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THIN MAGNETITE PLATES OF CARBONACEOUS METEORITES FROM ALAIS, IVUNA AND ORGUEIL

by

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SUMMARY

Magnetite crystals of strongly asymmetrical shape, theoretically predicted by Donn and Sears, have been observed in three carbonaceous meteorites of type I (Original Summary).

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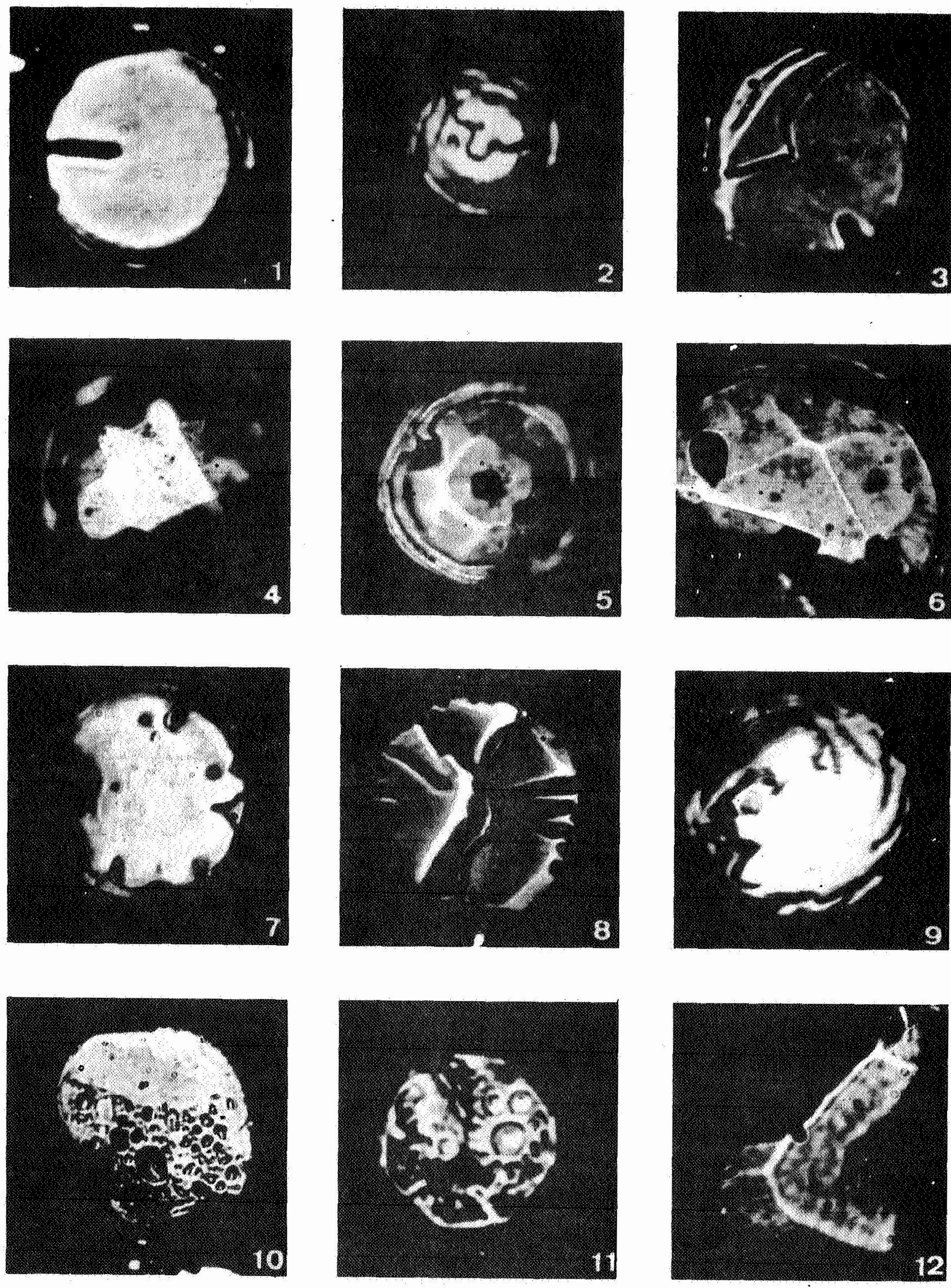
* *

It was stated on many occasions that carbonaceous meteorites, and more particularly those of Wilk's type I [1], constitute cosmic material least differentiated of all currently accessible to direct observation [2, 3].

On the other hand, it has been theoretically demonstrated that the first particles to condense in the solar system must have offered not spherical, but much rather very asymmetrical shapes, ideally represented by slabs and whiskers, as a result of spiral growth in oversaturated medium [4,5].

It could thus be that some of the most stable minerals of carbonaceous meteorites, of the most primitive kind, have preserved in their present-day morphology traces of the conditions that have prevailed at their origin and growth. The confirmation of this hypothesis would be all the more interesting as a morphological discrimination could serve as a basis for the chemical study of the different stages of condensation and agglomeration of meteoritic material [6].

(*) LA MAGNETITE EN PLAQUETTES DES METEORITES CARBONEES D'ALAIS, IVUNA ET ORGUEIL.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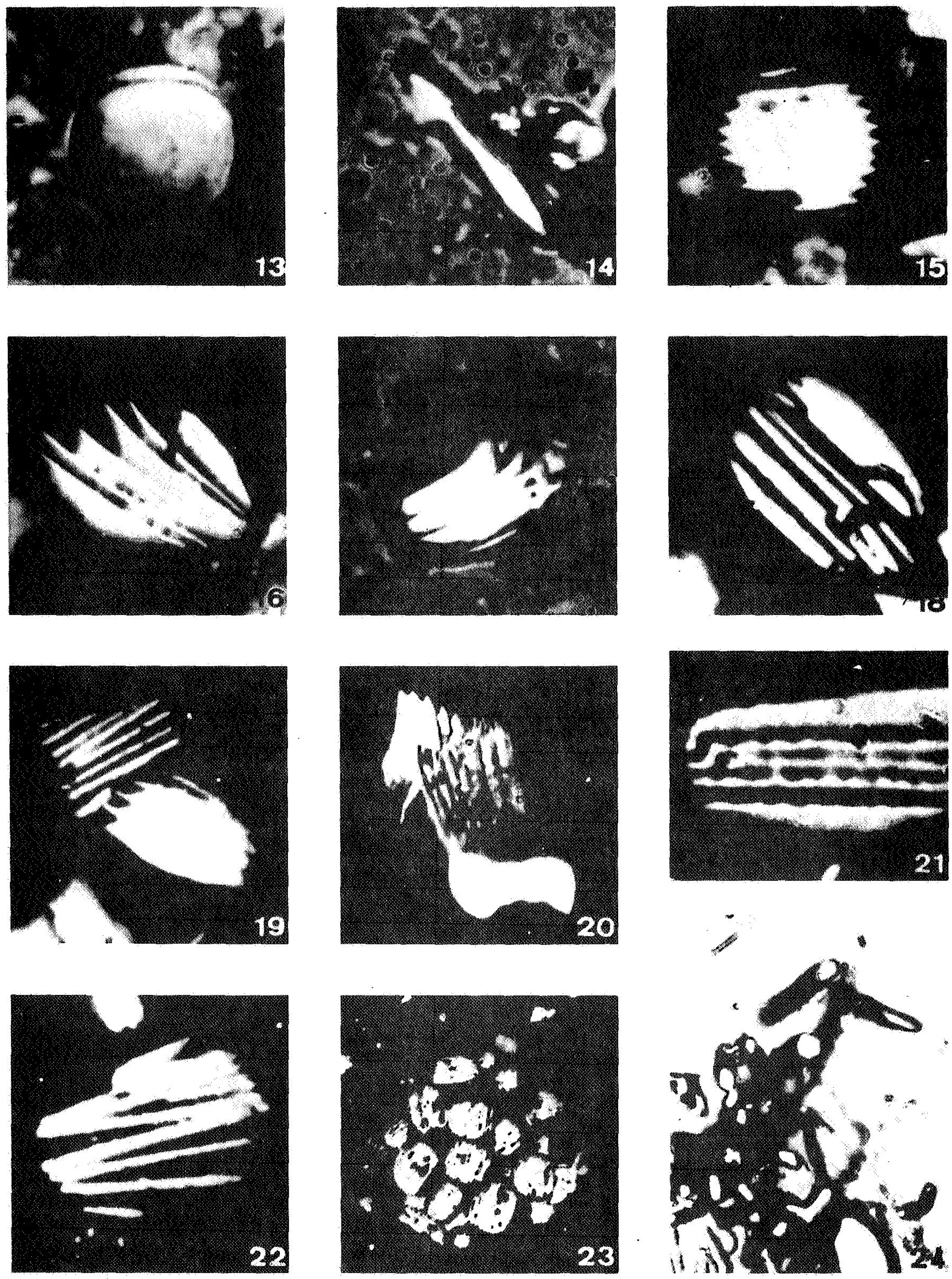
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CAPTIONS

PLATE No.1, page 2.- All particles show their original surface, except photos 9 and 10, where they are partially polished.

1. IVUNA, x 5150 R	5. ORGUEIL, x 1800	9. ORGUEIL, x2600 R
2. IVUNA, x 3500 R	6. ALAIS, x 1500 R + T	10. IVUNA , x 2100 R
3. IVUNA, x 3500 R	7. IVUNA, x 2300 R + T	11. IVUNA, X 3500 R + T
4. IVUNA, x 1800 R + T	8. IVUNA, x 2300 R	12. IVUNA, x 3100 R

PLATE No.2, page 3. All particles are polished, except 13 and 20.

13. IVUNA, x 3100 R + T	17. ORGUEIL, x 2400 R + T.	21. IVUNA, x6200 R
14. IVUNA x 1500 R + T	18. IVUNA, x 2 00 R	22. IVUNA, x3300 R
15. IVUNA, x 3300 R + T	19. ORGUEIL x 3400 R + T.	23. IVUNA, x1000 R
16. IVUNA, x 2600 R + T	20. ORGUEIL, x 2400 R	24. ALAIS, x1650 R + T

We undertook the examination of the morphology of type-I meteoritic particles precisely with this in view, remembering that this material is probably not entirely primary [7], and that the observed morphology may actually be the resultant of several effects, including artefacts.

At the outset we turned our attention toward magnetite, for it is indeed exceptionally abundant in type-I meteorites, relatively stable and easy to recognize and distinguish from the amorphous matrix. Various facies have already been described among the Orgueil material; these facies would correspond eventually to different epochs of formation [6, 8, 9, 15]. It could have been formed at the very earliest stages of proto-planetary condensation with hydroearbons and ice [10]. Finally it is probably abundant among solid particles of comets [11], meteors [12, 21], micrometeorites [13] and cosmic dust [14].

Thin coats of the named meteorites were prepared by embedding into a synthetic transparent rubber and polishing into a layer of a few microns. It was thus possible to observe in microscopic transparency and reflection opaque particles, polished in surface or in suspension.

Very asymmetric magnetite particles were effectively found in abundance in the three type-I meteorites available to us. These particles could be visible only at very great magnification; the generality of the phenomenon is evident only after a systematic investigation of relatively extended surfaces. We shall describe here the most prominent traits, recalling that the asymmetrical facies are eventually found alongside the already described symmetrical shapes [6 - 9, 15]: spheres, spherolites, hollow spheres, groups of small spheres and isometric crystals.

We shall designate as asymmetric facies all those that depart from the sphere and from isometric shapes of the class Oh-m3m. These facies include some principal shapes and associations which we empirically classified according the contingencies of preparation and observation: 1) isolated slabs of generally circular shape; 2) slabs of irregular contour, concave, probably derived from the former by corrosion; 3) regular piles in regular or irregular slabs; 4) whiskers of ci ular, elliptical or angular section (photo 24). For this and the following, refer to Plates 1 and 2.

Platelets(slabs) are either very frequent or piled up, while whiskers are very rare. This difference obviously cannot yet be interpreted in genetic terms, but one may recall that the conditions of artificial formation of these two facies are identical [16].

<u>ISOLATED PLATELETS(SLABS)</u>. It is probable that the bulk of these pla elets are the result of disintegration by the polish of the described groups in the following. The simplest shapes, which are also the smallest (from 2 to 5 μ) are fundamentally constituted of a circular disk with a smooth and plane face.

Curves of diameter frequencies have been plotted for the three meteorites: the distributions are sensibly longnormal.

Morphological complications are frequent:

a) Circular "chamfers", either continuous or feebly angular (ph. 1, 8, 13).

b) Crystalline faces: combination of steep "hilly" face with quite lower pyramides, belonging to one or two families. The former may be missing (ph.4-6).

c) incomplete plates, eventually with umbilicus (photos 2, 3, 8]. These faces suggest a shelf gradation linked with the spirals, but the observation technique utilized did not allow us as yet to make evident the presence of authentic spirals, which, however, may be presumed to exist (curvilinear edge of photo 3, helix of photo 9) [19].

d) shapes of corrosion: rectilinear centripetal concavities often affect the faces and edges of plates (photos 1, 3, 5, 6, 8, 10 - 12). At times they show a relationship with symmetry (photos 5, 7).

GROUPS OF PLATELETS. By a mere frontal look one may already feel that the isolated plates are associated with identical shapes of larger diameters (photos 1, 2, 5, 6, 9). The existence of a large number of spherical or elliptical agglomerations of platelets (or slabs) confirms both the presence of platelets having a certain individuality and their regulated growth. Isolated platelets and the spherical groupings are identical objects, observed at different angles. Looking laterally, one recognizes the morphological details described above with a few more precisions:

a) "chamfers" may be simple or double, which results in platelets with beveled or lanceolate edges, at times even "mucronated"* (photos 14 - 16, 19). Regressions similar to those earlier described for Si crystals [20] have been also observed (phot.17);

b) shelves and fractures, which may be regulated, angular or spherical (photos 18, 21);

c) Corrosions affect the groups of platelets which remain anellate (ph.20). Comparison may be established between these shapes and those of striated iron-nickel particles found by Parker and Hunter [21] in snows of the Antarctica.

The groupings of platelets may show a perfectly circular contour (ph.15) elliptical (photos 16, 18) or irregularly-angular (photo 19, above and left).

Two phenomena still deserve to be mentioned here:

1) platelets must have dissociated themselves at a very early stage, for groupings in an accordeon shape, penetrated by amorphous matrix are found (photo 22).

"*) N.B. No proper term could be found for "mucronés" in dictionaries and glossaries at this writer's disposal.

2) There exist populations of groups of plates cemented by glass and offering the shape of micro-chondrules (photo 23). These peculiarities seem, in our opinion, to prove the very precocious character of plate formation; if their observation in isolated state is due to a preparation artefact, their fissility constitutes the fundamental property of this magnetite facies.

C O N C L U S I O N S

Asymmetrical facies of magnetite, mainly that of plates (or slabs), have been observed in three type-I meteorites. They have been theoretically foreseen by Donn and Sears [4] for cosmic particles in general. Traces of spirals have not yet been quite definitely revealed, though some accessory singularities are actually present. This confirmation of theory cannot, however, be fully accepted, unless one attributes a common origin to cosmic dust and type-I carbonaceous meteorites (or at least to their magnetite in slabs).

The observation of corrosion phenomena on particles included in meteorites confirms the possibility of extra-terrestrial corrosions of micrometeorites observed on another occasion [23].

Elliptical groupings in slabs such as have just been described, could account for the elliptical impacts observed by means of space probes [18].

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*** T H E E N D ***

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References follow.

REFERENCES

[1] H.B.Wiik, Geochim. Cosmochim. Acta 9 (1956) 279.
[2] A.E. Ringwood, in: Researches on Meteorites (New York, 1962) p. 198.
[3] B. Mason, J. Geophys. Res. 65 (1960) 2965.
[4] B. Donn and G.W. Sears, Science 140 (1963) 1208.
[5] N. Cabrera and R.V. Coleman, in: The Art and Science of Growing Crystals (New York, 1963) p. 3.
[6] K. Boström and K.Fredriksson, Smiths. Misc. Coll. 151 (1966) 1.
[7] E.R. DuFresnes and E. Anders, Geochim. Cosmochim. Acta 26 (1962) 1085.
[8] J. Orcel and B. Alpern, Compt. Rend. 262 (1966) 1393.
[9] P. Ramdohr, J. Geophys. Res. 68 (1963) 2011.
[10] H.C. Urey, The Planets (New Haven, 1952).
[11] K.P. Florenskii, Geokhim. (1963) 301.
[12] P.M. Millman, Smithsonian Contr. Astrophys. No. 7 (1963) 119.
[13] R.A. Schmidt, NASA Techn. Note TND-2719 (1965) 132 pp.
[14] F.W. Wright and P.W. Hodge, J. Geophys. Res. 68 (1963) 5575.
[15] J. Jedwab, Compt. Rend. 261 (1965) 2923.
[16] D.C. Reynolds, in: The Art and Science of Growing Crystals (New York, 1963) p. 62.
[17] J.F. Wedder, Space Sci. Rev. 6 (1966) 365.
[18] C.L. Hemenway, R.K. Soberman, E.F. Fullam, J.J. Balsamo, J.Cole, D.Hallgren, P. Yedinak, A. Goodman and G. Hoff, Smithsonian Contr. Astrophys. 7 (1963) 93.
[19] W. Dekeyser and S. Amelinckx, Les dislocations et la croissance des cristaux (Paris, 1955).
[20] W.C. Dash, J. Appl. Phys. 30 (1959) 459.
[21] D.W. Parkin and W. Hunter, Advan. Astr. Astrophys. 1 (1962) 105.
[22] B. Donn, Ann. N.Y. Acad. Sci. 119 (1964) 5.
[23] R.A. Schmidt, R.V. Venkataraman, M.L. Jackson and G.P. Woollard, Science 142 (1963) 581.