bédarrieux. Cars may also be hired in Béziers, but here the distance is longer, approximately 45 km. Faugères is at an altitude of 258 metres above sea level, while Cabrerolles is situated roughly 50 metres higher. At once it must seem very unlikely that prehistoric craters should have been well preserved in a so intensively cultivated region, and this calls for an explanation. Actually we find the craters in a countryside just in the zone between the plain and the mountains. Here the mountains send long rocky "peninsulas" out in the plain. These rocky plateaus are not cultivated at all, their surfaces are left quite in their natural state, while the valleys between them are very fertile and well cultivated. The author is not a geologist, but even a very superficial geological experience allows him to state that great erosion has taken place in this country; further it is also evident that the rocks here belong to the pliocene age; we are dealing with schists. It is obvious that the rocky surfaces have been heavily attacked by air and water; the rocky "peninsulas" do not exhibit great irregularities. The French discoverers point out that we are dealing with a series of craters arranged on a line 5 to 6 km. long. The main crater, which is called "Le Clot", is

at the western end of a strip running from south-south-west towards north-north-west, on which one large crater and some small ones, especially in the neighbourhood of the village of Faugères, are arranged. I think that it will be wise to give here a translation of the very short French article published by the two French discoverers in *Comptes rendus de l'académie des sciences*, Paris, April 24, 1950, omitting the summary, which precedes it and some few lines at the end:

We know that craters which may be considered produced by the impact of great meteorites are rather seldom met with in terrestrial topography. Only eight cases are known.* But some depressions found by one of us near the eastern extremity of the slopes of the Black Mountains, seem to be of meteoric origin. The depression at Cabrerolles, called "Le Clot", to which our attention was first drawn through the examination of some aerial photographs, is situated approximately one km. to the south-south-east of the village and presents itself as a hole in the schists. It interrupts small ravines from the quaternary age, and its depth is approximately 50 metres, and it penetrates into the eroded soil, which probably is pliocene. It is quite circular with a diameter of 200 to 300 metres at the upper rim, while the diameter of the flat bottom is roughly 100 to 110 metres. The inner slopes are very steep, partly covered with broken stones (coarse gravel). Five km. from here to the east-north-east (300 metres from the railway station of Faugères) we find a similar crater, although smaller (diameter at the upper rim 50 to 60 metres, maximum depth 23 metres). This crater has been hollowed out of the schists, having penetrated the pliocene surface just at the upper edge of a deep quaternary ravine. Other similar depressions are also found in the immediate neighbourhood, two of them being situated just to the west of the village of Faugères (diameters: 45 to 50 metres and 50 to 65 metres, depths 28 metres and 20 metres), and one more to the north-east of the same village (diameter 45 to 50 metres, maximum depth 9 metres) and one or perhaps two 1400 metres to the north-north-east of the same village (the most certain one has a diameter of 15 metres and a depth of 5 metres), but as they are holes in the same strata of Devonian limestone, we cannot *a priori* exclude a karstic origin.

Several reasons support the supposition of the meteoric origin of these craters:

1. For the two first quoted craters a karstic origin is impossible, as they are hollowed out in pure silico-aluminous rocks and at distances of 600 to 1000 metres from the nearest limestone rocks, reckoned horizontally as well as vertically.

2. A very pronounced magnetic anomaly is found in the interior of the Cabrerolles crater and in its vicinity, the magnetic declination here attaining a value of 10°. . . . . .

These are the facts pointed out by the two French surveyors, and from this alone we may draw conclusions in favour of a meteoric

*It seems that the two authors do not know all the craters discovered up to the present. *L.J.*

origin. We are now going to supplement these short remarks with our own observations made in September 1950.

We started by rail from Béziers and got off at Faugères, which consists of a small group of houses along the side of the main road from Bédarrieux to Béziers and a rather large winery, the property of Mr. Noël Salles. The first thing to be done was to find the crater, which should be within 300 metres from the railway station. Therefore we asked the station-master for information. He seemed at first to know nothing of it. He had lived there for many years and he had never heard of holes of that kind, nor of any explorers. At last, as we asked if there were no holes at all in the vicinity, he burst out: "It must be the valley in which I collect mushrooms." We had, he said, only to climb the steep slope behind the village in order to reach it. We followed his directions and forced our way through a rather complicated scrub covering the slope of a very beautiful rocky hill. Although its height was only 100 metres or so, it was a rather troublesome ascent, but at last we reached the upper rim and were standing at the edge of a vast vineyard, but we could see nothing but vines and scrub. As we were just in the midst of the wine season, there were many people in the fields collecting the ripe grapes. We asked the nearest man and to our astonishment he answered at once: "It is just there behind those trees," pointing out some bushes 100 metres away. We hurried to the indicated place and suddenly we stood at the upper edge of a deep circular hole with very steep interior slopes. The sight was very remarkable as the hole is situated on the very slope itself in such a way that the uppermost point of the edge of the hole touched the horizontal line marking the upper edge of the slope, the plane of the rim of the crater having almost the same inclination as the slope. We found, that the dimensions of the crater were in full accord with those given by our French colleagues. The inner slopes were very steep (the inclination was 45° or so) and partly covered with scrub, but at many places the rock was visible, that is the slopes were covered with a number of large stones and very coarse gravel or stone bits. The bottom of the crater was flat and horizontal, some rather high trees were standing there and their tops were almost in the horizontal plane of the plateau above the slope. Much of the coarse gravel was also noticed in every uncultivated place in the vicinity of the crater, and many of these small

stones were of a kind of limestone much resembling marble-stone. This mineral did not seem to belong to the surface of the rock but to some thin stratum deep in the ground. I believe I saw such strata in both craters, but, as I am no geologist, this observation must be accepted with reservation. If it is correct it gives very strong support to the supposition of the meteoric origin of these craters. The white stone bits must have been ejected from the bottom of the hole. Naturally all the stones have been removed from the cultivated areas, we are here in an intensively cultivated region, where human activity has produced many disturbances, but the slope on which this crater is situated is not cultivated at all.

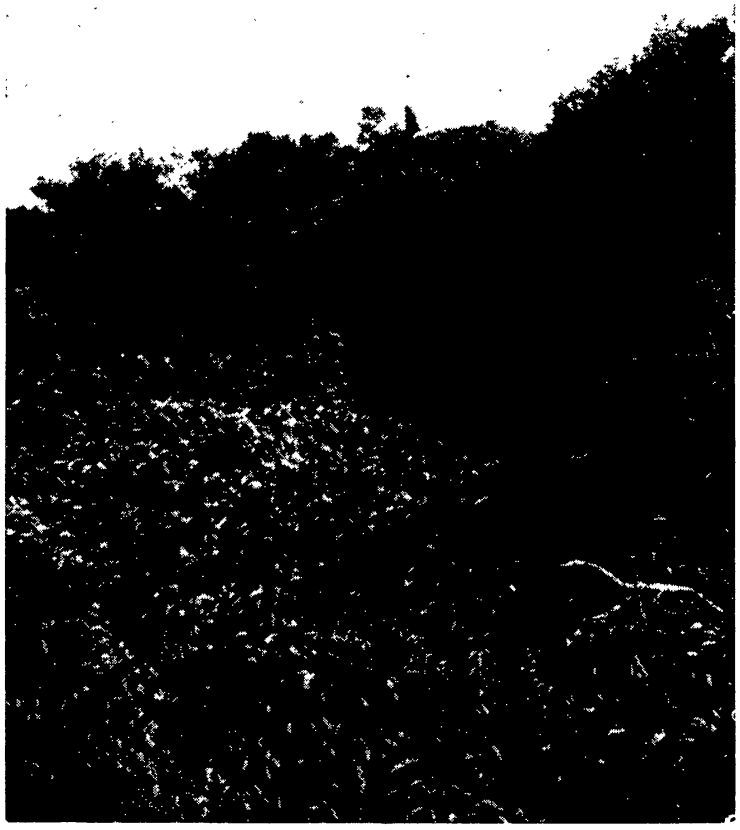

FIG. 1.—The Faugères Crater from the lower part of the rim.

Figure 1 is a view of the crater from the lower rim. The steepness of the inner slope is clearly shown, the high trees at the left are standing on the bottom of the hole. The dimensions are easily estimated when we use the height of Mrs. Luplau Janssen, who is standing at the upper rim, as a scale. The form of the crater is quite circular and the conditions of the slope bear testimony of a violent explosion. There cannot be the least doubt of the meteoric nature of this crater.

The view of this crater was very impressive, but it was nothing in comparison with that of the Cabrerolles crater, "Le Clot", which we visited later on the same day. As there is no hotel accommodation in Faugères, we had to finish our research in one day. After some adventures we reached Cabrerolles by car and located Mr. Jerôme Carattié, the owner of the land on which "Le Clot" is located. He knew nothing of the origin of the formation, but he drove us there, a distance of one km. from the village along the road to the west of the narrow Cabrerolles valley. He led us on foot up a sandy path along which some small bushes and low plants barely covered the rocky surface. After a walk of about 500 metres we suddenly stopped on the elevated rim of an astonishing hole in the plateau. We had reached the aim of our search. The crater was quite circular and the slopes seemed still steeper than in the case of the Faugères crater. The consistency of the soil was identically the same in both craters. The slopes presented some few blocks of stone and an enormous quantity of gravel. The dimensions were found to correspond exactly to those given by the French surveyors.

The depth from the rim is about 60 metres and the tops of some high trees standing on the bottom of the crater are considerably below the top of the rim. At places the inclination of the inner slope was nearly 60°. Also here the condition of the materials showed traces of a formidable explosion, and here again many bits of white limestone were lying on the ground. The rim was elevated some metres above the level of the plateau on which this crater is situated.

The bottom of the crater is flat, and here Mr. Carattié has arranged a small vineyard and garden. Figure 2 is a photograph of the bottom and of the inner slope. The proportion of the height

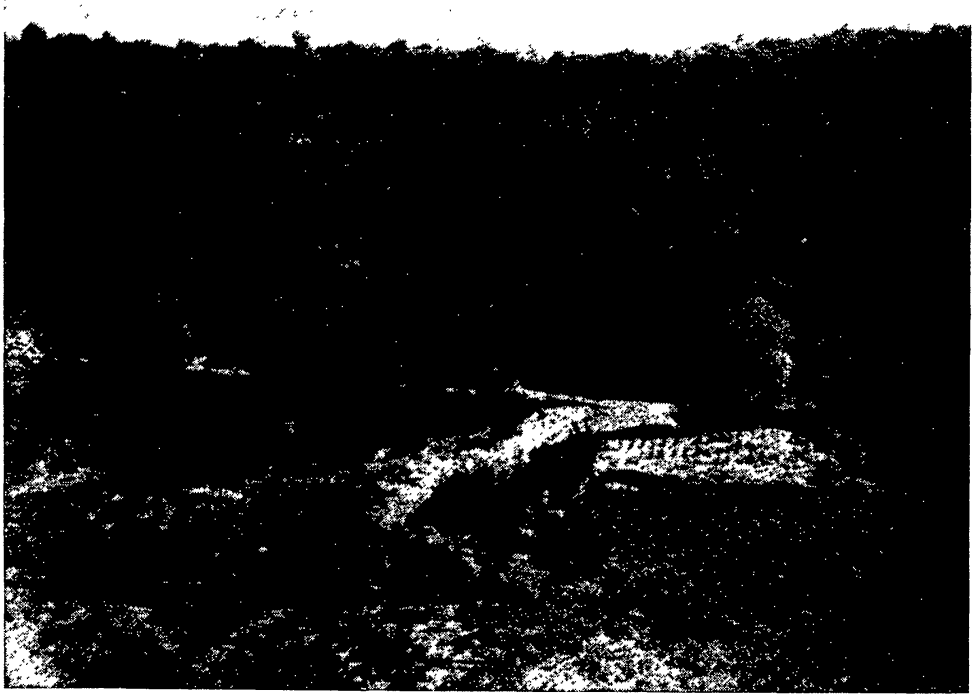

FIG. 2.—The interior of the Cambrerolles Crater.

of the trees to the height of the slope gives a fairly good impression of the size of the crater.

As we have already said, the crater is circular, presenting an elevated rim, but a closer examination of the latter reveals a very remarkable thing. The rim has some depressions, two of them being rather distinct. If we examine the surroundings we find that the crater overlies one or possibly two ravines torn out of the plateau on which "Le Clot" is situated. This leads us directly to the well known case of the Hyginus ridge on the moon where we also find a crater overlying a ravine. Just as in the case of the Cabrerolles crater the ravine is older than the crater, which completely interrupts it. Obviously, as the French geologists also say, the ravine at Cabrerolles is from the quaternary age, and this tells us that the crater is, astronomically, a recent formation; it should not be older than 10,000 years.

Figure 3 presents a contour map showing the interrupted ravines and also a cross section showing the present surface and the supposed former surface.

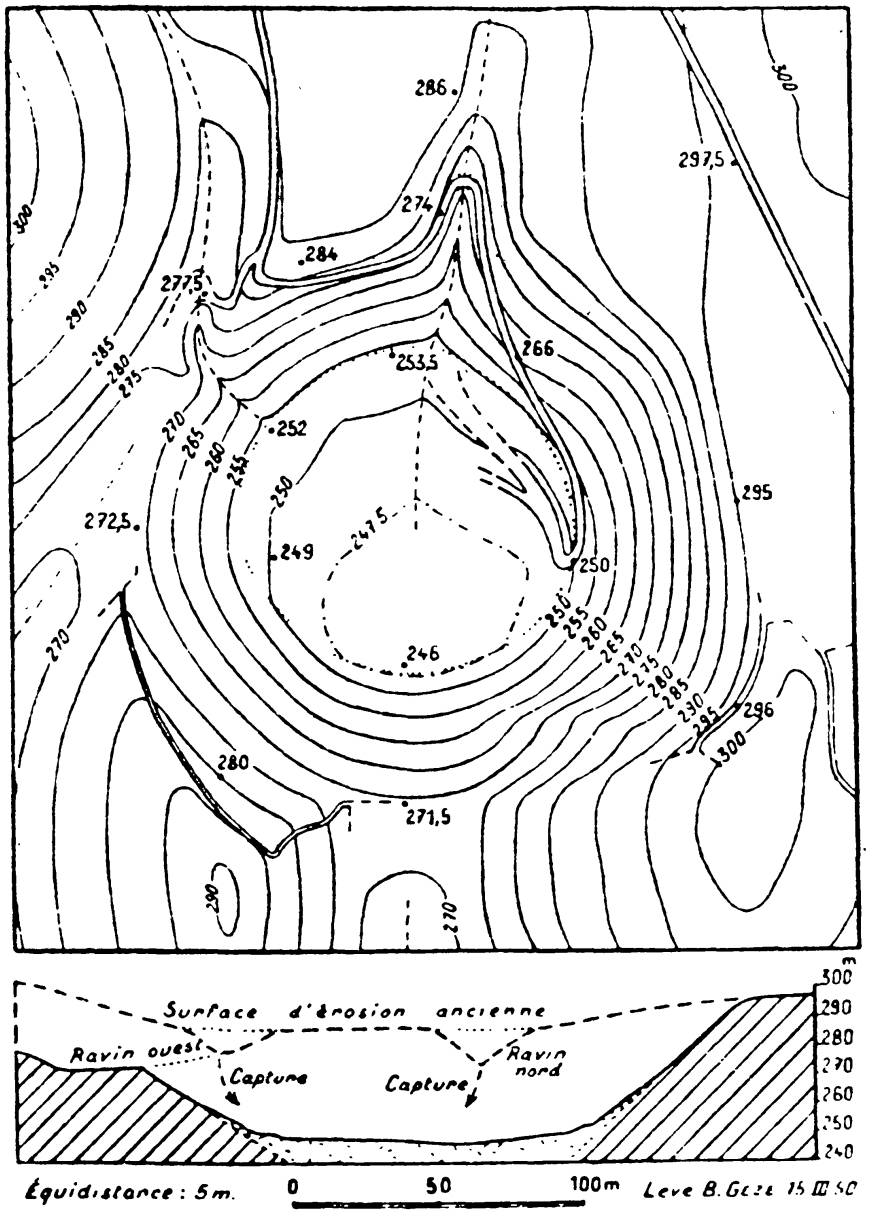

FIG. 3.—Map and cross section of "Le Clot", from "Comptes rendus de l'Ac. d. Sc.", Paris, 1950, p. 1535. Heights in metres above sea level.

We must confess that "Le Clot" to some extent is covered by vegetation, but it is easily seen that if the vegetation was removed, there would be a very close resemblance to the most typical meteor craters known. It is not easy to evaluate the significance of the strong magnetic anomalies observed. It may be that some iron

mass is hidden below the ground. The high magnetic declination is limited to the crater and its immediate surroundings, and this might give us some hints in this direction. I have not the least doubt that we are here dealing with a meteor crater.

As the ages of the two craters mentioned here seem to be of the same order, it is reasonable to ascribe them to fragments from one single meteorite. If this is right we may also think that the other and less important craters in the region are also meteoric and produced on the same occasion. Further examination of these remarkable formations will surely lead to interesting results.

The craters are well preserved in spite of the intensive cultivation of the soil. Nobody in the region had the least suspicion of the origin of these holes and everyone was very astonished to learn that "Le Clot" was a marvel of nature. I suggest that the two areas in question should be laid out as national parks and put under real protection on the part of the French State. Really, "Le Clot" is one of the greatest known meteor craters in the world, fourth in diameter to the Chubb crater, the Arizona crater and the Wolf Creek crater. In one respect this crater surpasses all the others, it is placed in a very beautiful spot, the immediate surroundings are very attractive; looking towards the north we may admire the fine Black Mountains, towards the east and towards the west we see the pleasant slopes of the mountains towards the coastal plain, and if we direct our eyes towards the south we see the Mediterranean as a bright blue band on the horizon, across the fertile coastal land. Above our heads we see the deep blue sky of southern France. It is a most lovely place. We were loath to leave.

For an astronomer the visit to the Cabrerolles craters was a very interesting experience, and I should recommend every astronomer interested in these things to go to see them, they are the most easily accessible terrestrial "lunar-craters" of all.

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